SHAPING THE HUNTER

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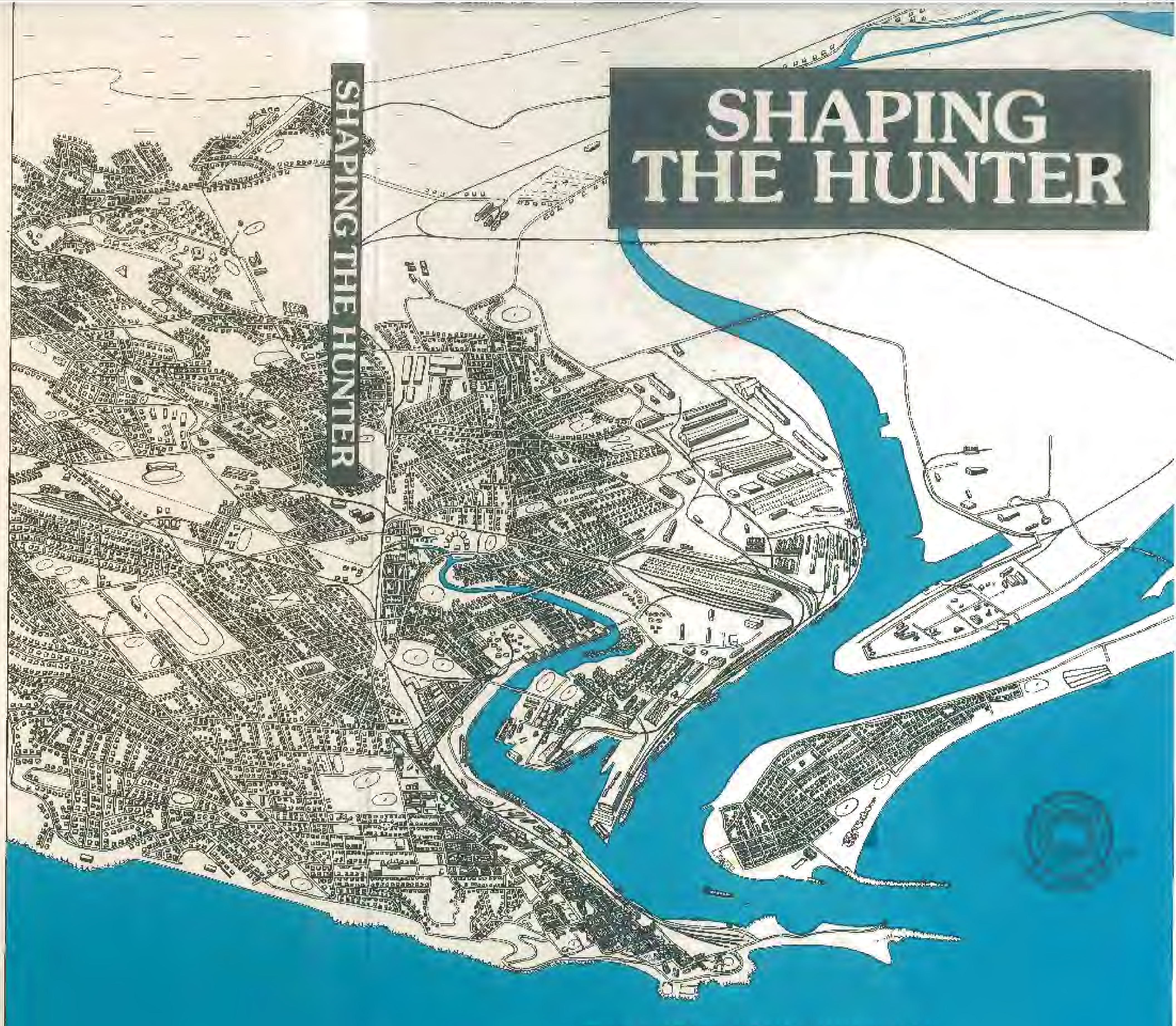


THE ENGINEERING HERITAGE
Produced by NEWCASTLE DIVISION

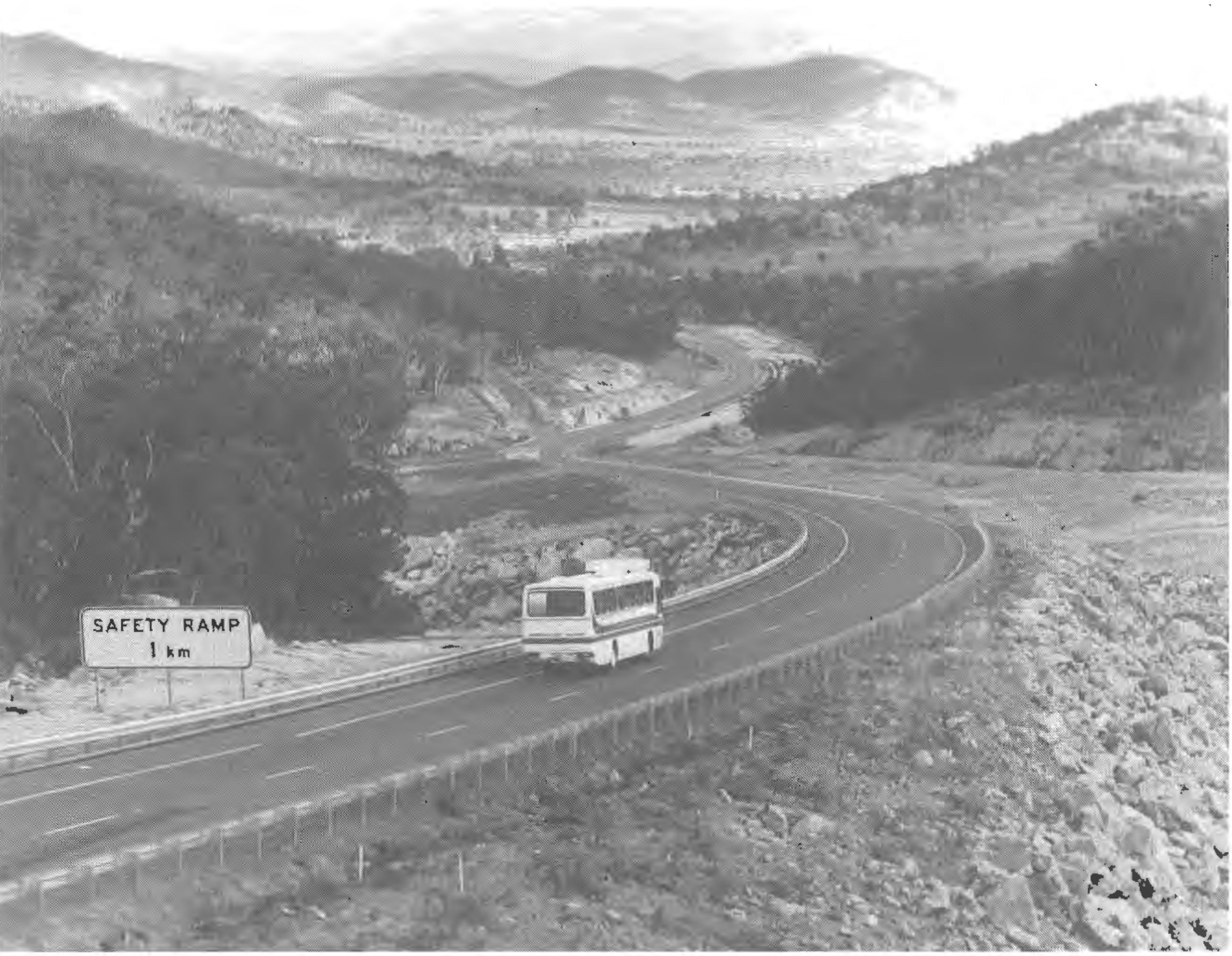
SHAPING THE HUNTER

A story of engineers,
and the engineering contribution
to the development of the
present shape
of the Hunter Region,
its river, cities,
industries and
transport arteries.

Edited by JOHN ARMSTRONG

Newcastle Division of the
Institution of Engineers,
Australia.

Convenor of the Heritage
Committee - Ian McC Stewart



North out of the Hunter.

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FOREWORD

This is a story of patience in establishing roads and taming a river and the sea, initiative, ingenuity and skill in building machines which could not be bought or imported, teamwork in establishing a new great industry, steady unsung service to the community and more. We believe that it will interest people of the Hunter Valley, engineers generally and students of industrial and local history.

Interest in the topic was first aroused in 1981. Mr. Astley Pulver, retired Engineer Surveyor and the oldest member of the Newcastle Division of the Institution of Engineers, Australia, challenged the Division to write the history of engineering enterprise in the Hunter Region. It was suggested that such a work would be a worthwhile follow-up to the Hunter Manning Group of the Institution of Surveyors' publication, *Surveying the Hunter,* which appeared in 1980.

The idea was eagerly supported by Emeritus Professor Ian McC. Stewart, Convenor of the Heritage Sub-committee of the Newcastle Division of the Institution of Engineers, and by Brian Johnston, then Division Chairman. Professor Stewart and members of his sub-committee set about collecting information. They enlisted men with first-hand knowledge of their respective undertakings to research and write the chapters. These authors are listed on the opposite page. The division is deeply grateful to them for their contributions which have resulted in an authoritative work.

We also offer most sincere thanks to:

- John Armstrong, for his professional editing which has brought the contributions together in a balanced presentation of reasonable length and consistent style,
- Ken Cousins, a Newcastle commercial artist, for his skilful layout of illustrations and careful re-touching,
- A large number of engineers, and others, for having contributed useful information and discussion (their assistance is acknowledged at the end of the chapters),
- Amor Futter, Linda Aurelius and Dianne Oughton for their patient typing of many drafts, and
- Newcastle City Public Library, the Auchmuty Library and the Department of Geography at the University of Newcatle, Newcastle Region Maritime Museum and other libraries for having kindly lent illustrations and given permission for them to be reproduced.

A large number of individuals and members of many remarkable families contributed to the shaping of the Hunter Region. The work of these pioneers has been described in some detail. However, in this century, with the tremendous development of engineering science and the establishment of larger enterprises, engineering has become a task for large teams of professionals. Credit for achievement should go to the team as a whole. In listing those senior men who have led engineering groups we believe that our authors have brought out this team concept. We have not been able to cover enterprises which commenced after World War II.

Of course, it is impossible when preparing a book for a general readership to give a comprehensive account. *All* activities and *all* those who made noteworthy contributions cannot be included. We gladly accept the fact that a great deal of additional research is required if the *full* story of the engineering contribution to the Hunter Region is to be told. In compiling the material, authors found that most organisations had great gaps in their records of engineering achievement and of past engineers and managers.

On the other hand, a great deal of interesting material was compiled for which space was not available. We hope that this publication will stimulate others to produce more detailed engineering histories of their own undertakings and maintain continuous records of engineering innovation and achievement.

Neil Robbie,
Chairman, Newcastle Division of the
Institution of Engineers Australia,
Ian Stewart, Project Convenor.

Harbour Mouth deepening, 1982. Drill rigs were built in Newcastle by Eglo.

OVERTURE

In the year 1770 Captain James Cook R.N. sailing in the "Endeavour" north from Botany Bay noted a "clump of an island". It was not until 1797 that Lieutenant John Shortland, on a voyage seeking escaped convicts, discovered a large river estuary behind that island. He named it Hunter's River and reported the thick coal seams in the cliffs and the tall timber on the main flats.

An attempt to establish a prison colony failed in 1801 but in 1804 Lieutenant Menzies established a penal settlement for recalcitrant convicts in the little valley up which Watt Street runs. Fish were plentiful in the river; the grassy Shepherds Hill above the settlement provided grazing. Game for the officers' tables was plentiful around the wooded creeks a mile to the west. The aborigines kept away from the settlement's guns.

Convict discipline was harsh. Work groups moved up the river by boat to fell "Coal River Pine" ("Ash") and the red cedar which towered above the thick rainforest filling the flood plain to well above Maitland. The timber was rafted downstream. Some coal was mined in a primitive way. The dreaded task was the burning and loading of lime which originated in the beds of shell and coral sand on the northern bank of the river.

By 1813 some well-behaved convicts and free settlers had been permitted to establish farms at Wallis Plains, south of the Maitland flood channels, and at Patersons Plains to the north. A store-ship *St. Michael,* at the head of navigation on the Hunter served these settlers. This was the beginnings of the Port of Morpeth. Paterson and Clarencetown later developed as villages at the head of navigation on the tributaries.

By 1820 John Howe had blazed a trail from Windsor through mountainous country to find fine grazing land, Patrick Plains (now the Singleton District). Exploration rapidly opened South east to Wallis Plains and north over the Liverpool Range into the rich Liverpool Plains. By 1821 the valley was open to settlement. New settlers streamed in from the river landing at Morpeth. Lieutenant Close, on appointment as "Engineer and Supervisor of Public Works at the Settlement of Newcastle" acquired a grant of 2000 acres, including the whole Morpeth river-front.

However the main village, Maitland, developed along the river bank beside a ford, a few miles to the west. Surveyor G.B. White drew up a town plan in 1829, mindful of explorer Oxley's warning that the river had a propensity to flood severely. He planned the town above flood level at Green Hills — to become East Maitland. However, West Maitland continued to grow more rapidly than its well laid-out counterpart. It became the service and industrial centre for the upper valley. There Muswellbrook, Aberdeen and Murrurundi grew up at river crossings on the route to the Liverpool Plains. Merton, the manorial homestead of the Ogilvie family, became the town of Scone.

In the meantime, the Australian Agricultural Company acquired a land grant of one million acres to the west and north of Port Stephens for the purpose of growing fine wool. Settlement commenced in 1826. The headquarters village was named Stroud. The land proved to be unsuitable for sheep. The venture languished until Sir Edward Parry became Governor of the Company in 1829. Parry took over coalmining at Newcastle from the Government, in return for a land grant, which hemmed in the village of Newcastle, and a monopoly in coal mining.

The opening of the first A.A. pit in 1831 began to revive the dwindling village of Newcastle. Parry, with Henry Dangar's assistance, negotiated large new land grants on the Liverpool Plains. Sheep were on these properties by 1833, adding to the traffic from Morpeth and Maitland along the North Road.

The years between 1830 and 1840 were "boom" years in the Colony of New South Wales. Assisted sea passages and the availability of land to people who brought capital with them stimulated immigration. Pioneer engineering enterprises were set up to service the industries that were developing in rural areas and towns.

The 1840s, by contrast, was a period of severe recession, with the rural sector and industries in the Hunter Valley markedly affected.

In the 1850s, after labour shortages due to the gold rushes, a rapid increase in population and activity began in Newcastle. The A.A. monopoly on coal mining was broken and new mines were opened. The first parliamentary elections were held; local government was established. The opening of the Great Northern Railway from Newcastle to Maitland in 1857, together with the increasing size of ships, made Newcastle the general cargo port for the valley. With increasing coal trade also, government action became essential for port improvements, dredging and wharfage. These activities stimulated engineering manufacture and services in Newcastle. A telegraph line to Sydney in 1860 assisted business activities.

Newcastle became a hustling, dusty, smoky, cramped-up unattractive town. Maitland continued to develop as the prosperous, pleasant, rural, commercial and industrial centre, with a direct overnight steamship service from Morpeth to Sydney.

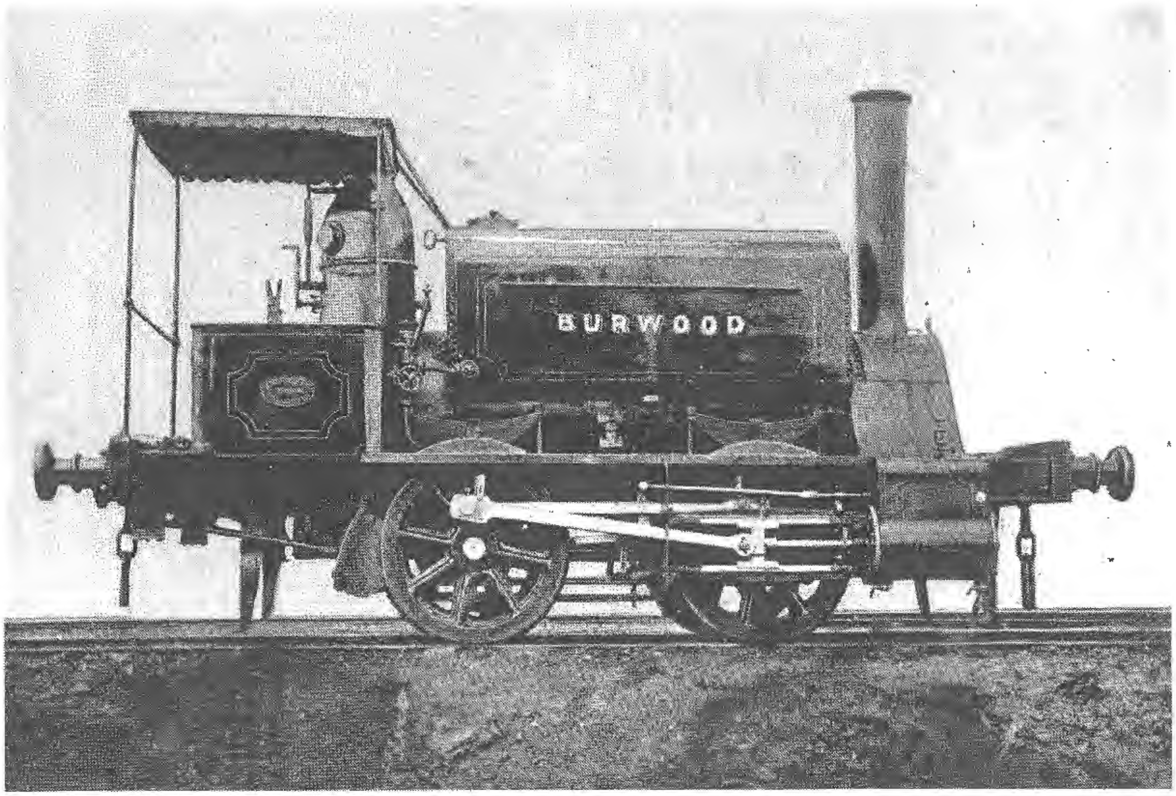
The completion of the rail link to Sydney in 1889 brought a temporary depression to Newcastle. The ports of Newcastle and Morpeth lost business to the railways and many engineering firms could not meet the increased competition from Sydney. The financial depression of 1893 compounded these problems.

The opening up of the thick, high quality coal seams of the South Maitland field at the beginning of the new century had some of the characteristics of a gold rush. The towns of Kurri Kurri and Cessnock grew rapidly and engineering operations in Newcastle were stimulated.

By 1915 the opening of The Broken Hill Proprietary Ltd. Steel Works and the decline of the Newcastle coal mines had brought great changes. No longer a mining town, Newcastle grew rapidly as an industrial and commercial city and exerted a growing demand for engineering services.

Maitland has continued to grow as a dormitory satellite of Newcastle, but development is turning towards Lake Macquarie and the Upper Hunter with the discovery of a magnitude of coal deposits and the construction of coalfield power stations in these areas. Muswellbook and Singleton and the Lake Macquarie towns, made new bursts of growth.

In the pages ahead, we present the story of the contributions that engineers have made to the shaping of the Hunter Valley.



The Burwood, the first colliery locomotive to be built in Australia — by Rodgers Brothers. *RO*


THE HUNTER REGION
TAMARANG
NUNDLE
WALCHA
COOLAH
GREATER TAREE
MUDGEE
RYLSTONE
COLO
GOSFORD
WYONG
MURRURUNDI
MERRIWA
SCONE
GLOUCESTER
DUNGOG
GREAT LAKES
MUSWELLBROOK
SINGLETON
MAITLAND
PORT STEPHENS
NEWCASTLE
GREATER CESSNOCK
LAKE MACQUARIE
Murrurundi
Scone
Merriwa
Muswellbrook
Denman
Singleton
Gloucester
Dungog
Forster
Maitland
Raymond Terrace
Cessnock
Newcastle
Boolaroo
Hunter R.
Manning River
Paterson River
Williams River
Karuah
North River
MacDonald River
Wollombi Brook
Myall R.
NEW ENGLAND
MAIN NORTHERN
COAST RLWY
PACIFIC HWY
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SOUTH PACIFIC
OCEAN
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DEPT OF ENVIRONMENT AND PLANNING NEWCASTLE

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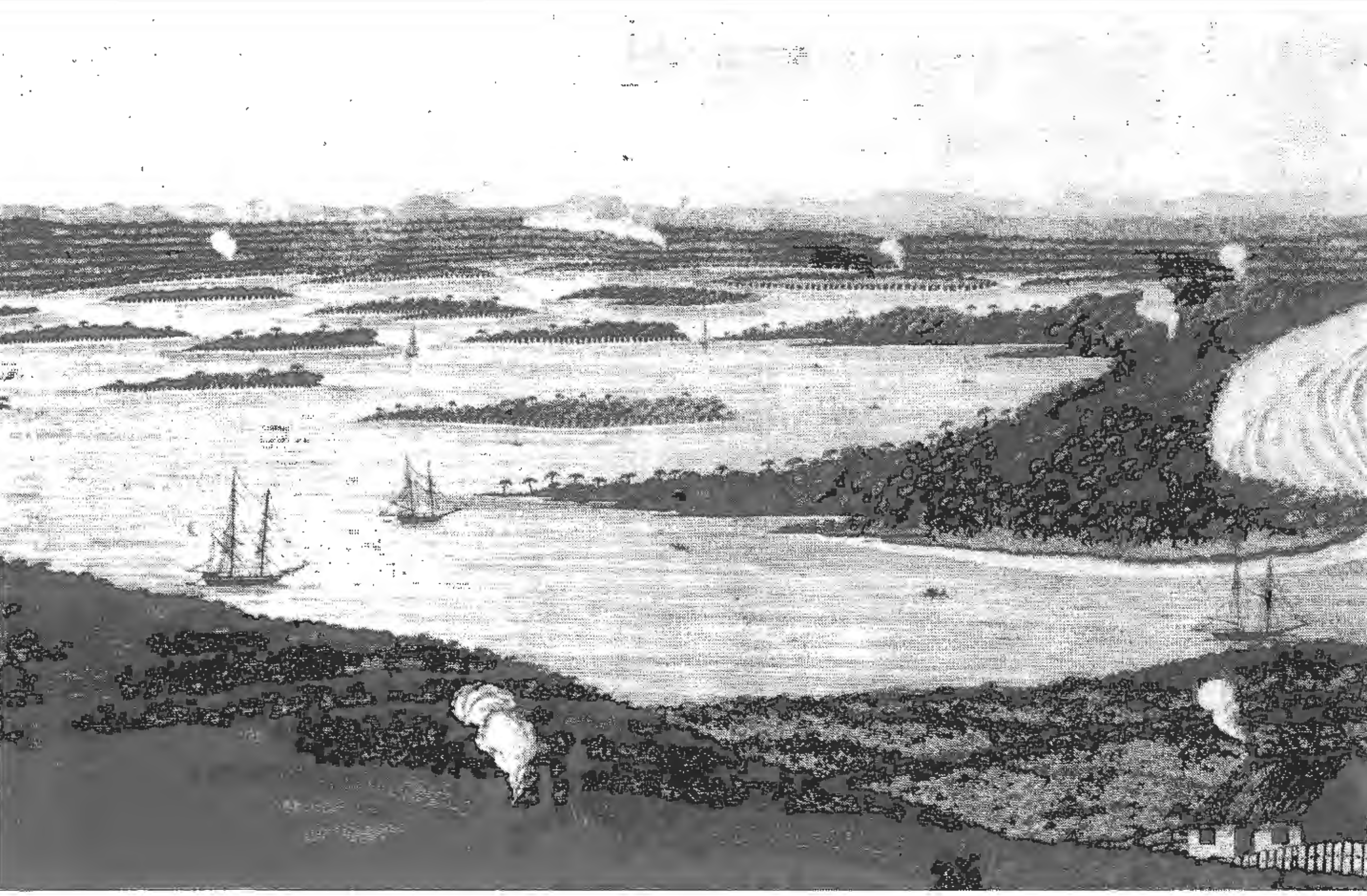
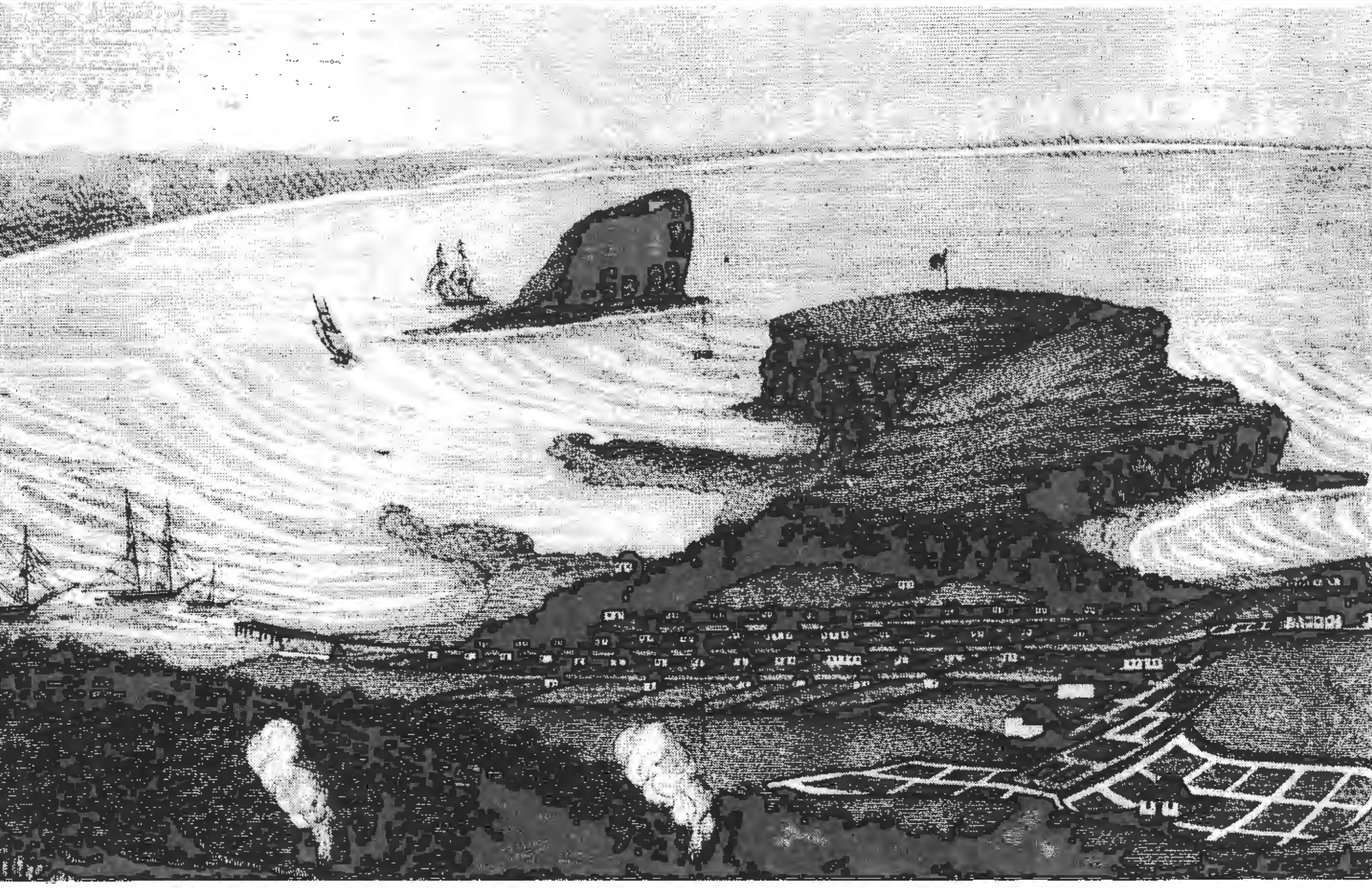


Hunter's River near Newcastle, and Newcastle with distant view of Point Stephen. Published by A. West, of Sydney, in 1812. Drawn by I.R. Brown. Engraved by W. Presston. NRG



TAMING THE RIVER AND THE SEA
The Port Of Newcastle
by Ian Stewart

Gateway to the Hunter

Newcastle's main legacy from engineers is the shape of the city itself, in particular the Port and the Lower Hunter River.

When Lieut. John Shortland found a deep channel behind Cook's "clump of an island" (The Nob, Nobbys) in 1797, he entered a broad river estuary, for some miles upstream, about twice as wide as the present lower river. The estuary was dotted with small islands and tidal mud-flats. The narrow peninsula, Pirate Point, that bounded it on the East, covered with thick scrub, was about half the width of the present Stockton. Nobbys was a magnificent crag — twice its present height, with sheer cliffs on the southern side (now a gentle ramp). North-west of it, the main channel, some 14 feet deep, was bounded steeply by the treacherous sands of the Oyster Bank. To the south, shallower channels separated Nobbys from the broad Beacon Hill (now called Fort Scratchley) with sheer cliffs to the river bank. A high sandhill, thickly vegetated, separated Beacon Hill from the treeless Shepherd's Hill. The shore of the mudflats and lagoons wandered west to the fertile Honeysuckle Point. The sandhills are now the flat, residential area of Newcastle East; the mudflats and lagoons are now the adjacent railway yards and the main railway station. A smooth line of walls and wharves have been placed beyond the old shoreline and through where Honeysuckle Point was. Further upstream, a mosaic of mudflats and channels has been re-arranged to form Wickham Basin, The Basin, the Steel Works Channel, the industrial area of Carrington and the Dyke, the Steel Works site and Kooragang Industrial Estate. The original set of shallow, winding, shifting channels, has been turned into a deepwater port. This dramatic change was achieved through more than one hundred years of engineering, studying, planning, building and dredging.

The first changes were slow. Ships sent boat-crews in to pick up coal from the shore on Nobbys; the Caledonian Coal Company claimed that the first export was in the barque *Hunter* to India in 1799. Paterson and Grant explored up the river in 1801. Lieut. Menzies, with soldiers and convicts, made a settlement in 1804 in a "pleasant little valley" just upstream of the sandhills (where Watt and Bolton Streets now are). Newcastle had begun. Nobbys was used to confine recalcitrant prisoners. A little wharf was built at the foot of Watt Street. An adjacent lagoon provided a harbour for small boats which conveyed convicts upstream to fell timber, or to the lime pits, where shells were burned to produce lime. These were sited a few miles up-river on the Stockton shore. For many years the jetty and the "harbour" sufficed for harbour works.

Governor Macquarie's brig *Lady Nelson* attempted to enter the "Coal River" in 1812 but failed because of adverse tidal currents. When sandbanks began to build up around the wreck of the brig *Nautilus* in 1816, Captain Wallis, who was in charge of the convict settlement was probably the first to imagine a "strong Rampart of Massy Stone Work" placed between "Nobby Island" and the mainland to restrict the tidal flow to the main channel. Francis Greenway also claimed credit for the idea. Whoever it was recognised the engineering principle that a river can be trained to scour its own channel.

The construction of the breakwater was commenced with convict labour and Macquarie laid a foundation stone in 1818. Stone was quarried from the riverside face of Beacon Hill. The breakwater was often washed away and when work ceased in 1822 it was not one-third of the way to the island. The settlement for troublesome convicts was then moved to Port Macquarie and further funds for the project could not be found until 10 years later.

The navigational aids (apart from Nobbys) were a signal flagstaff and a coal fire on Beacon Hill, where "a neat sort of pagoda house for signalman and stoker" was built. A large brick windmill, with Dutch-type sails, on Shepherd's Hill, above the church, was a valued sailing mark.

With the opening of the district to free settlement in 1823, the 20 or more farms at Paterson's Plains and Wallis' Plains (later Maitland), Green Hills (later Morpeth) and Hexham had ship connection to Sydney. The settlements grew after John Howe found a route from Sydney to the grassy Patrick Plains (Singleton) and to Wallis' Plains. It was claimed in 1825 that 200 tons of agricultural produce was shipped to Sydney per week from the river ports, compared with 50 tons of coal from the government mine at the top of Watt Street.

Mills and forges were built in Maitland, which expanded rapidly, as did Morpeth, which became the main river port. In 1831 the paddle steamer *Sophia Jane*, of about 250 tons, commenced a regular run to Morpeth. Wharves and warehouses were built on the river bank. The masonry work from a stone quay can still be seen. Paterson and Clarencetown also became shipping ports as did Hexham and Raymond Terrace.

The river shipping trade continued through until 1931 (remains of timber wharves can still be seen at Paterson). Perhaps the best reminder of the trade is on the Paterson River at Hinton — a steel road bridge built in 1904 with a lift span to permit the passage of tall ships.

By contrast to Maitland, Newcastle was a small settlement of about 300 people. However, the town's population started to grow in 1830, when the A.A. Co., for the consideration of a monopoly in the coal trade, and 2,000 acres of land, hedging in the town to the South and West, began to operate a mine near the top of what is now Brown Street. Coal production was 5,000 tons p.a. in 1830 and rose to 30,000 tons in 1840. A "high level chute" was built on a pier over the water at the foot of the hill. Coal skips ran direct from the pithead to the pier by gravity, hauling up the empties. The coal was tipped direct into small vessels.

With the arrival of larger ships, more trade and continuing wrecks, the Government was persuaded in 1832 to re-commence work on Newcastle breakwater, but the breakwater did not effectively grow. In 1836, Colonel G. Barney, R.E., noted that some types of rock disintegrated fairly rapidly. He recommended a better selection of material and quarrying from the top of Nobbys to build inward from that end. Although it was reported in 1846 that the wall was joined to Nobbys, frequent wash-outs occurred — so drastic that ships could apparently take short-cuts through the gap (one writer claims as late as 1864). So much of Beacon Hill was quarried away that the flat area was left on which Zarra Street Power Station was later built.

Overseas ships for wool and wheat as well as coal arrived in ballast in sufficient numbers to warrant the provision of better port facilities. Captain Merion Moriarty, the new Port-Master for New South Wales, made a visit in 1843 and arranged for a ballast wharf to be built.

The Circular Wharf, a small stone quay in European style, was built around the end of a sand pit just east of the Watt St. Wharf. Masonry blocks shaped in Sydney were shipped up and placed by a convict gang under Major Macpherson (free labour was unobtainable). The masonry would apparently not stand up to boat movement caused by the "range" of heavy swells which frequently moved up harbour; heavy timbers

E.O. Moriarty.

were later placed to support it. Ballast unloaded here was formed into a wall extending towards the Watt St. Wharf, partly enclosing the large lagoon used as a harbour for small boats.

Mudbanks had built up to such an extent in the Hunter River near Fullerton Cove that the steamers to Morpeth were occasionally grounded. Surveyor G.B. White, who laid out East Maitland 20 years before, was instructed to survey the river. A "dredging machine" was sent from Sydney in 1845. In the same year a regular ferry service to Stockton was started. Stockton had become a sizeable township, with an iron-foundry, woollen mills and other industries. The establishment of a Bishopric of the Church of England in 1847 changed Newcastle into a City — with still less than 1,500 inhabitants. The A.A. Co.'s monopoly ceased in the same year and new mines were opened at Burwood, Wallsend and Minmi. Coal exports rose to more than 170,000 tons in 1850.

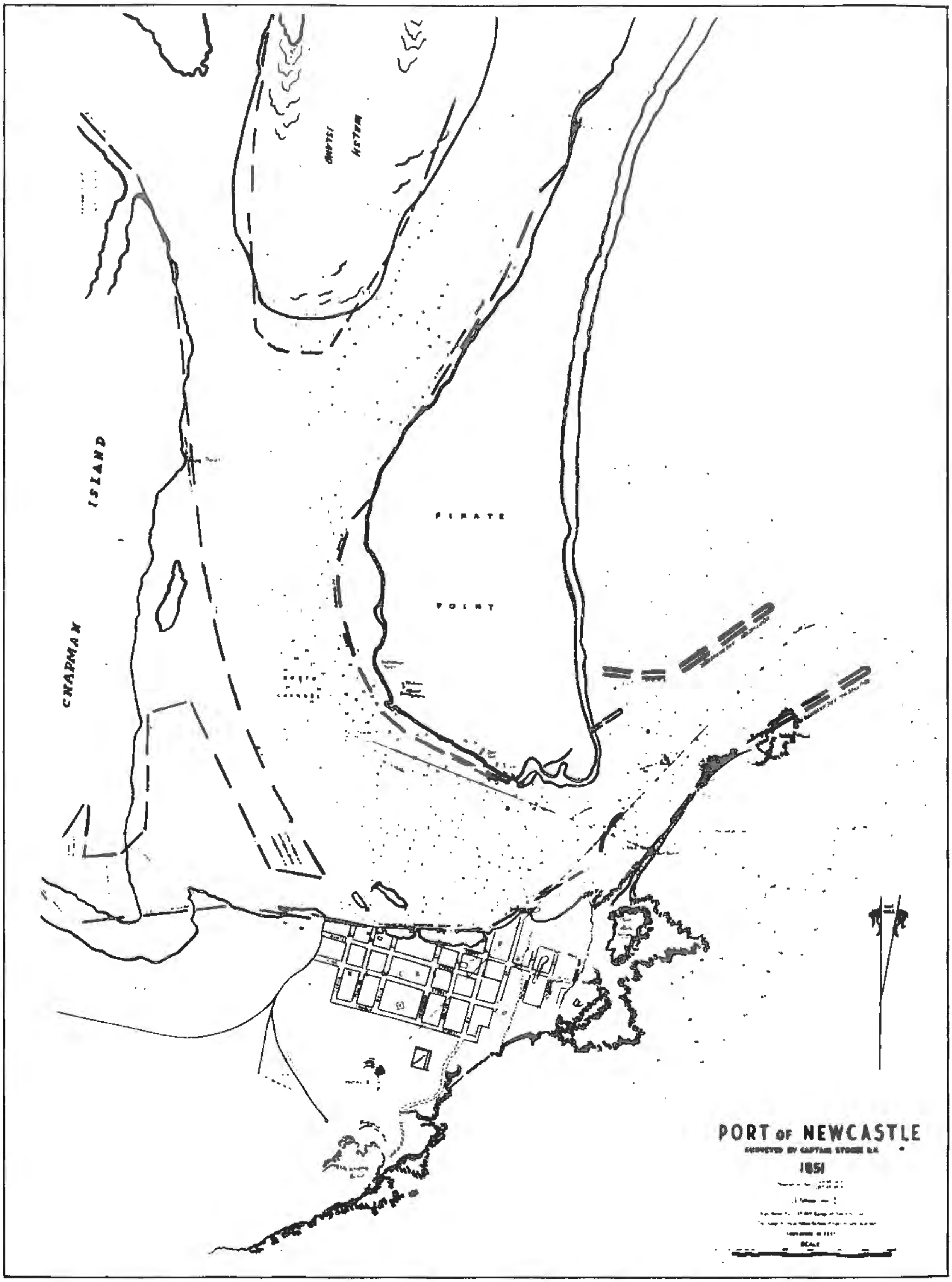
Around 1850 the Hunter Valley coal and shipping interests were seething, both at government inaction in response to demands and Sydney interference in port affairs. This frustrated fury continues at regular intervals through the life of the port to this day.

The first protest was at the sudden demolition in 1847 of the windmill on Shepherd's Hill, then used as a sailing mark for the Harbour entrance leads. A masonry obelisk was erected in 1850 on the same spot. It was not long used as a harbour sailing mark; with improvement to the entrance a new leading light was built at the top of Brown Street in 1866 as a round masonry tower which was used until 1918 and is still standing. The obelisk still has its use as a rear-marker for one of the "measured mile" bearings for ship trials off the port.

Then came the stir over the "plot to blow-up our Nobbys". For some time ships' masters had complained that, on entering the harbour with wind between South and East, their sails lost wind as they passed behind Nobbys close to the hazardous Oyster Bank. Lieut. John Lort Stokes, R.N., on his survey in 1851 on the paddle-sloop *HMS Acheron* reported this and recommended that the height of Nobbys be reduced. Colonel Barney, who by this time had built Victoria Barracks and Circular Quay in Sydney proposed that the most economical way to do this would be to topple it across the breakwater by carefully placed explosives. However, the rumour spread that explosives were already placed at the water-line "to blow up our Nobbys". John Bingle, a retired naval officer, who was to bring the first steam tug to Newcastle in 1859, argued that there was no need to cut down Nobbys, vessels should lay-off until the weather was right and then be brought in slowly and safely by kedging. After an exciting public meeting, he led a deputation to Sydney. Apparently no explosives were used. By continued quarrying from the top and carting down a ramp to the breakwater, the height was reduced from the reported 203 ft. to the present 92 ft. by about 1855. It was levelled off and the lighthouse was built and in operation by 1858. The harbour master, Captain David Allan, moved the signal station there immediately.

The most serious concerns were the water depth within the harbour and the wharfage. The Macquarie breakwater had apparently stabilised an entrance channel at 20 ft. depth, but the mudbanks in the harbour were such that it is hard to imagine how coal trade was carried on. There was apparently a shallow channel to the old wharf at the foot of Watt Street and to the "Circular Wharf" further downstream, sheltered from the swell by the rocky spit. However, small channels at the coal shoots were separated from the "coal channel" by mudbanks. To ships of any size, coal had to be transported by small lighters. Continuous representation was made to Sydney.

The first parliamentary elections in Newcastle for the new Legislative Assembly were due in 1856. Perhaps this had some influence on the decision to direct experienced river and harbour engineers to produce a development plan for the



The port 1851 and 1950, a composite. *PWD*

The base-plan (full lines) is from Lieut. Stokes' map of 1851. Heavier lines show the highwater shoreline. Broken lines show the 1950 shoreline. By 1982 Throsby Basin, to the west, was completed.

Harbour. By 1854 a development plan had been produced by Mr. J. Woolston Ellis, Civil Engineer. This plan, with training walls for the river to Fullerton Cove, including the Dyke Wall with a shipping basin behind it and other features, was apparently the basis of the final plan. Action followed with the appointment of Edward Orpen Moriarty (1825-1896), C.E., in 1855 as Engineer-Surveyor responsible for Hunter River improvements. The son of Merion Moriarty, Edward appears to have had great energy, organisational ability and self-confidence coupled to innate engineering ability. He had commenced engineering training as a cadet on the construction of a breakwater on the Isle of Portland in Britain, but left with his family for Australia in 1843 at the age of 18 and set up as consulting engineer and surveyor in Sydney. In 1849 he became an assistant in the Surveyor-General's Department, in 1853 Engineer-Surveyor (later chairman) of the Steam Navigation Board, 1855 Engineer for Hunter River improvements, 1858 Engineer-in-Chief for Harbours and River Navigation of the Department of Works. He later served terms as Commissioner and Chief-Engineer for Works, Supervisor of water-supply for various country towns and Commissioner for Water-Supply for Sydney. He was an officer in the Volunteer Defence Corps, member of the Philosophical Society, Linnaen Society and the Royal Sydney Yacht Club, took private pupils and did some private consulting work including investigation of the Grey River entrance in New Zealand. His major task in Newcastle from 1855 to 1858 was observation of the river and development of the "Moriarty plan" to control the sea entrance by extended breakwaters and the river channels by stone training walls. This plan, followed over the next 50 years, produced the shape of the port as we see it today.

Moriarty also organised design and construction of the substantial ladder dredge *Hunter;* (machinery at P.N. Russel's works in Sydney and hull by Captain Rowntree at Waterview Bay near Morts Dock). This was in operation in the river in 1859 — a speed of operation which would be excellent today. He also organised design and construction of a steam crane for general cargo which was in operation on Queens Wharf by 1861. Moriarty returned to Sydney on 10, October 1858. On his departure Thomas Francis was appointed Engineer of the dredge *Hunter* at a salary higher than that of the Master. He was the Senior Officer, responsible for carrying out the dredging to Moriarty's master plan and can be reckoned as the first Resident Engineer, Harbours and River Navigation, in Newcastle. His residence is shown as on board the dredge!

Wharf construction had commenced in the 1850s under a Mr. Davison of the Colonial Architect's department. Stone quays were abandoned; Circular Wharf was demolished and Queens Wharf was built on timber piles, copper sheathed for teredo protection, along the line of the ballast wall from Circular Wharf. They carried a hardwood deck. The design was far-sighted enough to permit future dredging to nearly twenty feet along the length. By 1860 500 feet had been completed. The railway to Maitland was opened in March, 1857, with the terminus at Honeysuckle (the present Civic). This was half-a-mile distant from the city and nearly a mile from the only general cargo wharf - Queens Wharf; in the original railway plan this had been considered the practical limit of access. Rail tracks, at various levels, to the staiths (shoots) of the A.A. Co. and Newcastle Coal and Copper Co. crossed the route, and further along, lagoons and mudflats and the boat harbour. Protests against the location started with the beginning of construction in 1854; Frank Whitton, the forthright Chief Engineer for Railways insisted that there was no point in running the line unless it continued to the wharf. Railway crossings and links were negotiated, and the site of Newcastle Station was filled with sand from the sandhills, then continually encroaching on the town at what is now Pacific Street. By 1858 the railway was through to the present Newcastle Station and along to Queens Wharf. In this way the present shoreline from the pilot station to Merewether Street was established. The strong influence of the Department of Railways on the development and operation of the port had begun. The congestion between railway, road and wharf was to become a problem in the 1950s.

Developing To A Plan

In 1861 work started on Moriarty's daring proposal to widen the entrance channel northwards "in accordance with the principles laid down by Smeaton and the other great harbour builders of Great Britain." Up to this point the safest channel had been that between the Southern Breakwater and Beacon Rock or Lighthouse Rock, which was a submerged reef. Water was deeper north of the reef, but there was a great risk of being driven ashore on the sandspit (Pirate Point) or sandshoals, near Stockton Beach and the Oyster Bank.

The plan was to build an inner-breakwater starting some 500 feet inshore from the tip of

Life Boat Harbour. *Queen's Wharf with coal cranes.* *Sydney "Packet" Wharf.*

from The Sydney Illustrated News, 1875

Pirate Point, with an extension beyond Stockton Beach. With some initial dredging, the river should scour the channel to achieve the extra width, while the breakwater extension should stop sand from drifting in from Stockton Beach. A pier was built near the point, and ballast, chiefly Melbourne bluestone, was banked across the sand to form the inner wall and the rail-track base. The beach was reached in 1872, but the ballast was washed away as soon as it reached tide level. Consequently large rock from Waratah was required. Gantry cranes were erected at Port Waratah and Stockton and a punt was built to transport the large rocks across the river. By 1878 the wall had been stabilised beyond the high water mark and the sandy point was rapidly eroded. The further seaward extension of this inner breakwater was completed in 1886. Although wrecks continued on the Oyster Bank, the entrance channel was kept free of sand for a time.

Meanwhile, floods accompanied by a south-east gale breached the southern breakwater extensively in 1867 and shoaled the entrance to 14 feet. Bluestone ballast from Melbourne was dumped but washed away. Large stones were needed; a quarry was opened at Waratah. Massive sandstone blocks weighing up to 30 tons were produced. Despite the slowness of funding, Macquarie's breakwater was finally secure in 1872. Planning to extend the breakwater to the Big Ben Reef several hundred feet beyond Nobbys as Moriarty had proposed was then commenced. The object was to give entering ships protection from southerly and easterly seas as they passed the Oyster Bank. Again, the funding was irregular but the work was completed in 1883.

The sea and the wind continued their relentless attack. Moreover, the depth required for shipping steadily increased. By 1896, Stockton beach had built up appreciably and sand was moving round the northern breakwater into the entrance channel of the harbour. The end of the southern breakwater had collapsed. With reasonably large seas the "range" of movement of water in Newcastle harbour caused trouble for ships loading, as far up

Boat Harbour. *Coal staithes.* *A.A. Co.'s staithes.* *Honeysuckle Point.*

JA

as The Dyke. Large wave traps were required and the river needed to be trained to scour further the main channel. Government funding was approved for the implementation of the plan presented by Mr. C.W. Darley, M.Inst.C.E., Engineer-in-Chief for Public Works. On the northern side a new breakwater, 3,000 feet long, would be built out towards the Oyster Bank, curving shorewards north of the old wall to form a wave trap. This wall was built on top of 10 known wrecks and was almost complete when funding ceased in 1907. On the south an inner wall would be built from the river wall, below the end of Queen's Wharf, out to the Lighthouse Reef. This section had been forseen by Moriarty. The wall would both train river flow into the new main channel and provide a wave trap. The sand which built up behind this wall is Horseshoe Beach. The Southern breakwater extension deteriorated and repairs were slow with frequent washaways occurring. The minimum size of the stone was increased to eight tons and, when funding ceased in 1907, the proposed length had nearly been reached.

Satisfaction was short lived. By 1908, sand was again building up round the tip of the new northern breakwater.

During the 1880s, prickings taken in the entrance channel showed that a hard-rock bar existed below the sand at a depth of about 24 feet on the leading line sloping down to the north but extending for about half-a-mile along the channel. A Lobnitz rock-breaker and a punt for drilling and blasting were constructed. Major rock obstructions in the entrance channels were removed as weather permitted but most of the rock-breaking was done inside the harbour.

Work inside the harbour was more rewarding. Queen's Wharf was completed in the 1860s for a length of 1,500 feet — from near the Pilot Station to about Watt Street. The wharf was equipped with rail tracks and light steam cranes for coal loading. As this blocked access to the old boat harbour just down-stream of Watt Street, a new boat-harbour was built in a lagoon near Market Street in 1852. Masonry from the old quay made a neat finish on the banks. This remained in use until 1902 when the Railway required more width and the final small boat harbour was excavated a little further west. Later some 500 feet of wharf was built for the Newcastle and Hunter River Steamship Navigation Co. After the demise of Morpeth as a port, the company continued an over-night service to Sydney through until 1951.

The expanding coal trade increased the need for staithes, or shoots, for coal tipping. By 1865 there were five for the A.A. Co. and four for the Newcastle Coal and Copper Co. in the port. Upstream at Port Waratah, the Waratah Company had four and further upriver, at Hexham, J. and A. Brown had three.

The Dyke, almost half-way between Bullock Island and Stockton, began to grow as ballast was tipped from lighters.* Sand dredged from the harbour was pumped behind the long training wall and sufficient land was formed by 1875 to allow wharves for coal loading to be built. A roadbridge had been built between Newcastle West and Bullock Island and by 1878 a rail bridge at Cowper Street linked the main railway line to The Dyke. Four nine-ton hydraulic cranes lifted coal-hoppers at the wharves. The Department of Public Works installed these, together with an engine house and boiler plant to provide pressure water for them. The facade of the engine house, which was a very fine piece of industrial architecture, still stands near The Basin and is classified "A" by the Heritage Commission. Hydraulic cranes of 15 tons capacity each were installed at a later time and some remained in service until 1964, when the last crane at The Dyke was demolished. The circular brick foundation of the first No. 13 crane can still be seen between Tie-up Dolphins on The Dyke at the shipyard. An electricity generating plant, with three Westinghouse Engines driving Manchester Dynamos, was installed in 1889. Just a few days before electric lighting was switched on in Newcastle in 1890 The Dyke cranes were brilliantly lit by 5,000 c.p. arc lamps. All coal-loading in Newcastle harbour was transferred to

* Some ballast was eventually used for the walls behind Newcastle Beach. The contorted crystal pattern of Augen Gneiss from Brazil may be recognised in many of the rocks.

Queen's Wharf, 1870s. *NRL*

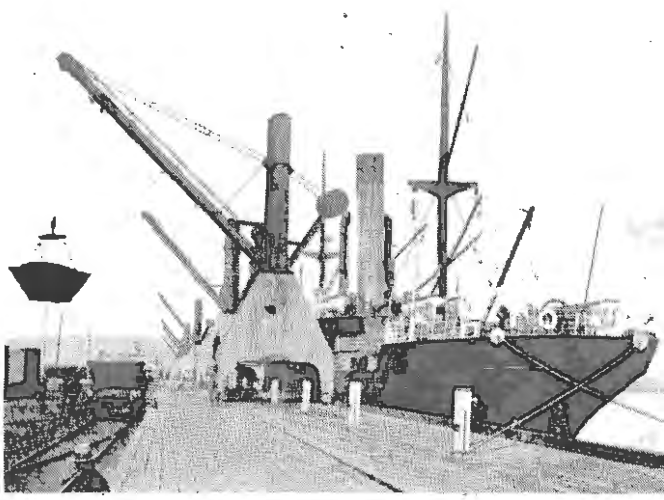
The Dyke by 1890, except for operations at the A.A.Co.'s staithes below Merewether Street, which remained in use until 1915.

Development of The Basin toward its present shape continued. Coal wharves, with rail track and hydraulic cranes, were built on the eastern side and the northern end. Tie-up dolphins were provided on the western side — the last side to be filled. All this development, along with the trend towards bigger ships, required extensive amounts of rock to be removed inside the harbour. Rock-bars from Honeysuckle Point to The Dyke and across the entrance to the inner Basin gave only 12 feet of water in places. The rock was broken to a depth of more than 20 feet. Sand and silt dredging also went on. An estimated three million tons dumped in the 1893 flood was cleaned up. River training work continued, with stone walls extending along the river side of Stockton and upstream of part of Walsh Island. The areas behind were reclaimed by dredging, as were the swamps adjacent to Throsby Creek.

1908, Another Dynamic Engineer

However, by 1908, the city was again angry about the lack of facilities in the port.

Early that year the Chamber of Commerce held an angry meeting with the New South Wales Premier, Mr. Wade. There were two major complaints. There was insufficient water in the entrance channel, so that 45 ships had left partly loaded in the previous year, and further, general cargo facilities were quite inadequate. As for the latter grievance, King's Wharf (previously the Queen's Wharf) had no cargo sheds, although it had been recently widened and the berth deepened. Further, Newcastle and Hunter River Steamship Co.'s wharf had very little depth of water. Although work had started on the construction of a new wharf west of Merewether Street, the city was still unhappy. The Premier quashed the argument by announcing a plan for new wharfage and a depth of 30 feet at the entrance to the harbour. More effective, however, was the appointment of Mr. Percy Allen, as Engineer for Public Works in Newcastle. The Chamber of Commerce noted that in Mr. Allen "we perceive we have a friend". Allen had been a member of the Hunter District Water Supply and Sewerage Board for the previous four years. Born in Sydney in 1861, he joined the Public Works Department as a cadet in 1878 and was trained by pupilage to meet the qualifications of the Institution of Civil Engineers. As Assistant Engineer for Roads and Bridges, he was responsible for the design of



Twelve-ton hydraulic movable cranes, eastern side of The Basin. *NRL*

Glebe and Pyrmont swing bridges in Sydney and, later, as Principal Assistant Engineer Water Conservation, for the design of Sydney's sewerage system. On his transfer to Newcastle in 1908 he became President of the Hunter District Water Supply and Sewerage Board.

Percy Allen's major task in Newcastle was the harbour. He immediately made a very detailed sounding survey which indicated that the remains of the *Regent Murray* (protruding inside the northern breakwater) were preventing the tidal scour of encroaching sand. Removal of the old wreck made changed dredging procedure possible. This increased the recognised navigable depth from 20 feet to 22½ feet within 12 months. Not content with the limited information obtainable from soundings, he sent divers down and ascertained that much of the supposed solid rock was a mass of independent boulders. By removing these by clamshell grabs, an extra foot of effective depth was obtained (to 23½ feet). The small area of solid rock which needed to be broken to secure 25 feet was also delineated. Percy Allen laid down the importance of the technique of "sweeping" with a bar, in addition to soundings, to establish clear depth.

His completion of the northern breakwater was a fine piece of engineering management. He devised a system of control to ensure that the largest stones were placed on the outside, that advance was continuous and as rapid as possible and that the end was finished in a stable manner. Every rock was numbered and recorded at the quarry and at all transfer points until tipped.

Fifteen-ton electric travelling cranes, Basin Wharf, west side, about 1915. *NRL*

Contours were recorded daily. The breakwater was completed within cost and time estimates and the rounded end has remained stable.

Lee Wharf was completed. New wharves were built on the western side of The Basin, with the novel use made of long, precast concrete slabs to retain the fill behind the wharf. Allen had 15-ton electric travelling cranes designed for this wharf. Such cranes installed from 1915 to 1918 were still a new development when designed. Two of these, modified for general cargo handling were in service at West Basin, until 1986.

Port Stephens had not been completely neglected. From early times timber had been shipped down the Myall River into the Port. Ships made connections with small settlements up the Myall and Karuah Rivers. In 1911, a new wharf was built at Nelson Bay (with 18 feet depth alongside) "for ocean-going steamers". At this time vested interests in Newcastle became disturbed because a Parliamentary Royal Commission determined that Port Stephens should become a major port, with new railway links. Country interests, gave their enthusiastic support. No development of this port was ever realised.

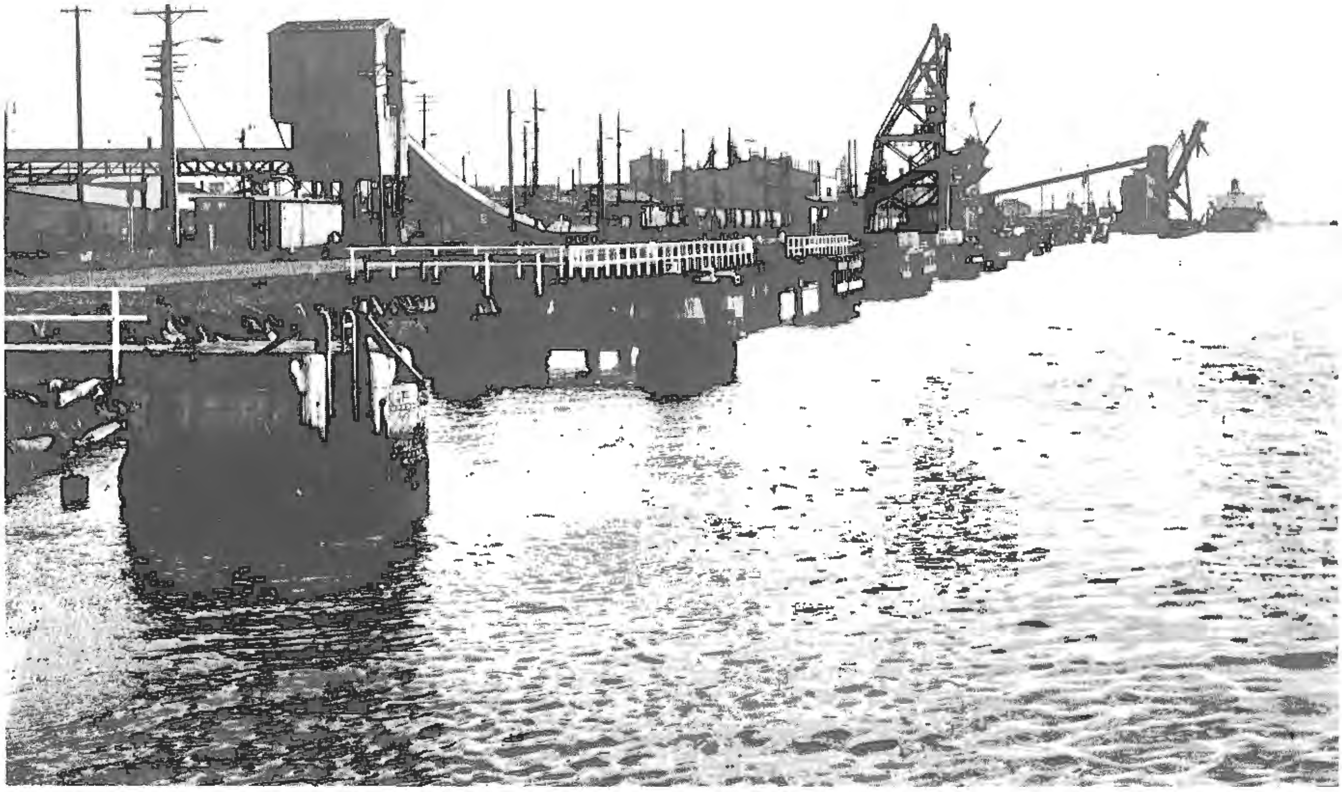
Development to 1940

As the northern breakwater was being extended, concern mounted about the increased "range" in the harbour. Percy Allen strongly supported the proposal for the southern breakwater to be extended to shield the northern breakwater. The expenditure of funds was authorised. To expedite the project, a gantry and new tipping wagons were built. This phase had not been commenced when Allen returned to Sydney in 1912 as Chief Engineer, Harbours and Rivers, for the Public Works Board. The work on the breakwater went ahead slowly and intermittently and was frequently washed away. Over a period of time, quarried stone was replaced by 40-ton, cast concrete blocks. By 1950 60-ton blocks were used for maintenance. Cast in a form on the wall above where the block was required, they were tipped when cured. The wall was stabilised at about its original length by the end of the 1950s. Only then, after additional wave traps had been built and some model studies carried out, was the proposed 400 foot extension abandoned.

Work went ahead on breaking the rock-bars, at the entrance when weather permitted, but mainly inside the harbour, between the Newcastle shore and The Basin and just beyond The Dyke. It was slow work; the 15-ton needle of the Lobnitz rock-breaker penetrated only a few centimetres at a blow. Drilling and blasting from floating punts was, apparently, no quicker. By 1950, the depth was only 25 feet six inches — far from the promised 30 feet.

Suction dredge Richard Vowell *dredging the approaches to Stockton Vehicular Ferry, 1960s.* *PWD*

Cutter Suction Dredge I pumping fill at Stockton for the new passenger ferry jetty, 1957. *PWD*



100 years of coal loading on The Dyke. The photo was taken in 1980 from a point off the State Dockyard. Foreground at left: Brick foundations for a nine-ton hydraulic crane (circa 1880). Behind it: Timber poles from a 15-ton hydraulic crane (c. 1911). Centre at right: Partly demolished tower for the first belt coal loader (c. 1958), capacity 300 t.p.h., built on the foundations of the McMyler Hoist, which operated 1908 to 1916. Centre at left: Transfer tower for the Basin Coal Loader (c. 1967), capacity 200 t.p.h. Background at right: Steelworks Channel loader (c. 1976), capacity three x 2500 t.p.h. EC

A continual dredging operation was the maintenance of the Steelworks Channel. The provision of 25 feet of water at the wharves and a swinging basin for ships was one of the conditions for the establishment of the steel works.

In 1931 a barrage was placed across the South Arm of the river near Hexham at low water level in the hope of reducing silt-laden flow. It had no observable effect. However, the constant dredging provided fill to reclaim the estuary islands.

For the shipyard urgently needed by this country in the First World War, Walsh Island was levelled by 1915. Wharfage and channels were provided for fitting out and the floating dock.

The western end of Newcastle Harbour assumed its present shape as a consequence of the development of Throsby Basin. The work transformed a shallow, winding creek into a large, deepwater basin by removing Honeysuckle Point and part of Bullock Island. The road bridge at the end of Denison Street was removed and rail access was moved to Port Waratah in 1908. Lee Wharf was extended, and in Wickham an inflammable liquids wharf was built. When a shipyard was required again (during the Second World War), the State Dockyard was accommodated at The Dyke and appropriate wharves were built. The floating dock was placed in Throsby Basin and Slipways were built. Wheat silos were built on the south-western corner of The Basin in 1936.

The Final Development — Post World War II

This was a period of difficulty and challenge for Harbour Engineers. Firstly, there was the very dramatic trend towards bigger ships. Further, the limited wharfage was so heavily occupied with the growing general cargo trade that access for repair was almost impossible. Cargo handling and ship sizes were revolutionised at a rate faster than the design and construction services could match. Finally, there was the series of floods, culminating in the great flood of 1955, which deposited an estimated 20 million tons of silt in the harbour.

Before the flood problems arose, a Newcastle Port Development Committee had been set up, comprising the Public Works Department, the Maritime Services Board, the Railways Department, Newcastle City Council and Northumberland County Council. A.R. Ford, B.E., M.I.C.E., M.I.E., Aust., who later became Principal Engineer for Harbours and Rivers of the P.W.D. detailed the recommendations in a paper in 1954:

Wharf construction, West Basin, about 1915 — the pioneer use of reinforced precast concrete slabs.
NRL

- The breakwaters to be extended.
- The harbour to be deepened in two stages from 25 feet six inches to 28 feet, then 32 feet, by rock removal inside the entrance channel and at the entrance to The Basin and other points.
- New wharves to be built for general cargo.
- Extensive training walls to be built in the main channel to beyond Fullerton Cove, and (most dramatic of all),
- The whole island area from Ash Island to Walsh Island, with their waterways and mudflats, to be transformed into 6,000 acres (about 2,500 hectares) of industrial land by pumping sand and silt from the river.
- New rail and road bridges to be built to the islands.

The wharf proposal illustrates the problems. Although a Lee Wharf extension and new wharfage in a new basin in Throsby Creek had been outlined in 1915 and continual demands had been submitted, State funds had never been provided. Continual general trade activities (excluding coal and steel) would have required this extent of wharfage if manual handling from ships' derricks (still universal in 1950) had been maintained. Use of fork-lift trucks was envisaged in the plan, which provided single-level concrete decks. The two-level construction of Lee Wharf is a reminder of the days of hand-trolleys; a wharf shed at rail truck or motor-truck level was a labour-saving innovation. The increased size of fork-lift trucks, with their increased wheel loads and the ability to stack pallets high on top of each other, created real problems at existing wharves and continual revision of the design codes for new ones. By the time Lee Wharf extensions were completed the quantity of loose general cargo shipped had dropped dramatically. Stern-loading, roll-on-roll-off ships of modest size began to look like an answer to motor transport for interstate trade. With much pressure from Newcastle interests, a dock was built in The Basin for this purpose by 1972. Alas, by this time interstate general cargo had been taken over by motor transport operations and overseas trade almost entirely involved large ships and containers or quarter ramp RORO. Forty-ton containers were not envisaged when the ingenious level-luffing cranes on the Lee Wharf extension were designed to be suitable for extracting 5-ton collections from general cargo holds.

For the want of a local port authority responsible for seeking business for the port, Newcastle receives very little container business. Fortunately, the newest wharves, Lee Wharf 5 and Throsby 4 were built to maximum load specifications. The largest ships and containers in service have been accommodated there. The P.A.D. quarter deck RORO liners call regularly with their giant fork lifts and straddle trucks.

A neat piece of equipment regularly seen on Lee Wharf is the portable Toll-Chadwick loader. Designed by Mr. David Haldane, a former Superintendent of the Newcastle-Wallsend Coal Co., it can load mineral sand from motor trucks at 500 tons per hour.

Accurate planning of facilities for coal loading was extremely difficult in the 1950s. The demand from conventional coal markets (railway locomotives, ship-bunkers, gas manufacturers and industrial boiler plants) was declining, because of conversion to oil fuels. The Port Committee report assumed that the existing coal loading facilities in the Port of Newcastle would remain adequate. However, the competition from oil produced pressure to reduce loading and shipping costs for coal as did the developing market in Japan for coking coal for the steel industry. To reduce costs it was necessary to have larger ships, faster loading, larger rail wagons and large coal storage areas, with appropriate stocking and

reclaiming facilities at the port. Colliery proprietors, the Railways Department, the Public Works Department, the Maritime Services Board and the waterside unions were all involved in achieving the drastic changes of layout. Frustrated engineers prepared layouts while negotiations lingered.

The impasse was broken by the erection on The Dyke of a temporary coal loader by Newstan Colliery, a Joint Coal Board subsidiary, in 1958. The erection of The Basin Coal Loader followed in 1967. The loader was built locally by Goninan's to the order of the Maritime Services Board, with two heads each for 1,000 tons per hour, and replaced the cranes on the east of the Basin.

The overseas trade, particularly that with Japan, grew rapidly in the next decade. Port Waratah Coal Services Ltd., a coal-industry consortium, built a new coal loader upstream of The Dyke where the timber and cattle wharves once were found. The new unit began operations in 1977. The coal storage area, with a nominal one million tons capacity, received an Engineering Excellence award for its detailed dust control system. The loading heads can handle 4,000 tons per hour.

Newcastle Harbour improvements, 1920s — the filling-in of the Throsby Basin Wharves and a section of East Carrington. NRL

Next, port control was simplified. In 1961 the Maritime Services Board took over engineering design and operational functions for the port from the Public Works Department and, in 1978, its constructional facilities. Engineers managed the change-over with tolerance. However, by 1980 the need for a third large coal loader appeared urgent. Again, engineers suffered frustrations due to the large number of conflicting interests and the delays in reaching an agreed scheme for operation.

Dredging continued at the steady rate of about 1,830,000 tons of silt per year from 1915 to 1950, with a gradual increase in the harbour depth from 23 feet six inches to about 27 feet six inches. The basic dredging equipment was coal-fired ladder dredges, *Juno, Pluto* and *Hunter* (still in service after 90 years). These versatile machines could handle a wide range of material - silt, clay, broken rock and weathered rock and were the most common type of harbour dredge. However, they had the disadvantages of requiring moorings, making horrible screams, clanks and groans, and being cumbersome to repair. The repinning of a ladder-chain, weighing some 100 tons, was an engineer's nightmare. There was a fleet of attendant hopper-barges, tugs and launches.

By 1950 a new fleet was in preparation. Two large drag-suction dredges *William J. McKell* and *Richard Vowell* were much more appropriate for the mud and silt which forms the bulk of the Newcastle dredging load. In a busy harbour, they have the particular advantage of mobility. A cutter-suction dredge, and a new grab dredge *M.K. Weir,* were built for the more consolidated material in South Channel. The ladder dredge *Juno* was retained. Most of the equipment was built at the State Dockyard.

Beginning with the 1949 flood, a series of floods deposited silt in all channels of the harbour before the suction dredges were available. The required removal rate of 3,680,000 tons per year, double the previous average, was more than the available equipment could handle. A Dutch firm was called in to share the dredging work.

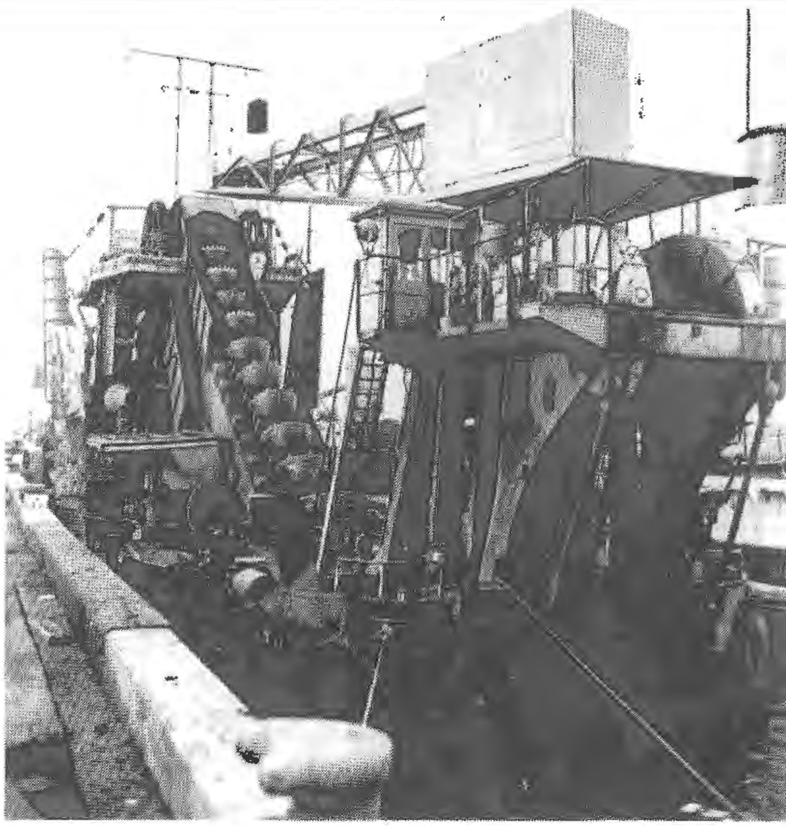
One project which went really well from 1950 was the Islands Reclamation Scheme. Any amount of silt was available. By 1964 the first area of 180 hectares had been filled, contoured and grassed at the Southern end of the "islands" and was available for sale. Walsh Island had been widened, shaped and joined to Dempsey and Mascheto Islands. The whole area was given the new name Kooragang. Rotten Row had been shaped and deepened for wharves. The Broken Hill Pty. Co. had filled in Platt's Channel and raised the level of Spit Island to make the South Arm of the river a straight, trained channel.

A new development from 1950 was the use of hydraulic models to assist planning for river training. The first study, at Newcastle University College under Dr. K. Johnston was of the transport of sand into the channel somewhat beyond the seaward end of the Southern breakwater. In more or less open sea this was a difficult area for ladder dredges to work. *Pluto* had capsized in the 1950s and had to be demolished under water by explosives and removed. It appeared that sand was washed off Stockton beach in heavy weather and was carried by any North-easterly seas towards the channel. A long breakwater was proposed.

However, further work by the P.W.D. indicated that continued dredging with modern plant would be more economical than any extension of the breakwater.

An investigation of the siltation in Newcastle Harbour required a comprehensive research programme. This was carried out under the direction

Right: Ladder bucket dredge. PWD
Far Right: The Basin coal loader, built by Goninans, which began operations in 1967. AG



of Mr. Arthur Lucas, B.E., then Head of the Hydraulics and Soils Laboratory of the P.W.D. at Manly Vale, in conjunction with the Hydraulics Research Station in England. From the data collected an understanding was gained of the two stages of siltation. During a flood, the mud-laden waters deposit "primary silt" on all shallow areas. Later, when wind waves pass over the shallow areas during changes in tide level, the silt is brought back into suspension. A salt water wedge moving upstream beneath the fresh water flow flocculates the silt into heavier particles, which fall into the deeper channels — "secondary siltation". This realisation gave support to the policy of reclaiming shallow foreshore areas, in particular in conjunction with the Kooragang Island development scheme.

Up-river, too, remedial work had begun. Investigations, particularly those made in the United States, had shown that flood mud was not primarily due to erosion of soil on the hills and slopes of the river catchments, but to the erosion of the high banks of alluvial soil adjacent to bends in the main river course. The Water Conservation and Irrigation Commission observed one section of river bank above Singleton, where in one half mile length some 2,000,000 tons of good alluvial soil was cut away from the banks by the river in six years.

In 1956, a river bank training and stabilisation programme to reduce these losses, and other flood damage, was set up by the Water Conservation and Irrigation Commission under Mr. A.F. Redoch. It is described in more detail in the chapter on Water Resources.

The Newcastle Harbour rock-removal project proved more difficult. Despite the limitations of available equipment, the first stage of the work (a depth of 28 feet) was reached in 1961. The size of bulk carriers was increasing rapidly, so rapidly that a depth of 37 feet was required urgently. Shipping interests claimed that it should be deeper yet. Tenders were called and a contract let in 1961 to an international firm which had successfully completed the deepening of the Suez Canal by underwater rock-breaking.

Unfortunately, the Newcastle rock bars did not shatter easily, as the P.W.D. knew from experiences and the contract overran. Mr. Vic Lindsay, of the P.W.D., who had been the project's Resident Engineer, had the task of attending long court sittings during which the contractor unsuccessfully sued for extra payment.

Barely 10 years elapsed from the completion of work on the deepening of the harbour to 37 feet (11.6m) until the point at which ships of 100,000 tons, and larger (requiring greater depths), became available for bulk shipping. Many proposals were discussed by engineers from various groups, including engineering staff from the BHP Co.

Ltd., Newcastle. The proposals included the development of Port Stephens (with, or without, a large canal to Newcastle), the building of a new harbour independent of the Hunter River by excavating the sandhills at Williamtown and the provision of an off-shore coal loader. However, in 1977, plans were approved for a $70 million project to deepen the existing harbour to 15.2m. Westham Dredging won the contract and procured first-class equipment. Two huge spud-mounted multi-drill rigs were built in Newcastle. Even these cannot withstand very heavy seas; an early-warning wave measuring device developed by electronic engineers of the Maritime Services Board, enabled more effective operations on the outer bar. The contract went smoothly; the *Daeyang Glory* left with a record load of 90,000 tons of coal on September 28, 1982. The work was completed early in 1983.

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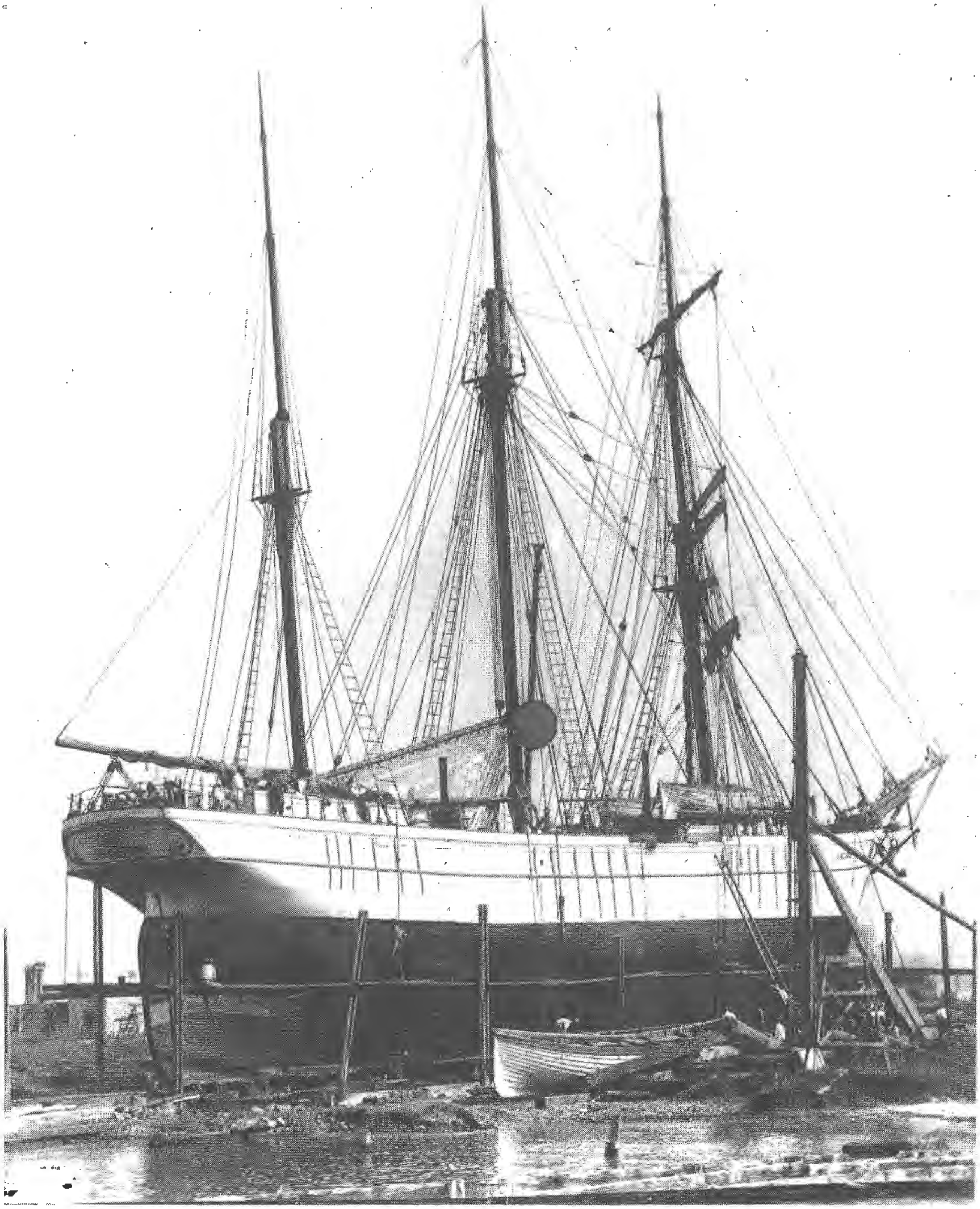


The Laura, *from Melbourne, pictured on the Stockton Patent Slipway around 1900.* *NMM*

THE SHIPBUILDERS:

by George Imashev

(Condensed from a detailed history which is being prepared by Mr. Imashev for publication later.)

River Shipbuilding

The Hunter Valley has always been a leading participant in the shipbuilding industry of Australia.

The first recorded ship to be built in the valley was the brig *Princess Charlotte,* of 60 to 70 tons. This vessel was built at Newcastle in 1819.[1] Despite this "first", the major area of shipbuilding in the first half of the 19th century was not Newcastle itself, but the many rivers in the hinterland. Initially, shipbuilding was slow to take off — because of the official restraints imposed for the sake of security in a penal settlement.

From 1823 when the port was opened to urban trade, until the 1870s, the river ports were in the ascendancy as large quantities of wool, wheat, tallow, maize, some tobacco, wine and timber were shipped from Paterson, Clarencetown, and, especially, Morpeth. All ships required maintenance and replacement. From 1831, shipbuilding and ship repair services were established along the Hunter River and its tributaries. Deptford, Clarencetown and Eagleton on the Williams River, Dockyard and Raymond Terrace on the Hunter River, and Wallalong on the Paterson River, were important centres.

The first recorded site was the **Deptford** yard on the Williams River near Clarencetown. There, in 1830, James Marshall and William Lowe commenced operations. Using local timbers of iron bark, flooded gum and native pine, they built more than nine ships in the next 25 years. Lowe, having been apprenticed at the Royal Dockyard at Deptford on the Thames, near London, was able to put his considerable skill to good use in the Colony of New South Wales.

In February, 1831, Marshall and Lowe contracted to build for Mr. J. Grose a steam vessel for the Hunter River-to-Sydney trade. Launched on November 14, 1831, the 54 ton *William the Fourth* became the first ocean-going steamship built in Australia, failing only by months to be the first overall steamship in Australia, a distinction achieved by the *Sophia Jane,* which was built in Great Britain. Launched fully rigged, the *William the Fourth* arrived in Sydney under sail, on November 24 and was fitted with engines.[2] The engines, of the jet condensing type, were of 40 h.p. and were constructed by Fawcett and Co. of Liverpool. During trials the ship averaged eight knots. Her dimensions were: length - seventy four feet, beam - fifteen feet, depth - six feet. The outside planking was of one and three-quarter inch flooded gum, and deck planking was of two-and-a-half inch native pine. She had two masts and was schooner rigged. Cabins and fittings were of cedar.

Affectionately known as "Puffing Billy", the ship was a "beautiful specimen of colonial enterprise".[3]

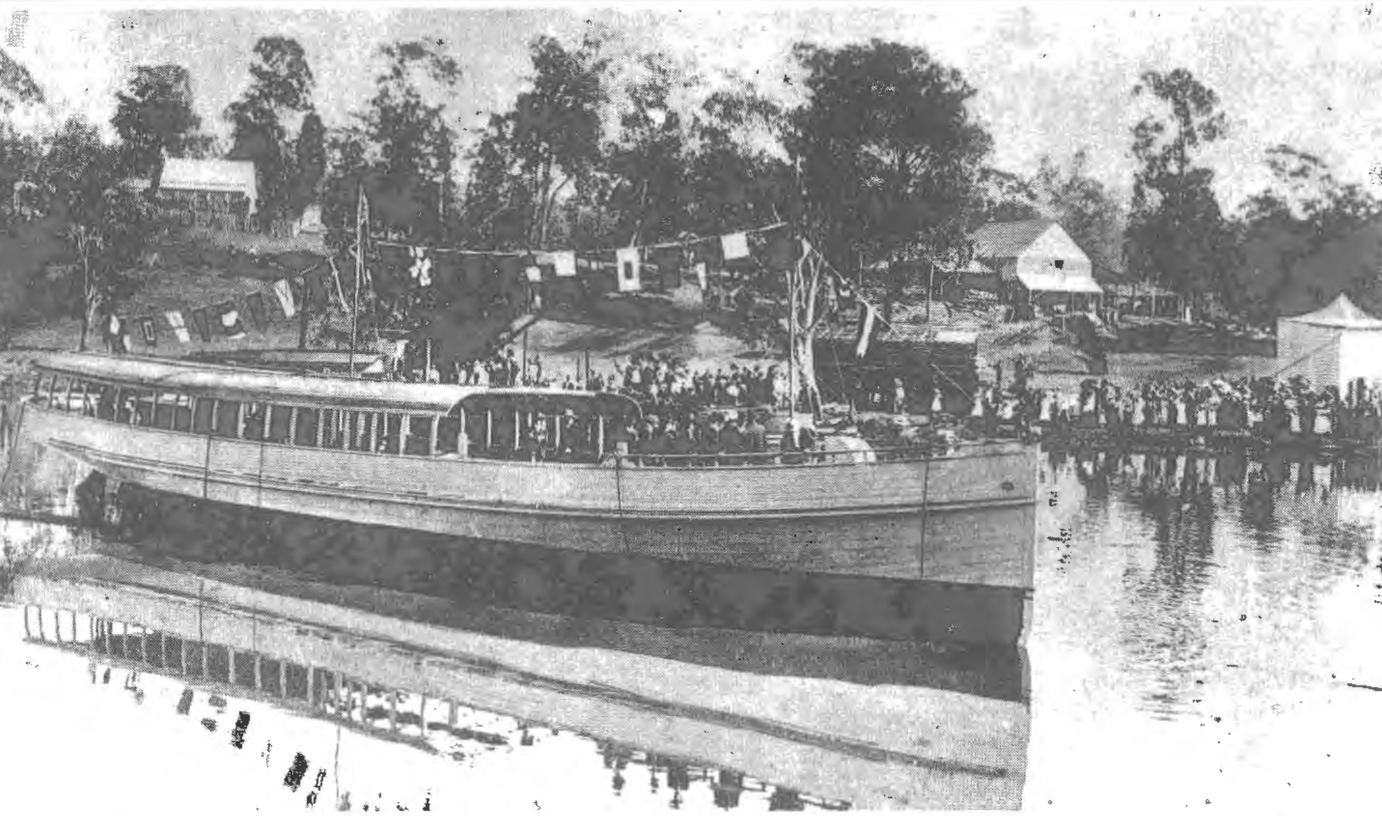
After 30 years of operations on the coast, the *William the Fourth* was sold to China and ran there for many years.

Other steam ships built at Deptford were the *Experiment* (1832), the *Ceres* (1835), the *Aphrasia* (1841) and the *Comet* (1843). Sailing ships built included the 170 ton brig *Enchantress* (1849), the 180-ton schooner *Rosetta* (1847), and the ketch *Elfin* (1854). In 1860, the yard closed down.[4]

Raymond Terrace, because of its strategic location, at the junction of the three rivers, was suitable for shipbuilding and repair works. The best known was the Dockyard, established by John Korff in the late 1830s one mile from Raymond Terrace. The first ship launched was the 196-ton wooden paddle steamer, *Victoria.*[5] The *Kangaroo,* also a steamship, was launched in 1841 and lasted well over 50 years, indicating the quality of workmanship. Today, no visible evidence remains of the shipyard.

Eagleton, on the Williams River approximately five-and-a-half miles north of Raymond Terrace, became a major shipbuilding centre in the 60s, 70s and 80s when William McPherson established the shipyard in 1860. He was followed by James Roderick in 1880 and by Robert Muirhead in 1884. More than 30 vessels were built in this period. All were constructed from local timbers.

One of the Hunter region shipbuilding successes was that of Mr. Edward King, of **Wallalong,** near Hinton, on the Paterson River. King, a farmer, had no shipbuilding experience, but the one ship he built proved to be equal to the best in the colony. This ship was the *Australian Sovereign,* a 353-ton barque, 134 feet long and launched in Feburary, 1872. In May of the same year, she commenced her successful maiden voyage to Hong Kong, with King and his sons as part of the



Launching the Eringhai *at Clarence Town, 1907.* *NMM*

crew. In June, 1880, she was wrecked near Noumea.

There are other names not as famous as those mentioned above, but who also contributed to the river shipbuilding tradition.

Concentrated on the Williams River, they were David Moynaham, Thomas Armstrong, Henry Ikin, William Breckenridge, George Felton, Dennis Sullivan, Hugh Hackett and Andrew Smith.

Despite the range in the size of ships built and the different degree of shipbuilding expertise brought to the newly established shipyards, river shipbuilding activities had many common features. While yards were generally not very long lasting, they were certainly prolific. Practically every bend in a river giving deep water and a stand of timber was a potential shipbuilding site. Construction techniques were uniform throughout the region, with flooded gum for hulls and native pine for decking being the format. When the pine cut out, New Zealand kauri was used: when the gum cut out, the site was usually abandoned. While at first Lloyds would not register these colonially-built ships, the durability of skills and materials was demonstrated by the longevity of ships like the *William the Fourth* and the steamer *Kangaroo.*[6]

Newcastle's Involvement

From the 1870s onwards, shipbuilding moved away from the river sites and closer to the coast and the rapidly developing port of Newcastle. Many factors influenced this shift. Most important of them was the rapid cutting-out of the natural timber. Once timber had to be imported it made sense to establish yards at the coastal port. Furthermore, clearing of land for agriculture caused siltation of the rivers, making navigation impossible. The move away from river sites was also hastened by the new technology or iron construction.

The earliest known shipbuilding operation of any size, or permanency, in the Newcastle area was established by the Stockton Ship Company. In 1847, the company leased an acre of land from Mr. A.W. Scott, of Stockton, and laid down a slip.[7] On May 24, 1848, two barges were launched. The barges, built by shipwright Mr. Winslip, were for use on Lake Macquarie at Reverend Threlkeld's mine.[8] The next impetus came from the Newcastle side of the harbour. During the 1850s and 1860s, numerous slips and yards were established there. In Scott Street alone, side by side, starting from Newcomen Street, were the boat-builders Frazer and Sons, Smith, McNaughton and Brooks and Goodsir. The shipbuilding yard of Mr. J.W. Scott was west of this group at Honeysuckle Point, before being moved to Bullock Island (Carrington). Other firms linked to shipbuilding and repairs were established in the 1880s on the Newcastle side of the harbour. They were, as listed in Knaggs Almanac: "William Johnston (late William Hunter), ship and general smith, No. 1 Staith, Newcastle", and "Rapson Brothers Shipbuilders, spar makers and boat builders, Government Coal Staiths, Newcastle".[9]

The Stockton side of the harbour also saw the establishment of shipbuilding yards. The Stockton Ship Company had immediate competition from 1857, when, in that year, Mr. John Hay, Mr. Robert Cameron and Mr. Ritchie established Hay's Slip.[10]

In 1860 the more important Scott's Patent Slip was established. The first vessel to occupy Scott's Patent Slip was the brig *Triton*. The slip was capable of slipping ships up to 400 tons register. J. Scott had plans for a floating dock and a patent for improvements. He formed the Newcastle Floating Dock Company, but nothing ever came of it. His invention was, however, adopted in Victoria Docks, London and elsewhere[11] and tenders were invited in Sydney for building a dock according to plans prepared by Scott prior to his leaving Newcastle.[12]

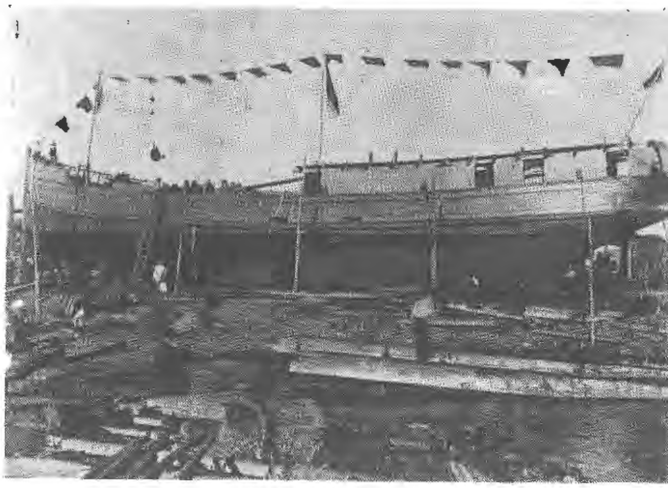
In 1869, Mr. D. McQuarrie purchased Scott's Patent Slip, which became known as McQuarrie's New Patent Slip.[13] The Manager of the Slip, Mr. Charles Chatfield, had come to Newcastle to superintend the erection of the Government coal staith after previous contractors had failed. In two years it was completed. Chatfield began work on McQuarrie's Patent Slip, transforming it into the most advanced slip in Newcastle and capable of taking up vessels of 1,000 tons laid down.[14] The success of this operation was mainly due to Chatfield's shipbuilding experiences in England and Sydney. McQuarrie sold the slip in 1874 to Messrs. T. O'Sullivan and Burns. The slip became known as O'Sullivans in the 1880s and, by 1900, simply as the "Patent Slip".[15]

Other shipbuilders in Stockton were Gillon and Nickol, Richard Lynn and Thomas Taylor.

On April 12, 1865, Gillon and Nickol launched a steamer of sixty feet length, thirteen feet beam and eight feet six inches depth. She was built to supply water to sailing vessels in the port and was capable of carrying 56 tons of water. Interestingly, Gillon and Nickol secured fresh water from a well on the river bank at Tomago and advertised, "Sweet Tomago water supplied to vessels in port twice daily".[16]

The firm that was to dominate the period 1880 to 1910 was Callen Brothers, shipbuilders, timber merchants and contractors, of Stockton. Peter Callen, the driving force behind the business, was born in 1846 at Broadwater, near Kincumber, Brisbane Waters, where his parents were fruit and vegetable growers. Peter, with his brother Michael, was apprenticed to the local shipbuilder, a Mr. Tom Davis of Terrigal. On the death of his father in 1862, he assumed responsibility for the family. After having built his own schooner and having been to Newcastle, he persuaded the family of the opportunities there. Accordingly, in 1870 at the age of 24, Peter Callen proudly sailed into Newcastle in his own ship.[17] From these humble beginnngs grew a diverse enterprise at Stockton. In 1888 Callen Brothers had developed to where they could:

> "Employ seventy-five men. They owned two steam lighters, one sea-going steamer, two sailing vessels, three ferry boats plying between Newcastle and Stockton, five pile-driving machines, and all necessary appliances for the erection of wharves. They are large government contractors, having constructed Stockton Wharf and executed a 3,000 feet extension to Bullock Island Wharf, and a 1,600 feet extension to Newcastle Wharf. They have built the fastest tugs and ferry boats plying in Newcastle waters, notably the *Stormcock, Energy, Gamecock, Ethel, Emu, Mystery, Adeline, Rose, Anne, Nellie, Saucy Jack* and *Pinafore*. They have now on hand a new and improved ferry boat, which will be superior to anything at present in the harbour. They have a large timber yard, a steam saw-mill and joining works at Stockton, and a patent slip. The firm can turn out vessels from racing boats to intercolonial steamers".[18]



The Idant, *a wooden ship 92 feet long, being built at Stockton in 1918.* *NMM*

What is also remarkable is the speed at which vessels were built. Between 1876 and 1884 30 vessels were built[19] followed by nine in the next three years.

Callen Brothers also engaged in salvage work and are credited with the first ship ever salvaged from Stockton Beach. The barque *Adderley* was driven onto the Beach on April 23, 1879, 17 miles north of Newcastle. All crew reached the shore safely, but the vessel lay broadside on to the beach with her bow facing north. The salvage commenced one month after the grounding and by October, the *Adderley* had been moved 300 feet. Finally with three tugs pulling her, she was freed and towed to Newcastle.[20] If further versatility need be demonstrated, it can be noted that P. Callen built the Swansea Bridge in 1908.[21]

Walsh Island

Work on the construction of the Government of New South Wales' **Walsh Island Dockyard and Engineering works** commenced in 1914. The site, on the Hunter River about two miles from Newcastle and immediately opposite the Broken Hill Proprietary Company Ltd.'s Steelworks, was selected on account of its proximity to cheap power, raw materials and labour.

It was intended to connect up the Walsh Island works and the mainland by a railway linked to the main northern and western lines. If this had occurred, all ports in Australia with railways would have become accessible. In 1930 transport links were maintained by a fast ferry service from Newcastle and a landing ground for aeroplanes on the northern portion of the island.

Through reclamation, **Walsh Island** was enlarged to 400 acres. A wharf frontage of 2,000 feet to the southern arm of the Hunter River was provided.

In 1930, 2,500 men were employed at **Walsh Island** in shipbuilding and general engineering. To meet engineering requirements, the following Departments were established:

- The **drawing office**, of 3,100 square feet, in which all plans, specifications and instructions for work were kept. In here many vessels, coasters, ferries, dredges, tugs and trawlers were designed in addition to piping plants, pipelines, cranes and machinery.
- The **mould loft** of 11,920 square feet, where ships lines were laid down full size and faired, and template work of all descriptions made.
- An **electric welding plant**, with a continuous supply of 4,000 amps, was also available. It was also used for manufacturing steel buildings, barges, buoys, containers and tanks.
- A **barge**, built of channels welded together at the heel and toe and stiffened transversely by deep channel brace girders spaced at wide intervals, was entirely rivetless and was used to transport rolling stock, locomotives, etc., between Walsh Island and the mainland.

Other works areas included a **physical testing laboratory** and a **chemical laboratory** for testing, research and control work on all machines and materials used.

The **shipyard** had three slipways, or building berths, each capable of taking vessels up to 6,000 tons dead weight. The slips were spanned by two four-ton cantilever travelling cranes, designed and built at Walsh Island, and two 10-ton Goliath Alliance travelling cranes. All the cranes were electrically operated.

Two **patent slips** were available for docking small vessels which required to be cleaned and repaired. The larger was capable of taking vessels of 230 feet and up to 600 tons in weight.

Also included in the Walsh Island Dockyard were a **pattern shop** of 18,100 square feet, a **foundry** of 77,100 square feet, a **blacksmiths shop and forge** of 13,400 square feet, a **machine shop** with erection bay of 37,410 square feet, and a **plumbers' and coppersmith department** near the outfitting wharf.

The **boiler shop**, of 30,170 square feet, was capable of making all types of tubes, including the scotch water tube and locomotive type.

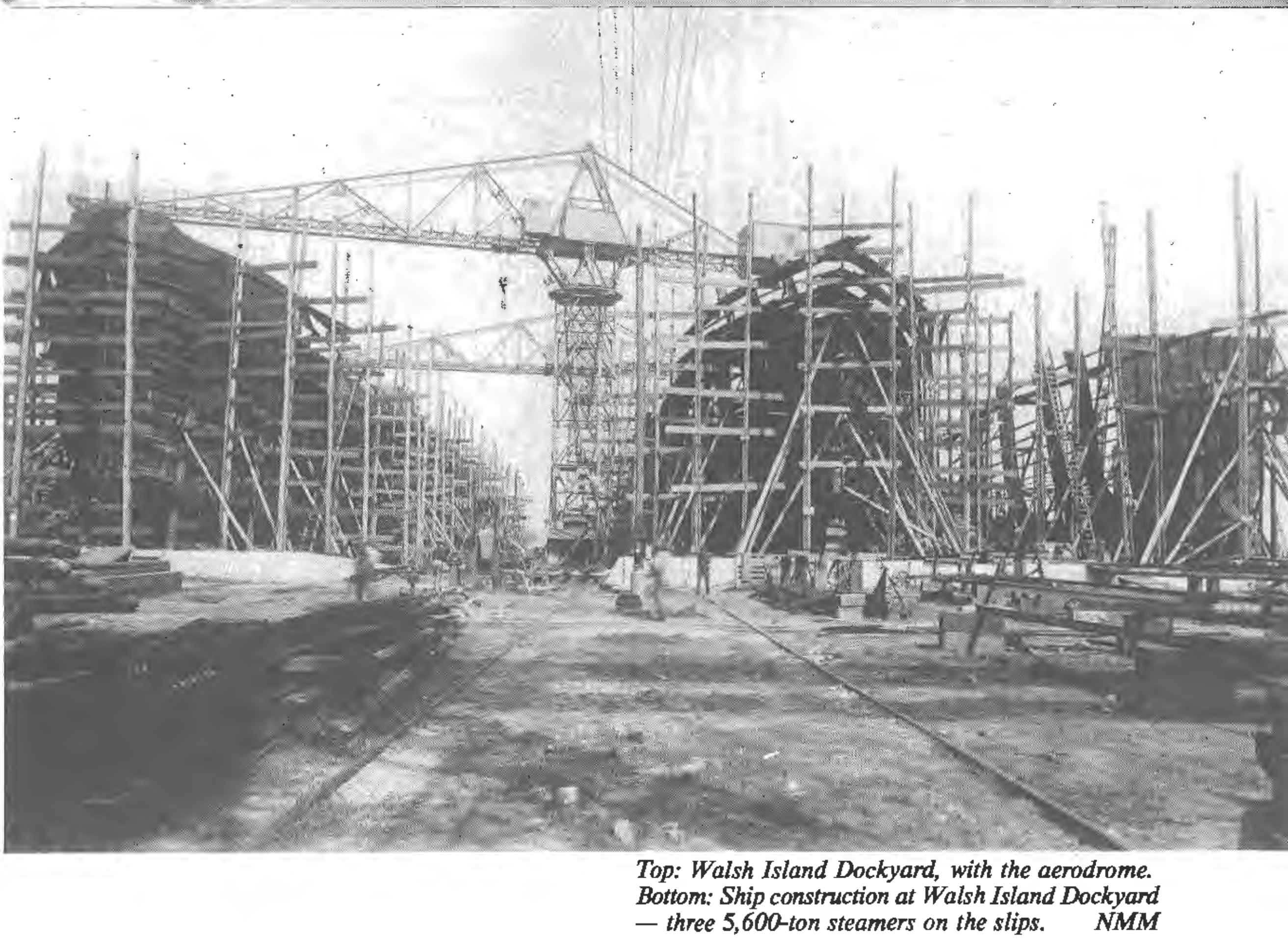
The **joiners' shop**, which was under the same roof as the **loft**, had a floor space of 15,135 square feet and could undertake all classes of work including ship joinery, cabin furniture and fittings for both ships, railway carriages and motor buses.

Other shops were the **paint shop**, and the **electricians' and upholstery departments.**[22]

Floating Dock

The Walsh Island yard also had a 15,000 ton **floating dock**, which was **built** on the No. 4 slipway. While J. Scott had successfully invented a floating dock, this one was the first that could take all manner of ships.

O'Sullivan's shipyard bought a floating dock in 1891 and had it towed to Newcastle by the tug *Stormcock*. The dock, "Graham's Floating Pontoon Dock", was constructed in 1887 and was previously on the Parramatta River. It was



Top: Walsh Island Dockyard, with the aerodrome.
Bottom: Ship construction at Walsh Island Dockyard — three 5,600-ton steamers on the slips. NMM

Mr. Arthur Waters, General Manager of the Walsh Island Dockyard.

120 feet by 36 feet and could only lift a maximum of 250 tons. It had four water compartments which took half an hour to empty, making the time to raise or lower the dock also half an hour.[23]

Since that time until 1930, there were continuous requests by Newcastle interests to Government Authorities to establish a floating dock. Finally, due to repeated requests by the General Manager of the Walsh Island yard, Mr. Arthur Charles Waters, supported by State and Federal Governments and the Navy, a floating dock was established.

The design, obtained from the firm of Clark and Stanfield in collaboration with A. C. Waters, was chosen to meet local conditions and to comply with British Admiralty requirements. The dock was in three sections of equal length and self-docking, with any two sections capable of docking the third.

The first General Manager of the Walsh Island yard was Mr. A.E. Cutler. In 1919 Mr. A.C. Waters, MIE (Aust.), became General Manager and held this position until 1933.[24]

Although shipbuilding had temporarily waned in the 1920s, Walsh Island diversified and was going back to full operation, with the new Floating Dock, when it was closed down in 1933. It had been able to compete effectively on the open market, without Government assistance.

State Dockyard

Unfortunately, no effort was made to help the dockyard over the difficulties it faced in the Depression. In 1933 all staff were laid off and their skills and experience scattered. Ironically, only nine years later, the State Government decided to re-establish shipbuilding in New South Wales as a State enterprise.

This was 1942 and the decision was necessitated by the Second World War, but, unfortunately, the human expertise, and most of the heavy equipment from the Walsh Island Yard, were gone forever.

Other factors leading to the demise of the yard on Walsh Island included the considerable cost of, and the delays involved in, transporting men and materials, and the damage done to submarine electric power cables laid across a busy waterway. Moreover, continuous dredging was necessary in the vicinity to avoid the building up of Hunter River silt.[25] In other words, the cost of supplying such a large engineering complex isolated by water, undermined profitability.

The new shipyard established by the State Government during the Second World War was called the **State Dockyard.**

On August 25, 1941, Mr. D. Lyon McLarty, MIE (Aust.) MIES (Scot.), was appointed Director. Because of the inaccessability of the old Walsh Island Yard, it was decided to establish a combined engineering and shipbuilding works on the Dyke End peninsula, where a small dredge repair shop already existed. In April, 1942, construction commenced.

A year later the Walsh Island Floating Dock

Ship launching at the State Dockyard — the first merchant vessel, the Dorrigo, *1945.* *NMM*

was moved to a mainland site at Carrington, following extensive dredging and the construction of the necessary heavy anchorages.

While many machine tools and buildings from Walsh Island were reused and relocated, the crane facilities on the building berths had long since been disposed of. Efforts were made to obtain shipbuilding crane facilities, but this was not possible at the time. The problem was overcome by utilising the columns of one of the old Walsh Island engineering shops. Crane girders were placed on the top of these columns, where the roof trusses had originally rested. The columns were braced to give lateral stability and spaced on each side of the building berth to suit the span of one of the existing ship construction shop overhead travelling cranes.

By March, 1943, five months after construction commenced, the engineering shops were completed and the shipyard shops well-advanced. The speed of this development (despite the small capital outlay of £500,000) was largely due to the fact that 90 per cent of the structural steel in the buildings and the major proportion of machine tools and other equipment at the abandoned Walsh Island Yards had been overhauled and used. It could be said that the State Government Dockyard was built on the neglected skeleton of the highly-successful Walsh Island Complex.

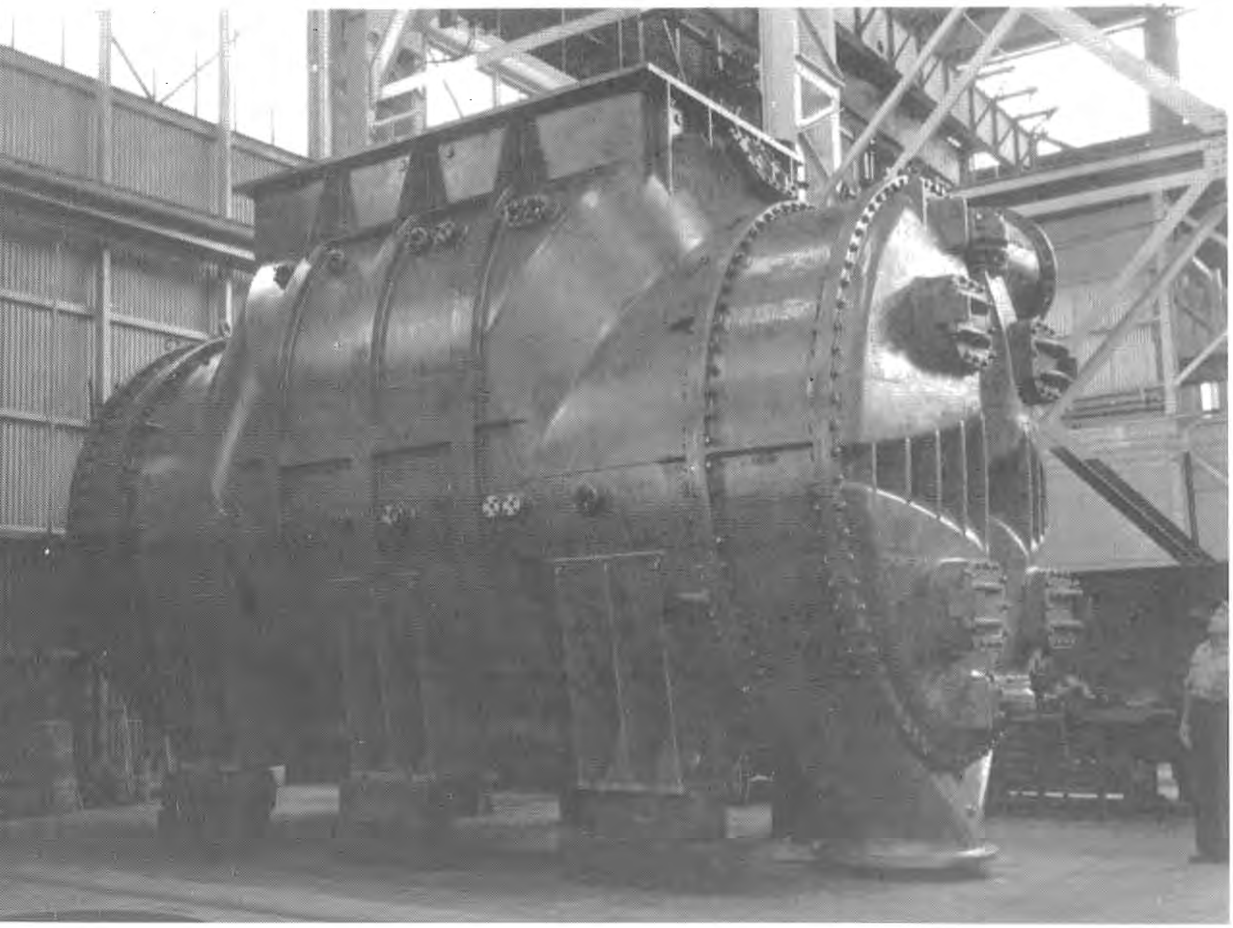
In less than four years of trading the State Dockyard achieved a profit of £165,000, turning a wasting, State asset into a profitable concern. In addition, the Floating Dock produced satisfactory revenue, whereas from 1933 to 1943 it had earned less than the cost of its maintenance and operation.

By 1945, the State Dockyard had established the full range of workshops. This included engineering shops, an electrical shop, pattern and joiners' shop, plumbers' and coppersmith shop and a fitting out wharf and shop.

The shipyard and ship construction facilities included a moulding loft, shipwright's shop and a ship construction shop. Four ship building berths were established. Full electric arc welding facilities were also installed, allowing automatic as well as hand welding. Three stores completed the material installations.

The number of staff employed in 1945 was 1,329, but due to the unavailability of suitably trained technical staff it had not been possible to fully man the facilities as they became available.

A condenser for Wallerawang Power Station. Manufacturing large items of power station equipment has been one of the State Dockyard's specialisations. *NMM*



Total area of the dockyard was 25 acres, with wharfage of 3,000 feet.

The activity in those years from January, 1942, to December, 1945, was remarkable. Not only had the works to be set up, but the following jobs were also completed: 23 vessels were built, six sets of triple expansion engines were constructed and 600 vessels of varying types up to 16,000 tons were docked and repaired, many heavily damaged by enemy action or collision.

But the Dockyard had not been established solely to meet a war-created demand. The first peacetime program merchant vessel, the *Dorrigo* — a single screw, 2,321 gross ton, freighter, two hundred and ninety feet nine inches OA length with forty six feet beam — was launched on October 27, 1945.[26] The first of the "D" class vessels to be built. This was followed by "E" class vessels as shipbuilding continued into the 50s, 60s and 70s.

The Dockyard is credited with many "firsts" in Australian shipbuilding:

The *Princess of Tasmania* vehicle deck, passenger ferry (built for the Australian National Line in 1959),

The MV *Bass Trader* vehicle deck, container vessel,

The MV *William Holyman* container (built in 1961),

The MV *Kooringa* container vessel (built in 1964), and

The MV *Lysaght Endeavour,* vehicle deck cargo vessel (built in 1973).

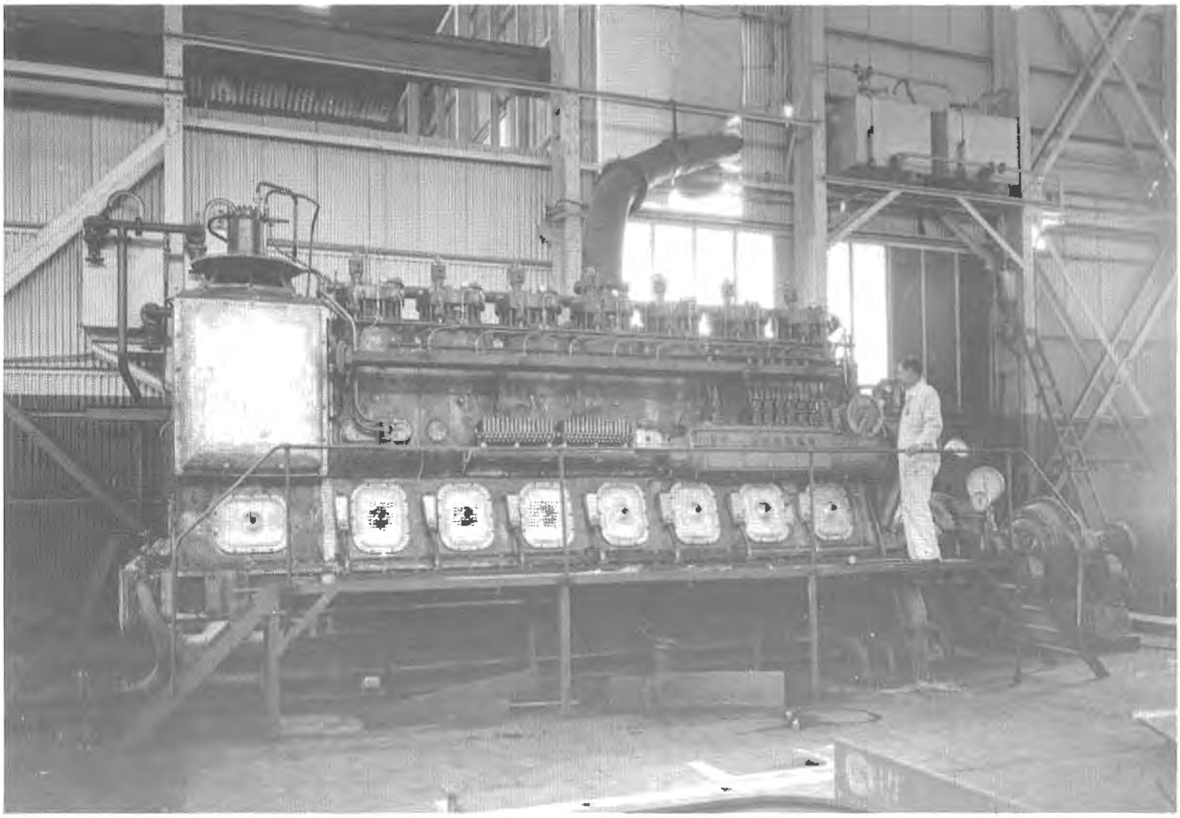
The new type of ferries for Sydney Harbour, the *Lady Woodward* and *Lady McKell,* were built at the Dockyard in 1970.

The maximum capacity of vessels that can be built is 25,000 dead weight tons and the types have ranged from dredges, tugs, ferry boats, hydrographic survey ships to bulk ore-carriers.

In 1977, the old 15,000 ton floating dock was cut up for scrap and a new 30,000 ton floating dock, the *Muloobinba,* was installed at Carrington. The new dock was built in Japan by the Hitachi Shipbuilding and Engineering Co. Ltd., from near Osaka, at a cost of $8.56 million. It was towed to Newcastle in 1978.[27]

In 1983, the shipbuilding side of the State Dockyard's activities began to cease, the last ships built being two Manly ferries for the State Government. Other management continues to provide general repairs and docking facilities using the *Muloobinba.*

Australian Polar Diesel engine (1310 hp) which was manufactured by the State Dockyard for the William Holyman, *1960.* *NMM*



Carrington Slipways

This is a private firm that continues the tradition of shipbuilding in Newcastle and the Hunter. It began in 1957, when Mr. John Laverick (Sen.), a shipwright with local and overseas experience, obtained a lease on a small shipbuilding site at Carrington. The first vessel to be built was a 10-metre wooden ferry for the Department of Main Roads. It took the workforce of four men seven months to build.

In 1962, a contract was won to build two ocean-going, dredging spoil barges for the Maritime Services Board in Sydney. It was then that the first of the overhead cranes that became a landmark for the Company alongside the Cowper Street bridge at Carrington was installed.

In 1965, the firm built its first tug. Due to the volume of ship construction, it decided in 1966 to concentrate entirely on shipbuilding. In 1968, the firm's 45th vessel was completed. The *Sedco Helen*, a 200-foot oil rig supply ship, was the largest single order up to that time. In the same year, a new slip was added to the yard, but by the end of 1969 it became obvious that the limits of the Carrington site had been reached.

After extensive investigations overseas, it was decided to move to Tomago and build a new yard on the flow line assembly principle, enabling ships of up to 130 metres to be constructed.

The system consisted of all major units being built in a line at right angles to the Hunter River, with the end of the building parallel to the specially dredged launching and fitting out harbour. Overhead cranes travel the entire length of the production line to simplify construction of up to four ships in various stages at any one time.

A special feature of Carrington Slipways is this sideways method of launching. Developed and used successfully over 20 years, it was used to launch HMAS *Tobruk* in 1980. The method, while unique to Australia, is not so overseas.[28]

The Company's move to the 11-hectare site at Tomago occurred in 1972. By 1975, plans were made to build a second and parallel assembly line. In the period from 1958 to 1973, the number of employees grew from four to 240.[29]

Moving the floating dock from Walsh Island to the State Dockyard at Carrington, 1943. Pictured left to right: The Minister for Public Works in New South Wales, Mr. Cahill; the Technical and Business Manager of the State Dockyard, Mr. H. Harding; Representing the British War Administration, Mr. A.C. Campbell; the Minister's Secretary, Mr. R. Perry, and the Under Secretary for Public Works, Mr. D. Ford. Mr. Lyon McLarty, Director of the State Dockyard, is in the foreground. NMM

At a time when other shipyards were hard pressed to obtain contracts, Carrington Slipways expanded. This was largely a result of overseas trips by key members of the firm, to study the latest techniques in shipbuilding, and to interview prospective customers.

In 1976, Carrington Slipways invested $750,000 into new equipment incorporating computer facilities — the first Australian firm to do so. In 1980, a computer assisted drafting system was introduced — again, an Australian first.

In November 1977, Carrington Slipways won the order to build HMAS *Tobruk*, a $36 million amphibious heavy lift ship of 6,000 tons for the Royal Australian Navy. Whereas the vessel was based on an accepted British design, improvements and modifications for Australian conditions were made.

HMAS *Tobruk* is the largest ship built by the firm and the workforce went from 300 to 400, resulting in the firm establishing staff training and development programmes and work practice manuals.

While major customers are Australian, orders come from the United States, Britain and New Caledonia. The types of vessels built include survey ships, oil rig supply vessels, tugs, barges, a naval vessel, trawlers and a catamaran.[30]

The overall success of Carrington Slipways is especially remarkable when other shipyards are examined. The Evans Deakin Shipyard in Brisbane has closed down, as has the Adelaide Ship Construction Company, not to mention the State Dockyard.

Ship building in Newcastle and the Hunter Valley has been continuous for 150 years. While no individual firm or yard has been in continuous operation throughout that period, there has always been at least one significant site where major shipbuilding activities has taken place.

The first ocean-going steamship built in Australia came from Newcastle and the Hunter Valley. Today, the most technologically advanced and profitable shipbuilding establishment in Australia is located in the same region.

Notes

Abbreviations:

SG Sydney Gazette
NC Newcastle Chronicle
NMH Newcastle Morning Herald
MM Maitland Mercury
NS Newcastle Sun

Knaggs Almanac - The Newcastle Nautical Almanac, directory and guide to the Port of Newcastle.

ACH The Aldine Centennial History of New South Wales, 1888.

NHDHSJP - Newcastle and Hunter District Historical Society Journal and Proceedings.

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The A.A. Co.'s Sea Pit — view taken from near the Darby and Bull Streets intersection. *DM*

WINNING THE COAL

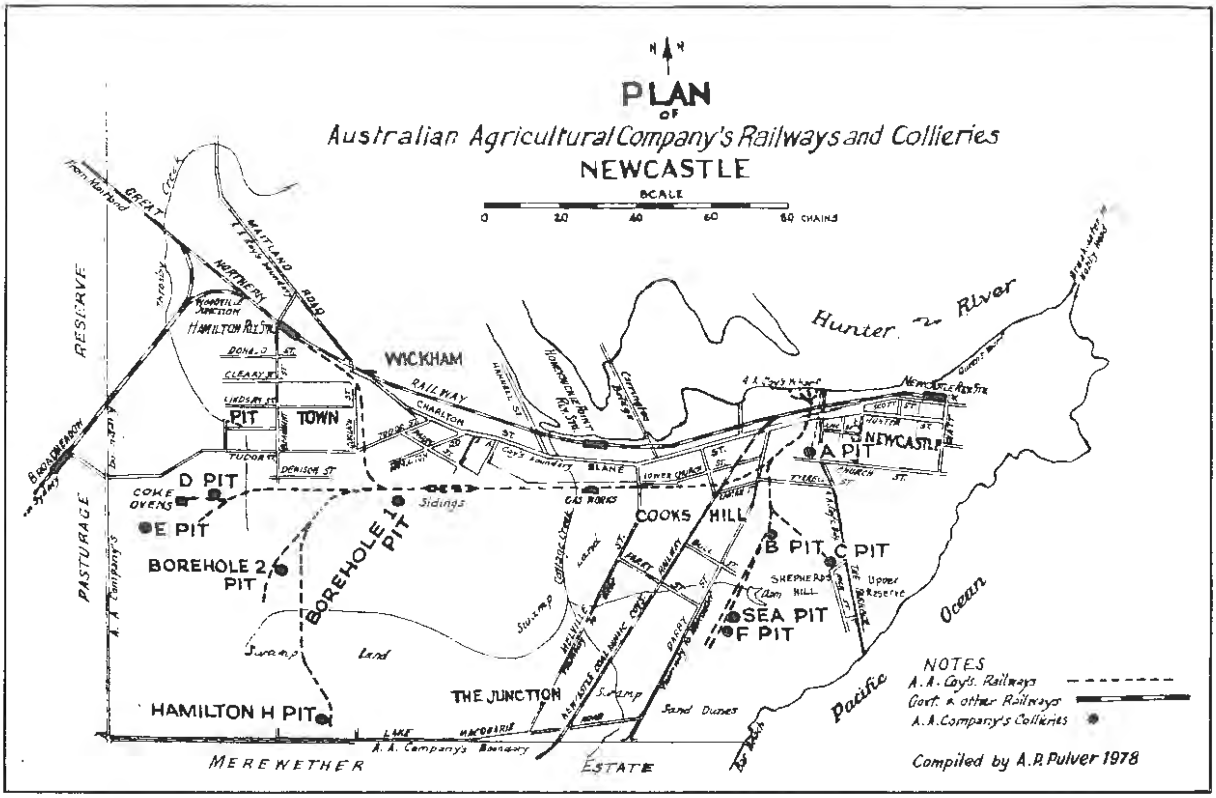
by J.W. Shoebridge

The beginning of it all was coal, coal found on the beaches and outcropping on the cliff faces close to where the city of Newcastle now is. The presence of vast coal deposits for many miles inland was not known at the time of discovery; they would form the basis for the prosperity of Newcastle and the Hunter Region itself.

In 1801 the first attempt was made to mine coal. Over the following 40 years, a pitifully small amount was won, from the narrow drives and shallow shafts, by convict miners under military supervision.

The day-to-day control of the actual coal mining operation was often in the hands of convict overseers — men like Platt and Grainger, themselves transported and owning to the trade of "miner". It was not until 1823 that the first true Mining Engineer arrived in the person of John Busby, a north-country "colliery viewer", who was appointed Mineral Surveyor and Engineer to the Government. Busby made a number of visits to Newcastle, reported shrewdly on the operations there and, for a time, supervised the activities at the "coal works". By the 1840s Newcastle's convict era was well past. The convicts had driven the first tunnels, sunk the first shafts and, above all, mined the first coal, their work being done by the most primitive means, despite the advancing technology of the coal industry in Britain. After all it had been a penal colony, capital investment was neither warranted not forthcoming.

In 1828 the Australian Agricultural Company, diverted from the objects of their charter, obtained a freeholding of 2,000 acres of coal-bearing land close to the port area of Newcastle, together with a Government guaranteed monopoly on the coal trade till 1847. As it happened, the A.A.Co's area not only embodied virtually all the existing access to deep water but was underlain by the then undiscovered Borehole Seam, the very foundation of the fortunes of the Company and of the Newcastle Coalfields. With a monopoly guaranteed and with British capital, the A.A.Co. was able and willing to invest in machinery and talent. Both were imported from Britain, the source of almost all such imports for the next 100 years.



It is perhaps appropriate to mention here, that, for many years, the title, status and responsibility of the Mining Engineer was embodied in the Colliery Manager. The managers selected the mine sites, prospected the coal and sunk the shafts. They specified the machinery and supervised its erection and they engaged the labour, worked the mines and often sold the product. The saying goes "a good pit makes a good manager". This was true in reverse: the most valuable asset of a coal company in the remote colony was a competent and energetic mine manager.

Steam Power In Coal Mines

In 1831 the A.A.Co. raised the first coal from its new A Pit fitted out under the supervision of the Company's Principal Manager of Coal Mines, John Henderson. In addition to ventilation and drainage arrangements, patterned on the latest practices "at home" and a self-acting rail track (delivering one ton coal trucks to the Company wharves), a steam engine raised coal from the mine . . . and, thus, the affair that the coal industry had with the steam engine for well over a century was commenced.

When, in 1972, the Yates and Thom 3,000HP steam winder raised the last coal from Hebburn No. 2 Colliery (which had, appropriately, also been opened by the A.A.Co.), the steam age was over. Coal mines had persisted with steam power long after other industries — for many years the Mining Engineer had been a Steam Engineer. Colliery Manager's examinations in the 1960's still stressed the need for knowledge of the arts of link motions, blowdown cocks, safety valves and indicator diagrams, whilst the colliery store would hold stocks of gland packing, boiler compound and gauge glasses. In the early years, steam was raised in egg-ended boilers. Some of these remained in use till the Minmi mines closed in the 1920s. However all but the more conservative (such as the A.A.Co.) or the poorer mines were using Lancashire or Cornish type boilers by 1870.

Although shell boilers remained in use till 1964 when the last was steamed at Abermain No. 2 Colliery, the final development in the story of steam raising was at Hebburn when Ian Stewart installed a pulverised-fuel International Combustion boiler in 1960. This plant was designed to burn unsaleable fuel direct from the washery and was also automated to adjust the firing rate to the steam demand. Indeed whilst there were water tube boilers installed at other collieries, it was the fluctuations in the steam demand of the winding engines which limited their use and only John Darling and Hebburn No. 2 supplied steam winders from water tube boilers.

And what fine machines these steam winders were! Though the tunnel mines hauled miles of endless ropes with plodding second-motion steam engines, it was the steam winding engine that was the centre of the shaft mines. The winder's exhaust was the very heartbeat of the mine and see how quickly the manager would appear in the engine house doorway if it were to cease in working hours.

The winding engines were usually obtained from Britain, from firms such as The Grange Ironworks Durham, Grant Richie Kilmarnock, or perhaps from Walkers of Wigan. Later, there appeared some engines from Australian makers, usually second-hand from the declining gold fields, from Hopwood Foundry, Bendigo, from Walkers of Maryborough, or from the Clyde Engineering Co. in Sydney.

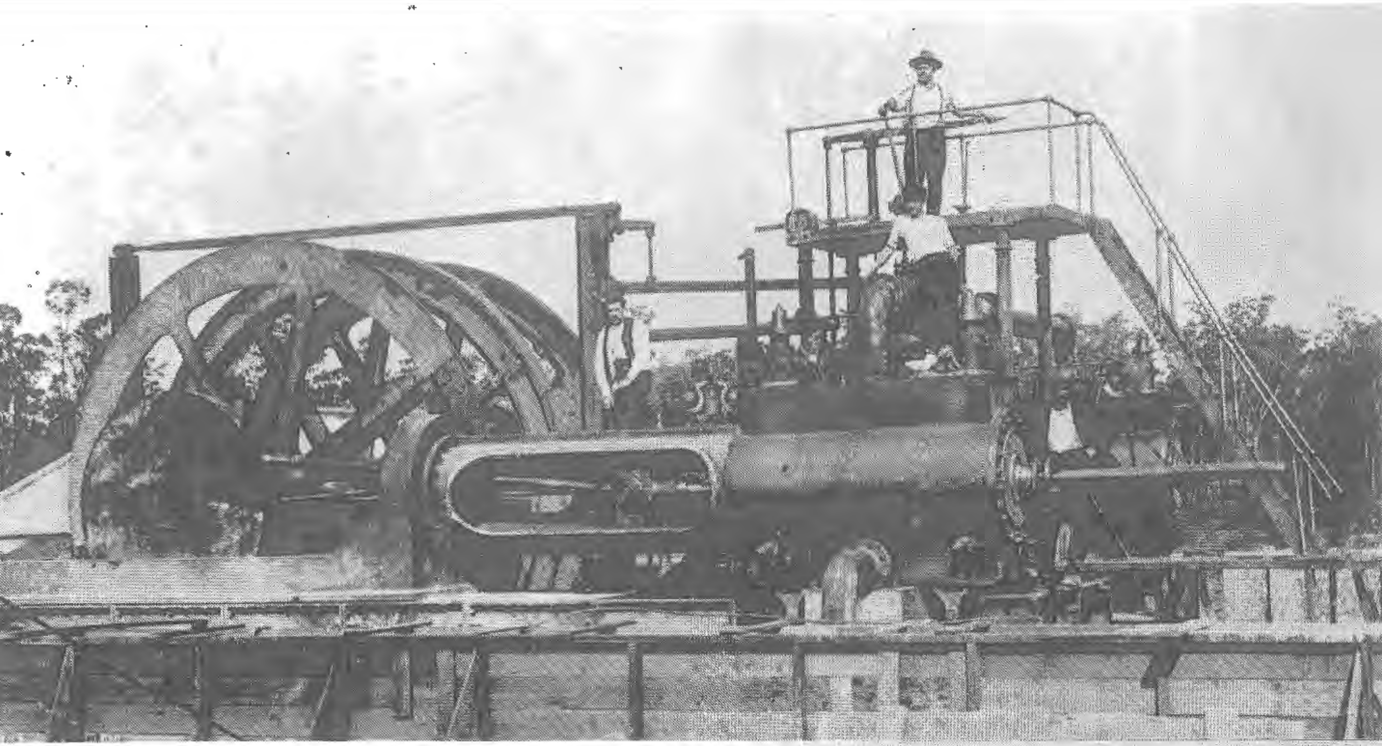
The subsidiary engines were often of local manufacture. Firms such as Goninans, Rodgers Bros. and Morison and Bearby built smaller engines of all shapes and sizes — second motion upcast shaft engines, strap rope engines, fan engines, screen engines and the like. Electric generators when they arrived, were usually contracted for, complete with a prime mover, perhaps by Bellis and Morecom, of Birmingham, Allens, of Tipton or Westinghouse from Schenectedy USA.

Virtually all have vanished. They had too great a value in cast iron and brass as scrap. Two have survived, the most significant, the Grange Ironworks main winder first installed in the Sea Pit in 1888 and later moved to Hebburn No. 2 Colliery, now lies dismantled at the Goulburn Steam Museum, far from the Coalfields. Hopefully it will be eventually re-erected and preserved. The other smaller engine, a second motion single drum winder, lies still in the derelict engine house at the Stanford Main No. 2 Colliery.

At the A.A. Coy's Sea Pit, William Turnbull (who it is said "said his prayers by Tangye Pumps and Robey Engines") installed a Robey steam main and tail haulage. It ran for 20 years till Robert Harle had it moved to the Company's new mine at Weston (Hebburn No. 1). There the engine laboured for another 50 years, overloaded by successive generations of undermanagers, drawing 20 skip trains on four miles of rope from the various underground districts, its piston speed exceeding that of an express locomotive and its exhaust rattling the windows in Weston township.

Soon after the mine was closed the engine was cut up. The ground is now levelled. Remarkably there still exists a reminder of its existence ... For the drivers who spun the throttle, stamped on the brakes and threw in the clutches (and there were few who could do the job), special rates of pay

"... and lastly in my declining years I desire to leave behind me a colliery in every way worthy of being a successor to Lambton" — Thomas Croudace writing to his Board of Directors in 1887 concerning Lambton B Pit at Redhead. Photo taken about 1890. *DM*



had been granted. Thus to this day, in the Enginedrivers' (Coal Mining) Award, amidst pay scales appropriate for Dragline Operators and Bulldozer Drivers, still the entry reads . . . Hebburn No. 1 Colliery Main Haulage: Special Rate.

The collieries' chimneys were landmarks, often in the early days they were circular and brick construction, later the square, Welsh design predominated. In the 1920's there were five large brick (and handsome) chimneys built on the Cessnock field. The Hebburn No. 2 concrete stack was the sole representative of that style. A number of mines had multiple chimneys, the most remarkable being the twin hexagonal stacks at Stanford Main No. 1. Many smaller mines had steel guyed chimneys; at Maitland Main for many years a steel stack from a Company steamship was used for the mine boilers. Nearly all boilers were handfired. Economisers and feed water heaters were usually reserved for the generating stations since economy was not as highly regarded as simplicity. After all, coal was for burning and a smoking pit chimney was the evidence of work for the mine and a full pay for the employees in the coal towns of the Hunter.

With the lifting of the A.A.Co. monopoly in 1847, chiefly following the activities of the Brothers Brown, there was renewed interest in the coal trade and a number of new mines were opened. South of Newcastle, Mitchell's Coal and Copper Company was working under Burwood Ridge and seeking to lay a wooden tramroad over the A.A.Co. land to the port. To the West the "big three", Wallsend, (opened 1860) Lambton and Waratah (opened 1863) mines were com-

menced in the virgin bush. Further afield in the west, the Browns took over the Minmi mine from the pastoralist John Eales. To the North the lone Tomago Company sank a courageously deep shaft (365 ft) to their wet and unprospected seams.

Of course the A.A.Co. was not standing still in the meantime. The A Pit on the hill overlooking Newcastle was soon to be superseded by the B Pit higher up and so on, until a string of mines dotted the plain to beyond Pit Town (Hamilton), where the H Pit (connected to the Company's older Borehole Pit) became their largest and most productive operation.

Extreme Left: A steam winder being assembled at Abermain No. 2 colliery in 1911. AS

Bottom Centre: In contrast to Lambton B: a rough early pit, probably The Dog and Rat (1867 to 1884), New Lambton.

Left: Thomas Croudace. NRL

The last and best remembered of the A.A.Co. mines in Newcastle was the New Winning, Sea Coal or Sea Pit, which was sunk in 1888 and was located along the course of Darby Street in Cooks Hill. The Sea Pit lasted till 1915 when the Company's mining activities were all moved to the Weston Estate.

Mining Railways

All of these mines had one thing in common — the necessity for the construction of railways. The coal was valuable only if it could reach the ship's side at a competitive cost and the steam railway was found to be the only practicable means of haulage. (Though indeed, the Rev. Lancelot Threlkeld, pioneer of Lake Macquarie coalfield, advocated a series of inland waterways to link the Newcastle Coalfields with the Sydney market.)

The Mining Engineers were Railway Engineers. In the Hunter there have been constructed some 75 colliery railways (exclusive of sidings direct off the main lines) and although most were built under the terms of mining leases, some required Parliamentary Acts for authority to cross surface lands.

Several of the lines were laid through most difficult country. The first railway tunnels in Australia were on the Coal and Copper Co.'s line from the Junction to Smelter's Beach. Other more substantial tunnels were driven on the Redhead and Richmond Vale railways.

Over all the lines ran the private coal waggons, the earliest being box waggons, comprising a frame carrying twin square coal boxes which could be tipped on a staith or lifted free by cranes. Their replacement began in 1865 when Thomas Croudace of the Lambton mine imported the first of the hopper waggons which eventually became such a familiar sight throughout the lines and sidings of the Hunter.

Peculiar to the Newcastle district the coal hoppers were crude, unspectacular and vital. Each one bore the arcane letters denoting the owning mine and they often as a group represented the largest item of capital of a coal company. At one time there were more than 10,000 of them in service. The hoppers were the means of storing coal against the varying demand caused by shipping delays in the days of sail; they were a rolling stockpile, until the Basin Loader spelled their doom in 1977. By 1982 a single fleet operated on the Minmi line between Stockrington Colliery and the coal preparation plant at Hexham.

To haul this mighty army of vehicles there were, of course, steam locomotives. Many mines depended on the Government Railways for their shunting and traction, but a number of mines used their own motive power. It is probable that, in all, some 100 private engines have been involved in coal mine railways in the Hunter.

A bullock team hauling sinking equipment to Elrington Colliery in 1924. *AS*

The colliery locomotive came in all shapes and sizes, from the quaint grotesque of Howley's "Coffee-Pot" (an ex tram motor) to John Brown's handsome Great Central designs (ex British Army). All but a very few came from Britain, from Beyer Peacock, Kitson, Avonside or Manning Wardle as the main builders. One indeed was built locally in Newcastle.

Perhaps it was appropriate that the last engine to be imported from R.W. Stephenson and Hawthorne, arrived in 1955 at Hebburn Colliery, the eventual successor to the A.A.Co., which had started all this locomotive business with its two Manning Wardle well-tank engines back in 1857.

Of all machinery from a bygone era, steam locomotives have survived best. Still hauled by locomotives designed for the East Greta Coal Mining Company in 1910, coal trains worked from Hexham to Stockrington and from East Greta Junction to the Cessnock mines into 1982. Their old boss, St. Vincent Heyes would have been proud of them . . . Rodolph St. Vincent Heyes was engineer at East Greta Colliery when the Company realised that their railway with its coal, passenger and goods traffic over two lines was as profitable as was their coal business and on the retirement of the original manager Thomas, he was made Railway Superintendent whilst Henry Morgan Williams became Colliery Superintendent. The East Greta line was one of four which operated passenger trains. The Seaham/West Wallsend Joint line, the Redhead Estate line and the Minmi Railway also at various times ran services to the mining communities associated with their collieries.

By the time that the Government Homebush to Waratah Railway arrived at its northern destination in 1889, the Redhead Coal Co. branch line

to the Dudley area (through Fernleigh Tunnel) was almost complete. This line served a rich coal bearing area south of the Glenrock Lagoon and soon a number of mines were being opened. The Burwood Coal Co. (successor to the Coal and Copper Co.) sank their Nos. 3 and 4 shafts and were thus able to abandon the line alongside the Smelter's Beach which had become expensive to maintain. Burwood Extended (a separate company) opened at Redhead in 1891 - South Burwood (again a new company) at Dudley commenced in 1892 whilst Thomas Croudace and his son Frank began sinking a new mine for the Scottish Australian Co. and gave it the name of Durham Colliery, later to be changed to Lambton B.

A similar branch line was built about the same time from the main line at Cockle Creek to the West Wallsend area where the collieries at West Wallsend, West Wallsend Extended (Killingworth), Seaham No. 1 and Seaham No. 2 were established and the flourishing group of satellite towns, eventually connected to Newcastle by Australia's longest tramway service, came into being.

Other mines at Cardiff and Teralba were opened, now that there was rail access, and the Bryant and Trummer Pits at Fassifern commenced their fruitless search for Borehole coal, the deepest sinking to this date.

Shaft Sinking

Most of these new mines were shaft mines, the better seams lay deeper now. The Mining Engineer sank shafts as part of his trade, supervising the itinerant sinking gangs (akin to the earlier railway navvies) through their "master sinker".

On the Newcastle field the average depth of shaft was about 500 to 600 ft. As the mines moved towards the deeper Greta Measures deeper shafts were sunk with Aberdare South bottoming on the coal at 1,400 ft. in 1910. The average depth by that time would have been 900 to 1,000 ft.

Shaft sinking in the delta of the Hunter River — Hetton Colliery, 1887.

Note the cast-iron tubbing in the gantry. The ships are moored at The Dyke. *AS*

Virtually all major shafts were circular in section. Many were brick lined, (where possible, mines set up a brick pit and kiln on the lease before commencing to sink), although cast iron tubbing rings were used in the shafts sunk in the water-bearing sand of the Newcastle coastal flats.

Hebburn No. 2 and Elrington Colliery shafts (1918 and 1925) were lined with concrete. After Elrington virtually no shaft sinking took place until the revival of the 1950's and from that time on all shafts were lined with concrete.

Towards the end of the 1870s the strata underlying the Hunter River Delta was prospected and it was realised that the Borehole Seam persisted under the river and harbour to outcrop in the area of Fullerton Cove.

Soon after, the exploitation of this submarine coal was commenced and the so called "Delta Pits" came into being.

There were some heroic sinking at the Delta Mines, the first, Ferndale, was brought into production in 1877, then at Stockton Colliery in 1883 Contractor Rossiter and the manager Johnathon Dixon used weighted iron caissons to descend through the running sand to bedrock. Nearby at Hetton Colliery (1887) William Thornton and Arthur Mathieson employed a similar method but had to resort to excavation of the spoil by helmet divers.

With this type of work extreme care was necessary to control the ponderous weights of the tubbing and to ensure that the shaft lining descended truly vertical.

At the Durham upcast shaft away at Redhead the Croudaces had the misfortune to have the caisson deviate out of line, despite considerable work with screw jacks and packing. Not dismayed, they sank a smaller cylinder inside the original and continued the job to a successful conclusion. The shaft is still in use in 1982.

Colliery shafts were often given names. Otherwise by tradition they were "A" shaft and "B" shaft. In some cases the names indicated the purpose of the shaft . . . Water Pit, Furnace Pit and Traction Pit and Minmi; in other cases events are commemorated by the Jubilee Shaft and by the Centennial Shaft both at Wallsend . . . Charles' Pit and Stewart's Pit were in all possibility named after the manager or the sinker, whilst the derivation of Blue Gum Creek Shaft and Flaggy Creek Shaft is self evident. When John Fallins of BHP Collieries had the Burwood Colliery cross measure drift driven in 1939, it signalled the end of the shaft era. The drift was fitted with the pioneer main haulage conveyor belt and allowed access to several seams. It closed, together with the shaft commenced in 1888 during October 1982.

The surface remains of many of the mine shafts still exist for the finding. Many can be located in the bush between Wallsend and Minmi, some there have been put to a later use as ventilation or pumping entries to Wallsend Borehole and to Gretley Collieries. The most accessible and one of the more historic is the Wallsend Colliery "B" Pit close to the township while the Jubilee and "C" Pits can still be discovered some distance away.

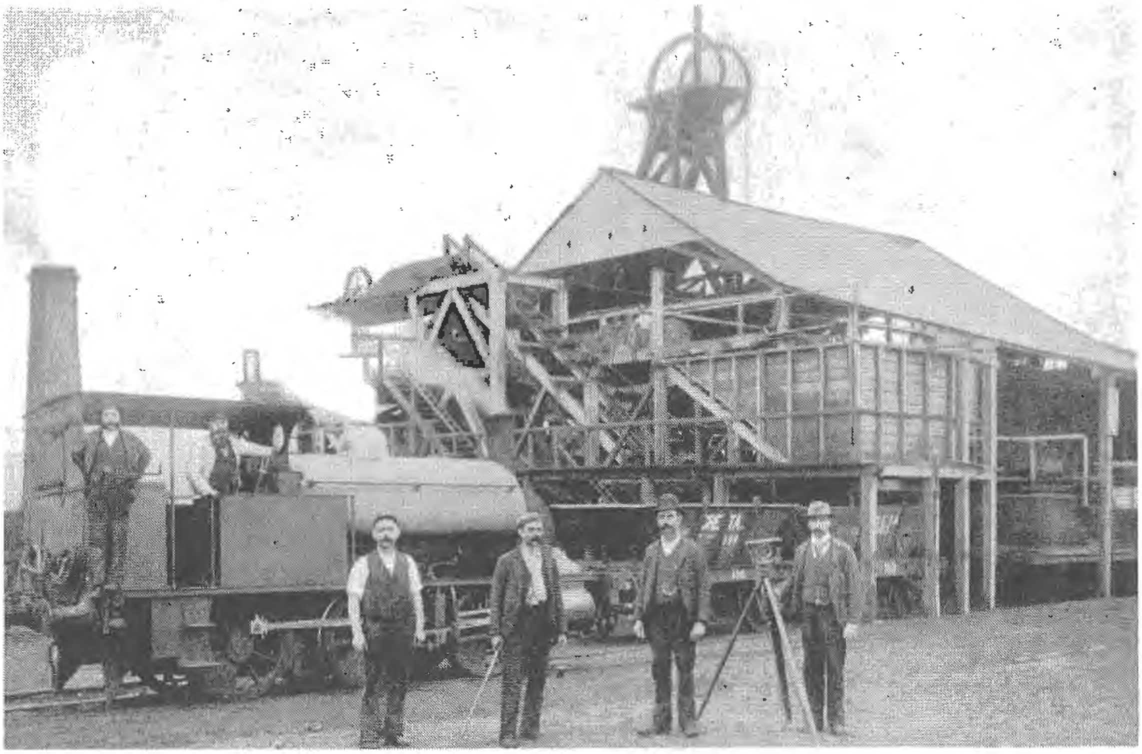
Development Up The Valley

Whilst extensive development was taking place on the Newcastle area, exploration and exploitation continued further up the Valley. On his property near Leconfield west of Maitland, a landowner, The Hon. E. Vickery discovered shale and coal and in 1880 he began a mine in nearby Greta, the commencement of a remarkable if short lived venture.

The success of Greta Colliery was due to the manager Dr. James R.M. Robertson who took up duties in 1882. In the short period before he handed over to Professor Benton in 1888, he had introduced the most modern and innovative methods and machines to suit the peculiar needs of working the Greta Seam, differing in many respects from the seams in the Newcastle Measures. Shafts and drifts were sunk, numerous wire rope haulages installed and inclines with self-acting jigs driven to deal with the steep grades. Compressed air powered the underground coal cutting machines and also a Stanley heading machine, forerunner of the modern continuous miner. On the surface a narrow gauge steam tram way linked the remote outcrops and a steam driven fan and a coal washing plant were constructed.

Though the mine was to be abandoned following a major, fatal fire in 1900, such enterprise had by then made it one of the leading undertakings in the district. Many of the methods of working were to later be used to exploit the South Maitland field. Robertson was a leading member of his profession, he sat on several enquiries and was a foundation member of the Northern Engineering Institute, as indeed were many of his coal mining colleagues of the day. He was Consulting Engineer to several large collieries, in particular, to Killingworth, Dudley, Redhead and Seaham.

Greta Colliery, 1890s, with the Engineer, the Under-manager, the Manager and the Surveyor. *DM*



Left: Men who participated in recovery operations after the Bellbird Disaster, 1923, with "proto" breathing sets.

Below: After the explosion at West Wallsend II Pit, 1979.

Mine Ventilation

The 34 ft. Guibal steam fan at Greta was the second to be installed, the A. A. Co. had also put a Guibal of 30 ft. diameter, into their Hamilton complex at the "G" Pit, it was their pride and joy and a showpiece throughout the district. Before long most progressive companies had replaced or supplemented their ventilation furnaces with steam fans, initially slow running, large diameter Guibal or Waddel fans with direct connected, horizontal steam engines, later came the smaller, faster, Walker and Schiel fans, usually driven by vertical engines or electric motors via cotton mulit ropes. The eventual most popular type of mine fan was the Sirrocco, though most were replaced by smaller axial flow units by the 1980's.

Maintaining adequate underground ventilation 24 hours a day consumed more energy than any other coal mining process. It was also the most essential responsibility of the Mining Engineer. The Hunter district contained a number of mines with a moderate make of flammable gas which could lead to dangerous situations in case of inefficient ventilation and the purpose-built fan houses became a conspicuous part of the mines' surface landscape.

Fan houses were usually of brick, they contained shutters to allow reversal of ventilation if required and relief panels to protect the machinery from underground blast waves. They were usually surmounted by an air chimney or an evasee.

In 1982, original fan buildings survive in use at Burwood and Lambton Collieries whilst significant examples survive disused at Paxton, Pelton and Stockrington Collieries.

Less evident are the complex remains of the underground furnaces. Constructed like subterranean brick-kilns, with great bricklaying skill, remains are disclosed in pillar extraction from time to time. Furnaces, and the last was in use till the late 1940s, were not as dangerous as the layman may imagine and many gassy mines were ventilated with safety for years by their induced draught. However they were inefficient in fuel and manpower and their ventilating power varied with climatic conditions.

Mining Accidents

The sinking of the Delta Pits had been difficult. No less hazardous were their working lives. All had major creeps and most had fires. Ferndale

Colliery was flooded and totally lost in 1886. One miner was drowned and there were many narrow escapes. A major tragedy took place at Stockton Colliery when an undetected fire deep in the wastes led to a series of mis-adventures and the loss of 11 lives. A monument to the heroism of the rescue party still stands, sadly neglected, close to the Stockton ocean beach.

Other mines had their disasters and their heroes. In a terrible earth movement in the 1880s at the Hamilton Pit a number of workers were entombed. Despite all efforts, some bodies were not recovered for months. Men were killed in the fire at Greta and by explosions at Burwood, Dudley, Redhead, Stanford Merthyr, Rothbury and Bellbird Collieries.

In all such incidents, Mining Engineers were in the forefront of rescue and recovery work. They not only took a personal part, they always remained in overall charge and alone bore the burden of responsibility.

Nor were they found wanting. John Brown, manager of Aberdare Colliery had hurried to Bellbird and offered his services in the 1923 explosion. A rescue party set off down the mine. The men they sought were dead before they set out and the group was cut off by subsequent blasts. Brown perished and his companions barely escaped alive — they reached the surface by back roadways, cutting through the mortar in brick walls with a pen knife to escape.

Loss of life was not uncommon in mines. There were fatal accidents at virtually all collieries, usually involving falls of ground, machinery or explosives. Managers were closer to the "firing line" than most other professions and the mine managers at Pelaw Main, North Wallarah, Aberdare South, Lily Rose and Dagworth Greta Collieries all lost their lives in the course of their duties.

At the big fire at Aberdare Central in 1944, Frederick Hemmingway, the manager, was carried down in the cage on a stretcher. He had been seriously injured in an earlier rescue. He supervised an attempt, in vain as it proved, to save the horses. The mine was soon to be sealed at the surface, the fire out of control. The subsequent reclamation work, carried out by teams wearing breathing apparatus and which involved the men working for several years under the most arduous and dangerous conditions, is an epic in its own right, a tribute to the courage of the workmen, the ability of the Manager and the determination of the Caledonian Company.

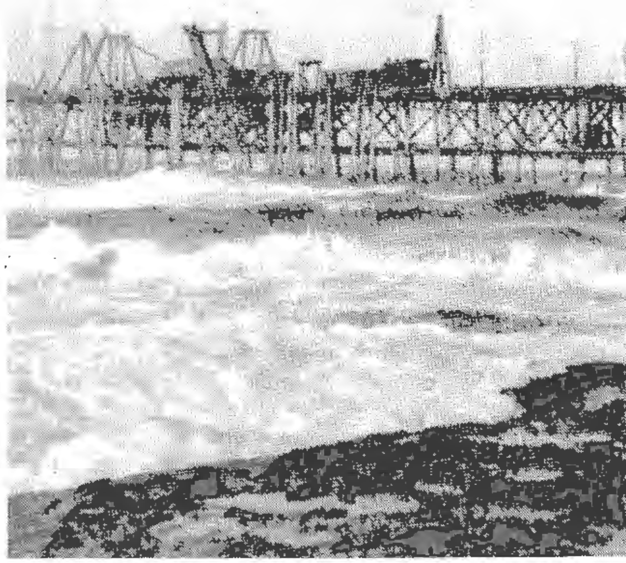
James Mathieson, at Bellbird, had been the first to use breathing apparatus men (Protomen). They recovered Bellbird Colliery back in 1924. Of necessity Mathieson had had to import the apparatus and instruct men in its use. The nine months' work, retrieving the bodies, filling out hot coal and re-timbering roadways was done without untoward incident. His proud teams were the forerunners of the Rescue Corpsmen, recruited when the British system of Mines Rescue Stations was required of the Colliery Owners. Rescue Stations, still in use, were built at Abermain and Boolaroo in 1926. From that time onwards, colliery managers were prominent in serving as volunteer mine rescue trainees.

Southern Outpost

Eventually, Singleton and then Muswellbrook succeeded Greta as the northern-most of Hunter Valley coalfields; the southern extent of the field was for many years marked by Wallarah Colliery — in splendid isolation at Catherine Hill Bay on the seafront south of Swansea.

Commenced in coal outcropping on the beach, the Wallarah mine (first known as the Newcastle New Wallsend Colliery) lingered for want of capital, until 1888, when a British shipping company, seeking independent supplies of bunkering coal, formed the Wallarah Coal Company and sent Thomas Parton from South Staffordshire to open its mine.

Under his supervision, with Joseph Sperring as his undermanager, work proceeded apace, tunnels were driven further inland, railways laid to con-



nect them and a substantial jetty was constructed. Soon coal was being taken by the Company's own steamers to the Sydney bunkering trade.

Eventually a little world developed, virtually isolated (it was accessible only by ship or launch till the late 1920s), with its own twin villages (Mine Camp and Middle Camp), jetty, railway, mines, sawmill and electric power plant.

To the South Maitland Field

With the success of the Greta mine and the geological exploration of the Greta Seam by Edgeworth David in 1886 it was not long before capital was devoted to the exploitation of the South Maitland Coalfields. The East Greta Company had been formed by local businessmen and they had taken up holdings on a prime portion of the seam and close to the main line railway.

In 1888, Azariah Thomas, who had experience in steep seam work in America, was engaged to develop the mines. He sank inclines down the 45-degree grade and installed jig carriages and other appliances to work them. Horse worked, a short branch railway was connected to the Government line.

By 1900, there were two East Greta Mines at work, the railway, now running its own steam locomotives was being extended to the Company's new Stanford Merthyr Mine. Soon after when the new railway was serving East Greta, Heddon Greta, Stanford Merthyr and Pelaw Main Collieries, negotiations were commenced with other mine owners so that their Aberdare railway could be connected to the East Greta line at Aberdare Junction and run south to the new Hebburn, Abermain, Neath and Aberdare properties. The South Maitland Railways Pty. Limited took over the East Greta Railway in 1918.

Whilst the interest in the new field had been slow to develop, by 1900 most of the older Newcastle coal companies realised that as their mine depleted, their survival depended on a move to a new area. Most chose to move to the Cessnock field (as the area was also to become known), a few relocated elsewhere.

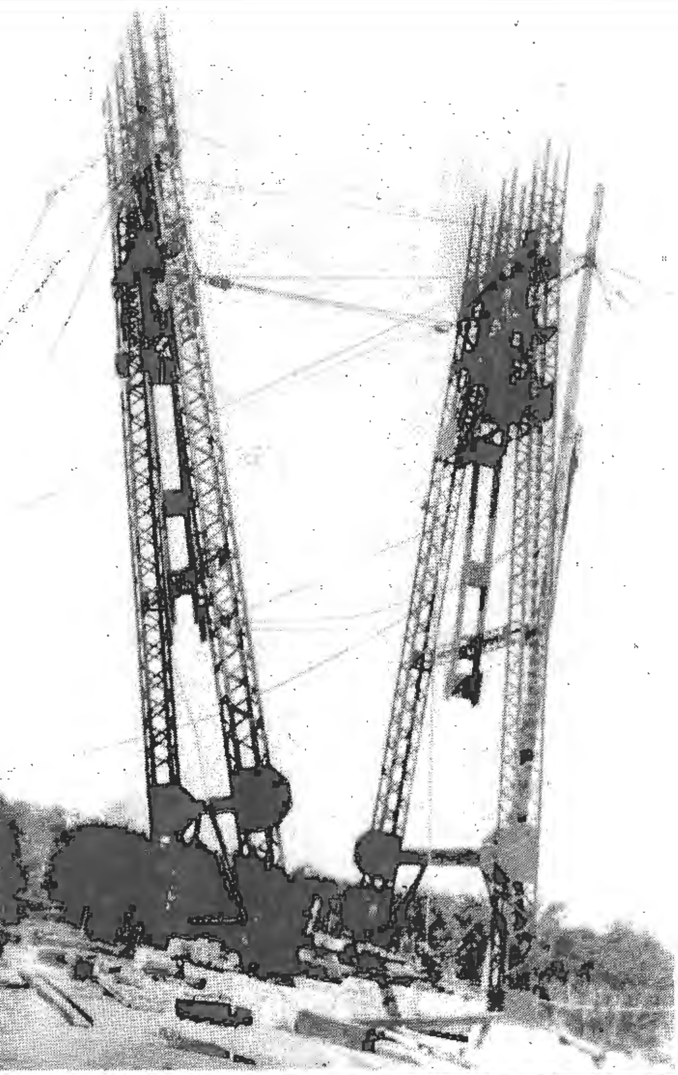
Thus in 1901, the A.A.Co. sent Robert Harle to develop the Hebburn property. He took one look at the country around Weston and decided to reside in Maitland, travelling to the mine site by train. The Seaham Company merged with the new Abermain Coal Company who had employed Joshua Jefferies from Greta and eventually developed three large mines, connected to the Abermain siding by their own railway. In 1905, Jones, from the Wickham and Bullock Island Coal Company arrived and took up leases to sink the Neath Colliery. Robert Kelsick selected the Aberdare shaft site for the Caledonian Coal Company in the best textbook manner, one third up from the dip side of the property. Having proved excellent coal with his shaft mine he then drove the tunnels at the Extended mine, the screen building situated almost in the main street of the new boom town, Cessnock.

Farther afield on Bellbird Creek, Arthur Mathieson took time off from running the Hetton Colliery to commence Hetton Extended in 1909. He handed the management of the mine over to his son, James and the name Bellbird Colliery was adopted soon after.

The Newcastle Coal Mining Company, with a change of name, tried their luck at Whitburn close to the now-sealed Greta venture.

Browns had bought Pelaw Main Colliery at Kurri in 1900. John Brown, son of Alexander, was now in control of the firm. Astute in business dealings and no less competent in technical matters, he decided to move in to the South Maitland field on a large scale. The undeveloped Richmond Vale Colliery was acquired and Brown quietly sought permission to extend the Minmi Railway through the Bluegum Hills to the mine site.

The 60-miler Wallarah *almost aground on Catherine Hill Bay Beach. Only concerted effort by the crew and mineworkers saved the ship by using the ship's gear to haul from the bow and the colliery's locomotive to pull from the jetty.* *AD*



The headframe of Cessnock No. 1 Colliery at Kalingo being raised by wire ropes and blocks from a gyn pole, 1923. *AWS*

The wealth of the South Maitland coalfield — the coalface at Stanford Merthyr, 1905. *DM*

Despite opposition from other mine owners and the Railway Commissioners, he opened the new Richmond Vale Railway in 1905 and soon had it connected through to Pelaw Main. This proved to be a most successful combination of mine and railway and the Browns were able to finance the Richmond Main Colliery from their own resources. Brown had declared that it was to be the finest mine in the State and all was laid out on the ground scale. Production commenced in 1913.

The plant at Richmond Main included a Siemens electric winder, the first in the coal industry. Also installed in the large electric generating station was the first turbine set in the industry.

Electric winders were eventually to be installed in Aberdare Central, Aberdare and Elrington before the Second War and at Kalingo and several newer mines since.

Electric Power

Very early, the Mining Engineers became Electrical Engineers. Transmission of energy for underground machinery was always a problem in coal mining. Horses, wire ropes, hydraulic power, compressed air, oil engines — and even underground steam boilers — were all tried and most were abandoned. Electricity was eventually adopted as the most safe and economical method and by 1910 most collieries had some electrical machinery in use. This was long before most other industries had ventured into this technology.

The first installation on Hunter coal mines had been put to use at the Northumberland Colliery (during the sinking of the ill-fated Trummer and Bryant Pits) by the Contractor, Crawford in 1886. The Wallarah Power House was certainly not the first electric plant, but is typical of the pioneer installations. It embodied two Babcock and Wilcox boilers, hand fired with a steel stack. The electric generator was from the United States of America, by Goodman — 100kW at 275 V.DC and driven from a horizontal McEwan steam engine by a flat belt. The plant was used to power isolated, underground pumps (gear driven tripple ram machines). When, a year or so later, Sperring, now promoted to manager, imported coal cutting machines, the new Siemens generator with its vertical direct-connected Allen steam engine was also installed in the power house building.

From the open knife switches and ceramic fuses on the marble switchboard, the current was carried into the mine by twin separate copper conductors, sheathed in natural rubber and suspended on porcelain insulators screwed to the mine props. At the bord ends, there were open fuses and knife switches in sheet metal cases and the flexible machine cables were clipped as required to the bared conductors, rubber sleeves being provided to cover the cable when no connection was being made. The face cables were suspended clear of the horse traffic by raw hide straps.

Electricity produced many problems. Through the district there were fires and sparks from open contacts and overloaded cables and there was considerable industrial opposition to the innovation. No major disaster ever arose from an electrical installation. More significant were the electric shock fatalities. For many years great interest and energy was devoted to improving the safety of electric machinery, a major step being the requirement that a qualified official should be appointed to oversee the electrical installation at each Colliery. Thus the Colliery Electrician came into being.

These men, such as Joseph Coo, Albert Cleary, Ross Doyle, Gustav Unbehan to name but a few, carried on the efforts of the pioneer engineer and by the 1960s colliery electric installations ranked alongside any in the world.

Power Generation

The Mining Engineers were also Power Plant Engineers, given their use of electric power in the days before grid supplies. At Richmond Main, two turbine sets were installed — a Parsons and a Siemens, both of 100 kVA capacity soon to be supplemented by other units till the plant (12,500kVA capacity) eventually supplied power to all of J. and A. Brown mines and to the town of Kurri. It was connected to the State grid in post war years.

Other companies followed the lead given by Browns. Bellbird Colliery with Bellis and Morcom reciprocating sets and a Curtis turbine

A large tunnel colliery, Hebburn No. 1. Coal was hauled by endless ropes in skips, which were tippled over screens into railway wagons. *DM* supplied their two mines and the local township. Hebburn No. 2 with Brown Boveri turbines (one a mixed pressure working of the steam winder exhaust) served the two Hebburn mines, Elrington Colliery and Weston town. At John Darling, B.H.P. Co. installed three reciprocating engines to send power to Burwood and Lambton collieries. Muswellbrook turbine power plant fed the two mines, the open cut and the town.

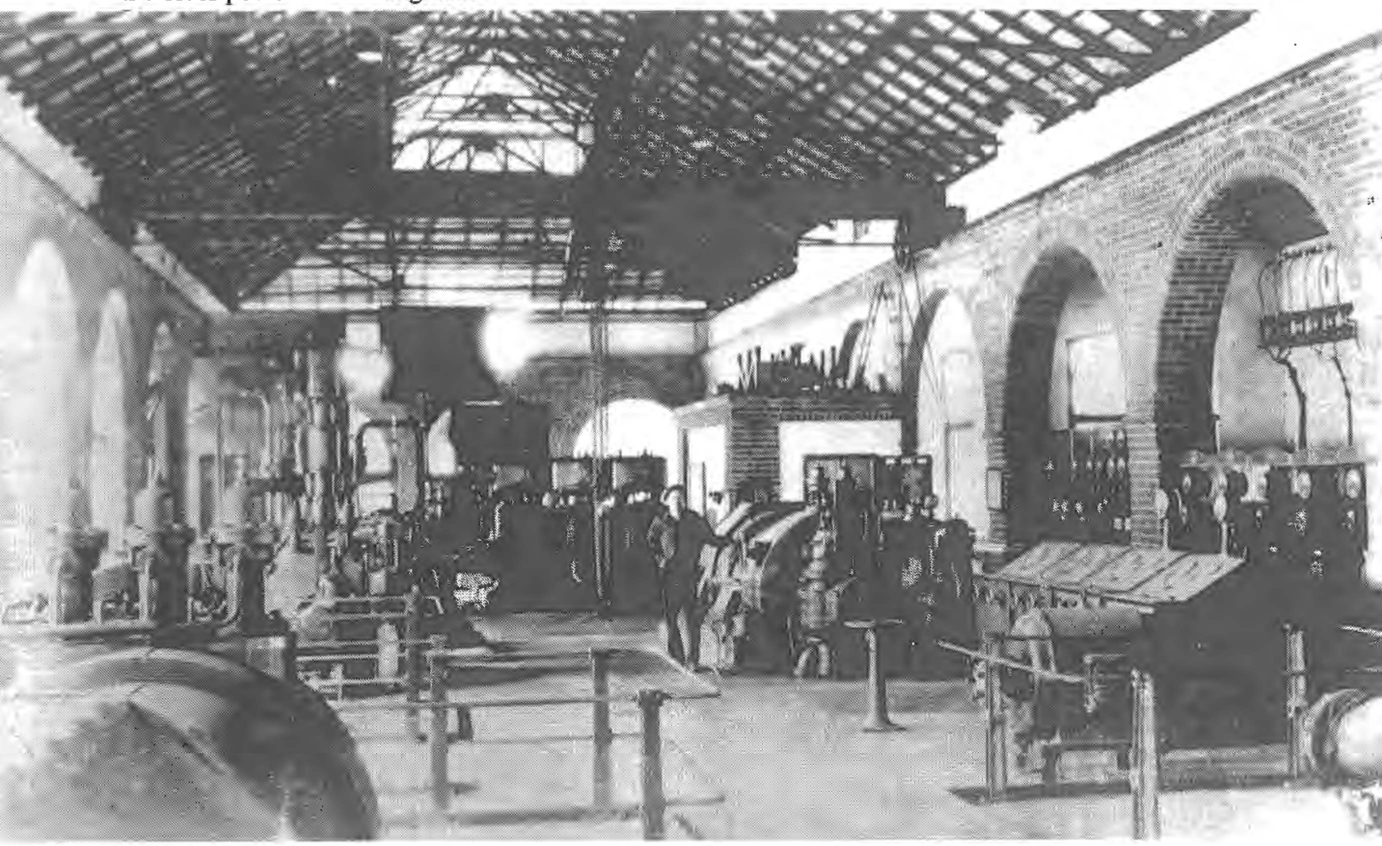
The largest company power station was at Cockle Creek. This plant had a capacity of 10,000kVA when it was built by Caledonian Collieries Limited in 1923 in the regime of Duncan McGeachie. It comprised water tube boilers and Brown Boveri turbines and supplied power via a steel tower transmission line (the first in Australia) over the range to the collieries at Cessnock and to the township itself. Eventually several towns and 17 mines were supplied. The Company maintained all reticulation, including street lighting. The eventual capacity was 13,000kVA.

When Coal and Allied Industries came into being the power stations at Richmond Main, Hebburn and Cockle Creek were interconnected but their days were almost over. The New South Wales Government did not deem it proper for private enterprise to supply electric power and legislative conditions were made difficult. At last politics and economics made the company decide to shut down their tired old machines and purchase power from the State. It would have made the older power station engineers sad to see how their plant had been allowed to run down at the end — men like Karl Reinhardt, Harold Gray, Louis Weichart and Bill Stewart. They were proud of their machinery. Although colliery power stations could not now compete in the days of multi-megawatt efficiencies they provided cheap (Caledonian power was the cheapest sold on the mainland for many years) and reliable power at the time it was otherwise unavailable.

The Richmond Main powerhouse, alone, remains. Hopefully, it will become part of a mining museum complex if finance and interest are forthcoming.

In the short boom period following the First War, the remaining mines in the Cessnock field were opened — Aberdare Central (Caledonian Collieries) 1914; Pelton (Newcastle Wallsend) 1916; Hebburn No. 2 (A.A.Co.) 1918; Cessnock No. 1 (Wickham and Bullock Island Co.) 1922; Stanford Main No. 2 (East Greta Co.) 1923 and finally in 1925, Elrington Colliery (B.H.P./ Hebburn consortium).

And Elrington was to be the last mine of any size opened for many a year. The dark days of the Depression and the "Lockout" were upon the coal industry. There was a nation wide drop in the demand for coal. Export trade had vanished during the war. Wage reductions led to inevitable industrial confrontation. Many mines were closed and many more were put on a care-and-maintenance basis.



On the Newcastle field there was little growth. Only John Darling Colliery was sunk by the B.H.P. in the 1920s. The B.H.P. also purchased the two Scottish Australasian Co. mines Lambton B and Burwood to ensure supplies of coking coal for their steelmaking operations.

Mechanisation

B.H.P. had joined with Hebburn in the Elrington venture to gain access to their leases via the Hebburn railway. Together with Hebburn Superintendent, Stanley B. McKensey, B.H.P. management had planned that Elrington would be the first all-mechanised colliery, the operation of the mine was to be in the hands of Hebburn officials with George Hindmarsh as manager. Though Elrington never reached its planned potential due to drop in demand for Greta Seam coal, the colliery led the way in many technical innovations.

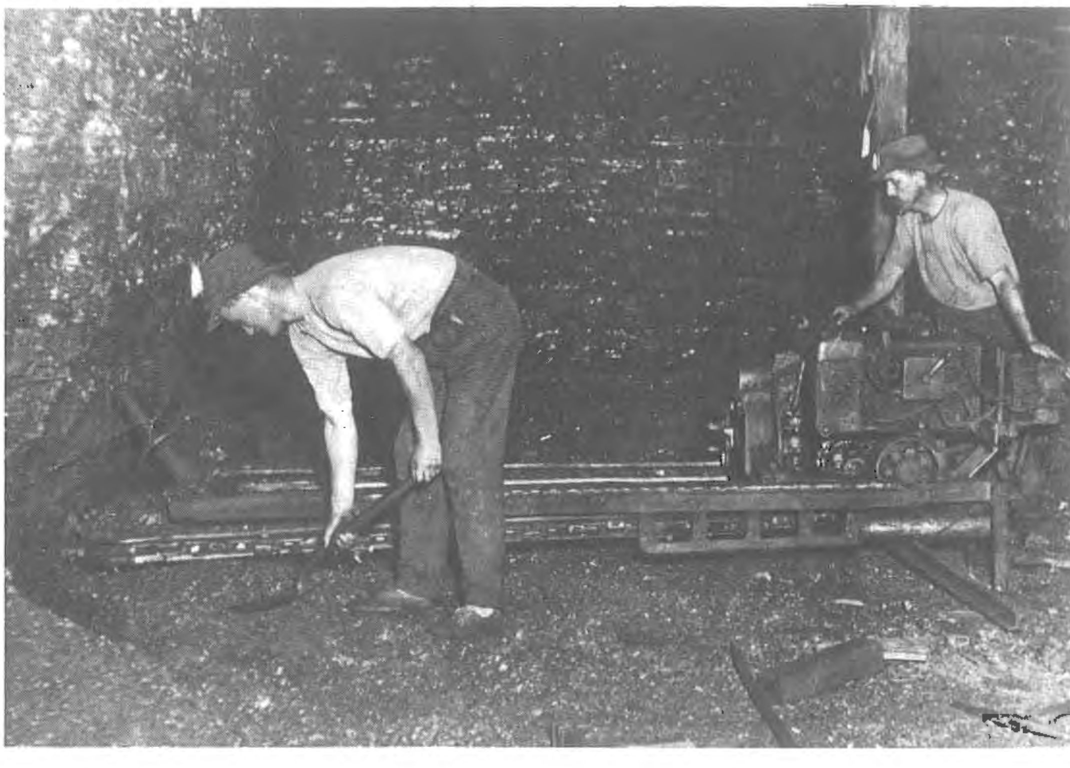
There had been many earlier attempts to introduce underground mechanisation. Coal under-cutting, a brutal task if performed by hand, yet essential for the safe and efficient "shooting" of the coal face, had been mechanised as early as 1890 by compressed air coal-cutting machines at Hetton, Greta and Lambton collieries. Soon other managers followed and by 1900 both compressed air and electric coal cutters were in common use. Electric machines proved to be more suitable, moreover, electricity could readily be adapted to numerous other tasks so the compressed air machines vanished from all but a few mines. They remained at Pelaw Main and Richmond Main till the late 1950s.

Both British and American coal cutting machines were used. Generally known as "machines" and their operators as "machinemen" they operated under conditions hardly imaginable to their designers. Acid water corroded metals. Sleeved bearings ground out in the abrasive dusts. They worked on gradients till the oil ran out of the gearcases — in wet places where the water leaked in — in places where the rats ate the leather seals. With forged picks blunted in just one shift of cutting, the recalcitrant machines were urged on by hammer blows from insensitive operators. Nevertheless the engineers persisted. Better seals were developed at Rhondda Colliery, roller races replaced sleeve bearings. Hebburn introduced tungsten tipped cutter picks. Monel metal was also pioneered at Hebburn for its acid resistant quality. And from all these trials, failures and successes, the present day underground machines were evolved.

Elrington had been equipped early in its life with cutters, loaders, mine cars and locomotives. There had been other mechanisation projects coincident with Elrington, one by Fallins at Lambton B Colliery for the BHP Co. and one by James Johnstone at Abermain No. 2 for J. and A. Brown in 1938. The three mines successfully proved the practicability of machine mining before the Second War. But union pressure on a short-sighted Government prevailed and mechanisation was restricted to "first workings". Thus, formed pillars had to be hand mined, even in mechanised collieries, despite proven higher accident rates and greater cost for hand work. The loss of coal from crush and heatings was enormous and most companies found their reserves seriously depreciated.

Left: The power house at Hebburn No. 2, in 1931 during "The Lockout". *AWS*

Right: A Goodman electric coal cutter in the early 1900s. *DM*



Skip and set rider at Wallarah Colliery. Rope haulage continued in mines until the 1960s. *AD*

The Joint Coal Board

By the end of the war in 1945, the coal industry was in a sorry state. The mines had operated through the war at a profit. At that time equipment was not available for replacement and development. Now there was no incentive for reinvestment in a turbulent industry. A fragile industrial peace had been bought by appeasement. The nation suffered its first great energy crisis. A Commonwealth Coal Commission had been set up towards the end of the war to oversee the coal mines. This legislation now lapsed and State and Commonwealth Governments made a combined approach to seek the rationalisation of the coal industry, essential for the Nation's post-war recovery. And so, in 1945 the Joint Coal Board was brought into being, with Robert P. Jack as Mining Member and Alan W. Shoebridge as Chief Engineer. The way to rehabilitation and a modern industry was opened.

The Joint Coal Board encouraged, cajoled and coerced the mining companies to modernise and mechanise their mines. Free technical advice was provided by the Board (it often went unheeded) and when capital was not forthcoming, machinery could be made available on lease. Repayments were made by a special increase on the selling price of the coal.

Under the aegis of the Joint Coal Board, several new mines were opened. These were all fully mechanised, trackless (that is without rail track) and used conveyors for haulage. The largest was Newstan Colliery (on the site of the old Northumberland Colliery) which opened in 1950 with James Johnstone Jnr. as manager. Wallarah Colliery had used trackless loading machines since the 1930s but they loaded into conventional rail skips.

About this time (in 1947) the State Government opened their second State Coal Mine (the first was in Lithgow) several miles further South. Awaba was to supply coal to the Wangi Power Station, the first colliery/power station combination and forerunner of things to come.

At Awaba, Milton Mathieson (third generation Manager) laid out his mine for rail mounted haulage with trolley wire locomotives.

Haulage

Underground haulage was a field peculiar to the Mining Engineer, there was little in surface practice from which he could seek guidance. The first miners moved coal by sled or basket, then by wheelbarrow. By the time the A.A.Co. mines were commenced, wheeled trolleys or "skips", were carrying coal, running on wooden rails. Skips of about one ton capacity became the norm for the next 100 years. By the end of the 1950s when skip haulage was in decline, the vehicles were designed the same as their ancestors. Some were steel bodied "dreadnaughts", with a capacity of 30 cwt; otherwise the fixed wheels, cast iron bearings and chain couplings were all the same. At the workface, men pushed, coped and slewed the skips over face rails — crushed hands, broken ribs and hernias being all part of the job.

Horses — and there were thousands of them, all named, stabled, shod and cared for; (sentiment aside they were a necessary link in the production chain and a valuable capital item on the mine books) — provided the first motive power. Usually, "wheeling" horses drew the coal over temporary track "face rails", from the miners' work places to the "driving flat". From here the "sidling" or "driving" horses ran short trains over branch line rails to the "clipping" or "haulage" flat. At this point, youthful "clippers" attached the skips to the wire ropes for their subterranean journey to the pit bottom, or the tunnel mouth.

Wire ropes provided the main mechanical traction source throughout most mines. The rope haulages were an art in themselves — complicated paraphenalia to draw coal trains on narrow gauge tracks ("engine planes") through miles of roadways, up and down grades, round curves, all out of sight of man. All the tommy-dodds, return wheels, side rollers, skid rails, chuck-ons, greasers, star rollers and the like . . . all the hundreds of miles of ropes, long-spliced and lubricated . . . all now a technology which has vanished and is virtually forgotten. The last coal hauled by rope was from Bellbird Colliery in 1976.

There were some huge installations, Richmond Main, for instance, had four big electric haulages. There they were known as "motors". They fed the pit bottom and the double deck cages ... The Main West Motor ... The East Dips Motor and the North East and The Stone Drive Motors ... and each had one or two subsidiary haulages and rope systems feeding onto it.

Underground locomotive coal haulage had a short reign. As mentioned above, Mathieson laid out a large trolley wire system at Awaba. Arthur Donne set up a similar haulage method at Stockrington No. 3 Colliery a year or so later and these two systems were the sole survivors into 1982. Other mines with trolley wire powered locomotives were Burwood, Lambton, John Darling and Rhondda. Diesels were used briefly at Cessnock No. 1 and at Stockton Borehole Colliery whilst a number of mines, in particular Hebburn No. 2, Elrington and Stanford Main No. 2 operated with battery locomotives.

An Era Ends

All this was to virtually vanish overnight in the face of a new technology ... belt conveyors. At about the same time, by the end of the 1960s, many coal customers, harrassed by decades of strikes and indifferent coal quality and in the belief that oil prices would remain low, had made alternative decisions. The locomotive trade, the gas market and the bunkering of ships also vanished to alternate technology.

Mines were closed, the first to go were the smaller ventures, "rat holes" some called them, that had opened on the outcrops in times of coal demand, mines such as Beltop, Ajax, Elermore and Rathluba. One or two of these small mines had been mechanised and, eventually, became producers of some consequence, Bloomfield, Buchanan, Liddell. Those mines which were too old or too difficult to justify this investment — Waratah, Pelaw Main, Hebburn No. 1, Milfield etc. — were also closed.

Technical changes came fast as the 1970s arrived. Underground, the cutter/loader units were replaced by continuous miners (first put in to Newstan Colliery by Johnston in the 1950s). Battery shuttle cars gave way to cable powered cars with four wheel drive and steer. Trunk belt systems replaced all but a very few rail haulages

The greatest revolution was in strata control. Use of roof bolt techniques, pioneered at Elrington by the McKenseys (father and sons) was refined to suit varying working practices and soon roof bolts provided almost all face area support. Combined with modifications and innovations in pillar extraction methods (such as the BHP shortwall at the three coastal mines) this made possible optimum extraction of coal with safety and productivity that would have been considered impossible a few years earlier.

Inclined drifts replaced all the existing Newcastle area shafts, though two new bulk coal winding shafts were commissioned at Newstan and Newvale No. 2. Diesel machinery was introduced underground, with undue haste in hindsight, and much was subsequently withdrawn.

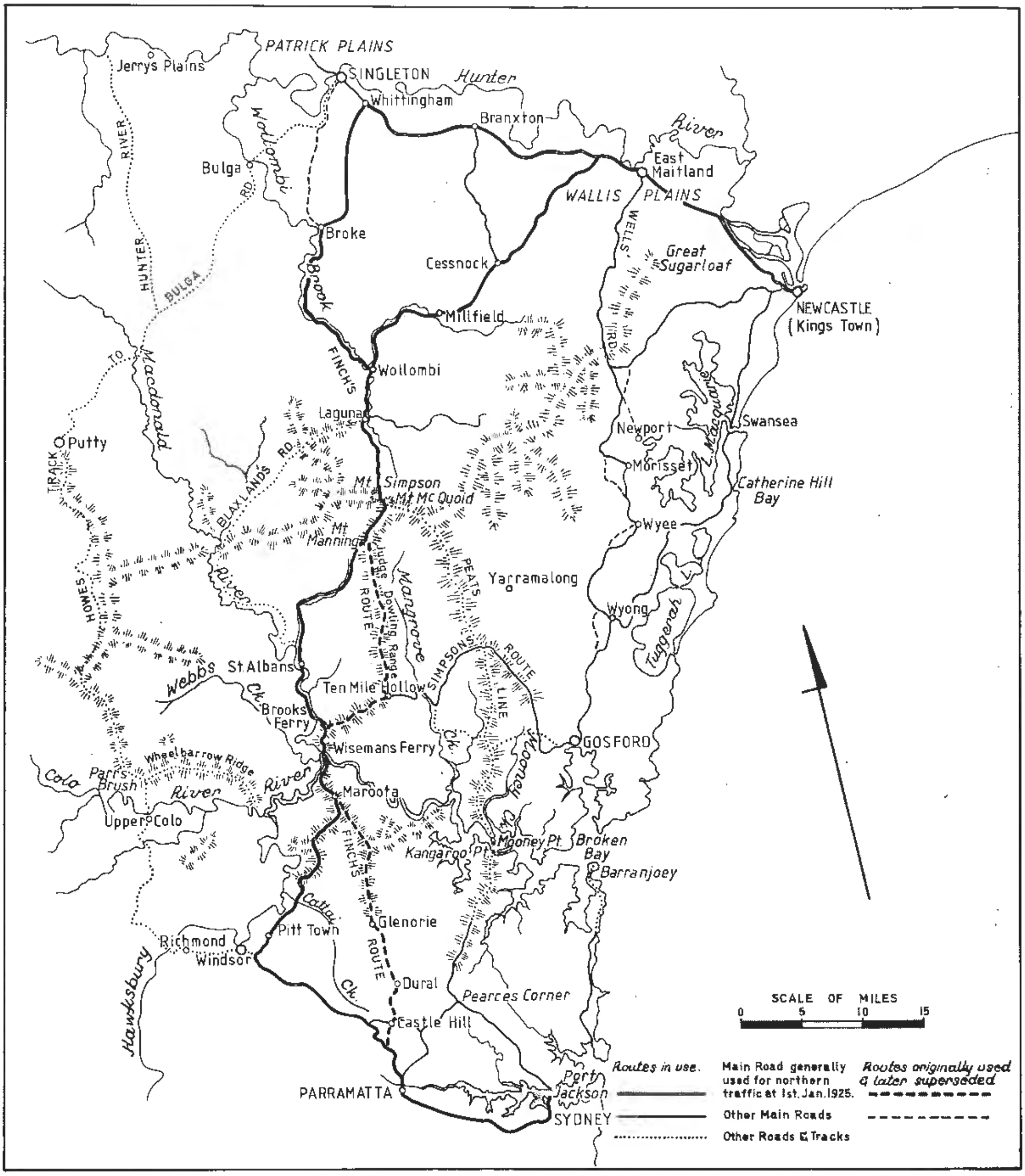
By the 1970s the South Maitland field was almost moribund.

The future lay in other areas ... to the South of Lake Macquarie where Electricity Commission mines fed deep won coal to the two large power stations. And in the Upper Hunter, in the Singleton/Muswellbrook area where multi seam open cutting was possible.

Open cuts had been pioneered by Gibson at Muswellbrook before the second war and the Singleton area was not a new field. Indeed it was from Singleton, at Rix's Creek Colliery that the Longworth Brothers had begun their coal and copper mining empire, which for a brief period, had rivalled even that of the Brown family.

Longwall mining was yet to come, after the downturn of the 1960s, mining was by the end of the 1970s becoming a sought after career, Mining Engineering graduates again began to seek practical experience to qualify them for statutory certificates.

For by now the whole aspect of Mining Engineering as a career had changed due to the changes in the industry . . . the competitive requirements of the export markets . . . the increasing capital cost of coal mine development and equipment . . . the growth of corporate structure and new accounting procedures in mining enterprises and the availability of specialist services, geological, geophysical and the like. No longer was the Colliery Manager often the sole professional engineer; whilst retaining the ultimate responsibility for the safe and efficient running of the mine he has become part of the corporate professional team with readily available specialist services in the fields of geology, geophysics, mine planning, mechanical engineering, electrical engineering, coal preparations . . . even in environmental rehabilitation.



A map showing the routes of main roads leading from Sydney northwards at January 1, 1925, together with other northern roads and tracks used from the commencement of the Colony of New South Wales. DMR

A TALE OF THE TRAILS

Main Road Development

by Arvo Tinni

Land Access To The Valley

Access to the convict settlement at Newcastle was supposedly by sea only. However, from time to time convicts escaped and made their way back to Sydney overland. It can be assumed that details of routes were not secured from the escapees and, therefore, were not recorded.

The first serious attempt to discover a route from Sydney District to the Hunter River Valley was made by Benjamin Singleton, who set out from Windsor with a party in 1818. Singleton failed to reach the Hunter, mainly because his provisions were getting low and he was uncertain about how he would be treated by natives. The natives, however, told him about a big river to the north, which must have been the Hunter. Singleton kept a journal during the expedition, which he forwarded to Governor Macquarie. Apparently this proved of sufficient interest to Macquarie for him to direct that a further expedition be undertaken to open up a track to the North.

The Bulga Road

On October 24, 1819, John Howe, Chief Constable at Windsor, set out with six others to find a route to the North. It is highly probable that he followed Singleton's track and was assisted by information given to him by Singleton. The expedition crossed the Colo River near its junction with the Hawkesbury, followed the ridge dividing the Colo River from Webbs Creek (Wheelbarrow Ridge) to Parr's Brush, then proceeded generally in a northerly direction to the Hunter River, which was reached on November 5, not far from the present township of Jerry's Plains.

John Howe had arrived in Sydney in 1802 in the ship Coromandel with his wife and two daughters. He was then 28 years old. He settled in Windsor and became a farmer, road and bridge builder, ferrymaster, storekeeper and auctioneer. He was also the Chief Constable for Windsor and later Coroner for that District.

Under instructions from the Governor, he made two subsequent expeditions north of Sydney. He reached the Hunter River again on March 15, 1820, at a point below that reached on the first expedition. He then proceeded downstream and reached Patrick Plains (now Singleton) on March 17. He named the locality Saint Patrick Plains in honour of the day he discovered it. He explored the river as far as Wallis Plains (now Maitland).

It is probably the case that his final journey proceeded along what is now the Comleroy Road, fording the Colo just above its tidal influence. On his return journey, when crossing the lower part of Wollombi Brook near Bulga, he named the stream Cockfighter Creek because a horse of that name was bogged during the crossing.

In 1822, Howe was given a grant of 700 acres (as a reward) on the eastern side of Singleton. He named it Redbournberry after his home town in Lincolnshire.

Howe's Track, later known as Bulga Road, was formally opened to the public by the following notice appearing in the Sydney Gazette on March 6, 1823:

> *"The road from Richmond to Wallis Plains is open for the public. A written permit must, however, be obtained from this Office (Colonial Secretary's) designating the brands of animals proposed to be driven; enumerating their numbers; and naming the individuals intended to accompany them together with the ships that they came by; the indulgences (if any) that they possess; and*

Section of the old road to the north — Ten Mile Hollow. *DMR* *specifying the days during which this journey will be accomplished."*

Available evidence tends to show that nothing was done to render this road trafficable for vehicles until after other lines of communication had been established. Thus, in his book *Two Years in New South Wales,* published in 1827, Surgeon P. Cunningham described the access to "The Settlement of Hunter's River" as follows:

"By land you proceed either by way of Windsor or Richmond. From Windsor to Patrick's Plains, on Hunter's River, is a distance of seventy miles (113km) in a direct line, but nearly ninety miles (145km) when following the convolutions of the road, which is as yet but a rugged bridle path over the mountainous ridge called Bulga, quite unfit to take even an empty cart by. Patrick's Plains, again, are twenty miles (32km) away from Wallis Plains, the head of loaded boat navigation, and forty miles (64km) from the town of Newcastle, at the outlet of Hunter's River on the sea coast. By the circuitous route of Windsor, therefore, Patrick's Plains are upwards of one hundred and twenty miles (193km) from Sydney, but a practicable route for a road has been surveyed direct from Parramatta thither, which will reduce the distance to Sydney upwards of thirty miles (48 km), crossing the Hawkesbury low down by a punt."

It is doubtful that Howe's Track had any work, other than some clearing, done in its early days and it was used only by the more venturesome of those who journeyed north to take up land along the Hunter River. It was not passable by drays and over sections was no more than a bridle track. As the number of settlers in the Hunter Valley grew they began to agitate for a shorter and easier route to Sydney.

The present day Main Road 503 (Windsor - Putty - Singleton), which was built during the Second World War follows the general line of Howe's route for the greater part of its length.

Parson's Road

In 1821, Rev. G.A. Middleton drove 173 head of cattle following the MacDonald River. As John Blaxland marked the trees along the route, it also became known as Blaxland's Road. It was hoped that it may become a stock route in the future. The route is roundabout and a little-used, mountainous, bridle path. No wheels have ever turned on the greatest part of its length. The distance from Newcastle to Windsor via this route was 169 miles (272km).

The *Sydney Gazette* of May 1, 1823, reported that Major Morisset, Garrison Commander at Newcastle, had arrived in Windsor after a most fatiguing journey of 169 miles, which had occupied nine days. Owing to the mountainous terrain, it was believed that extreme difficulty would be experienced in effecting an inland communication with the Hunter River along this route.

By inference, it appears that Major Morisset used Blaxland's route for at least part of the way.

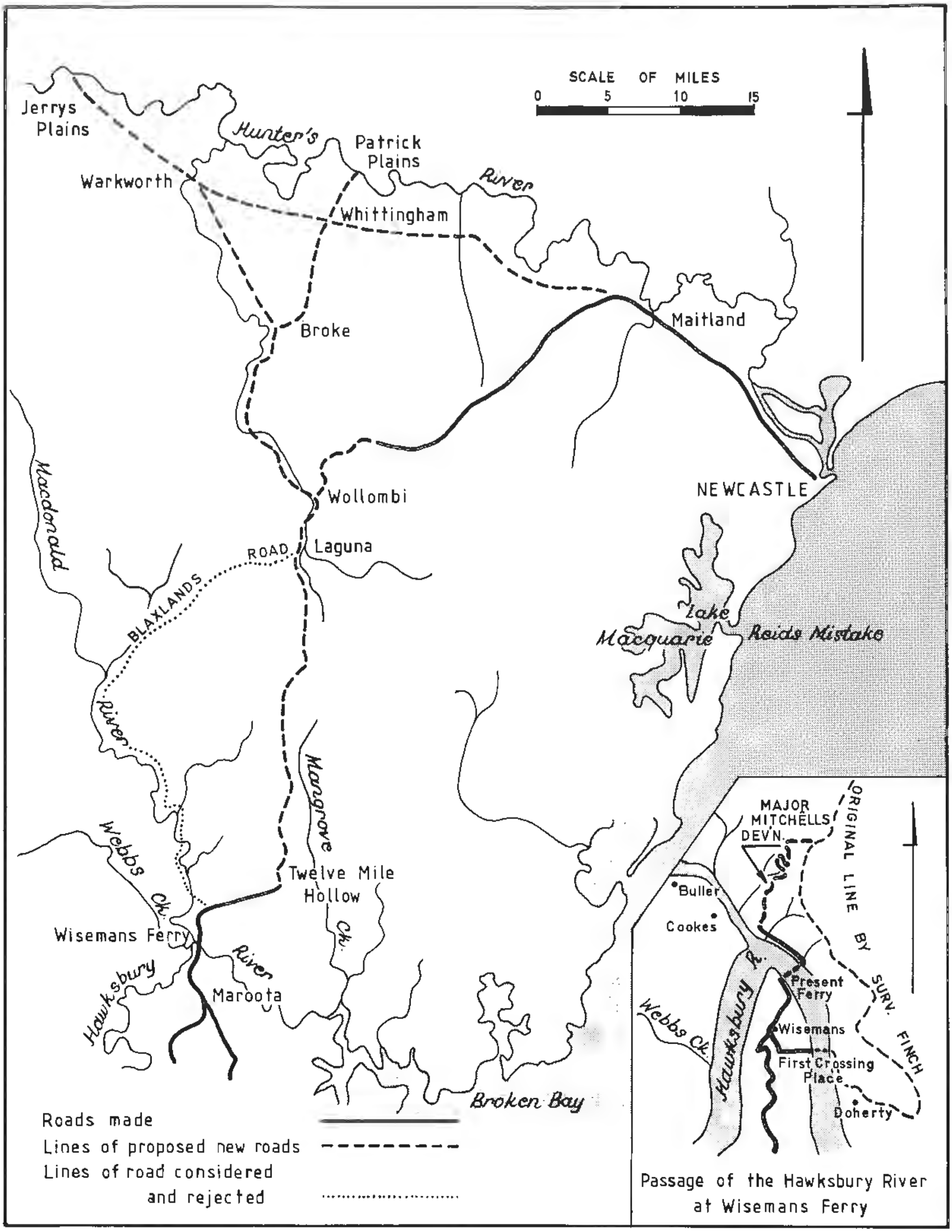
The Great North Road

As a result of agitation and petitions by the settlers, Sir Thomas Brisbane, the Governor in 1825, issued instructions to Mr. Assistant Surveyor Heneage Finch to carry out a survey with the view of finding a better route. By September, Finch had succeeded in locating a ridge leading from Castle Hill, which is 19 miles (30km) west of Sydney on the Windsor Road, to Wiseman's Farm on the Hawkesbury River. The line crossed the river about two km below the present ferry site, ascended the main range on the northern side of the river and followed the crest of Judge Dowling's Range to the head of Wollombi Brook. Except for one or two alterations in line, the present Main Road 181 (Wiseman's Ferry - Wollombi - Singleton) follows closely the line surveyed by Finch.

Hunter River settlers requested the opening of a road on the line marked out by Finch and in May, 1826, Captain William Dumaresq, Inspector or Roads, accompanied by John Oxley, inspected the route between Wallis Plains and Solomon Wiseman's Punt and reported favourably. The construction was commenced under Captain Dumaresq. Dumaresq also adopted a deviation suggested by William MacDonald, prior to him becoming the chieftain of a legendary band of bushrangers. On the route Finch established a farm of 1,000 acres (400ha) which he called Laguna.

The ascent on the northern side of the Hawkesbury River was steep and difficult and, after inspection, Governor Darling instructed the Surveyor General, (Major Thomas Mitchell) to locate a better route. Mitchell's Line shortened the road by 2¾ miles (4½km) and also relocated the ferry site to approximately the present position.

Construction of the road from Dural to Wiseman's was completed in 1830, but the road was trafficable to the Hawkesbury by March, 1828. Construction on the northern side of the river was commenced in 1827 and was trafficable by 1830.



A map showing existing tracks and roads in 1829 and additional roads then proposed. *DMR*

Even with the improvement obtained on the northern side by the deviation, the work in the approaches to the river on both sides was of a particularly arduous and difficult character. In places the road was hewn out of the solid rock and for long lengths on the steep sidelong ground stone retaining walls were erected to support it. The walls were built of massive blocks of stone and the good state of preservation in which they remain today testifies to the skill and labour then employed. It is evident that the work of constructing the road, which was carried out by convicts in irons under the direction of Mr. Percy Simpson, was pressed forward with all speed. At one stage as many as 520 convicts were employed on it.

In May, 1829, the Governor directed Major Mitchell to go firm on the route from Twelve Mile Hollow (now called Ten Mile Hollow) to Wallis Plains. In accordance with these instructions, the Surveyor-General made a general survey of the country between the Hawkesbury River and the Hunter River and located what he considered to be the best line for the road. The route avoided the steep undulations along the summit of the range and followed the slopes wherever an advantage was to be gained thereby.

The map on page 59 has been prepared from a sketch drawn by Major Mitchell to illustrate his report, dated October, 1829. Note that the road from Sydney to Twelve (now Ten) Mile Hollow, a distance of about 60 miles (47km) had already been constructed, as had the road from Maitland to within about 10 miles (16km) of Young Wiseman's (near Wollombi). Mitchell stated that the intervening length required only to be cleared, except for a few places (which he indicated) where construction would be necessary.

It was further proposed that the Great North Road should continue from Wollombi through Broke and Patrick's Plains "to the upper districts of Hunter's River." The surveys for this extension were completed in 1829 and the line as located by Major Mitchell was adopted. The lines shown on the sketch as Blaxland's Road and Simpson's Road (so described by Mitchell) were also considered as possible through routes but were rejected. According to early official returns of Public Works in New South Wales, construction of the road from "Dural to Wiseman's" (commenced 1826) and "Wiseman's to Newcastle" (commenced 1827) was finished in 1830. The distance was about 146 miles (235km).

In the year 1830 then — and for some time thereafter — the route of the main road from Sydney to Newcastle (as shown on page 56) passed through Parramatta, Castle Hill, Wiseman's Ferry, Ten Mile Hollow and Wollombi, from which the "Great North Road" led onto Patrick's Plains (Singleton) and the Upper North Road" led onto Patrick's Plains (Singleton) and the Upper Hunter.

Solomon Wiseman's grant on the Hawkesbury was dated June 30, 1823, but he was in residence and had licensed premises there as early as 1821. It is highly probable that land communication between Windsor and Wiseman's had been effected before the opening of the road to Parramatta to Wiseman's. The needs of local traffic along the road doubtless led to its steady improvement, while the total absence of settlement between Glenorie and Maroota may have been responsible for the neglect of that section of the "Great North Road". Whatever the cause, the road from Windsor to Wiseman's Ferry gradually superseded the one from Parramatta. The latter was ultimately abandoned as a through road and the Glenorie-Maroota section fell into disuse altogether.

From 1830 onwards settlers took up farms along the McDonald River. In the early days the only access was by water as far as St. Albans. Later, a track was opened to the "Great North Road" at Wiseman's. When the track was surveyed by Mr. Surveyor Pitt in 1864 it was still a bridle track. From then, it was gradually improved to carry vehicular traffic. A track from St. Albans northerly to Mt. Manning was likewise improved to serve the settlers along Wallambine Creek. It was reported to the Engineer-in-Chief of Roads in June, 1881 that "the road was well nigh formed throughout these roads". In his minute of June 29, 1881, he states: "this road will ere long be the main line of communication between Wiseman's Ferry and Wollombi". It appears as if the road through St. Albans was being preferred then to the direct road along Judge Dowling's Range. The distance between the two places was only four miles longer than by the main road. The 44 miles (71km) barren and practically uninhabited country along the latter route offered little attraction to the slow moving traffic of those days. It received little or no maintenance from the time of its construction and fell into disuse after the formal opening of the St. Albans Road in 1884.

Thus, the main road to the north became: Windsor, Wiseman's ferry, St. Albans and through Wollombi, resulting in a distance of 165 miles (266km) from Sydney to Newcastle. This was still the situation when the Main Roads Board was established in 1925.

The original basalt slab table drain in the Great North Road at First Moonbi Hill. *DMR*

Other Northern Road Connections

In 1932 the *New South Wales Calendar and Directory* described a road from Bulgowlah to Burrenjuey and also a road from Brisbane Water to Mailtand, with a branch to Newcastle:

> *"This track may be considered a continuation of the coast track northerly from Sydney. From Burrenjuey, the head of Pittwater, there is a ferry across Broken Bay to the head of Brisbane Water (Gosford?), the distance being 10 miles (16km)."*

It would appear that the track was the forerunner of the main road between Gosford and Maitland. It also mentions that "from Twelve Mile Hollow a branch road may be made easterly to Brisbane Water in 20 miles (32km)." However, this track was not surveyed until 1871. It is not in use anymore.

Even though a number of attempts were made to open up the coastal strip north of Sydney, George Peat did not establish a ferry service across the Hawkesbury River until 1844. Five years later the Deputy Surveyor-General, Captain Parry personally surveyed the line from Peat's Ferry to Wollombi. It would appear that the road was started, but never finished, due probably to the opposition of Sir Thomas Mitchell, who had never shown any enthusiasm for the scheme. The proposed route can be travelled today if the Pacific Highway is followed from the river to Calga, thence along State Highway 26 to Peat's Ridge and via Main Road No. 590 through Kulnura to Main Road No. 181 (the Wiseman's Ferry - Wollombi - Singleton Road) which is joined about 56km north of Wiseman's Ferry.

In 1854 the Colonial Secretary approved an expenditure of £570 per annum for the maintenance of the road to Wollombi via Peat's Ferry and for working the punt at Peat's Ferry. The route was apparently little-used and it was not thought worthwhile to make it fit for wheeled traffic. It was used only by horsemen and passage of stock. Peat's Ferry ceased to operate when the Sydney to Newcastle railway was opened in 1889.

With the introduction, and growth, of an extensive railway system, there was a corresponding diminution in the use of roads for through-traffic purposes. The importance of the roads north of Sydney dwindled to almost zero and it was not until the introduction of the motor car that brought about, once again, demand for adequate "through" roads.

Gosford To Maitland

A road from Gosford to Maitland was mentioned with some enthusiasm by *The Australian* on February 4, 1841:

> *"It is a great advantage to the inhabitants of these districts (bordering Maitland) that the new road from Maitland to Gosford, discovered by Mr. W.H. Wells, proves an excellent one. It avoids the hilly range of Wyee and the Sugar Loaf Mountain and is also shorter than the road lately in use. It is, our readers will observe, upon this new road that the town of Newport is situated, having Lake Macquarie on one side and the road on the other . . . It seems obvious that the settlers on Jerry's Plains will instead of going out of their way to Newcastle or Maitland bring down their wool to Newport direct, as shipping can lie within a cable*

length of the shore. The 'Kangaroo' will shortly be engaged to perform a trip from Sydney to Newport, passing through the straight called Reid's Mistake (Swansea Channel) and affording passengers a view almost for the first time since the existence of the colony, of Lake Macquarie in its entire beauty."

Newport was a township on Dora Creek. An advertisement for a land sale at Newport in April, 1841, after describing the beauties and advantages of the district, stated:

"The Great Gosford and Maitland New Road under a Government Surveyor, passes through the western part of the town and brings Gosford within a distance of fifteen miles (24km)."

Roads North Of Newcastle

In 1824 the Australian Agricultural Company was formed in England. It received a Royal Charter granting it one million acres stretching north east from Port Stephens to the Manning River and extending to the seas.

The headquarters of the company were located at Stroud, near the Karuah River. Subsidiary stations were established at Booral and Gloucester. Communications with Sydney was by road to Raymond Terrace and thence by the Hunter River and the sea to Sydney. The road ran through the centre of the A.A. Co's property, linking the small stations, which eventually became townships. By 1840 a well-defined road had been established.

In 1857, Captain Martindale, Commissioner for Internal Communication, published a map showing that the coast road from Raymond Terrace had been extended beyond Gloucester to Port Macquarie and Kempsey, then inland to Armidale, back to Grafton, and terminating at Casino.

In 1899 Mr. W.S. Campbell reported to the Government about activities in the Northern Rivers District, an extract from his report saying:

"Jolting along the roads for thirty or forty miles will have a tendency to knock the sentiment out of even the most enthusiastic in search of the beautiful, for the method now adopted of making roads throughout the whole district is cruel in the extreme, not only to man, but to the unfortunate horses as well."

The same comment would have been applicable to most roads in the Hunter Valley.

Establishment Of Local Road Communication

From 1813 onwards several people were permitted to occupy land at Paterson's Plains, on the left bank of the Hunter River, from Bolwarra to Phoenix Park.

In the early 1820s further land alongside the river was released to free settlers. Settlers preferred the rich soil of Wallis' Plains (now Maitland). Green Hills (now Morpeth) became the major port for ships plying between the Hunter Valley and Sydney. The Maitland areas prospered in the next 30 years, whilst Newcastle made little progress.

A footpath was blazed from Newcastle to Wallis' Plains in 1820. It followed the higher land on the river bank where practicable, but unavoidably passed through two swamps (at Ironbark Creek and Hexham) and was broken by the unbridged Wallis Creek. Traffic from Newcastle to the farms on the Hunter was chiefly by water.

By the Government and General Orders of November 24, 1812, Lieutenant Edward Charles Close, of the 48th Regiment, was appointed (on the recommendation of the commandant at Newcastle) to act as Engineer and Inspector for Public Works at the settlement of Newcastle. He was to be paid "5/- per diem (per day)." His duties were "to superintend the convicts at Newcastle, at the lumber yard, mills, pier, mines, cedar parties, lime burners, etc." He was succeeded by Lt. Thomas Valentine Blomfield at the end of 1822.

In 1822 Assistant Surveyor Henry Dangar was despatched to survey Wallis' Plains and look also for a road from the Government Township (East Maitland) towards the Paterson River.

More than 100 years old — the original convict-built retaining wall of the Great North Road, near Lochinvar. The wall still supports the New England Highway

From here land was opened up at a very fast rate. In April, 1823, only a month after the opening of Howes Track between Windsor and Patrick Plains, a new route between Maitland and Windsor was traced by Major J.T. Morisset, via Wollombi. By the end of 1823 a track suitable for drays (in dry weather) had been established from Wallis' Plains to Singleton. From Wallis Creek inland all transport was by bullock power. The original track west was along what is now Creek Road, in Maitland. It passed through the land promised to Thomas Broadman, which was later purchased by Samuel Clift in February, 1926. Clift built his first cottage beside the ferry where the successive bridges were afterwards built. The Bridge House (in existence today) was built prior to 1850.

There was a gradual improvement in the alignment of the track to the west as homesteads were established - James Glennie/Dulwich (Fal Brook - 1825), Ogilvies/Merton - 1826 etc. It ran along the general line of the present New England Highway, but on high ground to avoid swamps and thick growth.

In the same year, Assistant Surveyor Robert Dixon laid out the road from Ravensworth to Aberdeen (St. Heliers, Marsheen, Segenhoe). It is noted that the present bridge at Camberwell is 5km downstream from the old crossing at Alcorn's Inn.

A number of attempts were made to cross Campbell's Hollow (West Maitland), as drays were often held up for more than a month during floods. In November, 1833, it was reported that the bridge of "40 - 50 rods" was nearing completion. However, records show that the first Long Bridge was completed in 1840.

Many people who came to Australia to look for gold at Bathurst finally settled in the Newcastle District. Small coalmining townships were established in the bush near Newcastle. Stockton had begun to develop as early as 1834. River trade had caused the establishment of Hexham as early as 1840 and coal mining had brought development to Minmi. Waratah was in existence in 1854, Honeysuckle Point, now The Civic, by 1857, Wallsend by 1860, Lambton by 1862, Carrington (originally Onebygamba and then Bullock Island) by 1865, and New Lambton by 1869. Hamilton grew from the little settlement of Pittown, established when the A.A. Co. discovered a ten foot seam of coal at Cameron's Hill, near the present site of St. Peter's Church of England, in 1848. All of the townships had a common history of coal being discovered, pits being opened and small settlements of German brick huts developing around the pits. They were dusty little places wholly dependent on coal to give the menfolk their livelihoods. Tracks and "roads" connecting these, grew haphazardly as most followed "private" roads from the mines to the pier.

and was discovered as a result of the investigations carried out for the writing of this book. *DMR*

In 1827, Henry Dangar noted in his book that the road from Kings Town (Newcastle) to Morpeth has been in hand for some time, but latterly the work has been abandoned (said to be through lack of men).

Even though roads and streets had been surveyed in Wallis Plains by 1828, none were formed.

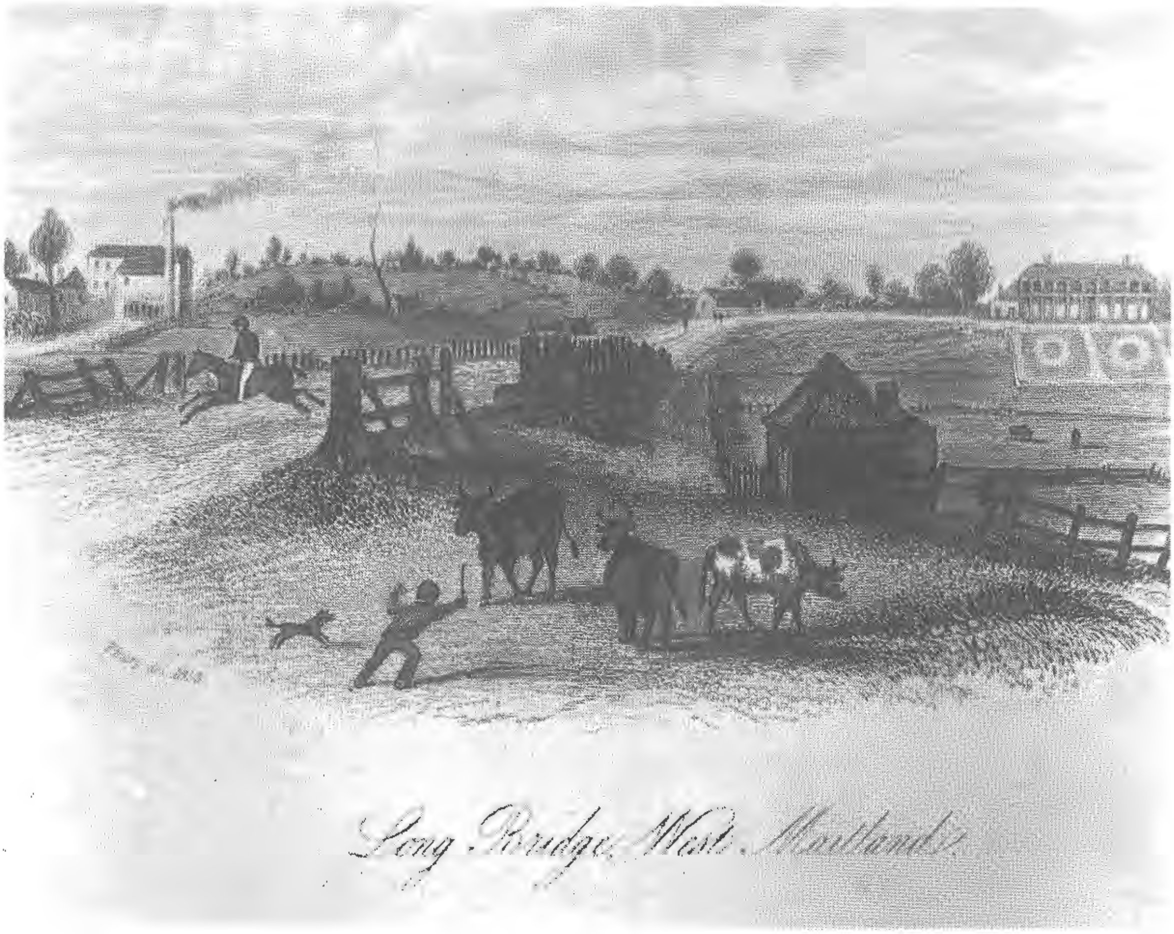
The Australian reported on March 14, 1828, that all bridges between Newcastle and the head of navigation had been completed (Throsby, Ironbark and Wallis Creeks) and considerable progress had been made building McLeod's Inn. (The latter being a requirement by the Government for allowing McLeod to build a bridge over Wallis Creek.)

On February 13, 1829, *The Australian* commented:

> *"The new line of road from Wallis' Plains to Wiseman's is a plight scarcely less miserable than the mouldering breakwater at Newcastle."*

The road which Surveyor Heneage Finch pegged in 1826 and commenced in 1827 was unfinished at the end of 1829, though almost £3,610 had been spent on the work. Some wheeled traffic got through in 1829, but it was a desperately rough passage.

A correspondent from Maitland reported in the *Sydney Gazette* on November 7, 1833:



The Long Bridge, West Maitland, 1853.

"Newcastle is truly a miserable place, where we (in the steamer) stopped for an hour . . . Between 11 and 12 o'clock we made the Green Hills — the landing place where the storeship St. Michaels lies. The road from St. Michael to Maitland, by which the Colonists bring all their luggage to and from the steamers and other vessels, is one of the worst in the Colony. It is situated on the side of a hill and really dangerous to travel in any kind of conveyance. An iron gang is now making a new road along the side of a large lagoon. . ."

Still, in April, 1832, the only completed bridge between Maitland and Upper Hunter was that over Stony Creek near Farley, serving the Wollombi Road and Major Mitchell's new alternative road to the Upper districts. Some priority programme appears to have been established as in 1833, Hawkins, the Superintendent for Roads was building bridges over Cockfighter Creek between Wollombi and Patrick's Plains.

With the opening up of many mines and the need to convey coal to the wharf, improvement of the tracks became necessary. Up to the time of incorporation of Newcastle as a Municipality in 1859, it was quite common to see bullock teams and horse teams up to the axles in sand in Hunter Street. No streets were formed. (Note that soon afterwards incorporated by the Municipalities Act were: East Maitland 1862, West Maitland 1862 and Morpeth 1865.)

As settlement spread westward from the lower Hunter Valley, so did the Great Northern Road take shape. Sir Thomas Mitchell, in his capacity as Surveyor-General, addressed the following letter to the Colonial Secretary in February, 1836:

"I have the honour to report to you, for the information of his Excellency the Governor, that the bridge over that part of Wollombi Brook which is called Cockfighter's Creek, at the point where the Great North Road unites with the road along the right bank of Hunter's River is now completed; and to acquaint you, that the next operation of importance on the Great North Road leading to Liverpool Plains is, the forming of the banks of the Hunter at Leamington Ford, and some sidecutting on the Stony Range

between the Ford and Muswell Brook, this being a work on which the labours of an ironed gang may be employed with advantage."

By 1851 the Great Northern Road had reached the Gap, two miles beyond Murrurundi.

A Select Committee which reported on the roads of the colony in 1851 (the Select Committee on the Great Leading Thoroughfares of the Colony) divided the roads into three classes:

Class 1, The main leading thoroughfares within the settled districts.
Class 2, The leading thoroughfares beyond the settled districts, subordinate to those in Class 1.
Class 3, The leading thoroughfares beyond the settled districts.

The report set out that £25 per mile was the sum to be spent on the Class 1 roads, £7 per mile on the Class 2 roads and for Class 3 "a fixed sum of £200 should be placed at the disposal of each Court of Petty Sessions, for the repair of the leading thoroughfares in their respective districts".

The Great Northern Road from Morpeth to The Gap "above Murrurundi" was included in Class 1. The recommended appropriation for each section of the road was as follows:

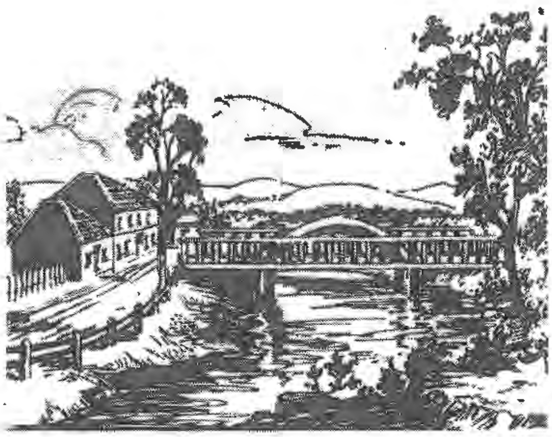
Section	Distance in miles	Rate per mile	Proposed Appropriation
		£	£
Morpeth-Singleton	33	25	825
Singleton-Muswellbrook	28	25	700
Muswellbrook-Scone	17	25	425
Scone-Murrurundi	25	25	625
Murrurundi-The Gap	2	25	50
Total	105		2,625

The road from Newcastle to Maitland did not then form part of the Great Northern Road and the road between these two towns was graded by the Committee in Class 2 at the rate per mile of £7.

Captain Martindale, R.E., who had been brought from England in 1857 as Chief Railway Commissioner, was responsible for the care of roads as well. He returned to England in 1861. During his term of office he furnished reports on the internal communication of New South Wales in 1857, 1858, 1859 and 1860.

These were most objective statements, pointing out the poor alignments, non existence of good construction and a general lack of bridging. In the case of the Great North Road, his suggested deviations between Morpeth and the Dividing Range, e.g. at Fallbrook, Muswellbrook (Black Hills), Warland's Range (where the grade was 1:4½) and Murrurundi Gap, were actually constructed. He also strongly urged bridging of the Hunter at Singleton and Aberdeen. Said Martindale in his fourth report:

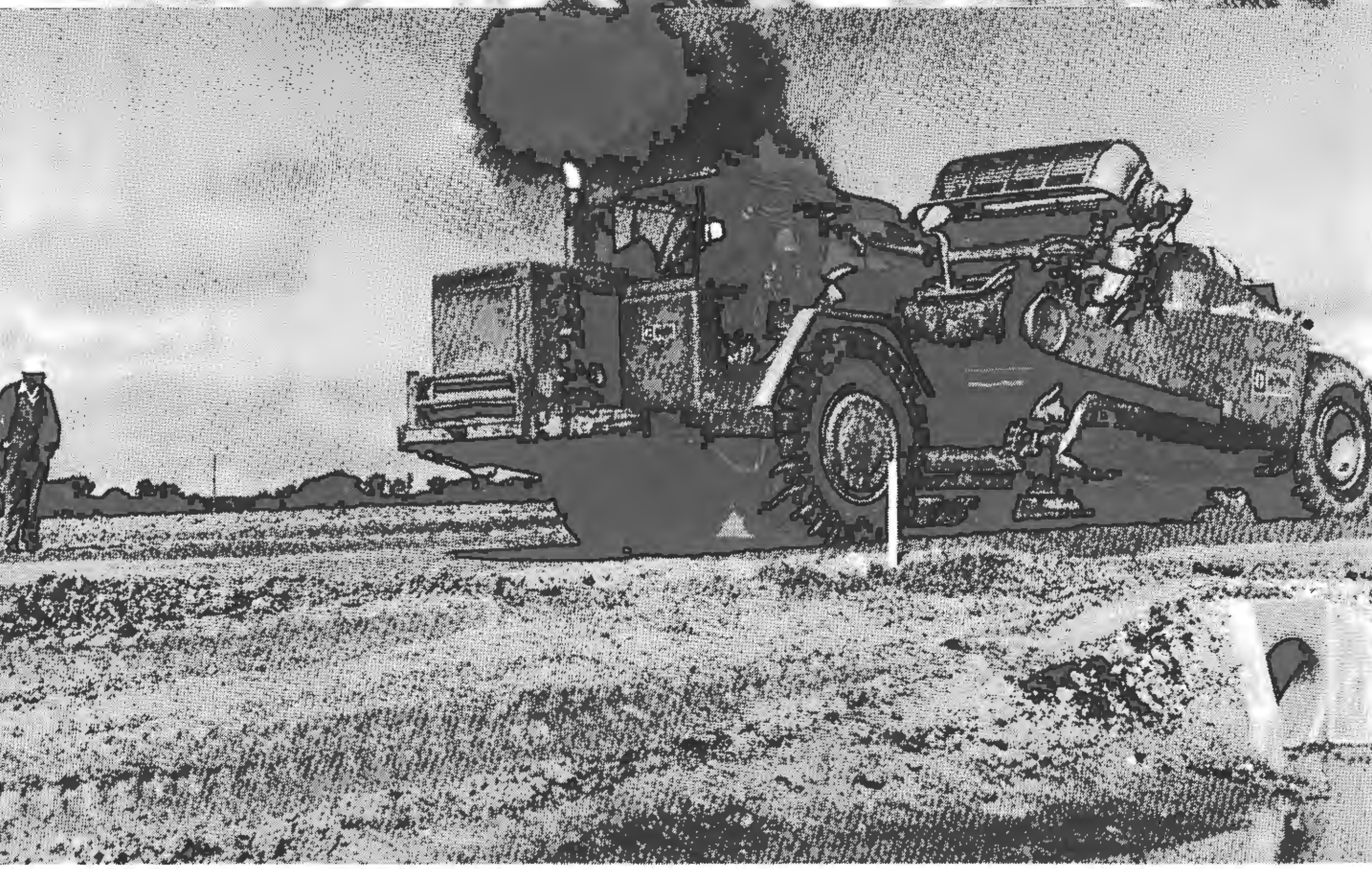
"Previous to the year 1859 there were about 40 miles (64km) of the Northern Road cleared and partially ballasted. During that year about 17½ miles (28km) were ballasted, and a considerable length of clearing and forming done. In 1860 contracts have been taken, or arrangements are in progress, for metalling six miles, ballasting 35 miles (56km) building 90 culverts and minor bridges, and reballasting nearly all the road ballasted during 1859; for forming five miles of new road near Muswellbrook, 1½ miles (2½km) on the new ascent to the Murrurundi Gap, five miles at Doughboy Hollow, and two miles (3.2km) new road at the Moonbie's Pass, which has been greatly improved. When these works have been

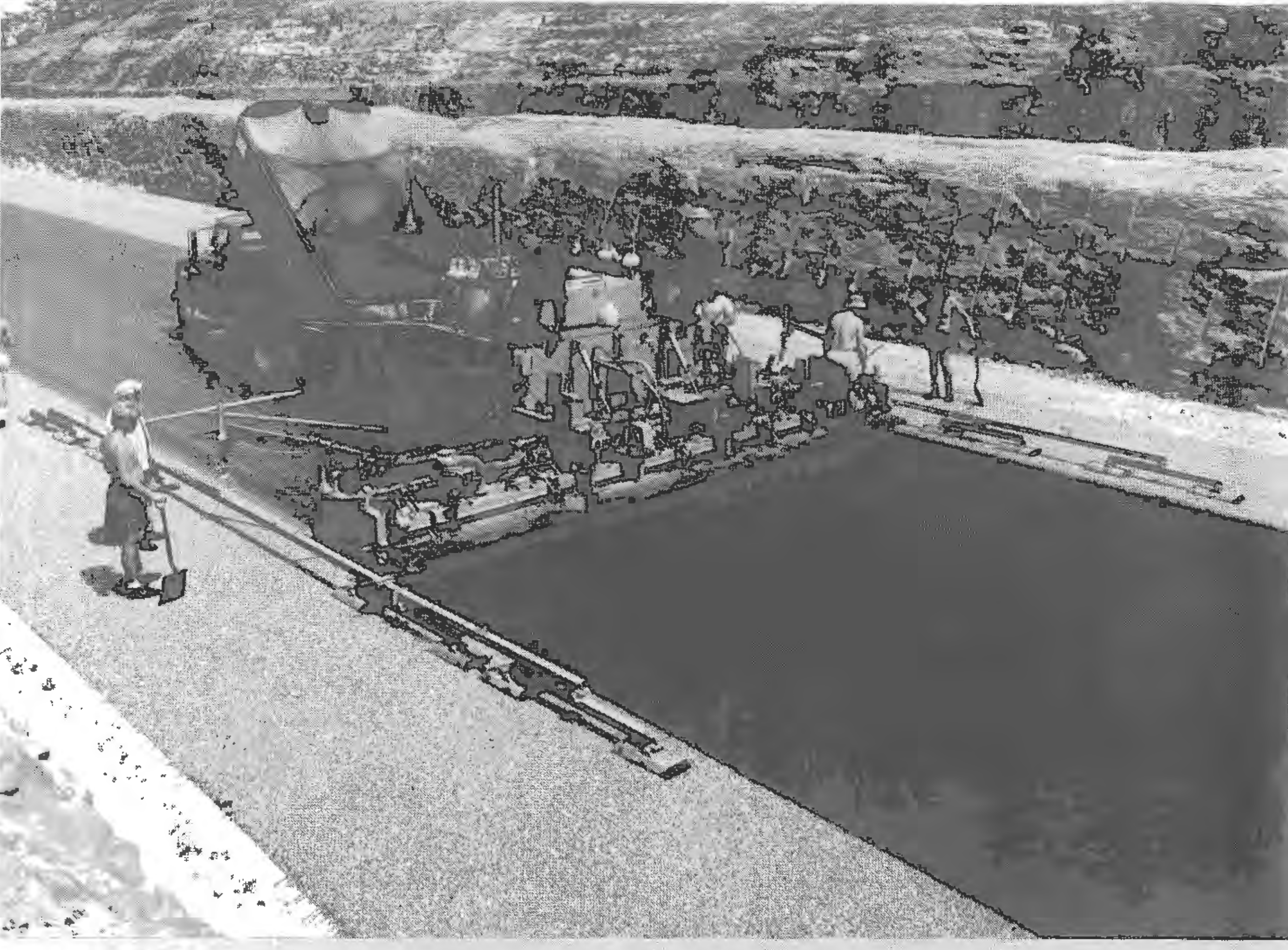


The Wallis Creek Bridge between East and West Maitland, 1873.

completed, some of the worst difficulties on the Northern Road will be overcome . . .

The object chiefly kept in view upon the Northern Road hitherto after the construction of the bridges, has been the formation of a gravel road from Morpeth to the Murrurundi Gap, which it is anticipated may, at the present rate of expenditure, be effected in 1861."





Left Top: Earthworks for the Sydney to Newcastle road under construction in 1928.
Left Bottom: The advantage of modern machines, Earthworks for the new Pacific Highway under construction by self-loading scraper, 1975.
Top: A dual-lane asphalt-paver in operation on the new Pacific Highway.
Bottom: The new Pacific Highway, of four lanes, south of Swansea. DMR

Improvement on the Northern Road was not as great, said W.C. Bennett, Commissioner and Engineer for Roads, in his *Report on the State of the Roads in the Colony of New South Wales, to 31st March, 1865,* as on other routes, since the systematic metalling of road was not begun until 1863. Bennett went on to say that improvement by 1865 was such that the mails were accelerated and were carried at night in many places, which had never been attempted in the late 1850s.

The stage reached in the development of the Great Northern Road by 1865 was as follows:

- Maitland to Morpeth - metalled. (West Maitland main Streets and Road to East Maitland were metalled in 1862.)
- Morpeth to Singleton - gravelled. The Hunter River at Singleton was bridged in 1865.
- Singleton to Muswellbrook - gravelled, except for some metalled sections where gravel was not available.
- Muswellbrook to Murrurundi - metalled, and the southern ascent of Warland's Range constructed to a width of 21 feet (6.4m). A deviation (never constructed) was suggested between Blandford and Murrurundi to skirt the Page River obviating two bridges.

The impetus of road improvements slowed down considerably during the construction of the railway north of Newcastle.

The Department of Public Works, which had been established in 1858, assumed control of roads in 1861. Its Roads and Bridges Branch designed and built numerous bridges and culverts throughout the State during the latter part of the 19th century and the early part of the 20th century.

Although bridges had been provided over the majority of the streams crossed by the Great Northern Road prior to this, it was the Public Works Department which built and re-built structures of an enduring type. Some of the bridges constructed during this period and which are still serving traffic are:

- The iron and steel bridge (Victoria Bridge) over Wallis Creek, Maitland, built in 1896 - still in use.
- The timber bridge over Glennie's Creek, north of Singleton, built in 1895.
- The timber bridge over Muscle Creek, Muswellbrook, built in 1887. A footway was added to this structure in 1897 and it was widened in 1928.
- The timber and iron bridge over the Hunter River at Aberdeen, built in 1893.

When the Local Government Act was passed in 1906, the greater part of the work carried out by the Roads and Bridges branch of the Department of Public Works was transferred to the local authorities. Public Works retained a number of the bridges by reason of their cost, size and the fact that their importance beyond the local council area would constitute a strain on the council resources. These were proclaimed 'National Works' and continue to be maintained by the Government. In the Hunter Valley there are 29 "ex National" bridges now under the care of the Department of Main Roads.

With the advent of the motor car and the rapid increase in its numbers after the First World War, roads that were built for slow moving "horse and buggy" traffic quickly became inadequate. On January 1, 1925 The Main Roads Board of New South Wales was created as the State road authority to manage the modernisation of the State's main arteries.

Pacific Highway to Newcastle

Surprise has been expressed from time to time that the early road builders did not at once find a route to Newcastle closer to the coast, following somewhat the present Pacific Highway route, instead of the longer and more circuitous route through the rugged country between Wiseman's Ferry and Wollombi. However, in this period the authorities were not concerned primarily in establishing road communication with Newcastle. That town was of less importance than the larger agricultural settlements which had developed on the rich country further up the Hunter River.

Morpeth became the terminus of steam packets from Sydney and for many years Newcastle was regarded as a minor port of call. Maitland was the centre of a big farming district and its produce was shipped via Morpeth. During the 1820s and 1830s Newcastle seemed to fall into the doldrums. The Rev. John Dunmore Lang said:

> *"The town of Newcastle, I have already observed, has somewhat the appearance of a deserted village. It is reviving, however, though rather slowly."*

The Monitor of December 13, 1827, has this to say:

> *"Accommodations for visitors are exceedingly meagre... there is no society... There is scarcely an agreeable walk about Newcastle, nothing but rock and sand. The only moving objects are the Government Gangs, employed about the wharf, the mines etc."*

An alternative route from Sydney to Newcastle was via Mangrove Mountain. This road branched from the Great North Road at Wiseman's Ferry and went via Ten Mile Hollow, Mangrove Creek, Mangrove Mountain to Gosford and thence to Newcastle via Wyong, Catherine Hill Bay and Swansea.

When motor traffic began to develop from 1905 onwards, Newcastle was poised to become the second city in New South Wales. In its first annual report in 1926, the Main Roads Board observed, "although 129 years have passed since the discovery of what is now Newcastle, no direct road yet links the two cities". The weight of importance had swung from the farms of Morpeth and Wallis Plains to the highly developed industries at Newcastle, and just as the early settlers on the Hunter agitated for a direct link with Sydney in 1819, so in 1925 the pressure was on for a shorter road linking Sydney and Newcastle.

A review of existing and previous routes showed that none was suitable throughout its whole length as a through road for modern traffic. If the existing road from Newcastle to Gosford were further developed and joined to a new road to be built between Gosford and Sydney via Peat's Ferry, the construction would be justified by the saving in distance alone, namely 50 miles (80km).

The work was commenced in 1926 and completed in 1930, including the re-establishment of Peat's Ferry with modern vessels. Traffic increased rapidly and the ferry was eventually replaced by a new road bridge in 1945.

The work was undertaken in three sections:

Hookhams Corner (Hornsby) to Kangaroo Point,

Crossing the Hawkesbury River and,

Mooney Point to Gosford.

The total length was 37½ miles (59km). The latter section of 22.26 miles (35.7km) was commenced in October, 1925, under the successive direction of Messrs. D.A. White and T.B. Shepherd and opened to traffic on May, 1930.

The road required nearly 600,000 m^3 of earthworks. Pavement consisted of both flush seal as well as long lengths of cement concrete. The 37.5 miles of road from Hornsby to Gosford cost £983,940, or £2620/mile (£1630/km). It is noteworthy that the average traffic at the time of opening the road was only 163 vehicles per day.

Improvement of the Wyong to Swansea stretch of road was undertaken in 1928 as part of the new route from Hornsby, Peats Ferry, Gosford to Newcastle. A total of 15.3km of the total length of 38km required extensive relocation. This was made up of 4km immediately north of Wyong and a further length of 11.3km in the vicinity of Catherine Hill Bay.

By adhering to the western side of the railway, it was possible to cross it on an existing overbridge 2km north of Wyong, and to consistently direct the road towards Newcastle. At Catherine Hill Bay, the road descended to, and ascended from, the bay by a route abounding in sharp curves and steep grades. The new road was 20 feet (6.1m) wide and was designed to a ruling grade of 5%.

Construction of the two deviations and replacement of the total length of the remaining pavement was commenced with unemployed labour in July, 1926 and was completed in 1931. The work was well documented and the construction methods employed are of interest. These are covered later in this documentation. Suffice to say here that the pavement consisted of 200mm of Telford base or conglomerate gravel, overlaid by 75mm of plant mix bituminous macadam.

When the work south of Swansea had been completed, the section of 6.7km between Swansea and Belmont ranked with the worst in the State. The pavement consisted of only 16 feet (4.9m) of tar surfaced waterbound macadam and gravel. It was eventually reconstructed by Department of Main Roads between October, 1933 and July, 1935.

The new pavement was 20 feet (6.1m) wide and had a minimum thickness of 225mm of conglomerate gravel (Teralba). It was then bitumen flush sealed with 20mm and 8mm crushed blast furnace slag aggregate. The total cost of the work was £10,386 (2/6 per square yard).

Over the years the road has seen a gradual improvement, culminating in the completion of dual 11.7m wide carriageways in 1982. The new pavement has a minimum thickness of 665mm as illustrated on page 70. During the 50 years since the opening of the current route, the pavement has been widened to a general 6.8m, with appreciable lengths to 7.4m. Most of the length now has 2 to 3m wide shoulders.

In the 1970's planning of Freeway No. 3, Sydney to Newcastle Freeway, had reached the stage that the first Works Office was established at Wyong to construct the $60M bypass of Wyong. This extends from Ourimbah Creek south of Wyong to Wyee (16km), with a Motorway connection to Doyalson (7km). Construction commenced in 1977 and it is planned to open the freeway to traffic in March, 1984.

Concurrently, Pacific Highway from Main Road No. 509 (at Doyalson) to Swansea, a length of 22km, was being reconstructed and widened to at least four lanes undivided with half the length being of dual carriageway standard. The work is estimated to cost $19M and is planned for completion in 1985.

New England Highway

The New England Highway originally formed part of the "Great Northern Road", stretching from Sydney, via Wiseman's Ferry, to the Queensland border. In 1928 the route from Sydney via Peats Ferry to Newcastle, Hexham and to the border was named the "Great Northern Highway" and, in 1931, the Sydney to Hexham section was named "Pacific Highway" as was the coastal route to Brisbane. The name New England Highway was adopted in 1933. It starts at Hexham and connects to Brisbane via Muswellbrook, Tamworth and Glen Innes. It is now classified as a National Highway.

Early Construction Techniques

It was not until the 1850s that some systematic pavement construction commenced. Gradually, but steadily, methods improved and with advances in technology, pavements became more and more lasting. For the purpose of this paper, only some examples of the various early construction methods are given.

The first "roads" were basically cleared tracks with some loose filling in of depressions to provide a reasonable path in dry weather. Up to 1860, the common practice in trimming for formations was to excavate the very soft material in the table drains and throw this in the middle of the road to obtain convexity. This was discontinued in 1865 when convexity was obtained by lowering the table drains and depositing extra material (or ballast) on the centre.

Where the ground was poor and better weight bearing characteristics were required it was customary to provide a Telford base course of 200 - 225mm of stone broken down to 100 - 125mm size (called ballast), blinded by a thin layer of gravel and allowed it to be compacted by traffic. Then covered by a thin layer of "metal" or gravel to form the running surface. Hence the terms, ballasted, gravelled and metalled. This is known as Macadam Pavement.

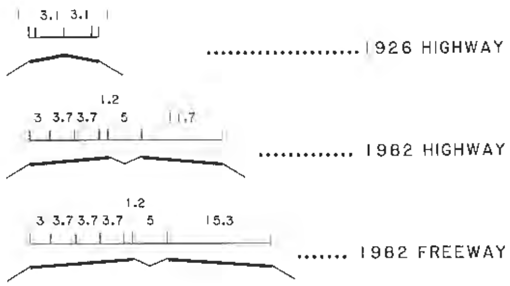
With the advent of soil classification techniques pavement cover requirements could be estimated and various suitable pavement construction materials categorised. Bitumen sealing of the gravel pavements to keep out the water was the next big step forward.

Use of tar and tar macadam did not start until the 20th century.

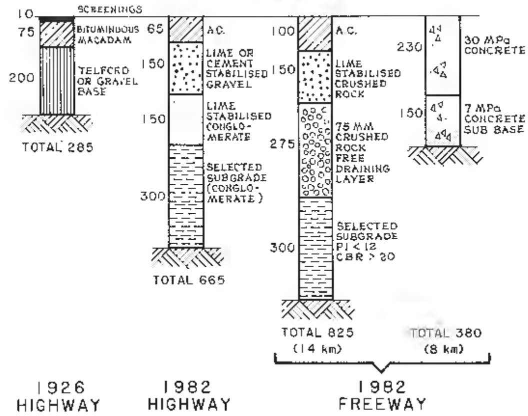
After the establishment of Main Roads Board in 1925, its first major undertaking was the construction of the direct link from Sydney to Newcastle. Some of the construction and problems encountered have been recorded in detail.

As an example the first (1926) construction between Wyong and Swansea used in part a 200mm Telford base course topped with Bituminous Macadam and screenings to form a pavement six metres wide. The amount of traffic and speed and weight of vehicles has grown so much since the 1950s that, for 1982, roads on the same route comprise two 11.7 metre sections with foundation thicknesses to 0.825 metre, as geophysically illustrated below.

PAVEMENT CROSS SECTIONS



PAVEMENT THICKNESS



BRIDGING THE WATERS

There are now over 500 bridges in the Valley. A large number have been reconstructed at least once and many, more than once.

Wallis Creek (Victoria) Bridge - East Maitland

Wallis Creek was originally a formidable obstacle between Green Hills (now Morpeth), where stores were landed, and Maitland. Agitation to bridge it commenced as soon as Maitland started.

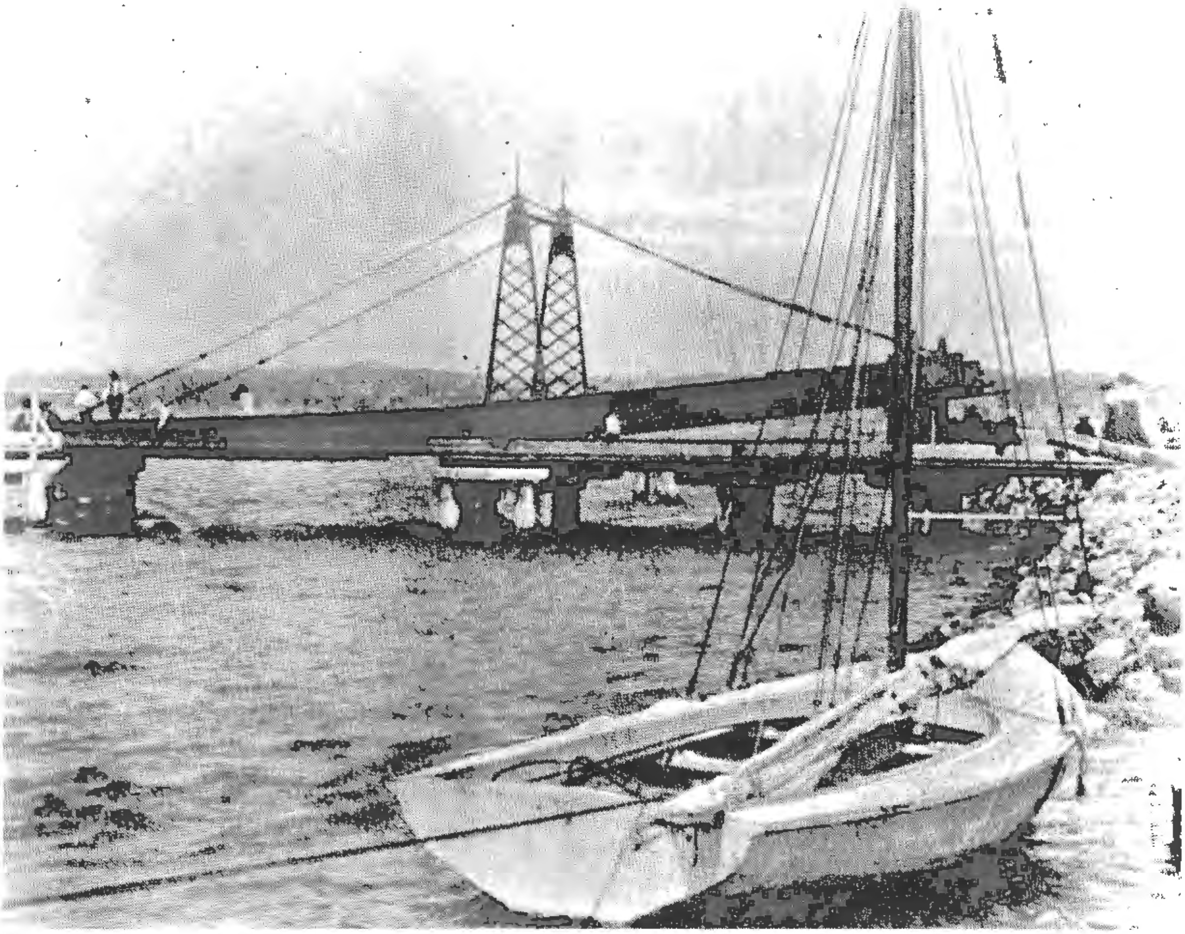
Following submissions by Captain Francis Allman and a number of prominent people from the district, including Alexander McLeod (of Luskintyre) and Peter McIntyre, the Government suggested that McLeod build a bridge and be reimbursed by the receipt of tolls for seven years from the day of the bridge being opened. An additional condition was that he build an inn and stockyards for the accommodation of travellers. Colonel Henry Dumaresq (brother of William and Private Secretary to Governor Darling) was approached to take a third share in the bridge, which he accepted. The bridge was constructed "over a stump to which the ferry boat had been moored" and completed on September 15, 1827. In 1927 McLeod and McIntyre were bought out by the Dumaresq brothers for £688/8/3.

In November, 1830, floods topped the bridge by 1.5m, but the bridge stood. A number of other floods in April and June, 1831, followed. Tolls were dropped in January, 1832, as the Government had not made collection legal, and William Dumaresq offered the bridge to the Government. However, Ambrose Hallam, Colonial Architect, inspected the bridge in February, 1832, and gave it an adverse report.

The flood in March, 1832, left the bridge badly damaged and whilst the Government was deciding what to do, it collapsed under its own weight. Instead of reconstruction, it appears that the bridge was raised and re-assembled by a gang of 10 men working under the Superintendent for Roads, Mr. Hawkins. The work was completed in October, 1832. The alleged cost was $25 (6d/man/day for rations and clothing). This bridge lasted in chronic disrepair for many years.

In 1851 a new bridge was constructed over the Creek. It was designed by Mr. E.T.B. Blacket. The bridge consisted of three bow string type iron girders, had a total length of 170 feet (52m) with one carriageway and two footways. It only cost £2,000. Some histories show that it was actually opened to traffic on June 21, 1852, and named Victoria Bridge.

The first Swansea Bridge, with the swing-type opening span, built in 1871. *DMR*



The present bridge, built in 1895, is a three span (2/8m and 1/11m) structure with a total length of 29m. It is a steel beam/buckled plate construction supported by steel RSJ trestles on concrete footings on timber piles. It has a carriageway of 9m with a 1½m footway. It also has reached the end of its useful life and is planned for replacement in the near future.

Swansea Bridge

It was not until 1871, that the Harbours and Rivers Department erected the first bridge over Swansea channel. It was a pile and timber beam bridge with a unique swingtype opening span. The swingspan had been part of the one used at Blackwattle Bay, Sydney. The bridge was replaced in 1909 by a similar timber bridge, but this time having a timber bascule opening span. Both bridges were approximately 175m long.

By the late forties the condition of the bridge was deteriorating fast and constant replacement of piles was required. The speed and weight of traffic was taking its toll.

The replacement bridge in use in 1983 featured a number of "firsts" for the Department of Main Roads. It has a double leaf bascule span, underneath counterweights and a light weight grid deck. No suitable tenders were received and eventually the bridge was built by day labour.

Planning was in hand in 1982 for the duplication of the existing bridge and it is now being constructed.

Elderslie Bridge

Over the Hunter River at Elderslie.

A long central span of 55.5m is a feature of this bridge. Built in 1890 it has three continuous lattice steel truss spans and two steel girder approach spans. The bridge is situated in a magnificent rural setting.

The abutments are stone and cast iron cylinders support the main spans. Length 162.5m.

Hexham Bridge

Over the Hunter River at Hexham.

One of the last steel truss and opening span bridges constructed, the bridge spans a broad stretch of the Hunter River.

Completed in 1952, the bridge's central lift span gives a clearance above water of 30m when raised. Five 36.9m truss spans form the central spans with the 37.8m lift span. Thirteen girder spans each 12.2m long form the approaches. Length: 382.8m.

Hinton Bridge

Over the Paterson River west of Hinton on the Hinton Road.

This bridge is a central lifting span bridge of a steel lattice design with two low truss flanking spans in timber and ten timber beam approach spans. Built in 1904, the lifting span was provided to accommodate the river steamers which frequented the Hunter Valley river system as the major form of transport.

Technically the bridge displays skilled design and construction and, for this area, a unique lifting mechanism making an interesting contrast with the Dunmore Bridge. Length: 156m.

Fitzgerald Bridge

Over the Williams River at Raymond Terrace on the Seaham Road.

It is a five span prestressed concrete structure. The unusual pier design gives the bridge a striking appearance which emphasises the clean lines which can be achieved using this material. It visually contrasts with the complex truss structures of earlier periods. Length: 251.1m.

Stockton Bridge

Over the North Channel of the Hunter River between Stockton and Kooragang Island.

Completed in November, 1971, the dual carriageway prestressed and reinforced concrete bridge rises to a 34m navigational clearance over a total length of 1025m. It cost $6.5M to build.

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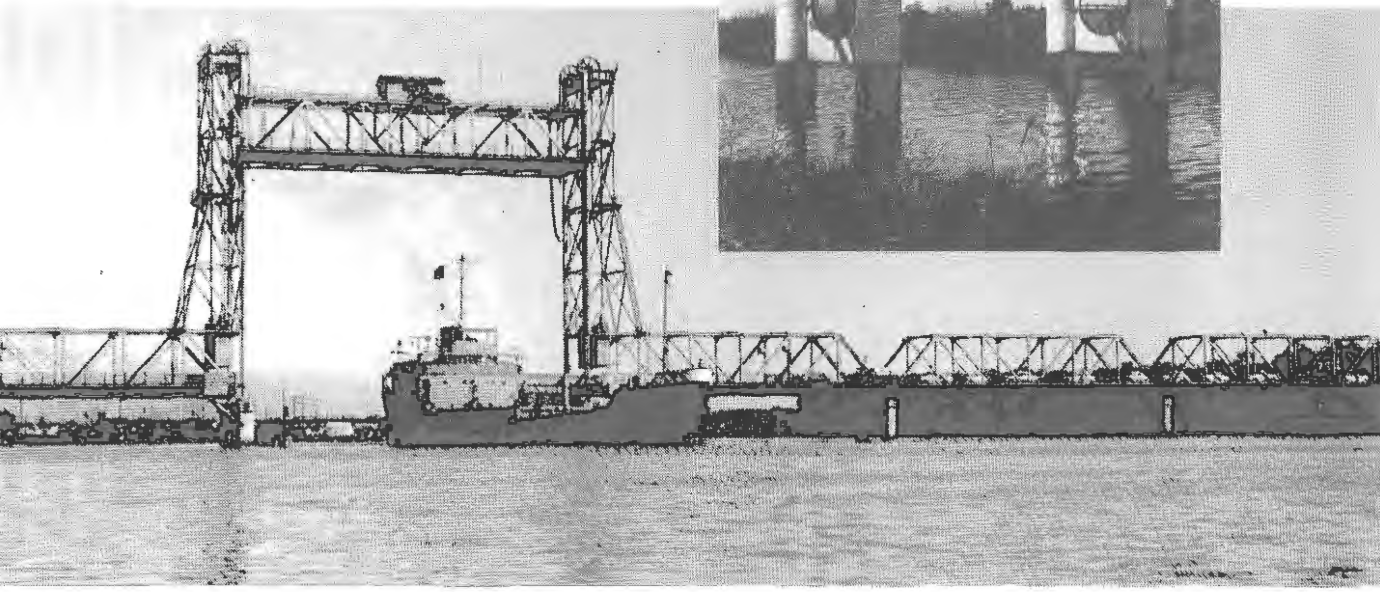
Hinton Bridge (at right).
Hexham Bridge.
Elderslie Bridge.
The Fitzgerald Bridge, Raymond Terrace. *DMR*



Garratt Locomotive 6002 hauls coal from Liddell Colliery through Tarro on one of the two special coal tracks which were installed early this century.

ARTERIES OF STEEL
The Railway System

by R.G. Preston

The history of Railways in the Hunter Region has followed the course of mining. To a great extent the two industries are still interdependent.

Indeed, the first record of rails in Australia describes a short "tramway" laid in the hill behind Newcastle to send out the coal won in an early mine to the wharves on the Hunter's banks. It operated from the early 1830's and, so successful was this early enterprise, that other lines followed and the present site of Newcastle became crossed with a number of these coal railways.

The Connection To Maitland

The establishment of a private company to construct the Sydney to Parramatta line was soon followed by a similar company in Newcastle, with a railway to Maitland as its objective. Formed in 1853, the Hunter River Railway Company soon found that the early mining activities placed barriers across its intended path. With finance at a premium, it was decided to terminate the line at the site of the present Civic Station, short of one of the tramways which ran along Merewether Street and before a timber trestle which carried a line of the Australian Agricultural Company, both of which would have posed operating and construction difficulties. A resident Engineer, J.N. Gale, was appointed, while J. Wallace, Engineer of the Sydney company, was to act as Consulting Engineer. Surveys were made, finance arranged and tenders for the track's construction called. A contract valued at £82,620 ($165,240) was let to William Wright to build the single line from Newcastle to Hexham (the present Tarro). Wright had a difficult task ahead, for the discovery of gold in the Colony had made the supply of labour and materials scarce. Mr. William Randle, father of the contractor for the Sydney line, was authorised to recruit 500 labourers from England. Messrs. Flower and Company acted as agents for the obtaining of materials and 1,000 tons of rails were ordered through them.

Wright's hopes of an easy passage across the swampy country to Hexham were soon dashed, as it became impossible to obtain a firm footing in the wetlands. Experience gained by George Stephenson when faced with similar problems at Chat Moss, in England, was put to good use. Large mats of brushwood were floated on the track alignment and soil for the embankment was heaped on them. The resulting mass has formed a suitable road bed to this day, although the footings of the bridge at Ironbark Creek have provided subsequent Civil Engineers with many a headache.

Despite financial problems, a second contract to construct the next portion of line from Hexham to Maitland (on the site of the present Victoria Street Station) was awarded to Wright and Randle in 1855. By this time, the Government's financial involvement was such that prominent public officials were everpresent and, at the turning of the first sod, Mr. Wallace, now the Chief Engineer of the Sydney Company, Mr. Brady, Assistant Engineer and Mr. Moriarty, Civil Engineer, represented the Government and foreshadowed the takeover of the company. When the line was opened by Governor Dennison on March 30, 1857, it was under full Government control and the Hunter River Railway Company, like the Sydney Railway Company before it, had passed into history. Thus, the New South Wales Government Railway had its origins. At the opening, Governor Dennison had named the Northern Section, The Great Northern Railway.

The two termini were situated at inconvenient locations and pressure was soon brought to bear to have Newcastle and Maitland stations sited nearer the centres of population. Contracts were let to Mr. Mark Faviell to build an extension to a new terminus, sited immediately east of the present Maitland station, while Mr. Wright constructed the line to the present Newcastle. Both additions opened to traffic in 1858.

North To the Liverpool Plains

The need to extend the line North had been realised for many years. Indeed, it had been the intention of the Company to reach Singleton as soon as possible.

Governor William Dennison had his own ideas as to how railways should be built and had gone on record advocating a series of cheap, horse-drawn lines to open up the country as fast as possible, with minimum financial outlay. It was John Whitton, Engineer-in-Chief of the

TENDER for Works on the Hunter River Railway between Newcastle and Hexham.

I, *William Wright* of *Sydney* hereby tender to execute certain Works, viz.: Earthwork, Fencing, Clearing, Brickwork, Masonry, Carpentry, and Ironwork; at the Rates shewn in the following Schedule of Prices; and I submit the following persons, viz.:— *William Randle, Contractor, Sydney* ~~and~~ as my securities to ~~the amount of~~ *any amount that the Directors may require* for the due execution of the Works.

I also agree to enter into a Bond for the due execution of this Contract when called upon to do so by the Directors.

SCHEDULE OF PRICES

Referred to in the foregoing Tender.

	£	s.	d.
Price for EXCAVATION taken out of the Cuttings, and deposited in the Banks, according to the form and dimensions shewn in the drawings			
In Clay or Sand deposited at any distance not exceeding 30 yards, per cubic yard	.	2	11
Price for Excavation deposited at any distance, not exceeding 20 chains			
Excavation in Clay or Sand, per cubic yard	—	3	9
Ditto in Ironstone Clay or Shale per cubic yard	—	4	6
Ditto in Sandstone Rock, per cubic yard	—	9	0
Additional Prices for carriage beyond ¼ mile, not exceeding ½ mile per cubic yard	—		3
Ditto, not exceeding ¾ mile per cubic yard	—	—	6
Ditto, „ 1 mile „ „	—	—	9
Price for Clearing Land from Timber and Scrub, per acre	8	0	0
Price for 3 rail Ironbark Fencing of the best description, per rod	—	15	0
4 Rail Ironbark Fencing, per rod	—	17	0
5 Feet Ironbark Paling Fence, „	1	15	0
6 Feet ditto ditto „	2	0	0
BRICKWORK in Mortar, for Bridges and Culverts per cubic yard	4	5	0
Ditto, in Cement, „ „	5	5	0
MASONRY.			
Coursed Rubble Masonry, per cubic yard	4	15	0
Ashlar Masonry, per cubic foot	—	4	0
Fine Dressed Ashlar, in String Courses, Coping, &c., per cubic foot	—	10	0
TIMBERWORK.	£	s.	d.
Ironbark Beams and Framing, fixed complete, large scantlings, per cubic foot	—	6	0
Ironbark in small scantlings, fixed complete, per cubic foot	—	8	0
Ironbark Sawn Planking, fixed			
4 Inch thick, per cubic foot	—	8	0
3 Inch ditto ditto	—	8	6
2 Inch ditto ditto	—	9	0
1 Inch ditto ditto	—	9	6
Baltic or Oregon Pine fixed small scantlings, per cubic foot			
Planking fixed			
4 Inch thick per cubic foot	—	7	0
3 Inch ditto ditto	—	7	6
2 Inch ditto ditto	—	8	0
1 Inch ditto ditto	—	8	6
PILING.			
Ironbark Piles shod with wrought Iron Shoes of 45 lb. each, and driven complete			
10 to 15 feet long, per cubic foot	—	10	0
15 to 40 feet long, per cubic foot	—	9	6
IRONWORK.			
Wrought Iron in Bolt	—	—	10
Straps, Nuts, &c., per pound	—	1	2

Signature *William Wright*
5th October 1854

NOTE.—Net Measurements only will be allowed in Estimating quantities of Work done.

The first locomotive on the Great Northern Railway — 0-4-2 Tender Engine 4N. *SRA*

Railways, who defied the Governor and specified that the lines should be built to sound engineering principles for lasting benefits and should be worked by locomotives. Whitton had his way, but the financial plight of the Colony hampered progress. Instead of calling tenders for the extension of the line to Lochinvar, Whitton had to be content with day labour working under the Railway's control. Progress was slow, but after considerable debate Whitton's resolve won the day and, from 1859, construction speeded considerably.

Improvements were made to the original surveys and a contract let to Sir Morton Peto and Company for the line to reach Singleton by the end of 1860. However, nature was to take a hand in the proceedings. Disasterous floods, as well as a shortage of suitable staff, delayed completion until May, 1863.

Ahead lay the wide flood plain of the Hunter and the crossing posed some problems. Also, coal production around Newcastle was increasing rapidly to an extent that extra facilities were necessary to cope with the traffic, which had increased twenty-fold since the line opened. Decisions were made to relieve congestion in Newcastle and a line was built to Morpeth to take advantage of the port facilities there. Benjamin Ventors laid the two miles 52c (4.26 km) of track which opened on May 2, 1864.

To further cater for the coal trade, some tracks out of Newcastle were duplicated, while three new steam cranes were installed at a new wharf at Newcastle. Thus the ever continuing problem of coal loading was temporarily solved.

The route ahead, through the headwaters of the Hunter Valley, was marked with that bane of Government enterprises — political interference. For a start, the first bridge over the Hunter at Singleton was specified by political decree to be made of timber so that the money involved would stay in the country and not go overseas as would be necessary for an iron bridge.

The bridge itself was unique in conception. It was a laminated arch structure, its main members made of large timber planks curved vertically to form the arches. The masonry piers were built on timber piles, necessary to obtain a firm footing in the sands of the river bed. Several contractors tried to build the structure, which was not completed until 1866, instead of the estimate of 1864. It carried both road and rail traffic.

Beyond, the line was planned in three sections to Scone. The first, to Muswellbrook, was let to Randle and Gibbons, who were unable to handle the job's complications. In turn, MacNamara and Edwards took over the work, which was completed to Muswellbrook in 1869. Two contracts were planned, one to Aberdeen and another to Scone. Both were awarded to George Blunt, who completed his task in 1871. Lessons must have been learnt, for this time a bridge over the Hunter at Aberdeen was built of three, wrought-iron lattice girders resting on cast iron piers. It was not replaced until 1980, while the Singleton timber spans were replaced in 1902 by four 126 ft. long Pratt trusses, built at the Newcastle Per Way Workshops.

In planning the section to Murrurundi, great skill was required as the line forged up the Pages River Valley in an ever-narrowing defile, with heavy earthworks. Messrs. Macquarie and Company were entrusted with the work, but could not meet the specifications required by John Whitton. After several extensions of time, the work was re-assigned to John Alger, who was able to complete the work in 1872 to the satisfaction of the Engineer-in-Chief. Here, work stopped for some time as money was not freely available. A construction cost of £10,084 ($20,168) per mile to reach Murrurundi was considered undesirably high. John Whitton was challenged with taking the line up the winding Pages River Valley and under the Liverpool Range in a tunnel at a cost of £7,000 per mile — an impossible task. His answer was sharper curves, steeper grades and a shorter tunnel than was his plan and progress was halted until a change in Government brought a change in attitude.

A contract was let to Mr. Wakeford to take the rails to Tamworth. Construction commenced in 1874. Progress was slower than anticipated and many questions were asked in the local press. It was explained, that the contractor was concentrating on the Ardglen tunnel. By August 29, 1875 a locomotive was able to pass through the uncompleted bore. Even so, the quality of work was described by the *Tamworth Observer* as poor. Wet weather had caused slips and other problems delayed work, so that the tunnel was not declared complete until December, 1876. A shortage of labour added to Wakeford's problems.

Eventually, with Whitton supporting the contractor in his hour of need, the line reached Quirindi on August 13, 1877. Thus the Great Northern Railway passed beyond the accepted region of the Hunter Valley. Compared with the original road haulage, travel times had been reduced to 2 per cent while costs had fallen to 66 per cent for goods and 50 per cent for passengers. Even Cobb & Co. announced that their southbound coaches would now only run to Willow Tree and connect with the trains.

Connection To Sydney

The linking by rail of the State's two major centres of population was still a dream at this stage. In the 1870s Newcastle, centre of an area of less than one fifth of the Colony, accounted for one third of its output. Economic interests in Sydney sought ways of bringing much of this trade to themselves. Similarly, defence interests sought a line from Sydney to Brisbane; a line to Newcastle was a logical first step.

Whitton was instructed in 1875 to initiate moves to bring the line into being and Surveyor Mr. Stephens was sent out to find a suitable crossing of the Hawkesbury. The size of the necessary bridge dampened enthusiasm so another attempt to join Windsor to Singleton was surveyed by Mr. Hoyle. According to Hoyle, the route would still need a large bridge, while river valleys were such as to require many smaller bridges.

More suggestions resulted in a Mr. Cummings surveying a line which closely followed the present main line to Lake Macquarie and then passed through Wallsend to get to Waratah. Political interests now started to lobby for their towns and the Member of Mudgee announced that the link line would pass through that town!

Finally, pressure was put on the Government to construct the line close to the coast. After debate in the House, it was suggested the line could cross the Hawkesbury by punt instead of a bridge. In 1883, Messrs. Amos and Co. obtained a contract for a line from Strathfield to the Hawkesbury River, to be completed in 1886. Such was their price that three months later the same firm was awarded a contract to link Gosford to Hamilton, the work to be finished in 1886 also.

George Blunt returned to the railway scene with his winning of the contract to fill in the gap between Hawkesbury River and Gosford in 1883. The Hawkesbury River Bridge was, however, to be a separate question. Whitton wanted to build a structure using local companies, but the Treasurer felt that this would burden the public with too high a bill, so it was decided to invite overseas companies to tender. Entries were received from England, United States of America, Canada, France and from several firms in Sydney and Melbourne. In all, 14 companies sent entries, some of them including more than one design.

A board to select the best design was set up, comprising Captain Douglas Galton, late of the Royal Engineers, Mr. W.H. Barlow, past President of the Institute of Civil Engineers, and Mr. G. Berkely, Consulting Engineer to an Indian Railway. The Government Consulting Engineer, Sir John Fowler was also asked to

The original bridge over the Hunter River at Singleton was of an unusual laminated timber construction.
SRA

The second bridge across the Hawkesbury River. RP

furnish an independent report, with Whitton having the responsibility of the final recommendation. The Union Bridge Company of the United States received the contract, British materials being specified. The line to Hawkesbury River was completed in April, 1887, while the Hamilton to Gosford link was forged in August of that year. In the interim, a ferry service was provided between the two railheads by the stern-wheeled steamer, *General Gordon.* In January, 1888, the railhead was extended south from Gosford through the Woy Woy Tunnel, with a length of 5871 ft., to Mullet Creek near the present Wondabyne, thus reducing the ferry journey.

Finally, the bridge, unique in many ways, was completed and the through line opened on May 1, 1889. Its pier foundations were deeper than any other bridge. It was the largest structure of its kind in the Southern Hemisphere and was the third largest in the world at the time. Thus, the two main lines leading to Newcastle were in place and along them much of the commerce and produce of the State was to pass. However, as planned, much of it now by-passed Newcastle, and Sydney grew in consequence. The steel arteries also grew in traffic and many additions have been made to cater for their traffic load.

Having examined the two most important railways in the region let us first complete their story. The Hawkesbury River Bridge came under suspicion in 1914 when rumours of a defect in its construction sparked off some protective procedures. True, two of the caissons used in the sinking of the piers had twisted out of alignment as they sank, but the five feet variation had been accepted. Similarly, the side trusses of the main span had differed in substance from those of the design, but the bridge had successfully carried a test load of 910 tons spread over both tracks to the satisfaction of all. However, tests carried out in 1937 confirmed defects in the bridge and the need for its replacement.

In 1939, with war imminent, a new bridge was approved. This time Railway Engineers and facilities were employed, special erection facilities being constructed on the river bank. Despite the war effort in which Chullora Workshops built aircraft, tanks and munitions, steel work followed design and the bridge took shape. Again the finding of firm foundations in the swift flowing tidal river proved difficult and caissons were used to sink the footings. Excavation was carried out by men working with minimal power tools inside the giant pressure vessels and the river mud and sand gave up its territory with reluctance. Finally, Brigadeer Fewtrell and his team watched the new bridge carry its first traffic on July 1, 1946, and the old structure passed to the scrap yards.

During duplication of the Sydney-Newcastle main line the opportunity was taken to ease the grades by deviations from the original alignment. Today "up" Sydney bound trains face a ruling grade of one in 75 with the Hawkesbury River — Cowan section using bank engines to conquer the original one in 40 incline. "Down" or Newcastle bound traffic still has to surmount one in 40 grades at Hawkmound and Fassifern while other grades north of this point were reduced to one in

75 to allow local coal trains an easier path. Similarly, on the Main Line beyond Maitland, improvements were made.

Singleton was situated at the feet of rising grades in both directions and bank engines were in common use. Again duplication offered the chance to reduce the grades and coal traffic from the Northern Fields now enjoys a maximum grade of one in 78 to Port Waratah, the grade from Willow Tree to Ardglen Tunnel remaining at one in 40. Bank engines are still used over this section, gaining extra duties banking trains from Murrurundi and Ardglen over a similar inclination.

Branch Lines

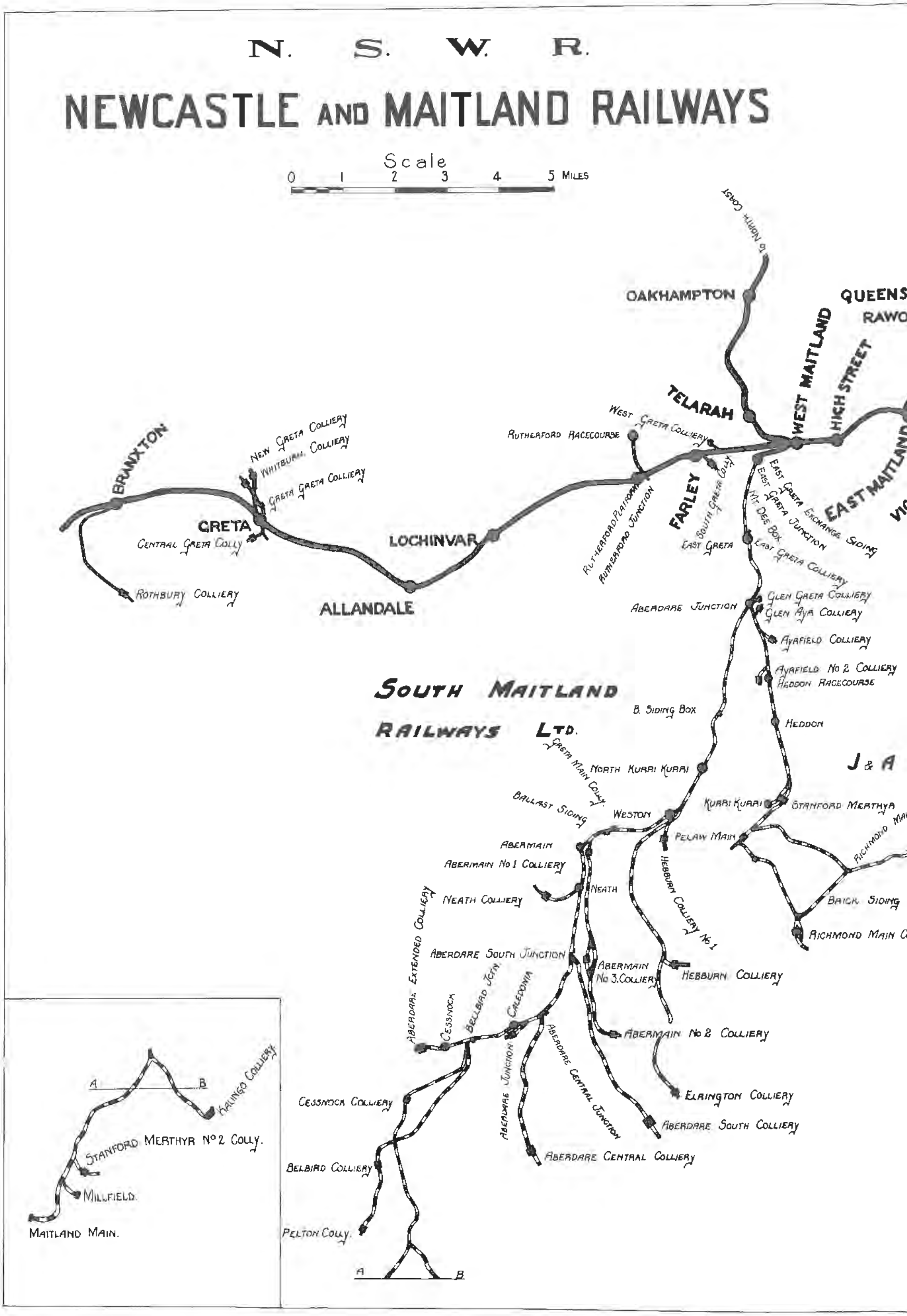
Main lines cannot exist in isolation. Morpeth, the first passenger carrying branch, opened in 1864 and many similar by-ways followed.

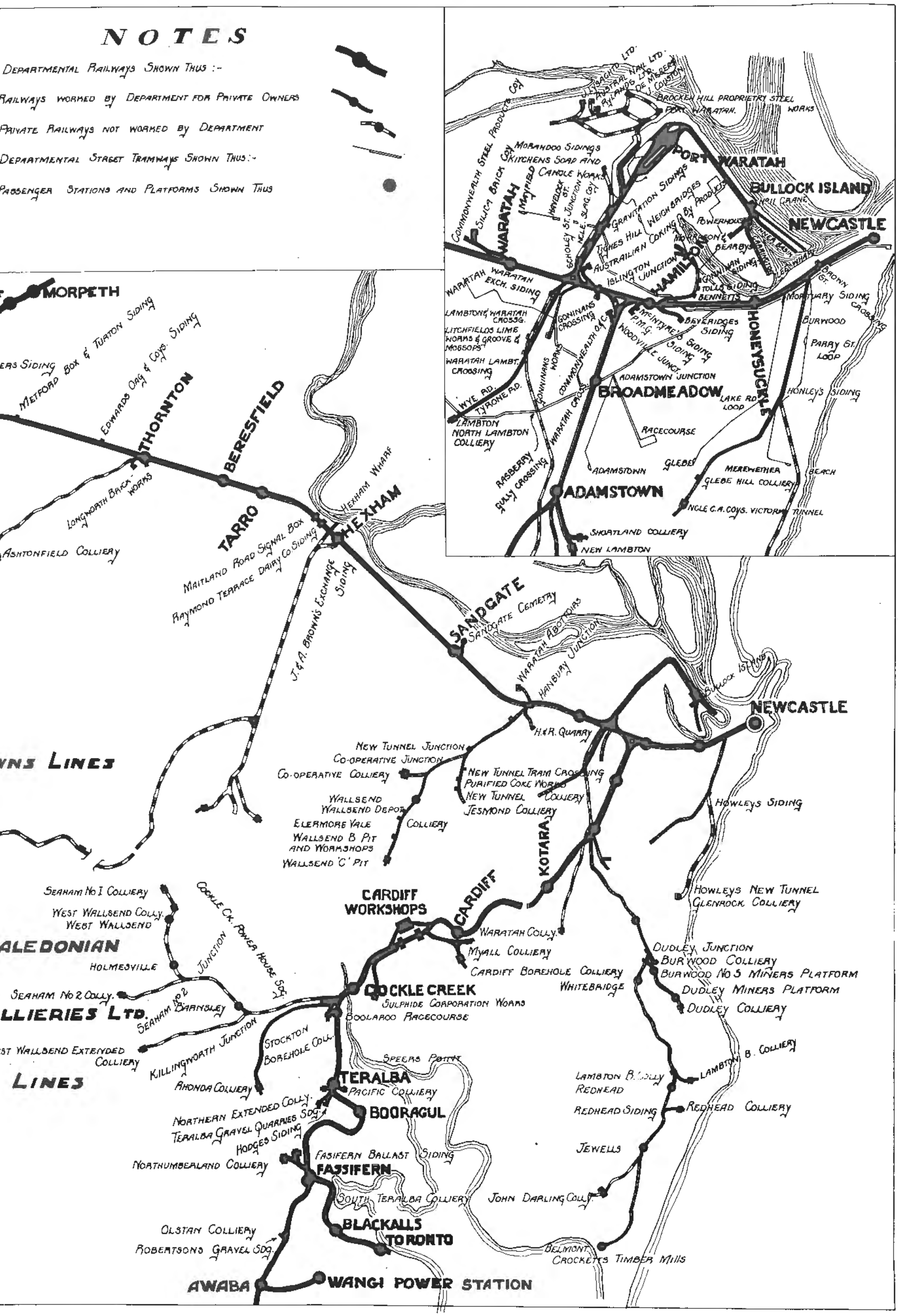
Port Waratah, a giant modern day Industrial complex, gained its name and had its start because of coal and railways. The Waratah Coal Company, decided to export their product through their own coal loader and thus avoid the growing congestion of the Newcastle wharves. In 1865, they built a loading facility on the Hunter's Bank in the general area of the Basin Coal Loader and from this small beginning has grown today's rail complex.

In 1877 the Government built a branch line junctioning with the main line on the Newcastle side of Hamilton and laid the rails through Carrington to Bullock Island near the State Dockyard. This arrangement served until increasing traffic resulted in a new line, the present Port Waratah Branch, was built in 1908 along the original Waratah Company's alignment. It was opened as a two track system and the original line from Hamilton was truncated in the back streets of Wickham. It still survives to serve some oil depots and other local industries.

Another branch which saw heavy traffic in its lifetime was the line to Wallsend, which made its connection to the outside world at Hanbury Junction beyond Waratah. Opened in 1861, the branch served several collieries, each with its own branchline, until its closure in 1960. In the intervening years, the line was duplicated and carried a passenger service. Several features along its length were unique and included a dual section shared with the electric trams which served Wallsend in the first half of the present century. Trams also crossed the right of way near where Newcastle University is now situated. Today, Wallsend Station and Goods Shed still remain, while several bridges, old cuttings and embankments help trace the course of the line.

The express passenger locomotive 3815 was built at Cardiff Workshops and was well suited to hauling the Newcastle Flyer. Picture shows the Flyer leaving Newcastle Station in 1968. RP


N. S. W. R.
NEWCASTLE AND MAITLAND RAILWAYS
Scale
0 1 2 3 4 5 Miles
To North Coast
OAKHAMPTON
WEST MAITLAND
HIGH STREET
EAST MAITLAND
TELARAH
West Greta Colliery
Rutherford Racecourse
Rutherford Platform
Rutherford Junction
FARLEY
South Greta Colly
East Greta
East Greta Junction
East Greta Exchange Siding
Mt. Dee Box
East Greta Colliery
BRANXTON
GRETA
New Greta Colliery
Whitburn Colliery
Greta Greta Colliery
Central Greta Colly
Rothbury Colliery
LOCHINVAR
ALLANDALE
Aberdare Junction
Glen Greta Colliery
Glen Ayr Colliery
Ayrfield Colliery
Ayrfield No 2 Colliery
Heddon Racecourse
Heddon
SOUTH MAITLAND RAILWAYS LTD.
B. Siding Box
Greta Main Colly
North Kurri Kurri
Kurri Kurri
Stanford Merthyr
Ballast Siding
Weston
Pelaw Main
Abermain
Abermain No 1 Colliery
Neath
Neath Colliery
Hebburn Colliery No 1
Brick Siding
Richmond Main
Aberdare Extended Colliery
Aberdare South Junction
Abermain No 3 Colliery
Hebburn Colliery
Cessnock
Bellbird Jctn.
Caledonia
Abermain No 2 Colliery
Aberdare Junction
Aberdare Central Junction
Elrington Colliery
Aberdare South Colliery
Cessnock Colliery
Aberdare Central Colliery
Bellbird Colliery
Pelton Colly.
A
B
Kalingo Colliery
Stanford Merthyr No 2 Colly.
Millfield
Maitland Main


NOTES
Departmental Railways Shown Thus :-
Railways worked by Department for Private Owners
Private Railways not worked by Department
Departmental Street Tramways Shown Thus :-
Passenger Stations and Platforms Shown Thus
MORPETH
Metford Box & Tuaton Siding
Edwards Org & Coys. Siding
THORNTON
BERESFIELD
TARRO
HEXHAM
Hexham Wharf
Longworth Brick Works
Ashtonfield Colliery
Maitland Road Signal Box
Raymond Terrace Dairy Co Siding
J & A. Brown's Exchange Siding
SANDGATE
Sandgate Cemetry
Waratah Abattoirs
Hanbury Junction
Bullock Island
NEWCASTLE
H & R. Quarry
New Tunnel Junction
Co-operative Junction
Co-operative Colliery
New Tunnel Tram Crossing
Purified Coke Works
New Tunnel Colliery
Jesmond Colliery
Wallsend
Wallsend Depot
Elermore Vale Colliery
Wallsend B Pit and Workshops
Wallsend 'C' Pit
Howleys Siding
KOTARA
Howleys New Tunnel
Glenrock Colliery
CARDIFF WORKSHOPS
CARDIFF
Waratah Colly.
Myall Colliery
Cardiff Borehole Colliery
Whitebridge
Dudley Junction
Burwood Colliery
Burwood No 3 Miners Platform
Dudley Miners Platform
Dudley Colliery
Seaham No I Colliery
West Wallsend Colly.
West Wallsend
Cockle Ck. Power House Sdg.
CALEDONIAN
Holmesville
Junction
Seaham No 2 Colly.
Seaham No 2
Barnsley
COLLIERIES LTD.
West Wallsend Extended Colliery
Killingworth Junction
Stockton Borehole Coll.
COCKLE CREEK
Sulphide Corporation Works
Boolaroo Racecourse
Speers Point
TERALBA
Pacific Colliery
BOORAGUL
Rhonda Colliery
Northern Extended Colly.
Teralba Gravel Quarries Sdg.
Hodges Siding
Northumberland Colliery
Fasifern Ballast Siding
FASSIFERN
South Teralba Colliery
BLACKALLS
TORONTO
Olstan Colliery
Robertsons Gravel Sdg.
AWABA
WANGI POWER STATION
Lambton B. Colly
Redhead
Lambton B. Colliery
Redhead Siding
Redhead Colliery
Jewells
John Darling Colly.
Belmont
Crocketts Timber Mills
LINES
LINES
Lysaghts Ltd.
Austral Nail Ltd.
Rylands Ltd.
De Meyers
J. Coulston
Brocken Hill Proprietry Steel Works
Port Waratah
Commonwealth Steel Products Coy
Silica Brick Coy
Morandoo Sidings
Kitchens Soap and Candle Works
WARATAH
Mayfield
Havelock St.
Scholey St. Junction
Ncle. Slag. Coy
PORT WARATAH
BULLOCK ISLAND
Hill Crane
Gravitation Sidings
Tighes Hill Weighbridges
Australian Coking & By Products
Powerhouse
NEWCASTLE
Islington Junction
HAMILTON
Bearbys
Gonninan Siding
Tolls Siding
Bennetts
Waratah Exch. Siding
Lambton & Waratah Crossg.
Litchfields Lime Works & Groove & Mossops
Waratah Lambt. Crossing
Gonninans Crossing
Beveridges Siding
McIntyre's Siding
Woodville Junct.
Adamstown Junction
HONEYSUCKLE
Mortuary Siding
Brown St. Crossing
Burwood
Parry St. Loop
Wye Rd.
Tyrone Rd.
Gonninans Works
Commonwealth Cross.
Waratah Cross.
BROADMEADOW
Lake Rd Loop
Lambton
North Lambton Colliery
Racecourse
Honley's Siding
Rasberry Gully Crossing
Adamstown
Glebe
Merewether
Glebe Hill Colliery
Beach
ADAMSTOWN
Ncle. C.A. Coys. Victoria Tunnel
Shortland Colliery
New Lambton

Steam Engine 4-6-4T 3046 served Toronto, on Lake Macquarie, in the days of steam. *RP*

Wallsend's railway career declined only a few years before a new branch line was opened slightly west of Hanbury Junction. Appropriately the Junction name was moved to the new divergence, which leads to Kooragang Island and a new generation of enterprises. Opened on May 16, 1968, the line is destined to play a role in future coal exports as a third modern coal loader takes shape on the Island.

Perhaps the most unusual branch line remaining in Australia lies at Sandgate, where a short branch leads to Sandgate Cemetery. Opened in 1881, the 34 chain (889 metres)-long line has been unique in recent years as boasting a service on Sundays only. Funeral trains, complete with hearses, were common until the coming of the motor hearse, and trains since the 1930s have catered for mourners only.

In the Coalfields, development both government and private, had seen a steady growth over a number of years and, to a certain extent, primary products have played second fiddle to coal. The North Coast line was to have corrected this trend for coal measures were not to be used as a reason for its construction. Defence, one of the ingredients for the northern start out of Sydney, did not get an extension on the planned link to Brisbane until August, 1911, when trains started to run out of Maitland to Dungog. In February, 1913, trains ran to Taree from Dungog, later to reach Wauchope in 1915 and the standard gauge line eventually reached Brisbane in 1930.

From Muswellbrook, a branch to Denman and then to Merriwa was opened in 1915 and 1917 respectively.

It was at the opening of the Denman section on May 29, 1915 that Mr. Fallick, M.P., in an inspired burst of oratory, suggested a line from Sandy Hollow, on the Merriwa section, to Gulgong, following the Goulburn River for much of its journey. This was the first tangible move to push for the legendary Maryvale-Sandy Hollow Railway, the subject which has filled many a page of Hansard in the following years. In fairness, it should be mentioned that Governor Dennison in his famous speech of 1857 had expressed a hope that The Great Northern Railway should include a branch to the west and had nominated the Goulburn River Valley as a suitable route to follow. Similarly, moves for decentralisation in 1911 had also advocated building such a line. So the legend which became an unfinished railway had its beginnings. First officially recommended in a Royal Commission Report, the necessary Act was passed in 1927. Construction of the line, designed to divert traffic away from the crowded western line, to the port of Newcastle, commenced in 1937. Work progressed well until the Second

Standard goods engine 5483 lifting goods out of the yard at Muswellbrook Railway Station in 1956. *RP*

World War brought progress virtually to a halt. Workmen returned to the field when peace was restored and in the next four years five tunnels were started. With the exception of No. 3, they were virtually complete by 1950. No. 3 was to be the longest bore in New South Wales, while many of the numerous bridges ranked in size with other spectacular structures. Economics called a halt in proceedings and the craggy hills of the Goulburn Valley remained undisturbed along the right of way.

Again, it was coal which breathed life into the railway and, when White Industries proposed an expansion of their mine at Ulan, near Gulgong, the "Railway Revival" began. For the first time in New South Wales, concrete sleepers were specified and a factory to manufacture the thousands needed was built at Denman. Upgrading of the formation from Muswellbrook to Sandy Hollow was included in the programme, necessitating the removal of the old track. Grades were eased to allow a ruling one in 80 against up trains. The highlight of the construction was the Planer SUM 1,000 tracklaying machine which, with a minimum crew, is capable of maintaining a construction rate of 1.5 km/day; a pace which would have made the early Engineers green with envy. Construction crews saw the result of their labours when the first train of Ulan coal left the mine on September 13, 1982.

Turning our attention to the Sydney link, a number of small but interesting branch lines have been constructed over the years.

On a trip south, the first Government line to be met is the Belmont Branch. In fact, this should be in the section which covers private lines, for the right of way is owned by the New Redhead Coal and Estate Company, but services have been operated by the Government for so long that the private ownership is well-disguised. First opened to serve the old Burwood Colliery in 1892, the line was extended through Redhead to Belmont in 1917. Tourist trains became a feature on the line early this century. Ten cars, loaded with those pleasure bent, would climb the steep one in 40 grade from the Junction to Fernleigh Tunnel, deep in the bush behind Highfields. Various collieries have been served over the years, as coal became the staple traffic. A branch line junctioning with the line near Burwood Colliery, carved a tenuous, steep, one-and-a-half mile path through hills towards the sea and Dudley Colliery. Today, Lambton B, at Redhead, and John Darling, near Belmont, remain as the main raison-d'etre for the rail link.

Regular passenger services were provided to Belmont and Dudley. On the latter, miners' trains were distinguished by hard wooden seats, designed not to show the dirt. The trains were further distinguished by the use of four and six wheeled cars and goods train guards vans to check their progress on the steep grades.

Economies in 1971 determined that the running or a single rail-motor thrice daily on the Belmont service was undesirable. With no services left beyond John Darling, the last two miles of the line was closed and the points to the pit replaced with a simple curve. Plans are in hand to upgrade the colliery and a balloon loop is planned to aid train movements.

Proceeding further towards Sydney, the next line again started its career as a private enterprise. In 1885, the Excelsior Investment and Building Company acquired an estate of 1,000 acres fronting Lake Macquarie at Toronto. As the nearest railway was the main line to Sydney, the Company sought to construct two-and-three-quarter miles of tramway to bring transport to the estate. In 1889, an act was assented to for the construction of the line to a guage of three feet, but this was amended the following year to be the standard gauge. The Company had rights to carry both passengers and goods on its line which had four small platforms. The line commenced at Fassifern. The Government acquired the line in 1910 after some periods in which horsepower had been introduced. Under Government ownership the line was relaid with better plant and easier grades and curves. In 1911 regular trains operated through to Newcastle and a goods yard was established near the shopping centre on the edge of the Lake. Real estate values and public pressure resulted in this land being released in 1979 and today Toronto Station is a single line of track with no sidings or points. Consequently, it can only be operated by two-car diesel units which require no run-around or other terminal facilities.

Proceeding to Awaba, we find an unusual branch line. Opened on May 25, 1954, the six-and-a-half mile long branch was constructed under the auspices of the Electricity Commission and was built solely for traffic leading to Wangi Wangi Power Station. All trains were, however, operated by the Railways.

The last Government line connecting to the Main North Line can be found at Gosford. Opened in 1916, the rails left the Sydney end of the Gosford yard, and headed west to Gosford Racecourse, a distance of about one-and-a-quarter miles. In time, the racecourse traffic gave way to freight traffic emminating from several small industries, but this traffic declined to such that, in 1960, the line was formally closed and reduced to the status of a siding.

Building the line between Muswellbrook and Ulan via Sandy Hollow was an important recent rail development project. A SUM 1,000 track-laying machine was used. *RP*

Private Branch Lines

It was to the private enterprises establishing their various industries that much of the credit for railway construction lies. In the early years, financial considerations prohibited the Government offering much help in linking isolated collieries to the wharves by rail and with no roads to speak of it fell to the companies developing the pits to provide transport for their hard won product and usually rail was chosen.

Around the Port of Newcastle, many small tramways were built to bring the coal from the hill to the wharves. As we have discussed, some of these existed from as early as 1831, well before the main line was constructed. The Australian Agricultural Company, at one time with a monopoly on coal mining, used rails to serve its collieries, which dotted the present suburbs of Cooks Hill, Bar Beach and Hamilton. The Company owned an extensive network of lines, with junctions to direct traffic to Newcastle or Bullock Island and with a main line along King Street, parallel with the main line which had its western end near Hamilton, after passing along the present Gordon Avenue.

First opened in 1864, the A.A. Co.'s network closed in 1921. One prominent feature of the system was a bridge, spanning the main Government line leading to the Company's staiths on the Hunter River, near Darby Street. It was erected in 1862. As local industry had not advanced sufficiently, the bridge was imported from Robert Stephenson and Company. It was demolished by Messrs. Morison and Bearby in 1923.

For many years, a well-known feature of Newcastle was the line which left the main line some 33 chains from Newcastle Station, passed along Burwood Street, crossed the tram lines in Hunter Street, passed the City Hall, crossed Civic Park and passed under Laman Street near the Cultural Centre. Originally owned by the Newcastle Coal and Copper Company, the line served several collieries around Merewether and reached its ultimate destination at Glenrock Lagoon. The "Coffee Pot" of Toronto fame ran on this stretch of track under the ownership of Mr. Howley. The pair of unlined tunnels of very restricted clearance cut through the hill behind Merewether Beach was a famous section of the line. Such was the lack of room that, even with cut-down cabs, locomotive crews refused to drive engines through the tunnels, due to their inability to leave the cab while in the tunnel. Their solution was to set the throttle when approaching the bores and then to "abandon ship". The train would then proceed "on automatic pilot" to the

The South Maitland Railway, which serves the Cessnock district, is the largest privately owned railway in New South Wales. Pictured is the Railway's 2-8-2 tank No. 31 heading a coal train across Swamp Creek Bridge at Abermain in 1970. *RP*

far end of the second tunnel where another crew would jump on and assume control. The Junction derived its name from the network of minor lines which fed to the Merewether main line at this point. All traffic stopped about 1950 and the rails passed into history.

In 1863, two companies commenced mining coal in the Lambton and Waratah areas and each in turn built its own railway. Old Lambton Colliery was the first to cross the flat land near Georgetown, a line which carried coal until November, 1963. The Waratah Company had moved its mining operations from its original Waratah site to the hills near Charlestown and Raspberry Gully. The new line required to serve this enterprise had an unusual route, as land availability and other legal restraints forced the Company to run parallel to the Old Lambton line and then cross it at an angle. The arrangement was fully protected with signals to prevent the Government-run coal trains on the Lambton line and the privately powered trains on the Waratah line from coming into conflict with each other.

To add confusion to the arrangement, the electric street tramway between Broadmeadow and Georgetown Roads crossed both colliery lines without the benefit of such protection. Before leaving the original Waratah site, it should be recorded that a quarry was established behind Waratah to supply rock fill to the harbour entrance breakwaters and training walls and a suitable rail connection was provided.

The Commonwealth Steel Company has its own network of lines serving their plant at Mayfield West and over the years has maintained its own locomotives — first steam and now diesel electric.

At Hexham, the first private railway to connect formally to the Government Railway System is still operating today. Even before Government trains ran between Newcastle and Maitland, John Eales had started his private tramway between his Minmi Colliery and the river bank at Hexham. In turn, J. & A. Brown assumed control, passing it on to the legendary John "Baron" Brown, who developed the railway into a system in its own right. At the height of its career, the Richmond Vale Railway extended 16 miles into the Sugarloaf Range, serving Richmond Main and Pelaw Main Collieries, with several other smaller concerns en route. The "Baron" acquired some 30 steam locomotives to operate his empire, some as large and as powerful as those providing the Government's mainline power. In 1982 the line still survived in a truncated form, and under the auspices of Coal and Allied, still operated steam locomotives over the six miles to Stockrington Colliery. On this run could still be found the wooden, "non-air", four-wheel coal hoppers which were once such a common sight on the coal trains of the Hunter Region.

At Thornton, another private line linked Bloomfield Colliery to the exchange sidings at the main line. Again the Company chose to power the trains over its branch line with its own locomotives, which survived well into the 1950s. A smaller branch trailed from Thornton towards the present highway.

The Morpeth Branch, as previously mentioned, was constructed in 1864 to serve the riverside port. As it was constructed the Junction faced trains from West Maitland, while the terminus confounded the critics by falling short of its main objective, although it did serve Queen's Wharf. In time, two further termini were constructed, with a further station, designed for passenger traffic from the town itself, located between. Eventually the junction at East Maitland was relaid to face trains from Newcastle. When traffic had declined to a negligible level, the line closed in 1953.

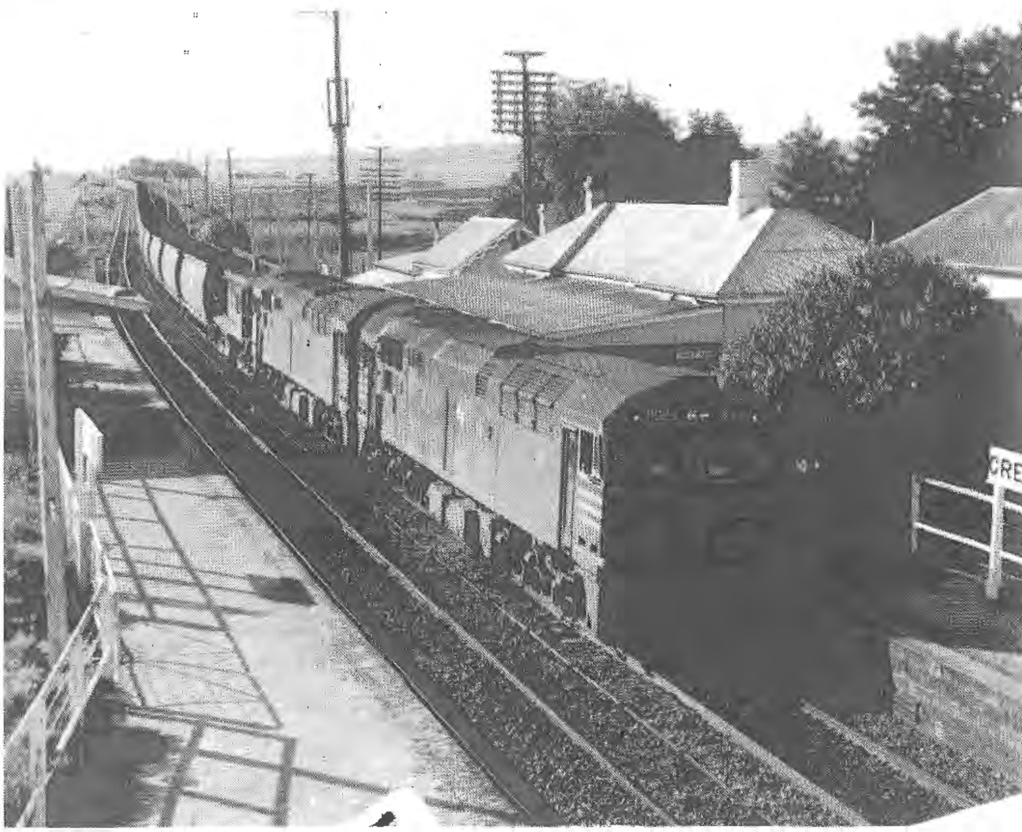
Of all the private lines, the South Maitland Railways had survived into the 1980s as the largest private railway enterprise. The first of the first line was turned on July 20, 1892, when the East Greta Coal Mining Company contracted with Messrs. Wright and Woodward to construct two miles of line from its pit to the Great Northern Railway. The junction was appropriately called East Greta Junction, a name it retains to this day. From this humble beginning developed a network of lines to Stanford Merthyr, Cessnock and beyond. Many collieries joined their pits to its main line and many of these runs were operated by the mine's own locomotives. Perhaps the most well-known of these was the Hebburn Company, whose link to its No. 2 Colliery branched out from Weston. On this line ran several steam locos, including the last steam locomotive imported into Australia. In time the East Greta Company became South Maitland Railways and a fleet of more than 30 locomotives and many passenger vehicles were acquired. In this latter department were three diesel railcars, which, in the 1950's, operated a passenger service between Maitland and Cessnock. While many of the lines have passed with the mines they served, the line to Pelton Colliery survived and in 1982 was the scene of double-headed steam powered trains, the only place in Australia where steam was still used in such a role.

Some three miles beyond Maitland was an unusual branch line, which opened in 1914 and stretched one mile and five chains to a two-sided platform at Rutherford. Originally a private branch owned by the Cliff Family, it first served Rutherford Racecourse, but in time provided access to the Bradford Cotton Mills. When motor cars became popular, the line lost its suburban passenger service, but remained as a goods and freight line until 1965, when its need passed.

Further up the valley, private colliery lines have existed at Greta, to Whitburn and Leconfield Collieries, at Branxton to Ayrefield and at St. Heliers to Muswellbrook No. 2 pits.

Another unusual line served the Commonwealth Oil Corporation's works behind Murrurundi. This little known line branched from the main at Temple Court and curved around the town to the plant. Boasting its own locomotive, the branch operated from 1910 to about 1914.

Several private lines made their junction with



Left Top: The Mount Thorley balloon loading loop, near Singleton, being tested in May 1982. Being tested is the largest coal train in New South Wales — 42 NHCF coal hoppers (total weight more than 4,200 tonnes) hauled by two 80-Class and one 45-Class Diesel locomotives.

Right: A large coal train passing through Greta.

RP

the main line to Sydney. Perhaps the most ill fated of these was the line which ran under the main line near Northcott Drive, Kotara, and into the hills under Charlestown Road, Kotara South. Opened and closed in 1897, the Australasia Coal Company managed to send out only some 9,000 tons until bankruptcy set in. Of only slightly greater success was the mine at Young Wallsend (Edgeworth), whose branch made its junction at the Sydney end of Cardiff Workshops. Government engines worked the line, which operated intermittently between 1889 and 1917. Another branch had served several collieries behind Cardiff from 1888 to 1931, while the Sulphide Corporation has enjoyed its own line and locomotives from 1889.

Cockle Creek was the junction for another network of private railways. Stockton Borehole Colliery lies nearest to the main line and is the last of the collieries of the area to be established. In 1982, its railway career was heightened by the construction of a modern balloon loop. Rhondda (later Northern) Colliery had a six mile long branch line which operated until the mid 1960s, but it was to West Wallsend and Killingworth that the bulk of trains operated, with passenger trains to the former. Platforms were constructed at various settlements and those can still be seen at Barnsley and West Wallsend.

Two collieries at Teralba, one on either side of the main line, had rail connections, and Newstan Colliery (at Fassifern) has had its association from 1889. Today, a modern balloon loop, with connections to send trains either north or south, has brought a bright future to this short branch.

Rollingstock Construction and Repair

When the Great Northern Railway was opened, a small locomotive maintenance facility was provided at Honeysuckle Point, near the Civic, site of the first Newcastle Station. In time, large workshops developed on the site and major locomotive overhaul facilities became part of its day-to-day functions. While locomotive construction was never carried out at Honeysuckle Point, its contribution to rebuilding and modifications, necessary to cope with a developing railway, should not pass unnoticed. Today the workshop buildings are classified under the National Trust and contain a rare example of a rope-driven overhead crane, one of the few remaining. The crane received its power from an endless rope running the length of the shop and which passed through a pulley network in the crane. A steam engine on the shop floor drove the rope via a series of belts and pulleys until "modernisation" replaced it with an electric motor. by the mid 1920s, locomotive development was taxing the size of the shops and a complete new complex was constructed at Cardiff.

Cardiff was a maintenance facility capable of overhauling all classes of steam locomotives from the smallest to the largest. Even the mighty 60 Class Garratt locomotives were overhauled here and when Manager Bill Wait was faced with overhauling a 105 foot-long locomotive in a 66 foot wide shop he came up with a layout modification to the works which allowed the impossible to be achieved.

Locomotive construction has been a feature at the Workshops. Following the Second World War, 12 38 Class 4-6-2 express passenger locomotives were built under the direction of Manager, Mr. P. Taylor. A need for freight engines saw two powerful 58 Class 4-8-2 engines built here, a programme which came to a halt when diesel electric units proved their superiority on the main lines.

In time, steam faded from the scene and diesel electrics took their place.

Today, Cardiff handles all classes of diesel branch line units and has a programme of overhauls for some main line units. Electric locomotives are now overhauled and rebuilt there as part of an on going modernisation programme for the State's Railways. In the programme, the Workshops are receiving new buildings, machinery and amenities to cope with a new generation of locomotives and vehicles.

Over the years, rollingstock was the mainstay of early Newcastle engineering works with a history of its own. Some of its facets are covered elsewhere in this book. Today A. Goninan and Company remains as the modern builder of both passenger and goods vehicles.

Trams

The street tramway network served Newcastle from 1887 to 1950.

First, the Plattsburg Steam Tramway was opened and the system grew to cover West Wallsend in the west, Speers Point on Lake Macquarie and eight terminii around suburban Newcastle. Depots were provided at Wallsend and Hamilton, with a service facility adjacent to the main railway line at Burwood Junction.

Trams were originally taken to Sydney for overhaul by sea, but with the completion of the

Steam engine and steam tram. A P-Class locomotive at Newcastle Station and a steam tram in Scott Street — in the 1880s. *SRA*

Below: Electric trams in Scott Street, and buses, which surplanted them, in the 1950s. *NRL*

Hawkesbury River Bridge in 1889 they were taken along the rail lines, observing speed restrictions over points en route. In time, the Gordon Avenue Depot at Hamilton was provided with workshop facilities to overhaul the 0-4-0 steam tram motors and bogie trailers which were in common use.

Just as the Sydney system changed to electric operation, the Newcastle trams were converted to 600 D.C. from October, 1923. All suburban routes were changed, with the exception of the West Wallsend and Speers Point lines beyond Wallsend and a short section from Port Waratah terminus to the Hunter River, where the Walsh Island Ferry terminus was located.

To work the service, a fleet of LP bogie trams was brought from Sydney by rail and these, with the exception of two N Class, remained the exclusive stock until the service ended. The first line to close was Mayfield in 1948 and the last trams were replaced by buses on June 10, 1950.

Newcastle was not the only street tramway system in the Hunter Region. The residents of Maitland commenced their agitations for trams soon after the mode was introduced in Newcastle and their efforts were finally rewarded when the first sod for a four-mile main line was turned in 1907. Mr. G. Champion had won the contract to build the line, which extended from near Victoria Street Station, past East Maitland, along High Street to Campbell's Hill. A half mile branch line ran along Church Street to West Maitland Station and the depot was constructed at Victoria Street. Again the 0-4-0 steam tram motors provided the motive power hauling side loading bogie trailers, similar to those used in Sydney and Newcastle.

Unfortunately, the financial results did not justify retention of the system and despite proposals to electrify the route, the last trams ran on December 31, 1926.

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Modern-style passenger transport in 1982 — the Intercity XPT. *RP*

"PERSEVERENCE WILL COMMAND SUCCESS"
Engineering Manufacture

by Deera Phong-anant and Ian Stewart

In the beginning, Newcastle, the little coal-mining settlement at the mouth of the Hunter River, and the pioneer villages, Morpeth, Maitland and Muswellbrook, had need of "ingenious artificers", but not many.

John Portus, an engineer, was erecting horse-powered threshing machines, flour mills and flax mills for John Oxley at Segenhoe and Kirkham (near Luskintyre) in the 1820s.

In 1832 *John Elliott,* a miller who is said to have trained as an engineer in Edinburgh, erected the Hunter Valley's first steam-powered mill on the river near The Falls at Maitland.

The Australian Agricultural Company brought out engineer James Steele to erect the engines for the company's new mine on the hill in Newcastle.

Several factors spurred the demand for engineering services — the growth of coalmining from 1831, the enterprises of Alexander Scott, James Mitchell and others from 1834 (in salt manufacture and woollen textiles at Stockton, and copper-smelting and salt, coke and brick-works at Burwood), the proliferation of mills and boiling-down works up the Valley and the building of steam ships. Scott also established a foundry in Stockton. In 1842 he made the castings for an engine for the A.A. Company, in 1843 a boiler for a new brewery in Maitland and, later, a 17 horsepower steam engine for a flour mill. Despite the fact that ships and agricultural machinery had to be repaired, his venture failed.

John Howden, who was trained as a black-smith in Scotland, fared better than Scott. In the early 1840s Howden opened a blacksmiths and general engineering shop at the corner of Hunter and Perkins Streets in Newcastle. He specialised in the construction and repair of ship's pumps. By the 1860s he had bought 10 acres of Crown land on Bullock Island and built a residence and an iron and brass foundry there. Howden advertised his services in 1872: "John Howden and Son - Engineers, Iron and Brass Foundries". Two years later the business was purchased by brothers *Robert* and *James Morison* and *Edwin William Bearby.*

Morison and Bearby

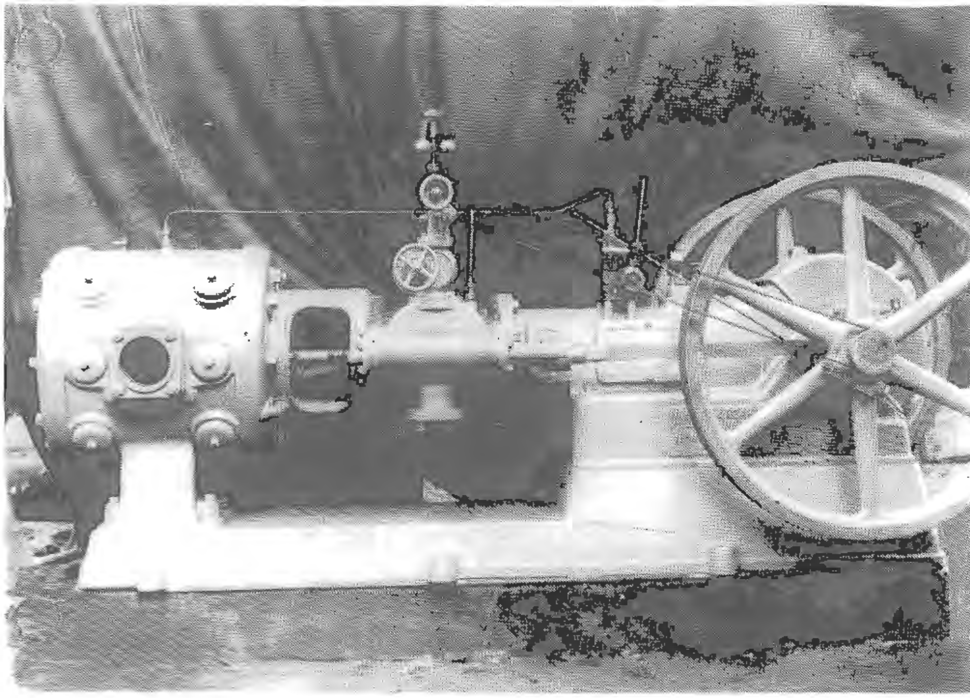
The Morisons were born in Lancashire and migrated to Sydney with their parents about 1860. Their father, an engineer from Perthshire in Scotland, entered partnership with a firm in Sussex Street, Sydney, where Robert and James worked. Both young men moved to Mort's Dock Engineering Works — then the largest ship-building and general engineering establishment in the colony. At Mort's they became friends with a young pattern-maker/moulder, Edwin William Bearby, born in Stockport, England, in 1842, who had arrived in Sydney in 1856. Robert Morison moved up to the Newcastle workshops of the Great Northern Railway and met and married Emily Webb. Seeing the opportunities for engine building and repairs, he persuaded James Morison and Edwin Bearby in 1874 to become co-owners of Howden's works. They ambitiously named the works the "Soho Foundry", after James Watt's firm. With two youths as assistants, they got repair work and built a four horsepower steam engine for a cordial factory. By 1878 they were employing three hands. A boiler measuring six feet by seven feet six inches and engines with twin nine horsepower cylinders were built for the screw steamer *Mystery,* launched by Callen at Stockton. Boilers and engines for ships launched at Clarencetown, Moruya and Bateman's Bay were also produced. By 1879 compound engines of 35 horsepower had been made and at the trials of the *Comet* (launched by T. O'Sullivan and Co.) the Harbour Master, Capt. D.T. Allan, proposed a toast: "Success to the engineers, Morison and Bearby, whose work is a credit to their skill."

By 1883, with 120 workmen, Robert Morison was General Manager, Edwin Bearby was Superintendent of the foundry and James Morison was in charge of engineering shops. They advertised:

"R. & J. Morison & Bearby,
Engineers, Boilermakers, Shipsmiths,
Brass & Iron Foundries
Soho Foundry
(near Hydraulic Engine House)
Onebygamba, Newcastle.

Right: When Morison and Bearby produced this steam vacuum pump, it was typical of local engineering manufactures before 1915. NRL

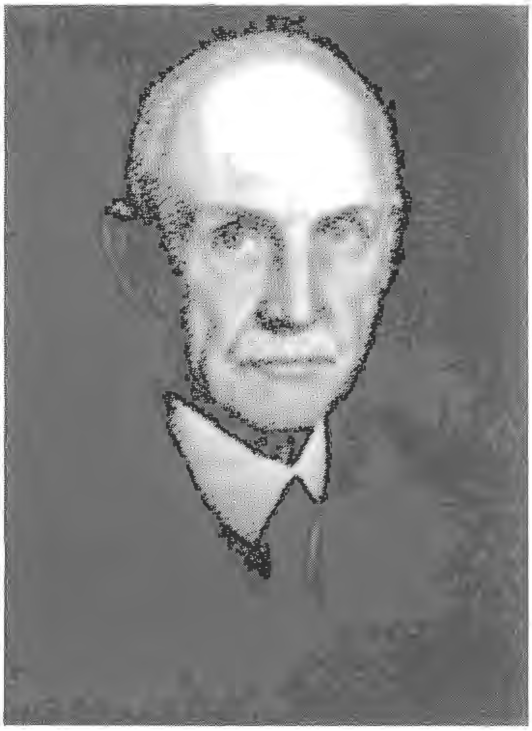
Below Right: David Niven Morison. NM



The above firm having increased the capacity of their plant are prepared to undertake contracts for the manufacture of marine and stationary engines and boilers, girder work, flour mill, sawmill, quarry-crushing, refrigerating, sugar-mill, mining and every description of machinery with the latest improvements.

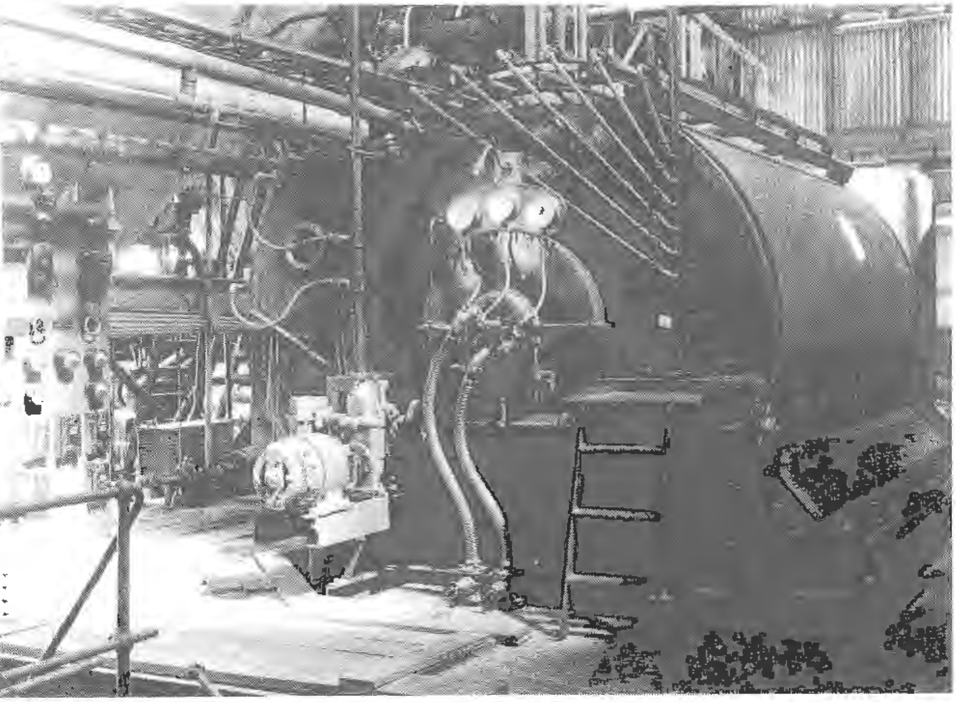
A large assortment of fluted and plain columns, pilasters, frieze and balcony railings, etc. etc. Orders executed with dispatch."

Onebygamba (now Carrington) was originally a series of mud-flats and mangrove swamps, named Chapman's Island by Lt. Col. Paterson in 1801. On clearing, good grass developed and the butchers (Fleming, Sparke and Hickerbotham) swam their cattle across for fattening. As the area was filled and settlement developed, it was officially referred to as Onebygamba, the aboriginal name for the area, but the common name remained Bullock Island until it was proclaimed the Municipality of Carrington in 1888.



A major venture for R. and J. Morison and Bearby in the 1880s was the production of cast iron tubbing to line colliery shafts which were sunk through sand and mud. The first order was received from Thomas Croudace for the Stockton mine; others followed for Bullock Island and Wickham Collieries. The cylinders were up to 17 feet in diameter and one-and-a-quarter inches thick; up to 375 tons were required for a shaft. Another achievement for the firm was the construction of a steam-powered press for collared clay pipes for Hughes Pottery Works at Merewether. Hughes had obtained a quotation, with plans and specifications, from England, but found that Morison and Bearby would make the machine for £200 cheaper here. When the Mayor and Aldermen of Newcastle made an official visit on June 24, 1887, the machine was acclaimed as a triumph for local industry.

James Morison died in 1901 and Robert



Left: Morison and Bearby's "wizard" filter. NRL

Below Left: Bascule span for Narooma Bridge, made by Morison and Bearby. NRL

Morison in 1914, to be succeeded by Edwin William Bearby as head of the firm. Several of the sons had joined the firm — Edward, Arthur, Alfred and Oscar Bearby as pattern makers and moulders and David Niven Morison, Robert's son, as an engineer. The Directors in 1914 were Edwin William Bearby, Edward Bearby, Alfred Earnest Bearby, Emily Morison, Katherine Jane Morison, Emily Dawn Ellis and David Niven Morison. On Edwin Bearby's death in 1916, David Niven Morison became head of the firm.

Old hands delighted in the story of a German ship which arrived in 1914 with demands for urgent repairs. Edwin Bearby delayed negotiations and inspections until the First World War started and the vessel was seized by the Commonwealth. However, Morison and Bearby had to wait until two years after the war was finished for the £600 bill for the repairs to be paid.

By the 1920s the works covered four acres and employed about 300 men. Structural steel, electric welding, cranes and grabs, air compressors, large centrifugal fans, valves and hydrants and electrical switchgear were added to the range of products. Overseas designs for a continuous, rotary drum filter were modified to become the successful "Wizard" filter, with a good market in the sugar industry.

Early in the Great Depression a bright young Scottish Engineer, D. Lyon McClarty was brought into the management. He had previously managed the Shanghai Dock Company. The Depression was weathered with orders for supply and erection of a bridge on the New South Wales South Coast, a large machinery order for Mt. Isa Mines and some overseas exports. There was during the Second World War a strong demand for the firm to provide ship repairs and to build barges and cargo vessels. Following the war, competition from Goninan's became strong and Morison and Bearby lost its earlier ascendancy in general machinery supply. The firm was taken over by Brambles Ltd. in 1963. The only operation remaining in 1982 was the firm's steel division, trading at Cardiff under the name Steelmark.

The partners, Robert and James Morison and Edwin Bearby, were active in civic affairs. Robert, a staunch Methodist, lived in Cooks Hill and was an active worker for the Central Methodist Mission, the YMCA and the Newcastle School of Arts. He was also a Foundation member of the Northern Institute. James became the first Mayor of Carrington in 1890 and was a Foundation member of the first Northern Institute of Engineers in 1889. Edwin was a notable sight. Always clad in a white coat, he rode a white horse to the works every day. His son Edwin was a keen cricketer and became Patron of the Wickham Albion Club, the Wickham District Club, and Vice-President, and later Patron, of the Newcastle District Cricket Association. He was a member of the old Northern Institute.

David Niven Morison followed his father as a supporter of the Central Methodist Mission. David was a part-time Lecturer in Mechanical Drawing and Applied Mechanics at Newcastle Technical College until quite late in his career (as Alfred Bearby was in Patternmaking). He joined the Northern Engineering Institute when it reformed in 1908 and became Secretary and, later, President. He was one of the two representatives of the Institute at the conference in 1918 from which the Institution of Engineers, Australia, was formed.

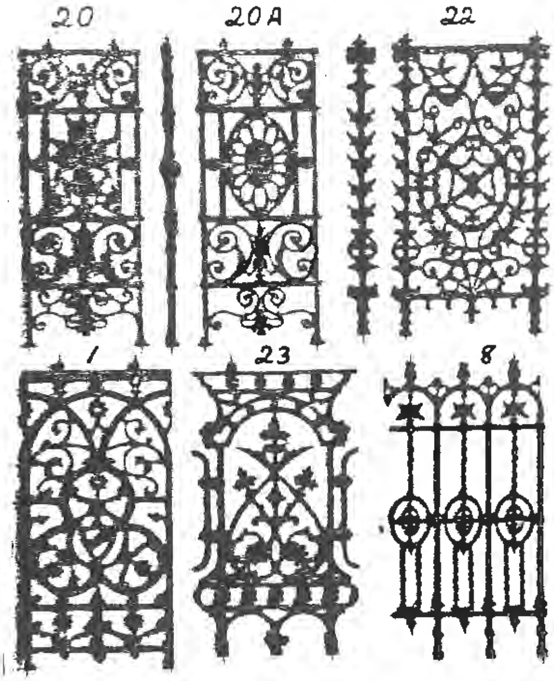
Sims Of Morpeth

For a brief time, Morpeth, the head of river navigation, and nearby Maitland, the railhead for nearly 20 years and at the node of roads to the Upper Hunter and Paterson, were the major engineering centres in the Hunter Valley. By 1869 Maitland had 14 engineering works and five foundries, compared with Newcastle's two of each. Duncan Sim claimed to have the largest of all of them.

Duncan Sim, born in 1818 in Dumbarton, Scotland, was trained as a wheelwright. Sim migrated to Australia in 1842 and found that the position he had been offered was in fact a supervisor of convict labour. He objected to flogging on principle and promptly resigned. He joined Henry Geering's wheelwright business at Hinton, near Morpeth. In 1849, after having married Sarah Elizabeth Ingall, he set up his own foundry and engineering works in Morpeth. This is how he told his brother in Boston in 1868 about his occupation:

Wine press at Tyrrell's Vineyard made by Sim of Morpeth. *IS*

"After returning from the diggings I started the business I had formerly been at of Wheelwright and Agricultural implement maker. I have steadily followed it ever since, increasing my facilities for doing work and making improvement as I was able. I never felt any great desire to be rich but was anxious to see the country improve by the steady employment of men in profitable industry. I have so far succeeded that I have one of the largest establishments out of Sydney and for some years back we have suffered a good deal in the Country by floods and farming has not improved as I expected it would and my business has been very dull, but at the commencement of last year pursuing the state of things that would prevail I tendered to build 30 good wagons for the Government Railway and will complete the delivery of them this week. There were 20 more of the same kind wanted for this year and I have succeeded in obtaining the contract for them so that I am not without something to do. The Government imported the wheels, axles and springs but all the other work is done on the establishment and must all be of the best description.



Cast-iron lace for verandahs was a steady standby for foundries in the nineteenth century.

You will feel surprised a little at how all this came about but an earnest desire to do justice to all you work for and a fair share of careful perserverance will command a fair share of success. My usual work is Hay presses, mowing machines, horse rakes, cornshellers, ploughs, dray wagons etc."

The mowing machine that was manufactured at Duncan Sim's works was given an award at the Sydney International Exhibition of 1879. Other items manufactured by Sim were lucerne hay rakes, hay presses, horse gears, intermediate gears, corn shellers, millet hacklers, harrows, wine presses, honey extractors, grape stalkers and crushers, broom making machines and sewing presses, baths, fuel stoves for wood and coal, and clothes boiling coppers. Iron work for many of the bridges built in the district and decorative cast iron columns and panels for houses were often obtained from the Morpeth establishment.

A descendant, Joseph Sim, has recounted that in the early days of the works Sim continued the tradition that apprentices should "live in". At times the family that was cared for by Sarah included six apprentices in addition to their own eight children.

Sim took an active part in public life and was held in high esteem in the Maitland District. He was a member of the first Morpeth Municipal Council for 17 years and was four times elected Mayor. He was a member of the provisional committee of a company formed in 1861 to construct a railway from Maitland to Morpeth. He was an original promoter of the National Schools and of the School of Arts, both of which were built in 1862. He was a member of the Maitland Hospital Committee and was appointed a Justice of the Peace in 1882. A man of very strict principles, he was not an adherent of any church. On his death in 1892 eulogies were delivered in Wesleyan, Presbyterian and Anglican churches.

In Duncan Sim's woodworking shop in Morpeth a mortising machine attracted considerable attention. The machine had been brought out from England and was on board the S.S. "Maitland" when the ship was wrecked near the entrance to Broken Bay. Robert Sim, Duncan's son, salvaged the unit and took it to Morpeth. Robert and his brother, Ernest, continued the business after their father's death. In his latter years, Ernest installed a crucible steel furnace, which is believed to have been the second of its type to be used in Australia. After Ernest's death in 1919 the Maitland branch of Sim's was sold and the works closed down in 1926.

Kings Of Maitland

The family tradition of engineering manufacture continued in the Maitland district with the King family. *Percival William George King,* who had been an engineer with D. Sim & Sons in Morpeth, set up his own small engineering shop in West Maitland in 1923 seeking work, in the first instance, on repairs to agricultural machinery in the Hunter Valley and as far as Tamworth in the North West. His sons, Don and Brian, were taken into the business in 1924 and 1930 to become P.W.G. King & Sons.

The Depression was weathered with a strenuous search for business. Don recalls cycling through the more prosperous residential areas with offers to take in lawn mowers for sharpening. Machine tools were built up to the level where the Ministry of Munitions virtually controlled the plant through World War II, producing aircraft parts, gun barrells, steel punches etc.

After the war the opportunity was seen to make spare parts for coal cutters, loaders and shuttle cars, being unobtainable from overseas. A challenge from Mr. Bede Kelly, Superintendent of R.W. Miller & Co., to make scraper loader winches led to the production of a large number of these machines.

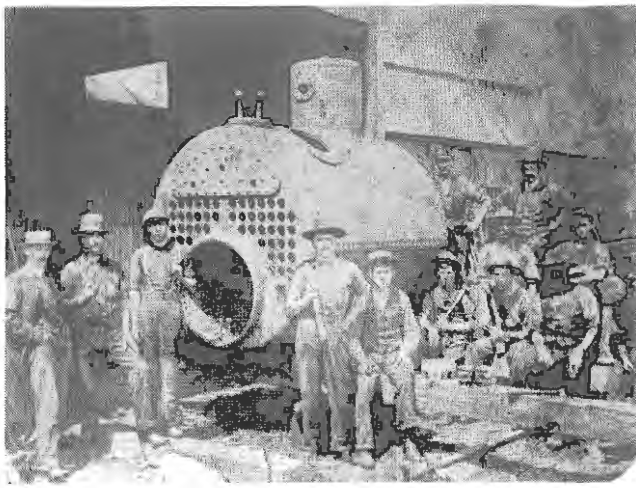
The spare parts business grew as machine mining of coal developed. Two grandsons and one great grandson of Percival King, together with Don's son-in-law, joined the firm.

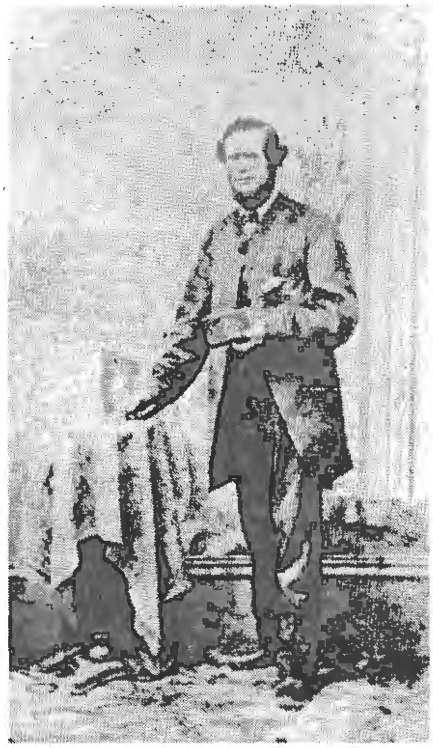
Now with approximately 45 men and three computer numerical controlled machines the firm is producing guaranteed spare parts for underground mining machines for Australia at highly competitive cost.

The Rodgers Family

Archibald Alexander Rodgers (originally Roger or Rodger), the next engineering entrepreneur to see the growing opportunities in Newcastle in the mid-nineteenth century, was born in Scotland in 1814. Trained as a blacksmith, Rodgers emigrated to Sydney in 1841 and entered a partnership in an engineering business. By 1854 he had moved to Newcastle and established a foundry. His "Iron and Brass Foundry and General Iron Works" at Honeysuckle Point was able to supply brass and iron castings of any dimension and meet all the requirements of mills, railways, farms and mining. Typical of the appliances offered by Rodgers were windlasses, winches, iron blocks, cranes, crabs, axles and wheels for wagons, hay presses and gears for mills and machinery. His total output in 1860 consisted of "manufactured Brass valued at £130, 33 tons of wrought iron and 174 tons of cast iron". Having had to face health and capital problems, Rodgers was nearly bankrupted in 1861, but remained open. Further additions and alterations were made to his foundry and works. *The Newcastle Chronicle* told its readers:

> *"It is a commodious and well-constructed workshop, 81 feet long, by 61 feet wide, and 41 feet high, divided into two executive compartments, containing different descriptions of lathes, boring, cutting, punching and other machines required in the trade, all set into motion by steam power, by means of iron shafts, on which are fixed driving-wheels over the machines, and in communication with them by broad, leather straps. The machines can be set in motion or stopped in an instant whenever required by gear which attaches by means of the drive straps, the driving-wheel of each of the machines to the driving-wheel of the shaft. The engine by which all the machinery in the factory is worked, is an eight horse steam-engine, and by its side is a horizontal engine*





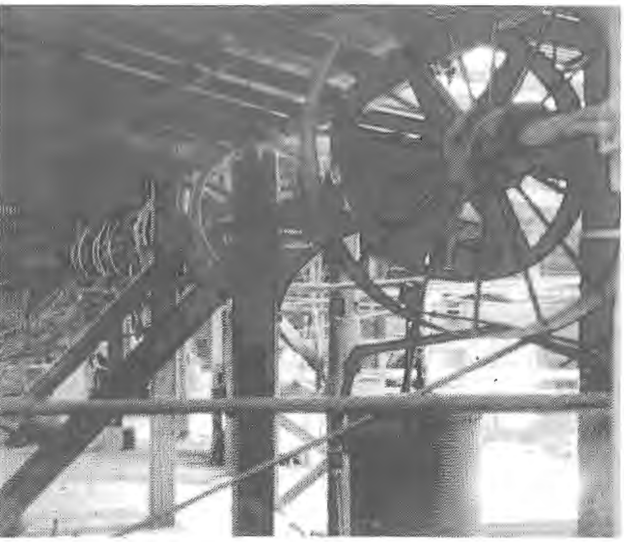
Top: Scotch marine boiler is completed at Rodgers' works. *RO*

Bottom: Archibald Alexander Rodgers. *RO*

Top Right: In the Age of Steam, a complete factory could be driven by belts from a single line shaft. This example from Brown's Monumental Masons, of Maitland, operated until 1981. *IS*

Centre Right: James Stuart Rodgers. *RO*

Right: Machine details from Rodgers' note book. *RO*

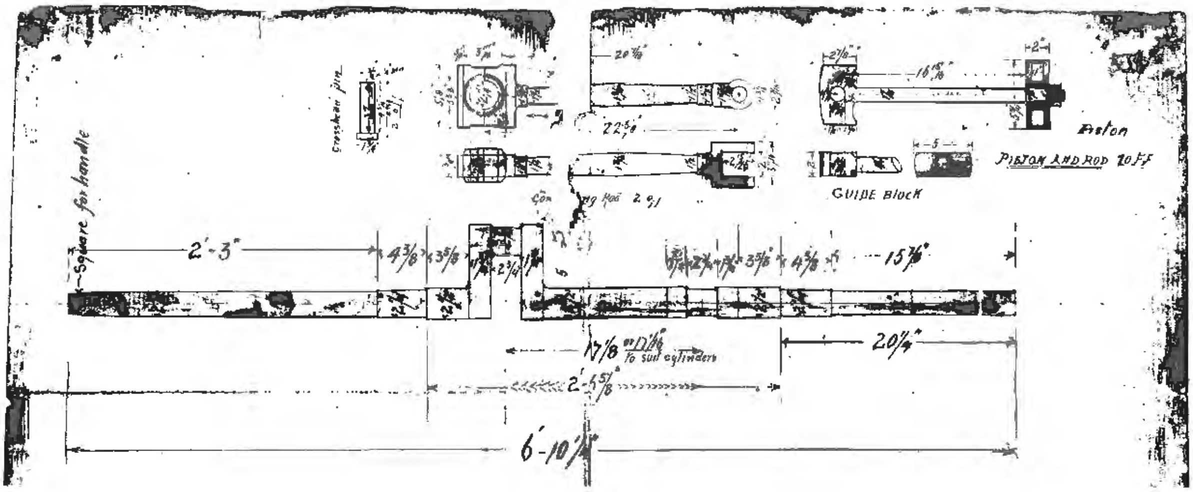


of two-five (sic.) horse power, driving a blasting apparatus for blowing the forges and furnaces in the factory."

As coal mining output in Newcastle grew, the need to maintain ships, railways and colliery engines increased. Demand for the products of foundries also rose steadily. Engines and castings were supplied to shipbuilders and sugar producers. In 1862 Rodgers' Newcastle foundry constructed screw moorings and buoys for the port. Three years later ladder buckets for the dredge *Hunter* and replacements for the port's cranes were being cast. The coming of the copper smelters after 1866 created a large amount of work for the firm.

Archibald Rodgers was active in the formation of the Newcastle Gas Company and was a member of the first Board of Directors. He died of tetanus after his hand was crushed in an accident at the works in 1870. James Stuart Rodgers and Alexander Rodgers, his sons, carried on the business; the name was changed to Rodgers Bros. Three years later, on termination of the partnership, ***James Stuart Rodgers*** became sole proprietor. James Stuart Rodgers had been born in Greenwich, in England, in 1838, and brought to Australia by his parents when two years of age. He served his apprenticeship as an engineer in the works of Messrs. P.M. Russell and Co. in Sydney. He worked for the A.S.N. Company at Pyrmont prior to joining up with his father, Archibald, in Newcastle.

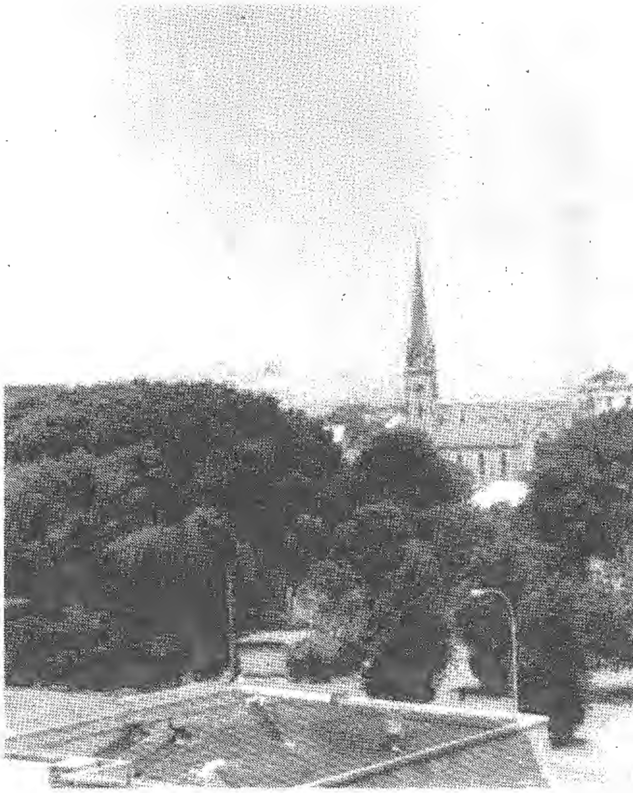
In 1872, Rodgers Bros. was busy producing what *The Newcastle Chronicle* described as "the largest casting that has as yet been made in the



colonies for the purpose of smelting ores." It was a four ton cast-iron crucible for Stephen's tin smelting works at Stockton. In the same year large pans for Matthew's meat preserving establishment at Tighes Hill were cast by Rodgers and Co. The firm manufactured a fog bell in 1872 which was believed to be the largest bell cast in the colony. The bell, first secured to a buoy outside the heads of Newcastle Harbour, was primarily used to warn ships to keep clear of the reefs when near the entrance. The bell is now at the Newcastle Maritime Museum.

J.S. Rodgers was very proud of the quality and workmanship of the products which the firm turned out in its workshops at Honeysuckle Point. Their high reputation was known outside the Newcastle district. They constructed the first steam soap-making plant to the order of Mr. C. Upfold, who pioneered soapmaking by the Sydney Soap and Candle Company. Rodgers Bros. also built the *Grafton,* the largest ferry on the North Coast at the time. The only complete iron pier bridge to be constructed in the district, still standing on the Nymboida River, was manufactured by the firm for £12,000 and transhipped to Grafton. Perhaps the firm's proudest achievement was the construction in 1878 of the "Burwood", an 0-4-0, side-tank locomotive. Built for E.C. Merewether's collieries for £1,350, it was the first colliery locomotive to be built in Australia. The locomotive provides a vivid picture of what was achieved by job-trained craftsmen using a well-established technology. Compared with the specialised design office and the sheaves of drawings which would be required today, all that was probably available to Rodgers Bros. was a single, well-detailed, general assembly drawing, workshop notebooks with typical details of various machine components and skilled craftsmen with a proper sense of engineering proportion, who could forge and mould and turn components from very simple sketches. With all our computational aids, such a sense of proper shape and proportions is still equally important for really good engineering design.

J.S. Rodgers retired in 1897. He had been active in civic affairs and became first Mayor when Bullock Island was proclaimed the Municipality of Carrington in 1888. He was twice an Alderman of Newcastle City Council, a Director of the Newcastle Steamship Company of the Wallsend Mining Co. and the Newcastle and County Building Company, and a founder member and trustee of the Newcastle School of Arts. With the formation of the Hunter District



Newcastle's fine Civic Centre (above) was developed on a site which had been used for engineering manufacturing. The before-1920 picture shows (from left): Varley's workshops, the Newcastle Fibrous Plaster Works and, to the left of the old Frederick Ash Warehouse, Rodgers Engineering Works, where the City Hall now stands. RO


PANORAMA

Water Supply and Sewerage Board in 1892, James Stuart Rodgers was appointed as the State Government representative on the Board and his son James Ewing Rodgers was elected a member.

The business was carried on by James Ewing Rodgers and his brother Archibald Rodgers. Another brother Robert was employed at the works. In 1927, part of the works site was reserved by the Newcastle City Council for the present City Hall and, shortly afterwards, the remainder was reserved to permit Nesca House to be built. James Ewing Rodgers, who had bought out his brothers interests, ceased manufacturing and built up a machinery business and practiced as a boiler inspector. He was a founding member of the Northern Engineering Institute.

Rodgers Bros. moved to Wallsend in March, 1971. The firm developed into plant-hire, specialising in air compressors, and passed on to James Stewart Rodgers, great grandson of the founder. It is still very much in business, managed by his son, John Stewart Rodgers.

Hexham Engineering

Shortly after Rodgers commenced operations, James and Alexander Brown, in 1861, took over Eales' colliery at Minmi. With characteristic thoroughness and drive they extended the workshops and "equipped it with the most modern machinery" to cater for both mining and shipping service. The "J and A Brown Minmi Engineering Works" provided damaging competition to Rodgers.

By the turn of this century Brown's mines had grown in number, their railway routes had increased considerably and their fleet of colliers, loading at Hexham, demanded larger workshops which were built alongside the wharves on the Hunter River. Increased activity in the Greta coalfields kept the workshops growing, with design and construction of pit-head equipment, as well as maintenance of ships, locomotive and colliery equipment. From the changes emerged the *Hexham Engineering Company.*

In 1919, *Ernie Hewett,* who had been trained as a fitter in Melbourne, came to Newcastle after being discharged from the Australian Flying Corps. Hewett joined Brown's engineering works as a draftsman. He played the trombone in *Hoyts (Hamilton) Picture Theatre* on Saturday nights. A man who found "engineering the most exciting thing in the world", he read and studied continuously and by 1930 he had become Works Manager and, by 1935, Chief Engineer,

Mr. Ernie Hewett. *CW*

Manufacturing and Construction. The Second World War was the opportunity for Ernie to release his tremendous energy. "He would have a go at anything", his friends said. The Hexham workshops built billet-cropping machines for munitions factories, designed and built wire-stranding and other special machines and 13, 75-foot ocean-going tugs for the Allied navies. With their design for rollover welding rigs, the workshops claimed that the ships were the first welded, ocean-going ships to be built in Australia. Mining machines were unobtainable from overseas until a long time after the war, so electrical underground locomotives had to be redesigned and built. Professor Eric Betz, Assoc. Professor in Mechanical Engineering at the University of Newcastle, recalled, as an apprentice, responding to the zest which Ernie Hewett stimulated in the measuring and detailing of spares for mining equipment.

Hewett, as Superintendent Engineer for J. & A. Brown, was by 1940 one of the most colourful engineers in the Hunter Region, enthusiastically promoting new concepts of ship-loading, long-distance belt conveyors, pit-top equipment, mine-stowage equipment and ship design. He worked hard at the production of an Australian Standard Code for mine-hoisting equipment, insisting on university research into stress distribution. *Hexham Engineering* is now established as a world-wide supplier of minecage safety detaching hooks. Despite his commitment to design and engineering management, Hewett kept closely involved with construction jobs. His tall, spare frame survived several serious accidents. One of his staff recalled his instruction about one troublesome job: "Be sure to keep me in touch, but don't ring me between 10 pm and 2 am, that's when I sleep." Hewett retired in 1964, but stayed on as full-time consultant engineer until shortly before his death in 1981.

In 1983 *Hexham Engineering Company* continued to manufacture a wide range of mining equipment for the industry generally, as well as its largest parent group, Coal & Allied Ltd.

An Ormerod mine cage detaching and suspension gear. This kind of job is a speciality of Hexham Engineering. HE

Some Others

The extension of the Great Northern Railway north west from Singleton into the Liverpool Plains in 1870 offered new engineering opportunities. In 1868, John Moyes and Andrew Donald established an engineering works in Brown Street, Newcastle, (the later site of Winn's store) and an associated foundry in Stockton to take opportunity of the demand for rolling stock. On winning a five-year contract for rolling stock, they moved to a larger site in Wickham in 1879. The purchase of new equipment over-extended their capital resources and they had to close the plant in 1880. The works were bought by a Parramatta firm, *R.A. Ritchie and Sons.* Further labour-saving machinery was installed, including steamsaws. Passenger carriages, including sleeping-cars, formed a considerable proportion of the business. Such was the Ritchie's success in securing contracts for the Southern and Western Railway Lines, as well as the Great Northern Railway Line, that a competitor, Hudsons, a Sydney firm, staged a takeover in 1884. R.A. Ritchie's sons, John and James Ritchie, were retained in management. John was elected to Wickham Borough Council in 1886. The Wickham works were extended to cover four acres and employed 200 hands. Hudsons closed the works down in 1893 and transferred all former activities to Sydney. Completion of the Northern rail link in 1889, followed by the reduced demand in the Depression of the 1890s, had enabled the firm to concentrate its production in the Sydney plant, which was larger. The works did not stay idle for long. In 1899, Alfred Goninan saw an opportunity.

In the meantime a number of other engineering enterprises developed. *The British Iron Foundry,* established by John Gibson in 1872 in Blane Street, Newcastle, made "all kinds of iron and brass castings, including columns, pilasters, palisading, railings, ovens, grates and Lancashire ranges, etc." In 1881 Gibson's son Robert, took over the works. He later organised a transfer to Lower Church Street (now King Street). Operations developed into blacksmithing and fabricating and the supply of equipment to the railways and collieries. Robert Gibson forged a crank-shaft for Newcastle's electric light power stations and made the iron brackets for the platform roof at Newcastle Railway Station.

J. Russell and Co., in Merewether Street, was in 1892 the largest engineering and establishment in Newcastle, with steady orders for ships' machinery and colliery haulage gear and repair work for ships, collieries and railways. Rail wagons and mine skips were built. A major coup was the contract for valves, hydrants, etc. required after the enactment of the Country Towns Water Supply and Sewerage Act.

E.E. Robbins, a Canadian, arrived in Newcastle in 1887 and opened a foundry and engineering works in King Street. Initially, Robbins fitted machinery and boilers to steamships in local trade and to John Dalton's tugs. He was shrewd enough to get into the new field of electricity and was engaged by Newcastle City Council for repairs to their electricity plant. Robbins is credited with the first complete colliery electric lighting installation in Australia, at the A Pit of Newcastle Coal Mining Company, in 1897. As an ingenious man with a skilled labour force, he earned the comment in *The Newcastle Morning Herald.*

> *"Robbins' firm was the successful applicant against many Sydney founders and engineers for the making of an hydraulic motor for the Sydney Town Hall Organ. With such skill E.E. Robbins Engineering Works was known to be one of the formidable rivals of iron industries in the colony to the credit of Newcastle City."*

The Varley Family

George Henry Varley was induced by shipping interests to set up a coppersmith's business in Newcastle in 1886 at a site in King Street. Unlike our other entrepreneurs, Varley was Australian-born in Sydney in 1852. He learned his trade at Mort's Dock, worked for the A.S.N. Company and Atlas Engineering and then at the Newcastle Railway Workshops. A brass foundry and machine and blacksmiths shops were added and a

The original premises of G.H. Varley in King Street in 1886. George Varley in the foreground. *VA*

second workshop built in Darby Street in 1912. The King Street plant was later closed and sold in 1925. Although steam was replaced by electricity in 1914, line-shaft drive to machines was retained until 1960. Heavy ship work, including the building of horse-boxes for the shipping of horses to the Army, occupied the firm during the First World War. George's older son, Reginald, took over the business in 1913. In 1918, a younger brother, Clem Varley (Snr.), trained in the works, took over on his return from the Air Force. In 1925 George Wilson, from Jim Crammer's Auto-Arc Oxy Welding Co., was engaged to set up what is claimed to be the first electric welding shop in Newcastle (a claim also made by Morison and Bearby and Goninan).

Ship repair continued as a major activity, with operation of the floating dock after the closure of the State Engineering Works at Walsh Island. Operation of the dock continued from 1933 until the opening of the State Dockyard in 1941. Clem Varley (Jnr.), trained in Newcastle and Sydney with McDonald Constructions as a Civil Engineer, was brought in as General Manager in 1966. The Company moved to a four-acre site in Carrington in 1965, the operations being expanded to carry out heavy engineering and construction activities. Subsidiary engineering companies have been established since in Newcastle and Port Kembla, engaged in the fields of sheet metal, heavy engineering, aluminium fabrication, electrical maintenance and switchboard manufacture. The Company has been involved in the design and conversion of ships to livestock carriers and drill ships and in refloating large vessels grounded around the port and in the attempt to salvage *Sygma,* blown ashore at Stockton in 1974. A design section of the establishment has grown to include naval architects and marine engineers. Clem Varley (Jnr.), a Member of Institution of Engineers, Australia, was President of Newcastle Chamber of Commerce in 1982.

The Goninans

Alfred Goninan settled in Newcastle in 1899. Impressed by the rapid development of the coal industry in the Hunter Valley, Goninan saw an immediate market for coal skips and rail wagons. In partnership with his brother-in-law, Harry Charleston, he leased, from A.A. Dangar, Hudson's abandoned rolling-stock works at Wickham and quickly gained an order for coal hopper-wagons.

Alfred was born in Cornwall in 1865. He was

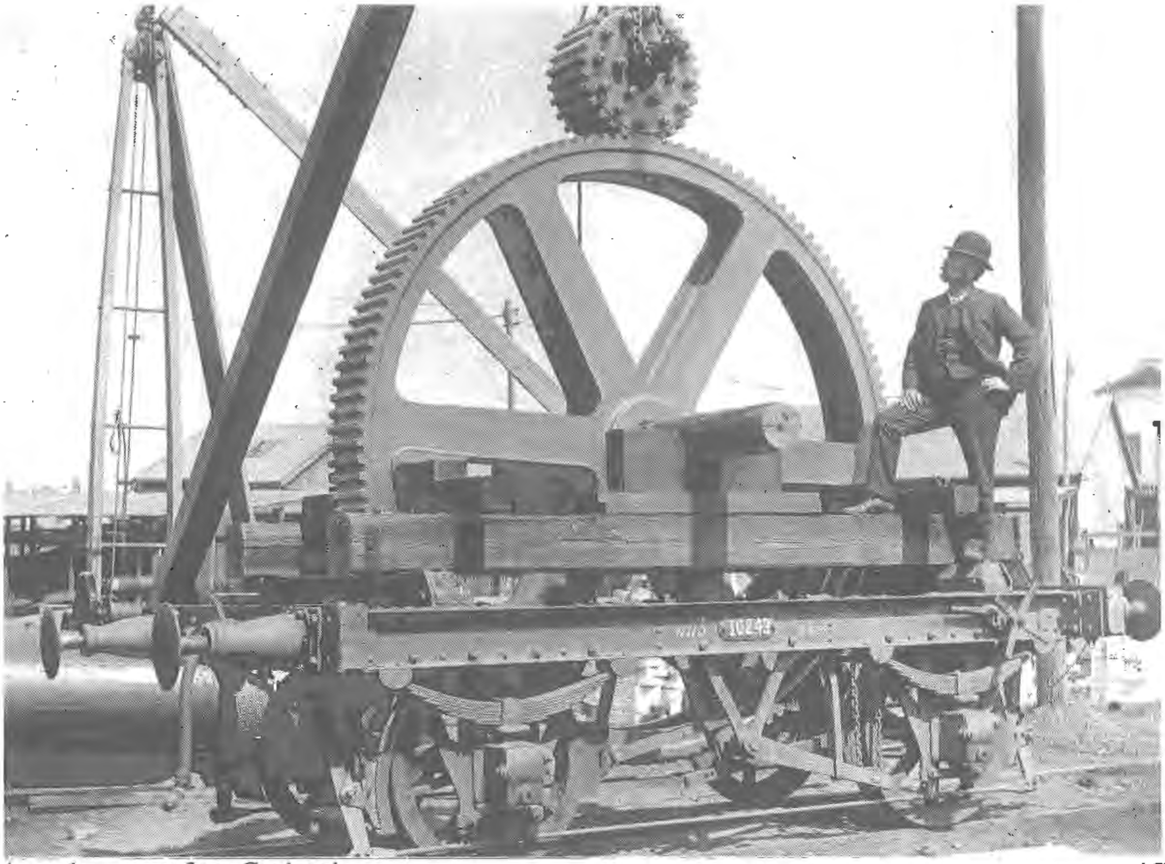
Alfred Goninan. *PG*

A steel-tyred road wagon made by Goninan's, when any kind of wagon business was eagerly accepted by the firm. *AG*

pupiled to Mechanical Engineering to a Cornish firm, Holmans, then went to sea and qualified as a Chief Engineer.

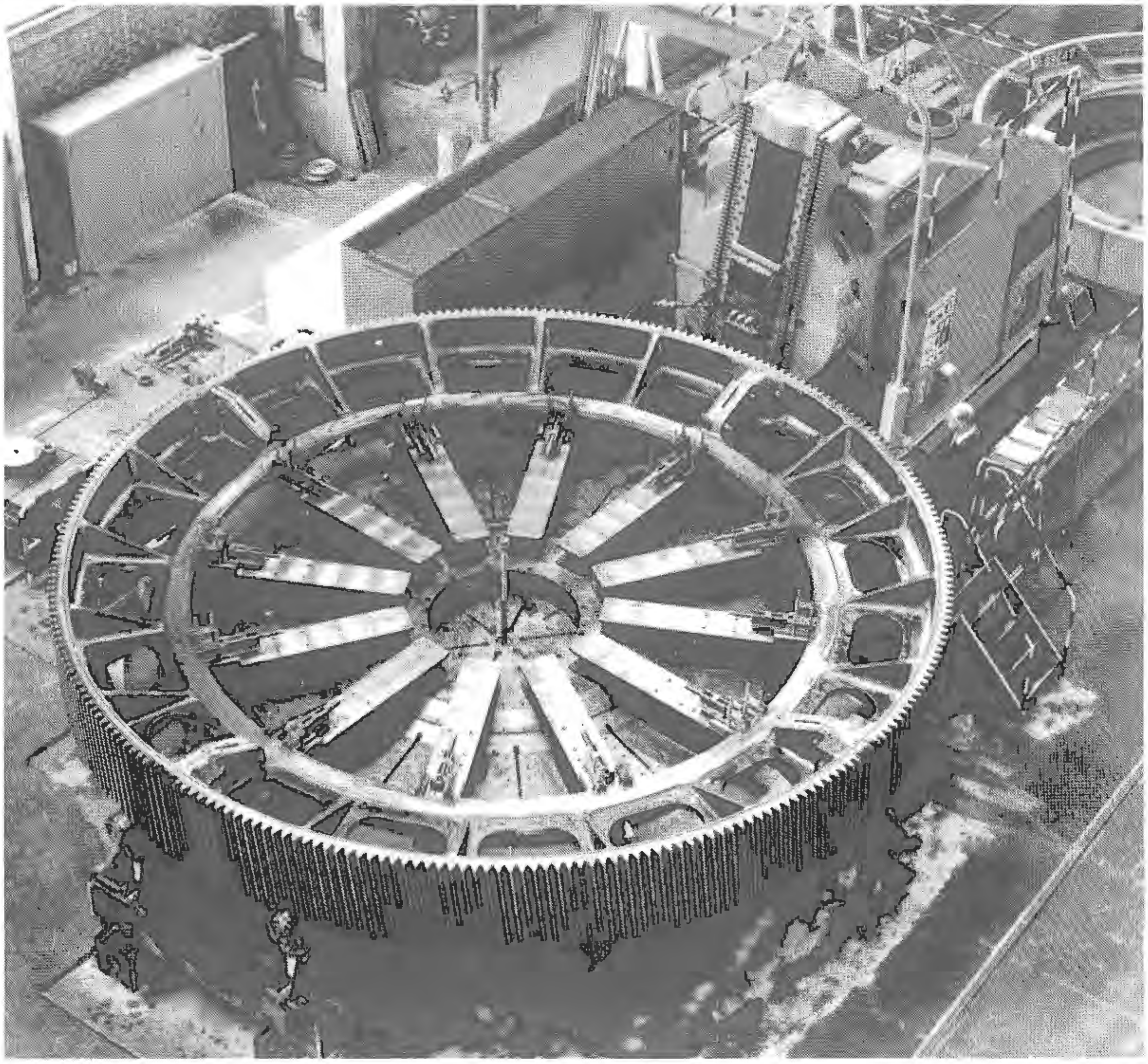
After his marriage he sailed in about 1890 for South Australia, where he worked at Adelaide and then became a partner in a small foundry at Port Pirie. Not liking this climate, he sailed in about 1894 for Newcastle, where he was offered the task of erecting the surface machinery for silver and gold mines at Sunny Corner and Lagoon Creek (near Orange). He returned to Newcastle in 1899 and worked hard to build up his new venture, ploughing all his earnings back into equipment. The enterprise became a private company in 1905. In an address to shareholders in 1909 he stated: *"It is essential that the whole of the mechanical equipment should be of the latest and most up-to-date design"*. As the Company grew in size he had battles with his board to maintain this concept. Alfred was an outstanding entrepreneur with a great ability to sense potential markets, as well as a drive to venture into new fields and to maintain excellence. Of great personal integrity, he was warm-hearted, trusting and persuasive. It was said that he was equally warm and at-ease in the company of royalty, or children, or factory workers. He entertained generously at "Venetia", the fine house in Wickham he leased from Dangar. Old hands at the works remember his regular inspections, with his dog always in the vanguard. He cherished the bowler hat, which was always worn on these inspections but it is claimed that there were excited arguments during which the hat was thrown to the floor and jumped on. Alfred Goninan was a Foundation Member of the Northern Engineering Institute in 1908 and of Newcastle Division of the Institution of Engineers in 1919. He was active in industry affairs and was for a time Chairman of the Newcastle Chamber of Manufacturers.

Alfred Goninan rapidly developed his business from rolling stock into a range of colliery equipment. He built the head frames for Aberdare and Caledonian Collieries. He set up a new company in 1910, Engineers & Colliery Supplies, to supply engineering stores. The warehouse was in Blane Street (now Hunter Street), where the Civic Theatre block now stands. Concerned with the difficulty of attaining imported wheels and axles during the First World War, Alfred persuaded four other companies to join him in setting up the Commonwealth Steel Products Company Limited at Waratah. Commonwealth Steel produced its first wheel and axle set in 1920. Although BHP later bought Goninan's shares, Alfred Goninan was retained on the Board of what was changed to the Commonwealth Steel Co. Ltd. In 1924, Alfred set up a consortium, Goninan Bridge Corporation, for the purpose of tendering for the Sydney Harbour Bridge in accordance with Dr. Bradfield's cantilever specification. However, the tender was won by Dorman Long, with their alternative arch design. At the other end of the manufacturing range, it was Alfred Goninan who earlier persuaded Henry Lane to come to Newcastle to manufacture rabbit traps, which were then in great demand. Lane's continue in Newcastle manufacturing engineering hardware, locks and fittings of all kinds and, still, rabbit traps for export.



An early gear set from Goninan's. *AG*

The MAAG gear planer for 7.5 m wheels, installed in 1973 at Goninans and subsequently updated. *AG*



By 1919, Goninan's enterprise had outgrown the Wickham site and new works had to be built. The new plant's facilities, on a 29-acre site at Broadmeadow, previously occupied by the E. & A. Copper Smelter, were the most modern then available in Australia. They comprised both fabrication and machine shops to a standardised width of 50 feet. Railway lines were laid throughout to facilitate the handling of raw materials and products. The Company's new head office was reputedly the second largest administrative building in the Newcastle District. By the mid-1920s the facilities comprised a boiler shop, a foundry, including a brass foundry, pattern shop, store, machine shop, blacksmith's shop and wagon shop. A 12 foot-six inch gearcutting machine was acquired in 1919. Structural welding was pioneered. A wide variety of engineering products were manufactured at the new works for customers in New South Wales and interstate and a new product line, rubber machinery, was introduced. Examples of the Company's work at that time are the 66-foot span bridges constructed for the New South Wales Government Railway, the structural parts for the Newcastle Gas Co.'s plant, the 40-ton billet shears for the BHP and structural parts for Sydney Central Railway Station.

Equipment for coal handling and coal transportation in the Hunter Valley collieries, together with jobbing work for the steel industry, were still a major part of A. Goninan & Co. Limited's business.

With his great family loyalty, Alfred Goninan brought a younger brother, Ralph, to Australia in the early 1890s. Ralph made several expeditions to the goldfields, but eventually joined Alfred in Newcastle and developed a steady dour disposition which balanced Alfred's flamboyance. Alfred retired in 1933 and was succeeded by Ralph.

Winning the contract for the structural steel extensions for Sydney GPO was breakthrough for Goninan's. Howard Smith and Co. Ltd., owners of Caledonian Collieries, acquired a growing shareholding in Goninan from 1917 onwards and, finally, gained complete control in 1964. The tradition of having the administration centred in Newcastle, with a works-trained engineer as General Manager, was continued by Ralph Goninan (Jnr.) from 1946 until his retirement in 1968. With his great charm, a flair of pricing, an enormous capacity for work and a fiery temper, Ralph Goninan (Jnr.) had some characteristics of both Alfred and Ralph. Bill Eddy, who followed as General Manager, was still in command in 1983.

Inspection of plate-work for Brisbane's Story Bridge at Goninans works (about 1937). From left, Mr. Evans, (—), Mr. Deakin, Dr. Bradfield, (—), Mr. Ralph Goninan, Snr., (—). (—) - not identified.
AG

As a result of strong support given by Bill Eddy and the engineering staff, the original emphasis on jobbing work was moved towards a product-oriented policy. The Company acquired many licences for the manufacture of products of leading international designs.

In the early Fifties, Goninan commenced the manufacture of GEC (USA) design diesel electric locomotives. The Sixties brought the Company's major involvement in the sugar industry. Sugar mills of Goninan design and manufacture are now among the world's largest. Goninan's manufacture of mineral grinding mills made headway and, in 1967, the Company designed and built a modern coal ship-loader in the Harbour basin — the first of its kind in Newcastle.

During the period of early growth the Company was well served by Design Engineers who had received in-house training after serving trade apprenticeships. Jim Cowan, Jack Steel, Cecil Dean and Alec Rice are examples. The advent of higher technology, together with the need to modify design to Australian conditions, brought the need for deeper technical training. Jim Beath, appointed in 1957, was the first university graduate to join the Company. By 1983 39 professionally trained engineers were part of the team, which used world-class production equipment, e.g. a MAAG gear planer to cut gears up to 7.35 metre diameter and Computer Aided Design and Drafting. Electric passenger cars for the State Railways System were mass produced at the rate of two cars per week. The Goninan Group head office in Newcastle administered subsidiaries in Taree in New South Wales, Mackay and Townsville in Queensland and Melbourne in Victoria.

Post World War II

This book is about our Engineering Heritage and cannot encompass new developments since the Second World War. It is important to record, however, that this most recent period has seen a much wider development of engineering manufacture, service industries and technical and consulting services than had occurred in the previous 150 years, not only in Newcastle but throughout the Hunter Valley.

Acknowledgements

Extensive use has been made of *Manufacturing in Newcastle 1801-1900,* by J.W. Turner, published by Newcastle Public Library in 1980, a paper by D.J. Goold for the Newcastle and Hunter District Historical Society, published on May 6, 1952, and the general collection of Newcastle Local History Library.

Appreciation is expressed for the information given by Messrs. A.P. Pulver and K. Bridger from Sim's family records, Mr. W. Eddy and staff re. the Goninan family, Mr. R. Crump re. Messrs. Morison and Bearby, Mr. J. Rodgers for the Rodgers family, Mr. J. Weatherby and Mr. Clem Varley for the Varley family, Mr. D. King re. the King family and Mr. J. Quale and Mrs. Clarice Watson re. Hexham Engineering and Mr. Ernie Hewett.

Electric inter-urban railcars, like the one pictured, are manufactured at an average rate of two a week by Goninans in 1982. *AG*

FROM WEIRS, DAMS AND SAND
Water Resources and Water Supply

by Mal Hindley

The Walka Pumping Station pictured in the 1930s. *HDW*

Walka Scheme

The first permanent water supply for Newcastle and its suburbs, the town of Maitland and the towns downstream along the Hunter River was completed in 1887. The scheme took water from the Hunter at Dickson Falls, about 2 kilometres upstream of the Belmore Bridge at Maitland.

At Dickson Falls the river is above tidal influence and so avoided the brackish water that prevails at Maitland and Morpeth.. However, as the river passed through pastures and considerable flood plain area, the water was not free of pollution and it contained a large amount of sediment or turbidity and was generally very hard.

The hardness of water made it unpalatable for drinking, washing and other household uses and so almost all the residents had tanks filled from roof water to satisfy their needs. Industry used softening plants extensively to render the water suitable for boilers and other important needs.

The drought of 1876 and the long dry spell of 1885, coupled with the growing population of Newcastle and along the Hunter River, prompted the New South Wales Government to take action to investigate the feasibility of a permanent water supply. The residents relied on tank water, wells and local water bearing sand and gravel deposits and these were far from adequate. Deaths attributed to the doubtful quality of the early sources of supply were also a contributing factor to the Government's action.

In 1877, William Clark, a renowned English Civil Engineer, came to Newcastle and commenced his investigations on behalf of the

Government. Proposals he looked at included the water bearing sands adjacent to Redhead Lagoon and near Raymond Terrace, but his final choice was the Walka Scheme on the Hunter River at Oakhampton, upstream of Maitland.

William Clark had been earlier recommended to the N.S.W. Government by the Institution of Civil Engineers, London, to advise on the water supply and drainage of Sydney. Born in 1821, he had a varied career in connection with English railway systems and drainage works and had won acclaim on his water supply and drainage proposals for Calcutta in India. He was later knighted for his work.

Clark estimated the population's usage at about 90 litres per head per day, but considered an actual allowance of 135 litres per head per day would be more realistic, due to the relatively harsh climate compared to that in England. His proposal provided for the pumping of water from the Hunter River just upstream of Dickson Falls to the Walka Lagoon, or storage reservoir, formed by the placing of a low embankment across the outlet of low lying land, on to a settling tank from which the water would gravitate to four filter beds, thence to a clear water tank prior to being pumped into distribution. The lagoon or storage reservoir had a capacity of 750 megalitres and was used to allow the sediment or turbidity of the raw river water to settle out. During times when the turbidity of the river water was relatively low, the water was pumped direct to the settling tank which had a capacity of 4.5 megalitres and thus the large lagoon was bypassed.

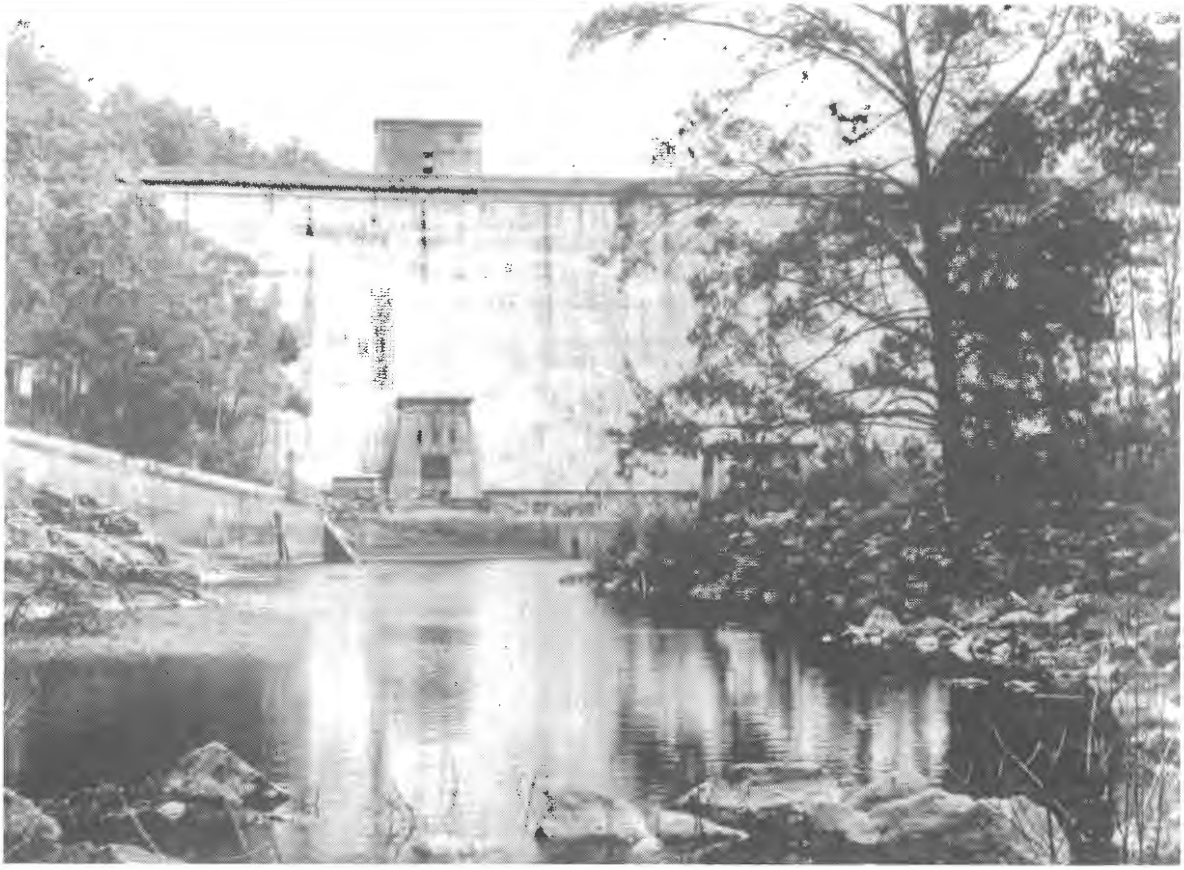
The four original filter beds were slow sand filters and these were used to remove any final stages of turbidity and the bacteria in the water. The four original filter beds were later augmented by four rapid sand and gravel filters each having a capacity of 10 megalitres per week.

A clear water tank of capacity 2.5 megalitres provided a steady suction for the pumping plant.

The original main pumping plant comprised three independent Woolf Beam pumping engines of 112 kilowatt (150 horsepower) capacity each, two being high lift pumps and one a low lift. The high lift pumps were used to force the water to the bulk storage reservoirs on the trunk main system and the low lift pump was used to transfer the water from the river to the lagoon or to the settling tank.

The pumping plant was housed in a magnificent cream brick and sandstone building about 1,000

The Obelisk Reservoir, which overlooks Newcastle, was constructed in 1887 and is still part of the water supply scheme for Newcastle. *HDW*



Chichester Dam photographed in 1952. *HDW*

metres from the river above flood level. The building is maintained by the Hunter District Water Board in excellent condition and is classified under the National Trust. The pumping station and the adjacent boiler room with the settling lagoon, filters, etc., were known as the Walka Waterworks.

The first water from Walka was supplied to Newcastle in 1885 and the scheme was officially completed in 1887. Final delivery pipelines from Walka were a 450 mm cast iron pipeline and a 500 mm rivetted steel pipeline. These carried the water to Buttai Reservoir, located on high ground just south of Maitland, through to further reservoirs at Newcastle and The Obelisk. A separate pipe carried the water direct from Walka to East Maitland.

The Hunter District Water Board was constituted in 1892 and took over the control of the Walka Waterworks and other water supplies. Walka continued as the main supply, with a capacity of about 14 megalitres per day, until 1923, when a new source was constructed on the Chichester River. It remained in service particuarly as a stand-by and for short term summer use until 1941, when it was completely superseded by the Tomago Sandbeds.

In 1949 the beam engines, boilers and other equipment at Walka were sold, but the Walka Pumping Station building still stands in all its glory and is expected to be used as a museum for engineering and other artifacts.

Chichester Dam - The Replacement Source

As Newcastle and the Maitland Coalfields moved into the 20th Century, it was evident that the Walka Waterworks would not be able to supply the increasing water supply needs. At times, the dependability of the source was extremely doubtful.

During the drought years 1902 to 1906, the flow in the Hunter River was barely sufficient to reach the Walka intake, after which there was virtually no flow left to pass down the river. Flow to the intake was regularly assisted by workmen, who cleared passages through the sand and gravel shoals that built up from time to time. The pumping of water from the river for irrigation purposes upstream of Walka was instrumental in diminishing the flow.

The New South Wales Public Works Department was instructed by the State Government to make the necessary arrangements to augment the Walka Scheme for the Hunter District Water Board, and during 1913 the Department was able to advise that a water supply scheme, embracing a dam on the Chichester River, was proposed as a replacement of the Walka Scheme. The new scheme would provide for gravitational pipeline flow of the water to Newcastle and Maitland.

The area in which the new dam and pipeline were to be constructed was a young rural area, with the main activities being the raising of beef cattle, dairy farming, fruit growing, the logging of timber and some gold mining.

Gold mining in the area was active for only a part of the time and was mainly centred at the little village of Upper Wangat on the Wangat River, a tributary of the Chichester River. Remnants of the village can still be seen and may be approached by a 7 km walk upstream from the end of stored water in the dam. Rainforest has largely taken over the village, but the foundations of some of the old cottages remain. Clearly visible are the heaps of quartz left by the miners from their tunnelling into the hillside for the precious ore.

> *"The Dungog District received more attention from bushrangers than most other parts of the Hunter Valley. Thunderbolt, the Jew Boy Gang and Jimmy and Joe Governor were all active in the vicinity. H. Boorer, who established an orchard, later submerged by Chichester Dam, is reported to have shot at Thunderbolt and wounded the bush-ranger's horse. Duncan Neilson, of Bandon Grove, was able to remember many local incidents occurring before the turn of the century. Hendry Milburn, whose stepson went to the Boer War of 1899 - 1902, was one of the first settlers in the Wangat Valley. Very shortly after the stepson returned from the war, the Governors bailed up R. Lord, the grandfather of a Board caretaker at Chichester Dam, John Lord."*[1]

Mr. John Lord was still caretaker at Chichester Dam in 1983. His wife, Lorna, is the daughter of the late Duncan Neilson.

The scheme as undertaken by the Public Works Department was the construction of a concrete gravity dam of 22,750 megalitres capacity on the Chichester River about 19 kilometres north of Dungog, and a 900 mm pipeline to Newcastle, with a 900 mm bifurcation branch pipeline towards Maitland.

The dam wall has a maximum height of 41 metres, is 27.5 m through at the base and is 3.6 m wide at the crest. The length of the wall is 254 m and this includes a spillway length of 81.5 m.

The catchment area serving the dam is part of the Chichester State Forest and covers an area of 197 square kilometres. The catchment area rises to a height of 1,550 metres A.H.D. (Australian Height Datum) in the Mount Royal Range and, so, in winter time, is partly served by melting snow. The area is dense rainforest, except for the

The concrete blocks which form the wall of Chichester Dam, 1924. HDW

immediate precincts of both the storage area and the village of Upper Chichester which nestles at the foot of the Range about 10 kilometres upstream of the stored water. The catchment area is regarded as one of the best in Australia, and, by agreement between the Hunter District Water Board and the N.S.W. Forestry Commission, no logging will be undertaken within the catchment part of the State Forest.

By virtue of the rainforest, the catchment area has excellent yielding characteristics and run-off of water continues for many months after rain has fallen, even during periods of prolonged dry weather. The size and nature of the catchment make it ideally suited for a much larger dam than presently exists, and is assessed to have an average yield in excess of 300 megalitres per day.

The water from Chichester Dam is almost free of chlorides, about 2 mg/L or less, and is very soft. As a result of this, the consumers, in time, did away with the tanks that they had installed as an essential supplement to and a means of overcoming the hard water from the Walka Scheme.

The original Chichester gravitation pipeline was made of wood staving between the Dam and Dungog. The pipe was paralleled with a steel pipe in the 1940s and subsequently abandoned. *HDW*

Below: J.B. Henson. *HDW*

As the original dam was not designed for hydrostatic uplift, 150 mm drainage holes were drilled into the concrete and underlying rock foundations during the 1960s. This was followed by lowering the spillway by 2.71 m in order to accommodate a large flood of about 1,000 years return interval. Post-tensioning of the dam wall, redesign of the spillway and its return to the original top water level were in progress in 1983.

Chichester Dam is the Board's oldest source of supply still in service and continues to supply a major part of the district's water supply needs.

Mr. E.M. de Burgh, the Public Works Department's Chief Engineer for Water Supply and Sewerage, was responsible for the design and construction of the original dam. Mr. C.W. King, Engineer-in-Charge of the Newcastle District for the Department was associated with the construction work and Mr. E.T. Henning was Resident Engineer on the construction.

Tomago Sandbeds Water Supply Scheme

In recording information for this kind of publication, which emphasises the subject of "Heritage", the names of four engineers who were *vitally* involved with the introduction, investigation and the initial installation of the Tomago Sandbeds Water Supply Scheme are brought to mind.

They are Messrs. J.B. Henson, J.M.C. Corlette, J. Ewing and A.E. Jeater. These men were *very active* members of The Northern Engineering Institute of N.S.W., which had its headquarters in Newcastle and was, in 1919, absorbed by The Institution of Engineers, Australia.

J.B. Henson was Board Engineer when The Hunter District Water Supply and Sewerage Board was first constituted in 1892. J.M.C. Corlette was J.B. Henson's assistant from 16th April, 1908, until J.B. Henson's retirement on 30th June, 1925, when he became Chief Engineer.

Tomago No. 2 Pumping Station, 1938. HDW

Obtaining a supply of water from sandbeds for the needs of the Newcastle area had its genesis in the mind of J.B. Henson. As early as 1907-08, he referred to the existence of extensive sandbeds north of the Hunter River Estuary, and suggested the possibility of them being a source of water supply to Newcastle.

Nothing came of the suggestion, except it is understood some consideration was later given to a proposal for industrial water for the Steel Works, then under construction, to be obtained from the sandbeds at the northern end of Stockton Peninsula.

However, it wasn't until about 1916, when a Parliamentary Public Works Committee was investigating a proposal to obtain a supply from the Chichester River, that the matter of the sandbeds was again mentioned. It is understood the Committee expressed concern at the high estimated cost of the proposed Chichester Scheme.

Mr. Henson, at this stage, again suggested the Stockton-Raymond Terrace Sandbeds area as a possible source of supply; the suggestion didn't receive any encouragement. The State Government approved the Chichester Scheme.

It was in 1920 that J.B. Henson was authorised to confirm or disprove that the sandbeds contained sufficient water to be useful as a potential source of supply to Newcastle. The investigations subsequently carried out consisted of sinking a number of bores into the sandbes in the vicinity of the present No. 1 Station. These bores proved the depth of water bearing sand to be 15 to 20 m. J.M.C. Corlette and E.A. Jeater were closely associated with these initial investigations.

In 1922, the investigations were carried a step further — a small pumping plant was installed and operated for about three months. Results demonstrated that this area contained much water and that at the pumping site it was of good quality. The test was carried out at the eastern end of the present No. 1 Station Suction Header.

J.M.C. Corlette, as J.B. Henson's assistant, was vitally involved in these investigations, as were J. Ewing (pumping equipment) and E.A. Jeater (field surveys, test results etc.).

First water from Chichester was delivered to Newcastle in November, 1923; the maximum capacity of the 900 mm pipeline was 45 megalitres per day and the "safe draft" of the storage was estimated at 80 megalitres per day under worst drought conditions.

Not long after Chichester water was delivered to Newcastle, it became evident that the discharge capacity of the 900 mm Chichester Gravitational Pipeline was likely to become insufficient within a few years.

Even at this stage, despite the 1922 sandbeds test, prejudice against groundwater as a source of supply was still alive.

However, in 1926 J.M.C. Corlette, then Chief

The Hunter District Water Board's main pumping station at Tomago, with the Water Treatment Works in the background and another treatment unit under construction.
HDW

Engineer following J.B. Henson's retirement on 30th June, 1925, submitted to the Board the following recommendations:-

(a) to accelerate the rate of flow in the existing 900 mm pipeline by means of pumps (boosting).
(b) the gradual construction of a second pipeline from Chichester.
(c) construct a plant of 9 megalitres per day average capacity in order to test the sandbeds on a practical working scale as a source of water supply.

The above recommendations were submitted by the Board to an Engineering Experts Committee for review. The Committee endorsed them in full.

When J.M.C. Corlette first submitted the above recommendations to the Board, he forecasted it may be possible to obtain 90 to 100 megalitres daily from the sandbeds.

Intensive experimental investigations were subsequently carried out under the personal direction of J.M.C. Corlette. These culminated in water from the Sandbeds being delivered into the Board's water supply system in January, 1939.

Since that time, the Tomago Sandbeds Scheme has been progressively developed as a major source of water supply for The Hunter District Water Board. At the time of this writing, the Tomago Sandbeds have been developed with the construction of 21 primary pumping stations, the majority of which are deep bore stations using submersible pumping units, while the remainder are of shallow development using surface mounted pumps. The storage capacity of the sandbeds down to 1 metre A.H.D. is assessed to be 85,000 megalitres and the safe draft 57 megalitres per day.

It is of interest to note that the name "TOMAGO" was derived from the Aboriginal word meaning "sweet water". This was a name given to the fresh water well on the banks of the Hunter River which the Aboriginal King, Toocooyoo, claimed was never known to be dry. Only recently has this well been filled in.

This original well and others were located along the river bank where the Hunter District Water Board's delivery pipelines from Tomago and Grahamstown cross the north arm of the river. The wells were extensively used to bunker ships with fresh water and Mr. T. Callen was a prominent resident of the day who ferried the water downstream to the ships by lighter. (See the Chapter on Shipbuilding.)

The Grahamstown Water Supply Scheme

The Grahamstown Water Supply Scheme is the largest and most recent of the Hunter District Water Board's major sources of water supply. It was brought into service in April, 1960, after construction of the Grahamstown Dam embankment and a number of components of the delivery system, including the George Schroder Memorial Pumping Station and the first of the 1050 mm

The Hunter District Water Board's first four Chief Engineers (from left), M.A. Hindley, F.E. Cooksey, J.W. Attwood and J.M.C. Corlette, pictured in 1970 at the commissioning of the South Wallsend Reservoir. HDW

delivery pipelines to Tomago.

An important feature of the scheme was the Board's ability to undertake construction work progressively and, thus, avoid early committal of all the funds needed for its completion. At the time of this writing, amplification of the pumping capacity of the George Schroder Memorial Pumping Station and the 1050 mm pipelines was all that remained to be completed.

Engineers of the Board with a vital role in the Grahamstown Scheme, particularly its early investigations and construction, were J.W. Attwood, Chief Engineer 1946-65; S.W. Cooper, Deputy Chief Engineer 1959-61 (Investigations and Liaison); F.E. Cooksey, Chief Engineer 1965-68 and President 1968-1970; M.A. Hindley, Chief Engineer 1968-82 (Construction and Design) and J.D. Davidson (Resident Engineer). Messrs. Attwood, Cooksey and Hindley were all Division Chairmen of the Institution of Engineers, Australia, at various periods of their careers.

Engineers of other State Authorities who played a vital role in the scheme were R. Young, Chief Commissioner of the N.S.W. Water Conservation and Irrigation Commission (Engineering Experts Committee) and T.B. Nicol, Engineer-in-Chief of the Metropolitan Water, Sewerage and Drainage Board, Sydney (Engineering Experts Committee and later Private Consultant).

The scheme had its origin from two principal causes during 1952. These were:-

(1) Strong opposition by various civic and commercial groups in Dungog and the farmers whose properties would be inundated by the construction by the Board of a proposed dam at Tillegra.

(2) The interest of C.G. Schroder, President of the Board from 1938 to 1953, in the artificial replenishment of the Tomago Sandbeds by piping to Tomago the excess water that passed over the spillway at Chichester Dam.

During 1952 Mr. Schroder attended an International Water Supply Congress in Paris and as a result of a Paper by Swedish Consultants, Vattenbyggnadsbyran (VBB), on the artificial replenishment of aquifers, Mr. Schroder telegrammed the Board while still in Paris "stop work at Tillegra . . ." At that stage a soils laboratory had been established on the site and was being used in the exploration for suitable soils to comprise the fill embankment of the dam.

In early 1953, V. Jansa and E. Isgard, of VBB, visited Australia and commenced their investigations in terms of Mr. Schroder's and the Board's terms of reference. Officers who worked closely with Jansa and Isgard were Messrs. Attwood, Cooper and Hindley and, in particular, Mr. S.W. Cooper spent considerable time in Stockholm with the Consultants in helping prepare the final report which was submitted in September, 1953.

The VBB report proposed the Grahamstown Scheme and was a significant deviation from C.G. Schroder's original idea. Apart from abandoning the artificial replenishment of the

Tomago Sandbeds, the scheme provided for the diversion of water from the Williams River upstream of a tidal weir to be constructed at Irrawang near the existing B.M.G. quarry.

The Engineering Experts' Committee, comprising the Board's Chief Engineer and engineering representatives of the Metropolitan Water, Sewerage and Drainage Board, Sydney, the Water Conservation and Irrigation Commission, and the Department of Public Works, was asked to consider in detail the VBB proposal and prepare estimates of cost. It was during the early stages of exploratory drilling for the weir at Irrawang that world renowned Consultant, Mr. Roger Rhoades, of California, U.S.A., first visited the Board. Following Mr. Rhoade's advising, the tidal weir was moved upstream to Seaham, where the rock formations on each side of the river would prevent any future by-passing of the weir. At Irrawang, it would have been located on a flood plain and, as the weir would present a barrier to the natural flow of water during a flood, there was a strong risk that the river would shift its course and by-pass the weir.

During 1955 the Board approved the modified scheme submitted by the Experts Committee, the major change with the VBB report being the transfer of the tidal weir from Irrawang to Seaham.

Construction of the scheme was commenced in 1956, with the official construction ceremony being performed by the Premier, Mr. J. Cahill, during 1957.

The work was carried out jointly by the Board and the Water Conservation and Irrigation Commission; the latter undertaking the original dam embankment, the Balikera canals and tunnel and the Board the remainder.

The scheme was first brought into service in April, 1960, by utilising water from the immediate catchment area draining into the dam and the existing Tomago Nos. 1 and 2 Water Treatment Works for treatment of the water.

The years of completion of major components of the scheme are:- Balickera Tunnel 1960, Grahamstown Dam 1961, Seaham to Balickera and Balickera to Grahamstown Canals 1962, Balickera Pumping Station 1964, Seaham Weir 1967, Grahamstown Treatment Works, Stage I 1970, and Stage II 1976, Sealing of the Central Section of Grahamstown Dam 1973, and Sealing of Seaham Weir 1978.

The Grahamstown Dam has a storage capacity of 152 590 megalitres and had an assessed safe yield of 182 megalitres per day prior to the drought of 1979-82. However, experience gained from this drought indicated that the safe yield has to be reviewed. The drought showed that the dam did not perform as well as expected largely due to the absence of flow in the Williams River and the absence of any replenishing rains.

Towns in the Upper Hunter

In Muswellbrook and Singleton, outside the Hunter District Water Board's area of reticulation, the Council's Engineers are responsible for Water Supply. Here, obtaining a regular supply of potable water has been a problem since the days of the early settlers.

Long periods of drought completely dried up surface flow in the Hunter River at Muswellbrook on many occasions until from 1958, regulated flow was available from Glenbawn Dam. In flood time, surface river water was too muddy for public use.

Singleton Council commenced a public supply in 1882. A pumping station in John Street lifted water to an elevated tank, from which it was reticulated to a small adjacent area or supplied to carriers for 3 d per 100 gallons (450 litres). Commenced in 1909, the current system draws water through the gravel of the river bed to a 20 metre deep well on the river bank. Steam-driven plunger pumps elevate the water to a 2ML reservoir on Gowrie Hill. The natural filtration is adequate, but a lime-soda water softening plant has been installed. With increased demand additional wells were sunk in Quaternary gravels adjacent to the river. A modern iron exchange softening plant and chlorination and flouridation equipment were installed in the 1960s. The treatment plant makes it possible to use water directly from the river during long dry periods.

In Muswellbrook the first water supply was built in 1913, designed by the State Public Works Department. River bed gravel was also used here as the primary filter, but adits were driven to under the river bed and a low weir was built below the well system. The original pumps were driven by a gas engine, which was replaced by an electric motor in the 1930s. The original 225 mm cast iron rising main and 1.36 ML reservoir are still in service.

By 1940 the increased demand from a population grown to 3,000 was being met by pumping direct from the pool above the weir into a new clarification and filtration plant capable of handling 2.7 ML/day. The pool at the weir dried up in 1957 and wherever isolated pools could be

Dozer and scraper constructing the Grahamstown Embankment, 1959. *HDW*

found in the river temporary pumps and piping were installed. Additional reservoirs were built. Demand grew to 6.65 ML/day for 8,500 people and a new treatment plant was built in 1974, including, for the first time, chlorination.

The Water Resources Commission of New South Wales

The New South Wales Water Resources Commission, in co-operation with other New South Wales Departments and the Hunter Valley Conservation Trust, provides a range of engineering services to the residents of the Hunter Valley, including:

- Water conservation and flood mitigation by the construction and operation of dams on the Hunter and tributaries.
- Regulation of streamflow for stabilisation of supply to riparian users, industry, power generation, townships, and irrigators,
- The stabilisation of river channels, and
- Water supplies to farms by development of surface and underground water resources.

To operate these services, the Commission deployed some nine engineers and 103 other personnel in the towns in the Hunter Valley in 1983.

The Commission's major dams in 1983 were: *Glenbawn* (built in 1958), *Lostock* (1971) and *Glennies Creek* (1982).

The Commission is best known for Glenbawn Dam. Mr. W.J. McKell, Premier and Colonial Treasurer, performed the ceremony to mark the beginning of the construction of the dam on October 19, 1946. By the Glenbawn Dam Amendment Act of 1957, the dam was authorised as a dual purpose work, providing both water conservation and flood mitigation. The comprehensive role of the dam in supplying water has included domestic, stock, and irrigation uses along the Valley, stabilised water supply to towns and provision of cooling water for Liddell Power Station.

Its flood mitigation storage has prevented any uncontrolled flood flow past the dam site since storage began in May, 1958.

Glenbawn Dam was one of the first large, rolled earth and rockfill dams to be built in Australia. Built of earth and rock-fill from sources adjacent to the site, its design and methods of construction were based largely on practice in the United States, where rolled earth-fill dams had been adopted extensively during previous years and special techniques developed.

In view of the importance of the work, assistance was obtained from several eminent American consulting engineers during the progress of the work. The Commission engineers most responsible for the design included Messrs. G.M. Ritchie, S.M. Munday, N.A. Wilson and H.S. Scott. Mr. D.C. Weatherburn was Resident Engineer for construction. He later became Commissioner for Water Resources.

The preliminary stage of construction (1946-1954) included the provision of roads, housing, works buildings, services and plant, the excavation for foundations of the dam, diversion works and part of spillway, the development of quarries and borrow areas, the detailed investigation of foundations, spillways, etc., with consequent changes of design. This stage ended with the diversion of the river in October, 1954.

The main construction stage (1955-1957) covered the completion of foundation excavation and grouting, the construction of the dam proper and the outlet works (except for pipe laying and valves). Included in this stage were the greater part of the spillway concrete construction and the development of the limestone quarries.

Also in this period came the floods of February, 1955, and February, 1956, the building of the Page's River Causeway and the reconstruction of the Allan Bridge over the Page's River, after its outflanking during the 1955 flood.

The last period (1957-1958) included completion of the outlet works (pipe laying and valve placing) and spillway, the excavation of the spillway outlet channel across the alluvial flats, the construction of the deviation of Main Road No. 105 (Scone to Moonan Flat) around the reservoir and the completion of permanent buildings, services and roads around the dam.

Finally, the lowering of the closure gate in the diversion tunnel and the concreting of the plug permitted commencement of storing water in May 1958.

The dam was officially opened by Mr. J.J. Cahill, Premier of New South Wales, on October 17, 1958. The dam wall, 76.5 m high and 823 m long at the crest can impound 360,000 ML of water of which 132,000 ML are reserved for flood storage.

River Management

The Water Resources Commission carries out works of river improvement and stream control on the Hunter River and tributaries above Maitland and on those sections of the tributaries above tidal influence which enter the Hunter downstream of Maitland. The River Management office was set up at Muswellbrook in 1956. The engineers best known for their association with these activities (1956-1970) were Messrs. A.F. Reddoch, Senior Engineer, Head Office (later Chief Commissioner) and D. Rankine, District Engineer, Muswellbrook (later Principal Engineer, River Improvement).

River Training Works

Where a relatively straight course and adequate width can be maintained by the river, the banks of the main channel remain fairly stable and cause little or no damage to adjoining lands. As meander increases and the river traces out a series of bends, erosion occurs on the outside of these, and sand and gravel deposits build up on the inside.

River training works now carried out consist basically of river training in which the stream is confined to a reasonable width, free from obstructions on the best possible alignment over a suitable length. Control is achieved by installing low obstructions to a suitable alignment in the bed of the river to restrain the movement of the river channel. These barriers obstruct and retard the bed currents which would otherwise undercut the banks and this is by far the most serious type of bank erosion. The river training works undertaken have consisted of wire mesh fences secured to steel piles driven into the bed of the river, forming obstruction to the bed currents and encouraging deposition and providing protection for plantations of trees. Floods are actually required for development by causing deposition amongst the barriers, the deposits being consolidated by tree growth. When there are massive sand movements, or large boulders are carried as bed load and/or the alignment is particularly bad, these fences may also offer insufficient resistance.

Under such circumstances a stronger work such as rock fill is used instead of the mesh fences but the same principles are adopted.

Adequate maintenance must be provided to withstand maximum flows and thus contribute to long term protection of lands along the streams.

Clearing and desnagging will, provided proper follow-up treatment is given, result in lasting benefits. This follow-up work consists of keeping the fringe growth under reasonable control, ensuring that trees on the banks likely to fall into the stream are cut down or lopped and that any fresh snags which come from upstream into the treated section are removed at regular intervals. Due consideration of environmental factors is necessary with such activities.

Among the benefits of work to improve the Hunter are the considerable reduction in the silt content of the stream, which otherwise would have deposited in the river channel, on farming lands further downstream or in Newcastle harbour, the safeguarding of the existing alluvial lands adjacent to the river and the gradual reclamation of some of the land already lost to cultivation, the protection of roads and bridges and some reduction in flood level through treated sections of the stream and, as a result, some alleviation of the flooding of towns.

Up to 1970, 170 km of streams in the Hunter Valley seriously affected by erosion had been brought under control and an equal length was under treatment. Between 1970 and 1980, the controlled length increased to 576 km, with another 82 km under treatment. By 1970, the total expenditure on this work was $4,860,142. This had increased to $15,521,328 by June 30, 1981.

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About 30 kms downstream of Denman where stable banks are being established after desnagging, re-alignment and bank protection. *WRC*

The Sulphide Corporation's works, early 1900s. SC

PROCESS ENGINEERING

by Ian Stewart

The first 90 years of white settlement in the Hunter Valley saw a succession of entrepreneurs attempting to establish industry on the basis of cheap coal, agricultural or pastoral products. Except for brick and pipe manufacture, few of these ventures continued for long.

Copper was highly sought after. Dr. James Mitchell, in 1850, built a substantial works at a "wild romantic spot on the sea coast" — Smelter's Beach (Burwood Beach, now the site of the city's sewerage disposal works) — to smelt copper ores from South Australia and New Zealand. Maurice Thomas, from South Australia, was Manager during the 10 most productive years at these works. Operated by the Newcastle Coal and Copper Company, and experiencing many ups and downs, the venture survived for about 20 years.

The English and Australian Company, with a mine at The Burra, South Australia, also built a smelter to take advantage of cheap coal. This plant operated at Broadmeadow in 1868. The Wallaroo Company about the same time established what was to become a larger smelter. Its site was on the South Channel of the Hunter River alongside the Waratah Coal Company's coal loading staithes. This was Port Waratah, the future site of the BHP Co.'s Steel Works. The dramatic fall in copper price led to the Port Waratah Works ceasing operations in 1893, by which time the Broadmeadow smelter had become a small operation, dwindling on for a few more years. This site is now occupied by Goninans.

The discovery of tin in Northern New South Wales led to a tin-smelting project at Stockton in 1872, but the venture survived only a few years.

The Sulphide Corporation

The Sulphide Corporation is the only smelting industry still surviving in Newcastle from the nineteenth century. Sulphide has been outstanding for its innovation, adoptation to widely changing circumstances and skill in developing new technology. Its story is worth following in detail.

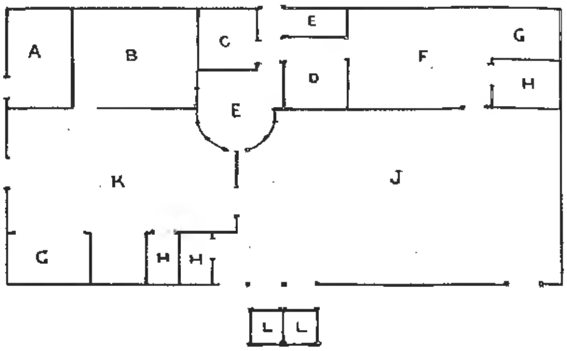
The Corporation originated from the invention of a young engineer, Edgar Arthur Ashcroft (1864 to 1938). An Electrical Engineer, Ashcroft had been engaged around 1890 to install electricity generation plant and superintend distribution at the BHP Co. Ltd. mine in Broken Hill.

Sulphide got its start from Ashcroft's interest in chemistry and the developing technique of electrolytic refining of metals. He spent a lot of time and money experimenting on how to treat the zinc-rich sulphide ores by then exposed in the Broken Hill mines. No adequate processes had been developed to recover this zinc. By 1894 Ashcroft felt convinced that he had an attractive process. Obtaining financial backing, he resigned from the BHP Co. Ltd.'s service. Detailed tests, carried out under an independent observer, Mr. H.H. Schlapp, a metallurgist previously at the BHP's mine, confirmed Ashcroft's claims. Trials conducted at a pilot plant in Essex, in the United Kingdom, indicated that the process was commercially feasible. Ashcroft's estimates pointed to a staggering profitability from the process and a $1 million company, Sulphide Corporation (Ashcroft's Process) Ltd., was rapidly subscribed. The Broken Hill Central Mine was acquired to provide an ore source.

In establishing the plant, which used a new, untried and quite complex process, great speed was achieved. Such an achievement seems almost unbelievable today. Within three years of Ashcroft making his first approach to backers, the site at Cockle Creek south of Newcastle had been selected, plant including a 1,000 kW generating plant (supplied from Britain) erected and operations started. The site had the advantage of being convenient to cheap coal deposits. The new zinc process gave many troubles and Ashcroft was given six weeks to sort it out. He was unsuccessful. Within a few months the plant was changed about and operating as a conventional lead smelter.

Ashcroft left the company in January 1898, his process discredited, and set himself up as a Consulting Metallurgical Engineer in London. Ashcroft and the Sulphide Corporation certainly made a great contribution to the development of electrolytic refining. Much more was needed to be known about the chemistry and physics of electrolytic deposition before a viable and simpler commercial process could be achieved. Ashcroft was reputed to have the characteristics of the inventor — confidence, extravagance in respect of cost and time, sensitivity to criticism, and obstinacy. He was also a good engineer. He saw clearly the advantages of making concentrates (even of the rich Broken Hill ores) despite some loss of tailings, and insisted on treatment plant being provided at the Broken Hill Central Mine. He foresaw the need for a sulphuric acid plant, although he could not get this financed. Perhaps surprisingly, he advocated strongly the appointment of an Australian General Manager "with mining and metallurgical knowledge and of proven ability and integrity in the management of large business", recognising that such was not a proper role for himself.

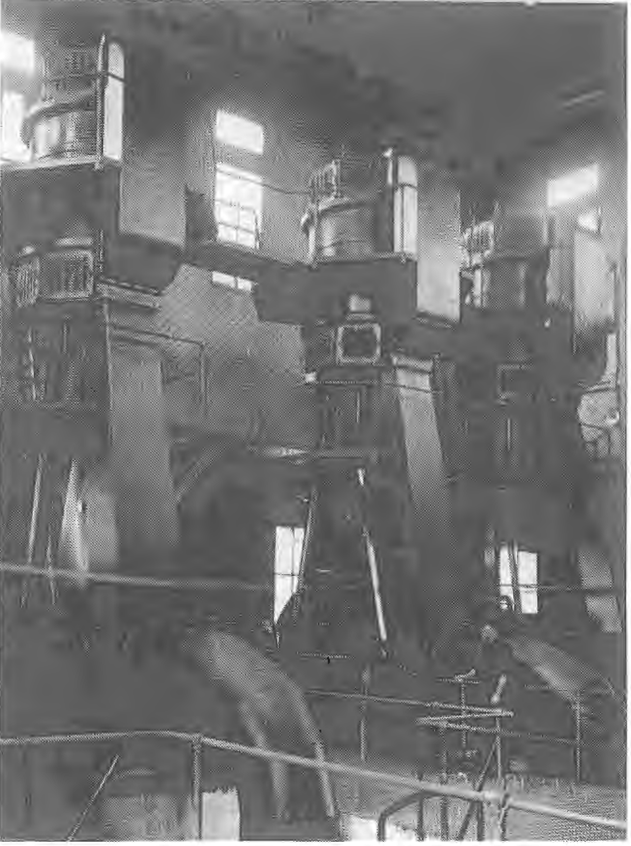
Footnote:
A detailed account, from which this summary was made, with a technical analysis of the process by Professor E.A. Hall, can be found in Dr. John Turner's book, *Manufacturing in Newcastle.*



PLAN OF SAMPLING MILL
SULPHIDE CORPORATION - 1909

At this time the corporation purchased many small consignments. For rich ores the whole consignment was sampled in this mill, for lower grades one bag in five. "The room marked E is for the accommodation of customers selling ore to the Corporation. It is situated in the centre of the mill; the floor is raised above the ordinary level, and there are windows all round, thus enabling the seller, if he so wishes, to watch in every detail the sampling of his own ore. Room F is reserved for gold-rich ores."

The original blast furnace at the Sulphide Corporation's works. Workmen are tapping slag. SC



The original electrically-driven blowing engines for the blast furnaces (The Sulphide Corporation's works).

Considering the lack of an organisational structure and the division of control between a Board in Melbourne and one in London with poor communications, the survival and profitable growth of the Sulphide Corporation are remarkable. The Board was courageous and determined indeed, but a great deal of the credit must be given to the Engineers, E.A. Ashcroft and H.H. Schlapp; J.H. Smith from the South Australian Railways, who was responsible for the initial construction phase; the initial Works Manager A.E. Savage, and his successor P.S. Morse.

Profitable operation was attained from late-1897, despite the loss of zinc in slag as a conventional lead smelter. Innovation was encouraged. New blast furnaces were built and smelting contracted for mines in addition to Central. From 1902 to 1908 experimental production went on to recover zinc by distillation from roasted zinc-rich concentrates mixed with carbon. The new roasters (Huntingdon and Heberlein sinter pots) installed in 1901 were partly superseded by a more modern Dwight and Lloyd sinter strand in 1912, with which came a plant to recover as sulphuric acid the sulphur dioxide from the stacks, which had been destroying vegetation on neighbouring hills. Continued experimentation allowed recovery of sulphur dioxide to be extended to the old H & H pots in 1917 — a world first.

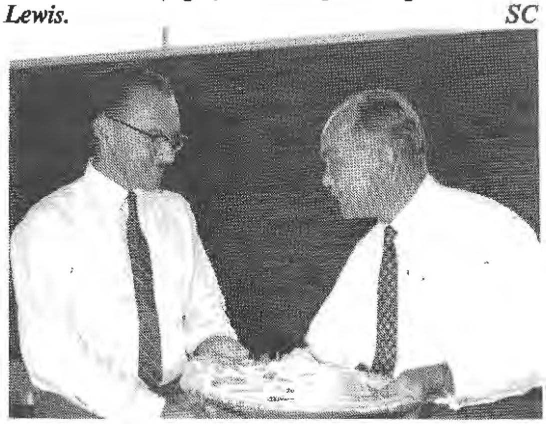
The Sulphide Corporation progressed by 1913 to use the by-product acid in fertilizer manufacture. This boldness was characteristic of the Company. Ammonia was obtained for sulphate of ammonia by gasifying its fuel coal in a Mond producer. Superphosphate was producted from phosphate rock which was imported. Later these products formed the basis for survival. After 25 years of profitable operations, lead smelting ceased in 1922. The fall in world metal prices meant that Australian smelting could only survive by a concentration of operations at Port Pirie in South Australia. The Company was determined to retain both its labour force and its site facilities. It expanded fertilizer production and launched into cement manufacture. Acid was produced from pyrites obtained from a mine near Orange and roasting of sulphide ores for the Electrolytic Zinc Co. in Tasmania under contract, supplemented by imported native sulphur. Coal for cement manufacture was obtained from Fassifern and a small mine on the Cockle Creek works site, clay from the works site, and lime from Attunga limestone (found near Tamworth) and from the convicts' early source, the shell beds in the river at North Stockton.

On fertilizer production and cement manufacture, plant for which was located among the shut-down smelter equipment, the Sulphide Corporation survived the next 25 years.

In 1948 Sulphide Corporation, an English company, was bought out by Broken Hill Corporation (to become Consolidated Zinc) and was reformed and registered in New South Wales. Larger amalgamations overseas by Rio Tinto and Zinc Corporation finally brought Sulphide into the CRA group in 1962.

The changes clearly presaged new developments. Since the end of the Second World War,

Jim Standish (right) and Project Engineer Owen Lewis. *SC*

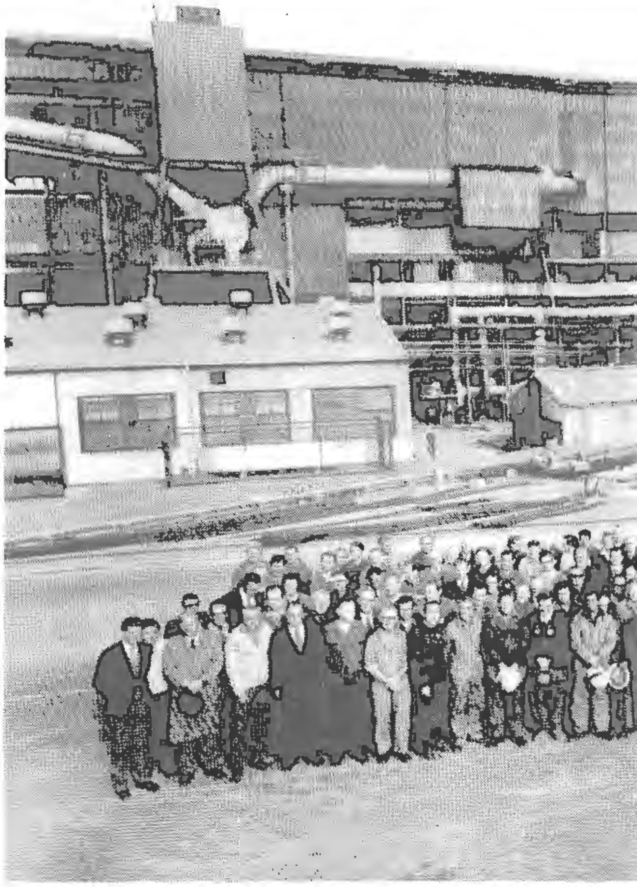


Consolidated Zinc was actively developing the Imperial Smelting Furnace at Avonmouth, in Great Britain. Preheated charge and very precise control of operating conditions were used to produce metallic zinc in the top gases of the furnace, while molten lead was produced at the base. The first commercial installation was at the National Smelting plant in nearby Swansea, UK, in 1960; the second was planned for Cockle Creek. Roasting of concentrates was terminated at Cockle Creek in 1952, and of pyrites in 1953. While Mr. Ken Wansborough was Chief Engineer, old plant was dismantled and the acid and fertilizer plants were modernised.

Mr. James Standish in 1957 came as Works Manager, moving later to General Manager and Managing Director. An Australian Chemical Engineer with early experience in munitions factories and the fertilizer industry, Mr. Standish had spent some years at Avonmouth, rising to the position of Deputy Works Manager of the company which at that time was known as the National Smelting Company. He built up a team for the new Imperial Smelting Furnace at Cockle Creek. Young engineers were enlisted. Mr. Don Vernon, a Chemical Engineer from Rum Jungle, and Mr. Peter Mead and Mr. Ron Bath, Metallurgists, were among those sent to Avonmouth as the I.S.F. process was developed to reach a commercial stage. Mr. Wansbrough went to the Melbourne office in 1957 to work on the design of the new plant. Mr. Don Crawford an Engineer with construction experience at Australian Iron and Steel, came in as Chief Engineer, to build a new plant which was commissioned by a team led by the Assistant Works Manager (Smelting), Mr. Bill Robertson, who had a long background of experience in smelting at the Avonmouth Works.

In 1961, the world's second I.S.F. plant was in production, with a completely new process train. Continued development of environmental controls has resulted in an almost zero discharge of air and water-borne contaminants. A refinery to produce high purity zinc and cadmium was commissioned in 1968. Mr. Don Vernon, the first Superintendent of the I.S.F., moved on through the group and became Chairman of Bougainville Copper. Mr. Peter Mead moved to AM&S in the Melbourne office in 1982 as Manager Technology & Development, Smelting. Mr. Ron Bath, from the commissioning team, became Manager Planning & Technology at Sulphide Corporation.

Operations at Cockle Creek have been continually improved and the original capacity has



been doubled. The success with production and environmental control has been such that Sulphide's help was sought both in commissioning new smelters and in overcoming problems at the U.K. smelter. This operation was acquired by the Australian Company, (AM&S). A team of engineers, technologists and commercial staff went to the U.K. from Newcastle for two years and made a significant contribution to the U.K. technology.

A recent development was the installation of the dross leaching plant to recover copper sulphate (principally used for ore-dressing at the mines). This allows several thousand tons of copper to be recovered per annum from the "dross" which forms above the molten lead. Dross leaching was developed by staff from the CRA Research Laboratories at Cockle Creek and designed and constructed under Mr. Sid Hoare, Chief Engineer. Mr. Hoare, who holds a Mechanical and Electrical Engineering Diploma from Brisbane and had early experience in power stations, moved through electrolytic aluminium production into the metal processing industry.

Mr. Andrew Thomson and Mr. Ian Moon, Newcastle-trained Mechanical Engineers, were involved in these developments. Mr. Thomson, after some years at the Commonwealth Steel Co., joined Sulphide as a draftsman in 1948. In 1962 he took charge of maintenance of the new smelter. He went to Hamersley in its development

The occasion is the production of the one millionth tonne of zinc by the ISF (August 7, 1974). Included in the group are the "Sulphiders" who worked at the works at Boolaroo from the start of operations. The Sinter and Recovery Plants are the in background; the ISF is on the extreme right. SC

stages in 1970 and came back as General Manager of Sulphide in 1971. From 1976 to 1979 he headed the European activities of the AM&S Group. Mr. Moon, after works training at Goninans and obtaining a Diploma in Mechanical Engineering from the Newcastle Technical College, joined the company in 1948. He was Works Engineer by 1950 and Chief Engineer by 1961. An early responsibility for him was the establishment of a new fertilizer plant.

Sulphide had developed a world reputation in superphosphate fertilizer technology, a leading contributor to this development being Mr. John Reynolds, an Australian, ex-Electrolytic Refining & Smelting Co., Port Kembla, who joined the company from the National Smelting Company in 1949 and who, in the sixties, was Assistant Works Manager (Acid & Fertilizer).

In 1964 work was commenced on the "in-house" design of a new fertilizer plant to be located alongside the harbour on Kooragang Industrial Estate. Typically, Mr. Moon found that a Chief Engineer's task is virtually "to reduce by about 500 per cent" the refinements demanded by the technical specialists during the initial planning stages. The plant, known as Greenleaf Fertilizers, later to become a part of the Australian Fertilizers Group, is modern and efficient. Control functions from a single room. The power generated as a by-product of the acid plant is interconnected with the electrical supply system. The fertilizer works came into operation in successive stages between 1966 and 1969. Visitors from overseas works were heard to comment, "Geez, it's clean! They must have a lot of money. It's even painted."

As 1982 closed, world metal prices were still very low. World industry was attempting to ration production and the engineers and metallurgists at Sulphide were challenged again to plan boldly, innovate and survive.

Chemical Process Industry

From the commencement of steelmaking operations at the Newcastle Steelworks, sulphate of ammonia, tar, naphthalene, benzene, toluene and zylene (solvents and motor fuel) were produced as by-products of the coke ovens.

In 1939, the Newcastle Chemical Company was established to produce chemical intermediates from the napthalene.

In 1967 Koppers (Aust.) Ltd. began producing anode-pitch from the tar for the world-wide aluminium smelting industry.

Based on the water in the Tomago Sandbeds, Masonite in 1938 established a plant near Raymond Terrace which manufactured building board from unmillable hardwoods. At a big factory nearby, Courtaulds produced viscose and rayon fibres between 1951 and 1976. An associated plant for the production of carbon-disulphide was still functioning in 1982.

The largest process plant, the world-class ammonia plant of "Eastern Nitrogen", now part of Consolidated Fertilizers Ltd. started operating in 1969 as a natural accompaniment to "Greenleaf".

Fuel Processing — Coke, Town Gas and Shale Oil

At first, coke manufacture seemed a logical industry for Newcastle, in particular when the A.A. Co. discovered the Borehole seam, with reasonably low ash and apparently good coking properties, in the 1840s. The technology was very simple, Dome-shaped "bee-hive" ovens, each 10 to 12 feet in diameter, were built in double rows. Filling in the spaces between the ovens gave a level top, along which the coal was

The older battery of coke ovens at Rix's Creek Colliery, near Singleton.
Above: Taken from Professor Edgeworth David's Memoir, 1907. *DM*

Right: The remains of the battery, 1982. *IS*

wheeled in small skips and charged through holes at the tops of the domes. The "charge" was heated by burning the evolved gas inside the upper part of the dome. The coke, when sufficiently burned, was partly quenched by a water-spray inserted into the top hole. Then it was raked out through a small arched door at the side.

The ovens first recorded were those that commenced operating at Burwood Beach on behalf of the ill-fated Newcastle Coal and Copper Co. in 1853. This venture was followed by coke plants installed by the A.A. Co., the Wallsend Co., J. & A. Brown and the Co-operative Coal Company. It was expected that the coke would be used for copper smelting in South Australia, but their market was lost to European coke. A relic of this kind of coke making is at Rix's Creek, north of Singleton. At this place was the first coal mine in what was to become a major coal producer about 100 years later. A battery of ovens was built at Rix's Creek and in 1890 the coke was described as the best available. Before 1900 a second battery was built to serve a new tunnel into a higher seam. This was the source of coke for the Cobar smelters until about 1920. The battery also supplied coke to the Newcastle Steel Works during its early operational stages.

Both batteries are clearly discernible at Rix's Creek. Although overgrown with trees, the ovens are virtually complete. Bloomfield Collieries was planning to carry out open cut mining in the area in 1982 and thanks to the enthusiastic co-operation of Mr. George McGeachie, Managing Director of Bloomfield Collieries, the Heritage Council and the National Trust were able to arrange for this example of coking technology to be preserved much as it was at the end of the eighteenth century.

Gas

Town gas was first piped in London in 1812. Sydney was lit by the Australian Gas Light Company in 1841.

In 1858, a small gas works was built in Charles Street, West Maitland, by John and Henry Tuck, who judged that supplying a population of nearly 4,000 was a commercial proposition. The demand grew and in order to acquire more capital the Maitland Gas Light Co. Ltd. was formed in 1873. George Cohen, John Warren Tuck and Edward Peter Capper were the Company's Directors. The streets of Maitland were lit by gas lamps from 1878 until electric lighting was introduced in 1922. In 1959, the Company was acquired by the Aberdare Council, which now supplies Maitland from a small gas works at Cessnock.

Newcastle businessmen had become interested too. A meeting of "gentlemen favourable to the formation of a Gas Light Company in Newcastle" was held on December 1, 1865. Mr. Archibald Rodgers, the engineering manufacturer, was active in organisation and negotiations with a Consulting Engineer, Mr. A.K. Smith of Melbourne. By 1866 the Company was operating with a capital of £10,000. The Act of Incorporation passed through the Parliament and a site on A.A. Co. land close to Steel Street, Newcastle, was selected. There were problems to be overcome with raising capital and two contractors failed in their attempts to build the retort house. However, after the equipment arrived from Britain in September, 1867, gas was being produced by the end of October and 9,582 yards of mains were laid by the end of December that year. The initial

price of 15/- per 1,000 ft. was high by current standards, but gas lighting was installed rapidly in houses and public buildings and on the wharves.

Mr. Thomas Reid was appointed Engineer as soon as the works were brought into production. Mr. Reid held that position for 38 years, retiring in 1906. During this period of service gas consumption increased from three million cubic feet to more than 100 million cubic feet per annum. Also in this period the price was reduced to less than 4/- per 1,000 feet, a quarter of the original. A large gasholder and a new retort house were built at the Steel Street site in 1888. The substantial retort house building, of simple but pleasing design, faces King Street and is now used by the Water Board as a stores depot.

Streets were lit by gas from New Year's Eve 1875. According to *The Newcastle Morning Herald*:

> *"There was a fitting demonstration by the citizens and many remained in the streets till the dawn of the New Year in order to be able to say that they had 'seen it in' with streets lighted by gas."*

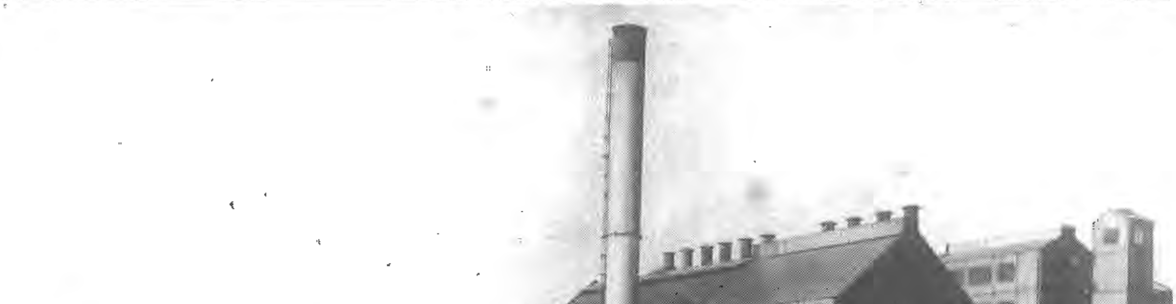
However, the flat-flame gas burners at this time could not compare with the brilliance of the new types of electric lighting — both arc and incandescent. Although Newcastle City Council installed generating plant for electric street lighting in 1890, it was well into this century before electric street lighting became reliable. Incandescent gas mantles produced brilliant light, and Press and public controversy continued for many years. For example the following comment appeared in *The Newcastle Morning Herald* on January 7, 1907:

> *"in the Borough Market on Saturday night I saw that electric light had been introduced into the markets, but like many other things in Newcastle I find the light not even so good as the gas-lights."*

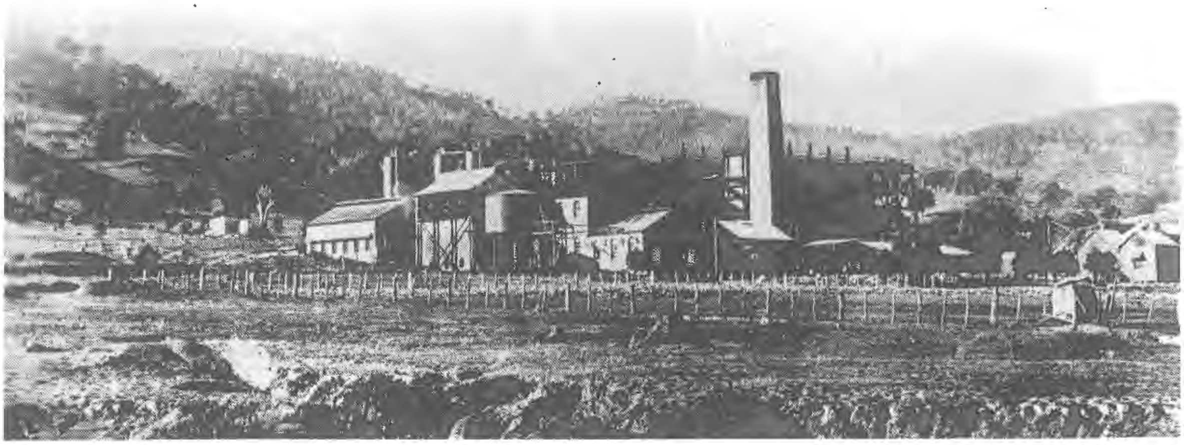
By 1890 cooking was the main gas load and industries were starting to use gas. Demand continued to grow. Mr. J. MacKenzie had trained in the British Gas Industry, joined the Gas Company in 1905 and was appointed Engineer in 1907. Along with a Consultant Mr. A. Wilson, he was given the task of erecting a new, large modern plant on a new site at Clyde Street, Hamilton.

The plant comprising four settings of eight Glover-West vertical retorts, oxide gas purifiers, tar and ammonium sulphate recovery plant and mechanical handling of coal and coke was completed in 1913. The works production capacity was about two million cubic feet per day. Supply to Stockton was provided by a cross-harbour pipeline in 1915. Supply to Waratah and considerable growth of industries required further plant extensions to more than double the plant

J. MacKenzie. *GC*



Top: Steele Street Gas Works, about 1900. Part of King Street in the foreground. GC
Middle: The Clyde Street Gas Works, about 1955. GC
Left: K.S. Wilkinson GC



The Shale Works at Murrurundi. *JA*

capacity by 1947. MacKenzie retired to be succeeded by Mr. W. Warhurst who had been trained in the Newcastle Gas Company. On his retirement Mr. K.S. Wilkinson, from a Sydney chemical industry, became Chief Engineer. From 1948 to 1955 the plant was modernised and a third retort house built to bring the capacity to seven million cubic feet per day.

By the 1960s, petroleum feedstocks had become more attractive than coal to the gas manufacturers. Prices for the by-products of coal, coke, tar and sulphate of ammonia, were low and labour costs were high. Mr. Matthew Frost, a Chemical Engineer from the University of New South Wales, with previous experience at the Australian Gas Light Co., joined the Company in 1954. Mr. Frost was sent overseas to investigate oil gasification in 1969 and he became Chief Engineer in 1970. A compact little plant producing an equivalent gas from light distillate naphtha was commissioned by Mr. Frost. The vertical retort plant was shut down and dismantled. Within a few years, Natural Gas became an assured alternative fuel. In 1979 the Newcastle Gas Co. merged its interests with the Australian Gas Light Co., of Sydney. Planning for conversion to natural gas was intensified. In July, 1982, natural gas became the sole source of reticulated gas for the Newcastle area and a different set of engineering tasks arose.

Country Gas Works

In Singleton, in 1881, Mr. Alexander Munro, the Mayor, privately set up a gasworks, which continued carbonising coal until 1967. Gas reticulation by pipes in the town ceased in 1982.

Works set up in Wallsend in 1886 and Waratah in 1889 were absorbed by the Newcastle Gas Company.

Maitland City Council established a gasworks in East Maitland in 1894.

Muswellbrook Council established a works in 1894 and it continued to carbonise until 1971. Gas supply by reticulation ceased in 1979.

One gas producing plant — "born out of due season" — continues to operate. We refer to Aberdare County Council's Works at Cessnock. In 1958 as Maitland and East Maitland Gas Works were approaching obsolescence, pressure from Cessnock for a coal gasification plant led to the formation of the County Council, which built the gasworks to supply Maitland and East Maitland, and, it was hoped, Cessnock, Kurri Kurri and Lake Macquarie. The plant is basically the old horizontal retort type but with coal and coke handled mechanically. In 1982, it was still operating — one of the very few plants of its type operating anywhere.

Oil Production

From about 1910 until 1920 Newcastle was an oil producer. The British-Australian Oil Co. opened a mine outside Murrurundi in a seam of oil shale. The shale was conveyed by an aerial ropeway to retorts near Murrurundi. Some pylon foundations can still be seen. A range of oil products was produced from the crude at a refinery at Hamilton where the Shell Depot now stands.

Mr. Gatley Lyons worked at the Murrurrundi plant and later, with his brother, Alan, at the gas producers at the Sulphide Corporation. Convinced that payable oil yields could be obtained from low temperature carbonisation of the Greta seam coal, the brothers purchased the old gasworks at Wallsend in 1926 and made extensive, successful pilot plant trials. However, by the arrival of the Second World War they had not

Commonwealth Steel Works, Waratah, 1929. *CS*

been able to raise sufficient capital, or government support, for a commercial plant.

Steel Processing

Production of merchant steel shapes at the BHP Co.'s Steel Works provided an incentive to process the steel to such final products as wire, sheet steel, pipes, tubes and forgings for shafts and axles.

Commonwealth Steel Products Ltd., (now the Commonwealth Steel Co. Ltd.) was a consortium promoted strongly by A. Goninan, who sought railway wheels, tyres and axles for the rail wagons which were still an important part of his products and had been unobtainable during the latter years of the war. The Company was registered in 1918 and made its first heat on February 19, 1919. Mr. A.M. Henderson was brought in with overseas experience and he and Mr. Lance Frankham were responsible for design and operation of the initial plant. The first tyre mill (built in Australia) was driven by a steam engine which had operated as the winding engine at Brilliant Deep Gold Mine in Queensland. A six-ton electric arc furnace, a six-ton steam hammer, a 2,000-ton press and a steel foundry were the other major plant items.

Mr. W.E. Clegg was appointed Manager in 1921 and General Manager in 1922. Mr. Clegg stimulated, guided and supervised a continually growing enterprise until his retirement in December, 1951. He began engineering as a mature-age trainee at Goninans. He studied at Newcastle Technical College and rapidly rose to Works Manager at Goninans. He was an active

W.E. Clegg. *HVR*

member of the Advisory Council of the Newcastle Technical College (he was President for 16 years) and on the Development Council of the NSW University of Technology. At various times he was Chairman of the Newcastle Division of the Institution of Engineers, President of the Institute of Management in Newcastle, the Chamber of Manufacturers and the Association for Crippled Children. The Trades building at Newcastle Technical College at Tighes Hill was named in his honour.

While attached to the Commonwealth Steel Co., Mr. Clegg travelled overseas to investigate new processes and equipment. Production of forged steel grinding balls commenced in 1929. The most significant new development at the works was the commissioning in 1941 of a plant to produce and roll special steels (with active technical support from the BHP Co. Ltd., an initial range of alloy steels was available by 1937) — in time to provide material for the production of weapons and aircraft parts which were needed for the war effort. Senior engineers involved in these developments were Mr. C. Cutcher (Chief Draftsman) and Messrs. B. Gluas and S. Clegg (Works Engineers).

Since then the engineering and technological staff at Commonwealth Steel have been involved in the implementation of a continuous programme of upgrading equipment and installing more modern plant. Special attention has been given to the production of the special steels that are required for motor vehicle engines and transmissions. Quality standards have been maintained at the top of available world technology. Modifications made to some pieces of equipment by Commonwealth Steel engineers have been so successful that the rights have been purchased by overseas manufacturers. A unique computer control of railway wheel machining was introduced in 1979. Senior engineers involved have been K. McLeod (CME 1940-45); S. Clegg (CME 1955-62), P. Scott (Chief Engineer 1960-68), E. Henderson (Eng. Serv. Supt. 1968-73), R. McDonald (Development Eng. Mgr. 1975-).

Wire

The Austral Nail Co. established a wiremill at Port Waratah in September, 1919. Its design, project management and commissioning was very much the handiwork of Mr. James Kenneth MacDougall, a chartered Electrical Engineer, who had already established an enviable reputation for himself in consulting prior to the 1914-18 War. He served as a subaltern in the 3rd Pioneer Battalion, AIF, and was expressly recalled from France on the order of the Prime Minister, Mr. W.M. Hughes, to make arrangements for the wiremill. The new plant drew a range of mild steel wires, some of which were galvanised or tinned, or converted to nails and staples. MacDougall was Manager and Chief Engineer and he was aided by Mr. W. Alex Lang (Engineer), who, like MacDougall, was a product of the Melbourne Working Men's Institute in Mechanical Engineering, and Mr. H. "Bill" Milne (Chief Draftsman).

In 1922, a branch of Rylands Bros., the world renowned Warrington (Lancs.) firm established a wire netting factory adjacent to the wiremill to make a wide range of netting for rural markets. Its manager, Mr. Mark Howarth, was a Production Engineer.

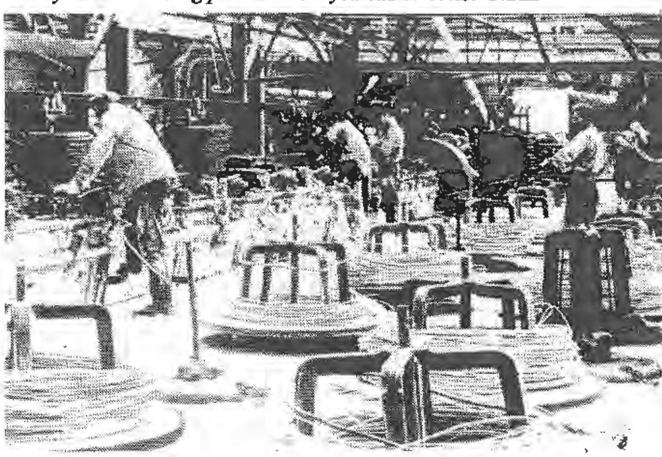
Pictured operating at the Commonwealth Steel Works, the new computer-controlled automatic wheel-turning machine. CS

Soon afterwards, the Austral Nail Co. and Rylands Bros. amalgamated. Mr. MacDougall retained his title and functions, and Mr. Howarth became Production Manager. In 1925, the Company, Rylands Bros. (Australia) Ltd., was absorbed into the BHP Group.

Rylands' facilities expanded apace and the development of their "Electric Control Wapping Off (wiredrawing) Machine" enabled them to draw low carbon wire at four times the rate of best overseas practice (3,000 feet/minute) on continuous machines. The Design Staff also engineered a world "first" — a ram truck for carrying rod coils — from a Lister truck, and joined with metallurgical staff to design a combined wire heat treatment and galvanising plant to make wires which hitherto could only be coated electrolytically.

By 1939, Mr. MacDougall claimed his wire-mill product range was "the most complex in the Southern Hemisphere."

Early wire-drawing process at Rylands Works. NRL



Ernest King. *WA*

During the Second World War, engineering development was restricted to munitions. Later, attention was given to the complete rehabilitation of the wiremill of Lysaght Bros., where spectacular increases in productivity were made using machines designed by Rylands. The lessons learned were applied to a new mill at Geelong. Newcastle engineers Messrs. Arthur Bates, Charles Bastian and Alan Wrigley featured prominently in these developments. They were diplomates of the Newcastle Technical College, and were closely associated with metallurgists and chemists at the plant in this work.

Engineering expertise was concentrated in the Fifties on facilities upgrading at Newcastle and wiredrawing machine design which outstripped, for a short period, that overseas. Later, expertise in galvanising line design led to the Australian Wire Industries (as BHP's wire interests had now become) leading the world in this field. To this was grafted a revolutionary gas gravel wiping method whereby coating speeds of up to 10 times that of conventional processes were possible. The work proceeded under the supervision of Mr. Bruce Clayton, as did the design and commissioning of the most high technology wire product in mass production, tyre cords.

By the 1980s, after just 60 years, the range of products made and marketed by AWI covered those required by Australian mining, manufacturing, construction and rural industries (except those in stainless or special alloy grades) — about 5,000 in all.

Australian Wire Ropes

With wire being produced at Rylands, BHP formed a consortium with the four leading wire-rope manufacturers in Great Britain in 1923. This enterprise, The Australian Wire Rope Works Pty. Ltd., was managed by Ernest King, an experienced rope-maker from Great Britain. Mr. King acquired a reputation for integrity, fair-dealing and maintenance of high quality. Some of his improvements in production methods were adopted overseas.

Machines and feed-wire were originally imported from Britain. Mine Managers in Australia were initially strongly prejudiced against locally produced ropes. Use of Australian feed-wire was introduced slowly over about 15 years' extensive testing. Acceptance was consolidated by the establishment of an Australian Standard in 1955, largely through Mr. Anderson's work since 1952 on the Mine Hoisting Panel of the Australian Standards Association.

In 1936, Mr. Bill Anderson joined the Australian Wire Rope Works as Works Engineer and became Works Manager in 1946. He was known before very long as a man from whom to seek advice on any troubles with wire rope (and troubles abound!). Born at Scone in Scotland in 1902, William (Bill) Anderson came to this country in 1911. In 1919 he entered Ipswich Railway Workshops in Queensland, as an Engineer-Cadet and completed his Diploma in Mechanical and Electrical engineering. He moved to Eveleigh Workshops and later Mort's Dock in

W. ("Bill") Anderson. *WA*

Sydney. While working for the BHP Newcastle Works as a Mechanical Draftsman his potential was spotted and Mr. Hacke made sure that he was given Construction and Maintenance experience. From 1928 he was an officer in the 1st Field Co. of the RAE and was Major O.C. when "manpowered" out in 1940. From his association with the mining industry, a major wire rope user, Mr. Anderson became a foundation member of the Newcastle branch of the Australasian Institute of Mining and Metallurgy. An active member for many years, he supported a reasonable mix of social activity - his performance on one occasion as a ballerina was reportedly memorable! A strong supporter of the YMCA and always physically fit, in 1982, at the age of 80 he supervised some building works for the "Y" and was still consulted on rope problems, here and overseas.

The Australian Wire Rope Works was forced to install new equipment as production expanded. Until 1957 the new equipment was designed by Mr. Anderson and built by Ernie Hewett at Hexham Engineering. A 30-ton Closing Machine for ropes up to four inches in diameter, built to help meet the demand in the Second World War, was still in production in 1982. At the other end of the scale, machines were designed by Anderson during the war to make field telephone cable and aircraft control cable. In 1953, with the formation of Australian Wire Industries, Bill Anderson moved up to become Technical Assistant to the General Manager. However, he returned to the shop floor for a few days in 1962 to undertake a daring task to hold the Australian market. This was the building of a 38 and-a-half ton rope for the first large cable-belt to be installed in Australia (at Coalcliff), achieved on a 30-ton machine. The rope was virtually built from the centre both-ways. Strong diversionary tactics were used to keep Ernie Hewett (this time the customer) out of the way during the critical change over. The rope conveyed 50% more tonnage than similar imported ropes.

With the demand for ever-larger ropes since then the Company installed large, imported machines, and was still winning orders for large ropes, against heavy international competition, in 1982.

John Lysaght (Australia) Ltd.

Galvanised iron is a building material with almost universal application in Australia.

By the time the BHP Co.'s Steel Works was approved, Australia was Lysaght's (England) largest customer for galvanised iron, with imports of 83,000 tons per annum. Lysaght's acquired a site alongside the Steel Works but advanced very cautiously, making sure it had tariff protection. There was a small plant (four mills) in operation by 1921 producing one-fifth of Australia's demand. In this era rolling sheet was a most arduous and highly skilled task. Red-hot sheet bar was lifted by two men with tongs and placed between flat rolls. The sheet was picked up on the other side and fed back over a higher roll. Then it was fed back again. The sheet was doubled as required and the process repeated until a pack

Manual rolling mills at Lysaght's Works. To construct the pits for the 164-tonne flywheels, serious dewatering problems had to be solved. *JL*

Workers turning a "pack" in the manual rolling operation at Lysaght's. *JL*

was produced of sheets of the desired size and thickness. The original mill was designed and commissioned by Alfred Tysoe of Lysaght's Newport Works. The mill drive shaft incorporated an enormous flywheel to provide for extensions. Under Mr. R.G.C. Parry-Okeden (Works Manager, Newcastle 1930-50), Mr. Albert Bear (Chief Engineer 1935-65), and Mr. V.A. Wardell (Research Superintendent 1931-9) the works were extended to include 16 pack mills and by 1936 the handling of the sheets was mechanised. Many innovations were introduced and production reached 100,000 tons per annum.

In 1938 the bulk of production was moved to Port Kembla where modern continous rolling plants were installed, largely designed by Newcastle Engineering staff.

Mr. Wardell became general manager of the combined operation in 1939 and production director in 1969. This originally heavily protected industry was, in 1945, selling sheet in Australia at $100 per ton when the price of overseas sheet in New Zealand was $170 per ton!

During the Second World War, Lysaght's older milling equipment was used to roll bullet-proof plate for armoured vehicles. Anderson shelters were exported to Britain. The great contribution of engineering versatility was, however, the production of the Owen Gun. Development was instigated by Mr. Wardell. Manufacture was shared between Port Kembla and Newcastle.

The Research and Development Department remained at Newcastle and it was there, under the direction of Mr. Don Cameron, Research Superintendent (1955-69) that great contributions to the industry were made. Mr. Cameron, a Science graduate from Great Britain, became an outstanding Physical Chemist and leader of the research group. Basic research at these laboratories in the crystalline changes in steel and coating metals during processing led to substantial improvements in strength and durability and processing speed. A group of Control Engineers developed more sensitive control systems for the new continuous machines at Port Kembla. A Chemical Engineer, Mr. Les Gore starting from a postgraduate project at the University of Newcastle, developed a world-class computer model of a continuous mill. The model justified the use of a bar-coiling process, and thus millions of dollars in capital and energy costs could be saved when the new mill at Westernport was established.

Special engineering projects were the design and construction of efficient, easily erected pre-fabricated farm bins and silos and steel shapes for composite concrete floors for buildings.

Tubemakers of Australia Ltd - Steel Pipe Division

The last of the major steel processors to establish itself was Stewarts and Lloyds (now a unit of Tubemakers of Australia).

After many negotiations, a joint venture by the BHP Co. Ltd. and Stewarts and Lloyds (initially registered as Buttweld Pty. Ltd.) established a plant adjacent to the Steel Works in 1934 to produce autogenous welded pipe from 3/16 of an inch to two-and-a-half inches (10 to 65mm). Mr. Andrew Hamilton came out from the United Kingdom as Works Manager in Charge of Procurement, Construction and Operations. Mr. Hamilton was born in Coatbridge, Scotland in 1900, was apprenticed locally and did his professional training at the Royal Glasgow Technical College. He joined Stewarts and Lloyds as a Draftsman in 1924 and moved on to their new plant at Corby. A very modest man, though with a proper sense of the dignity and standing of the professional engineer, Mr. Hamilton insisted upon selecting and developing a good engineering team. The original team, Messrs. C. Ingram, C. Allan, G. Dick, J. Porteous and H. Winn, had a pipe welding and galvanising plant in operation by 1935, and a seamless tube mill to produce heavy-duty tube to 8⅝ inches o.d. (220mm) by 1939. The skills and equipment were put to good use during the Second World War to produce heavy guns and shells. From 1957 onwards, production facilities for larger pipe and tube were developed in Port Kembla, because appropriate feed skelp was not available in Newcastle.

Mr. Hamilton moved on to become General Manager and Managing Director of Stewarts and Lloyds (Australia) and retired in 1965.

The Newcastle Plant has been progressively modernised and specialises in the production of galvanised merchant pipe to 65 NB and E.R.W. pipe to 168mm o.d. In particular, the development of a high volume Automatic Tube Galvanising Plant, which sold in the United Kingdom and Japan, was a notable achievement.

The most recent large development has included the addition of a hot finished Stretch Reducing Mill; this was a particular responsibility for Mr. Ken Murdoch, an Electrical Engineer, who joined Stewarts and Lloyds in 1957 after experience with the General Electric Company.

Senior members of the engineering teams during these various developments included Messrs. A. Attwood, L. Elliott, R. Tisdell, L. Daley, R. Scott, D. Moore and T. Height.

Andrew Hamilton. *AH*

An outstanding innovation, sharing first place in the State Pollution Control Commission 1982 Award, is a plant recovering all effluents from the galvanising process to produce pigments. The process was initiated by chemist Brian Callan in the Company's research laboratories and developed by Leigh Daley, a chemical engineer.

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Wangi Wangi Power Station — the first "coalfields" central electricity generating station in New South Wales. *SEC*

POWER FOR THE TWENTIETH CENTURY
Public Electricity Supply

by Terry Wall

Introduction

The discovery in 1831 by Faraday of the principles of electric generation and the invention of the incandescent lamp in 1879 made the use of domestic electricity possible. Prior to 1890, light, heat and power were available to Newcastle industries and residents from the gas mains of the Newcastle Gaslight and Coke Company.

The introduction of electric street lighting in Newcastle was argued on the ground of the then 'high cost of gas'[1] and the labour related issues which continue in the energy supply industries some hundred years after; that is, 'as the result of disputes that then existed in connection with the supply of gas to the public'. Baby Electricity must have been seen as one of the wonders of science which was about to take over from King Steam and King Coal.

"WHAT WILL HE GROW TO?"

Cartoon from Punch, June 25, 1881. UN

Lambton, The First In Newcastle

On November 8th, 1888, Tamworth became the first town in New South Wales to install electric street lighting. Other towns followed quickly, with electricity undertakings — initially for street lighting — being established at Young in 1888, Penrith and Moss Vale in 1889, Broken Hill, Lambton and Newcastle in 1890, Redfern in 1891 and the City of Sydney in 1892. The Department of Railways had established the first public power station in Sydney, for tramways supply only, at Ultimo in 1899.

The Council of the municipality of Lambton sent its Mayor to visit Young in 1889 and subsequently a contract was drawn up for the installation of a public lighting system using the Sawyer incandescent lamp at a cost of £7,000.

At 6.30 p.m. on September 9th, 1890, the first electric street lights were switched on. The Newcastle Morning Herald reports[2] that

> *"There were 160 street lights of 25-candle power 'placed at suitable distances apart' with 25 miles of wire connecting them. The 'white and pure light which streamed from the carbons of the lamps at Lambton' was generated from a plant of two engines, each 25-horse power. A correspondent remarked that an extraordinary feature of thes engines was the length of time they could run — 14 to 16 hours at a stretch.*
>
> *As well as the streets, the Council Chambers, the Primitive Methodist Church, the Post Office, the Criterion Skating Rink, a number of hotels and business houses and a few dwellings were connected with electricity and shone brightly on that first occasion. Soon, it was hoped, there would be many more."*
>
> *"Two young women, the daughters of Lambton aldermen, each had the honour of christening an engine and naming it after herself. One engine was named Amy, the other Thursa. The young ladies made a short speech one after the other, then broke two bottles of champagne over the least vulnerable parts of their respective name-sakes."*

Newcastle Council's first power station in Sydney Street. SCC

A verse appearing in the Newcastle Morning Herald proclaimed:

"When Electra rules the mart, the mine, the wharf, the store, the ship;
She will shave us, she will shrive us, blow our noses, cut our hair;
Make our boots and shoes and shine 'em, cut the very clothes we wear;
She will rule us, she will school us, boil the pot and bake the bread;
She will carry us and marry us, and bury us when dead;
Wallop Billy when he's naughty, nurse the baby, make the tea;
And we'll be hatched, and thatched and batched by Electricity."

The venture, however, did not succeed.

"Residents accepted the light in their streets but not in their homes. The council battled on, but could not meet repayments and, after a nine year struggle, resigned when the creditors foreclosed and took possession of the plant."

Newcastle City Council Supply

Newcastle Borough Council called tenders in October, 1889, for lighting of the city by electricity. The Newcastle Gas & Coke Company strongly opposed the Council setting up its own Electric Supply Department and, in 1890 decided to apply to the Government for a Bill giving it the right to supply electricity as well as gas.

As a counter-move, the Borough Council submitted its own Bill to give it the right to supply electricity in Newcastle and the adjoining areas. However, the Bill was not accepted by State Parliament in 1890 on a technical point raised by the Newcastle Gas & Coke Company.

Despite the setback, the Council was determined to succeed with its venture and the first sod of earth was turned by Alderman Colin Christie at the site on the central generating station in Sydney Street (now Tyrrell Street) Newcastle, in 1890.

Although continued opposition was lodged against the Borough of Newcastle Electric Lighting Act, the electric street lights were switched on in Newcastle on New Year's Eve — December 31st, 1890.

The original generating plant at the Council's Sydney Street power station was installed under contract by the firm of Messrs. Westcott, Marshall and Adams. At the time it was the largest installation of its kind in Australia. The heart of the generating plant was "two American-made Westinghouse reciprocating engines of 130 horsepower,* capable of supplying 1,500 incandescent lamps and 22 arc lamps. Each engine had a 7 ft. 6 inch driving wheel connected by a belt to an alternating dynamo, the wheel of which revolved at 1,650 revolutions per minute." Generation was 50 cycle single phase at 2200/250 volts.

Steam was supplied to the Westinghouse engines from two Babcock & Wilcox tubular boilers, located at the southern end of the operating shed. Only one engine at a time was used, the other being held in readiness as a back-up in the event of mechanical trouble.

By the turn of the century, Newcastle Borough Council had set up an Electric Supply Department, and this department controlled the supply of power throughout the district until the establishment of The Shortland County Council in 1957.

One of the service vehicles used by NESCA. *SCC*

Newcastle pioneered commercial developments covering the sales of appliances — about 1914 it introduced a scheme of hiring electric irons to the public at 4/- per annum. Power generation at the Sydney Street plant ceased in 1953. For a great many years, the electricity service in the Newcastle Region was known simply as NESCA — an acronym formed from "Newcastle Electric Supply - Council Administration". The name is perpetuated today in Nesca House.

Engineers Debate The Issues

The relative safety of gas and electric supply was debated during these early installations. In a General Meeting of the Northern Engineering Institute of NSW in 1890, Mr. H.J. Brown stated that[4]

> *"The fumes of gas, in the hands of people unaccustomed to its use, were sometimes dangerous." Mr. Brown instanced "some of the deplorable cases which have lately occurred, wherein fatal results had been caused; but if this was a danger which was being minimised every day."*

At the same meeting

> *Alderman Thorn said that "gas was liable to escape either through some defect in the pipes or perhaps at the meter. He understood that if anything happened to electric light the whole lot went out, and he thought this was an argument in favour of electricity, as it considerably lessened the risk of fire."*

A NESCA cooking class in 1935, following the advent of electric ranges. *SCC*

After some experience with electric light, safety was still an issue. In 1892, summarising experience in the United States, Mr. Rorison, Chief Engineer of the Newcastle Dredges, stated that[5]

> *"The alternating current has been in extensive use (worldwide) for about two years. In that time it has killed at least forty persons. On the other hand, arc light currents have been widely used for the past ten years. During this time the high tension continuous current has killed ten persons and the high tension alternating currents sixty. There has not been a single death caused by the low tension currents, which all companies are free to use.*

Guy Allbut. *SCC*

*** Measures of Electric Power**

Power stations are sized in terms of their rated electrical output, now as megawatts (MW). Current stations have outputs of several thousand MW, each boiler and its associated turbo-alternator being of 500 MW or 660 MW capacity. One MW = 1000 kW.

Early stations were rated in horse power (hp) equivalent to 0.75 kW. The original Sydney Street station — then the largest in Australia — was 260 hp (200 kW) capacity, one ten thousandth of the Liddell Power Station.

Electricity is sold in terms of units of kWh, the energy required to operate a single bar radiator for 1 hour.

Zaara Street Power Station. NRL

One of the most important considerations in establishing an electric lighting plant is the choice of a good motor. This is a matter of special importance in the installation of the large central stations which it is the custom at present to establish for the lighting of large towns.

It is no longer customary to multiply the number of engines. On the contrary; one must have resource to large and more important and more perfect motors. High speed engines have always given rise to unpleasant surprises in installations, in which the engines, like a racehorse, must, once set in motion, run uninterruptedly until its work is done. It is for these reasons that we now see all those who have the most experience in these matters have recourse to powerful engines, running at moderate speeds, built with the utmost care and solidity, with a view to avoid accidents."

Another speaker then referred to the temporary manner in which the posts carrying the wires had been erected, and their being out of the perpendicular made them appear very unsightly. He considered that the wires suspending the arc lights along the centre of the main thoroughfare were unsafe. He believed that they were to have steam trams running along Hunter-street shortly. The sulphurous gas from the motors, combined with the sea air, would soon cause the wire by which the arc lamps were hauled up and lowered to corrode, and suggested that, instead of the suspension wire being comprised of fine wire twisted together, a solid wire of the same thickness should be used, as it would be less likely to corrode than when the suspending gear was made up of so many finer wires, each one of which would be weakened by the corroding process, and cause the lamps to fall in the streets, where should the public be traversing up and down, serious, if not fatal, results would follow by the highly-charged wires coming into contact with the people passing below.

Another speaker said that doubtless the alderman, when specifying the kind of supports to be used, had the buildings of Newcastle in their mind's eye. If so, they had succeeded admirably in having posts erected in conformity with the architecture of the city generally.

The Regional Inter-Connection of Electricity Supply (Big Is Best)

By 1910 growth had been slow and unprofitable so that there were only 380 consumers connected to NESCA with a total annual income of about £8,000.

In July, 1911, Newcastle Council appointed Mr. Guy Allbut, from the Tamworth Electricity Supply, as Chief Engineer (later Electrical Engineer and Manager) and he, more than any other individual, was the guiding hand behind the growth and steady development of NESCA until his retirement in 1950.

Allbut appears to have been initially reluctant to enter the public debate concerning co-ordination of supply. As a member of the Plymouth Brethren, he was reluctant to speak at gatherings and he never joined the Institution of Engineers. His absolute dedication to his position and great demands made on his employees could be interpreted as tyrannical, but he held the loyalty of his staff and his support for the Hunter Region is obvious from his recorded statements.

In 1917, Allbut presented his case for the co-ordination of electric supply to the Northern Engineering Institute of New South Wales.[6] He proposed that a single 50 MW power station should be constructed to supply the future (1927) needs of the lower Hunter area. Zaara Street power station would eventually supply this demand, but not until 1940.

Allbut's extensive argument provided evidence for the greater economy of operating large power stations rather than small ones. Newcastle's small system resulted in great costs to the consumer.

Summary of 1917 Assessment by Allbut[6]

Newcastle District

Present:

Electricity generated on a practical scale by 1. Railway Commissioners. 2. Newcastle Council (8MW). 3. BHP 4. Sulphide Corporation (the Newcastle Council supply covering the areas of Newcastle, Wickham, Hamilton, Carrington, Adamstown, New Lambton and Merewether).

Future:

Expected to be 50 MW by 1927, exclusive of tramways and railways.

Maitland District

Present:

No plant of magnitude.

Future:

Expected to be 2MW.

Coalfields District

Present:

Scattered supply of about 20MW.

Future:

Expected to be 20MW.

(Note: The 1982 demand for the Shortland County Council was 540MW exclusive of the Alcan aluminium smelter and the BHP Ltd.)

Allbut argued strongly that ***"the State sees to it that an authority exists to control railways and tramways, water supply, sewerage, water conservation: but in that which vitally affects the development of manufacture and the conservation of the State's greatest asset, namely, coal, there is an entire apathy shared equally, to all appearances, by the public of this large district and the Government itself. Furthermore, everything points to a continuance of that apathy".***[6]

Growth in demand was greatest in the years between 1915 and 1929 when electricity was displacing other forms of energy for light, heat and power and for traction, industrial, commercial and domestic purposes. Demand in this period was doubling every five years.

The Sydney Street plant was extended to 2.5MW by the installation of a 500 kW BTH turbo-generator and then a 2000 kW Brown-Boveri set — both at 3 phase 50 cycle 2200 volts. This represented the limit of cooling water capacity at the site (the old Sea-Pit dam — now NESCA park).

The Rise and Fall of Zaara Street Power Station

The Government Railways Act of 1912 empowered the Department of Railways to undertake the supply of electricity in bulk to distributing bodies. By 1915 the Railways had built a "temporary" generating station of 2.5 MW at the eastern end of the Newcastle Railway yards (Zaara Street) generating at 2200V 25 cycles to light railway stations and yards and to supply the new electric coal cranes at Western Basin (Carrington).

In 1917 Guy Allbut reported that the Newcastle Council had been approached by Commonwealth Steel Products Limited for the supply of about

Early Overall Costs of Electricity Supplied from Steam Driven Stations[6]

Town	Year	Receipts per Unit (d)	Cost per Unit (d)	Units Sold
Newcastle N.S.W.	1916	2.84	1.75	1.931.511
Battersea	1914	1.69	.84	6.640.655
Melbourne	1913	2.28	.96	12.106.630
Bristol	1915	1.43	.66	18.202.156
Birmingham	1916	1.02	.62	117.916.321
Manchester	1915	.99	.55	127.735.646

Walter H. Myers. *SRA*

7,000,000 kilowatt hours of electricity annually for "a large business devoted to the production of steel in electric furnaces and other activities".[16] At that stage neither the Council nor the Railway Commissioners were able to supply this demand.

By 1920 a 10 MW 25 cycle unit was transferred to Zaara Street from White Bay, an interconnection was made with BHP steelworks and energy sold, through Newcastle Council, to the Austral Nail Coy and to the Commonwealth Steel Co. The main objective of the larger set was the conversion of the steam tram system to electric operation. The main substation building for conversion to 600V D.C. still stands, (classified by the National Trust) near Crown Street.

In 1922 a 2.5 MW frequency changer 25/50 cycles enabled connection to be made to the Council system and the railways erected 33 kV transmission lines alongside their tracks to give supply to Morisset and to Maitland City Council and from there to Singleton and Dungog.

Power purchased from the Railways was certainly cheaper than that generated by the small Sydney Street station. In 1922, the Council purchased 15.2 million units from the Railways at 0.77 pence/unit and generated 1.4 million units at 1.80 pence/unit.

Zaara Street by 1924 had transferred a 50 cycle unit from Ultimo and with total installed capacity of 29 MW was the main generating station of the region. (However the Cockle Creek power station of Caledonian Collieries supplying Cessnock and some lakeside suburbs as well as its coal mines opened in 1927 at 10 MW capacity. Browns at Richmond Main and Hebburn at Weston were supplying the rest of the South Maitland Coalfield.) With continued transfer of units from the Sydney stations of White Bay and Ultimo and to Lithgow the total capacity was held to between 20 and 30 MW until 1940, after which the installation of 15 and 20 MW machines brought the total capacity to about 90MW. By 1940 the Railways had built a 66 kV line from Hamilton through Gloucester to Taree and Kempsey, and another to interconnect with the Sydney system.

In 1953 the Zaara Street Power Station was taken over by the Electricity Commission of N.S.W. In late 1959 the reduction of its power-producing capacity began with the advent of Wangi Power Station, and finished prior to 1969 with the introduction of the Commission's Merewether sub-station.

It was reported in the Newcastle Morning Herald in June, 1971, that Zaara Street Power Station would be demolished, releasing the area for high-density commercial development in a beautiful harbour setting. The public was not nostalgic about the station which had kept Newcastle lit for thirty years. The Herald reported that:

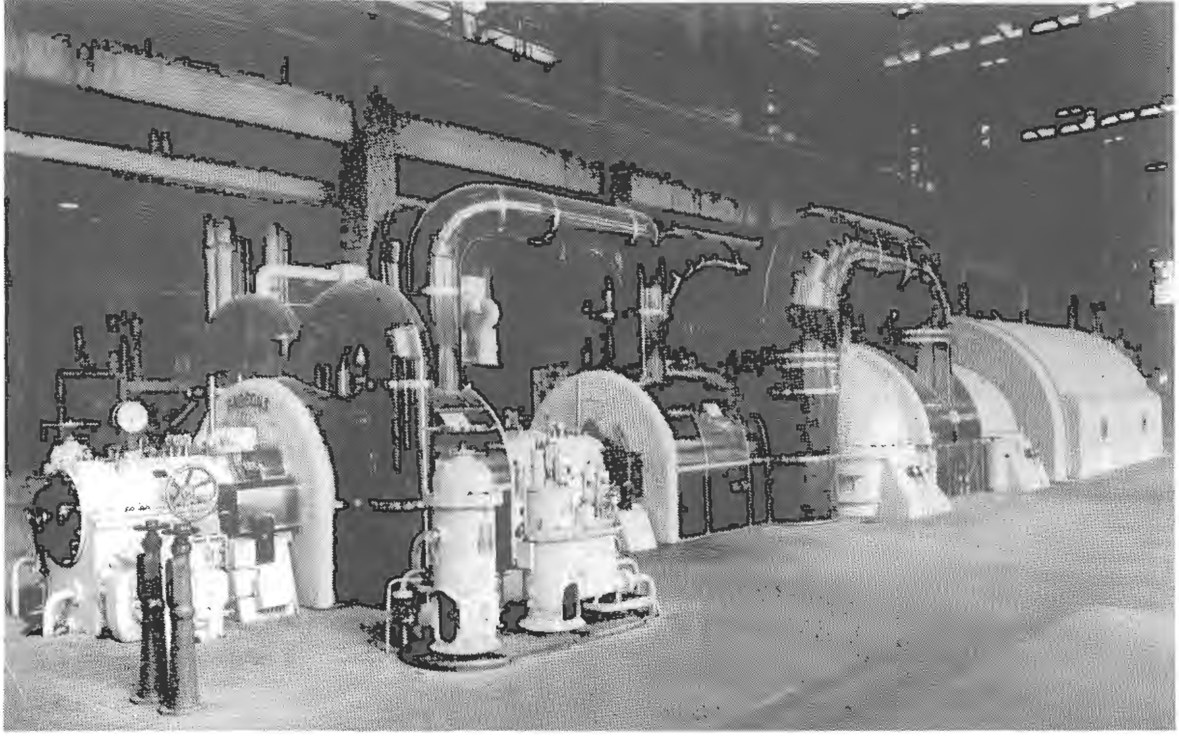
> *"Zaara Street Power Station, that obsolete and decrepit eyesore of the East End will be with us for a long time yet. Although the station is the oldest in the State — and generates only one five-thousandth of the State's power — the Electricity Commission has no plans to close it."*

In February 1976, the Minister for Labour and Industry advised that the site of Zaara Street Power Station would be available for inclusion in redevelopment schemes. Demolition work commenced in late 1977, and the vacant site now awaits the East End Redevelopment project which will rise from the grave of the old power station.

Bigger Is Better — Inter-Connection Between Regions

By the late twenties the possibility of integrating electric supply in New South Wales was raised by W.H. Myers, the Chief Electrical Engineer of the Department of Railways, which generated electricity in Sydney and Newcastle. He stated before the Newcastle conference of the Institution in 1929 that[7]

> *"It is the author's opinion that the local solution of the problem of electric power supply to the extra-coastal or country areas lies in the direction of suitably combining, by selected interconnecting lines, the few*



A 60 MW turbo-alternator set at Wangi Wangi Power Station. Steam conditions 900 p.s.i., 900°F. Commissioned about 1960. SRA

hydro-electric stations with the larger and more dependable steam power stations, but that, even on economic grounds, the popular (or political) idea as to the value of hydro-electricity in this country(excluding Tasmania), is largely a fallacy."

Putting the regional view, Guy Allbut did not agree with this suggestion and in the discussion to this paper stated that

"The idea of erecting long transmission lines in this country, or the tying together of remotely-situated generating systems, could not be justified, and, where undertaken by public authorities, must assuredly be financed per medium of the income tax which was extracting, in the State of New South Wales, ever increasing quantities of money from the tax-payer's pocket."

Allbut's antagonisms to the Railway Commissioners can be understood, as he states that

"Years ago, the writer, on behalf of the Newcastle City Council, approached the Railway Commissioners of N. S. W. with an enquiry for supply in bulk as it was then rumoured that the Railway Commissioners did intend to build a modern power station at Newcastle and the writer felt, obviously, that it would be undesirable to build two power stations. This request was met with a refusal. Believing however, in the principle of co-ordination, and in face of a written refusal, a second attempt was made before proceeding with the erection of a modern power station by the Newcastle City Council, and the Railway Commissioners then agreed to provide supply to the Newcastle City Council upon the understanding that the latter would reticulate the Newcastle district."

Myers did not respond to these comments, stating that they were " . . . largely political in their nature", and that he "could not see that any useful purpose would be served in discussing that phase of the matter".

In the twenties, the Railways had expanded its influence by transmitting power on Railway easements to Maitland — and eventually to Dungog, Singleton and Kempsey — perhaps limiting the NESCA influence. Allbut was upset at this move, and the antagonism between him and Myers would persist for thirty years as the Railways continued to claim itself as the power generator for northern N.S.W.

The antagonism between these two can also be seen as between servants of the Newcastle district (Allbut) and the State system, centred in Sydney (Myers). Allbut complained that "for decades past Newcastle had witnessed a process which it was entirely impossible to understand, namely the transport for 104 miles past the modern port of Newcastle of millions of tons of material for export."

The inter-connection of generating systems in New South Wales began shortly before the second world war. At the time of the establishment of the Electricity Commission in 1950 Newcastle was connected to both Sydney to the south, and to the Northern Rivers at Kempsey.

A Coalfields Power Station

In 1938 the Electric Power Advisory Committee debated the relative merits of the possible location of new power stations. This group of engineers comprised Guy Allbut representing NESCA, W.M. Myers representing the Railways, Vivien Brain (Public Works), Roger VineHall (Sydney County Council) and H.G. Conde representing the private Electric Light and Power Corporation which operated the Balmain power station.

Three alternative sites were considered in detail by a Technical Panel with representatives of the five authorities, Norm Letcher representing NESCA as Guy Allbut's deputy.

- A Hunter River Power Station somewhere between Nobbys and Hexham of about 100 MW capacity, principally for the Hunter area, supported by NESCA.
- A larger coalfields station at Wangi Wangi to serve Newcastle and Sydney, supported by Myers and Brain.
- An expansion of the Pyrmont Station in Sydney, supported by SCC and reluctantly by Conde once the possibility of the expansion of the Balmain Station was discounted.

Initially the separate Sydney and Newcastle alternatives appeared to be economically attractive. However, for two years, the groups argued for their own interests with the increasing cost of transport of coal to Pyrmont resulting in increasing support for the first two alternatives. The State Government was eventually to decide for the coalfields location, but not before the issues were debated in public meetings and in the press.

Fifteen years after his first proposal for regional inter-connection in 1929, Myers summarised the progress of a[8] *"decade, or more, of exasperating and futile efforts on the part of leading members of our profession to persuade the 'powers that be' to do something tangible in the matter, they (the remarks) must, at the moment of writing, stand as a striking example of the 'vanity of human wishes'. For some reason, mainly political in its origin, such a commonsense and obvious step has not been taken in New South Wales, which, alone amongst the States of the Commonwealth, still prefers to grow electrically like Topsy, although there are signs that the long period of neglect is reaching an end."*

Myers said that two alternative schemes could be considered *"(a) the simultaneous or 'concurrent' development of the more or less obsolete power station at Pyrmont, Sydney, with a rehabilitation of the older portion of White Bay Power Station, Sydney, and the building of a new power station on the south bank of the Hunter River, Newcastle, and (b) the building of a new power station of equivalent rating to the combined plants listed in (a), to be situated on the coalfields at Lake Macquarie, with duplicate transmission lines to both Sydney and Newcastle."*

Myers favoured alternative (b) stating that consideration should be given to technical and financial data for the development of a power station on the coalfields to act as a base-load station jointly for the cities of Sydney and Newcastle.

The first coalfields power station at Wangi was to produce its first electricity in late 1957, thirty years after Myers' first proposal.

The Electricity Commission of New South Wales

At the end of the Second World War the accelerated demand for electricity could not be met. None of the British manufacturers on whom Australia depended for its generating plant had been permitted to supply plant which could not be brought into service in time to assist the war effort.

By 1949 the situation had become acute and H.G. Conde was appointed Emergency Commissioner to oversee the rationing of electricity supplied to industries and the railways, as well as arrangements for load shedding.

In May, 1950, the Electricity Commission of NSW was brought into being with the immediate task of increasing power generation as rapidly as possible.[9] The position was so serious that generating plant was installed by industrial organisations to avoid production shut-downs. Arrangements were made for parallel operation with public supply. From 6 per cent to 8 per cent of peak demand in the Northern Region was available from this source.

Subsequently, in the Newcastle region, seven 533 kW diesel electric units were installed in the Civic area of Newcastle and a 25,000 kW 'package' power station with four stoker-fired boilers was installed at Maitland on the old Walka Waterworks site. Another package boiler set was installed at Muswellbrook and a diesel station at Kempsey. A steel-tower 132 kV line was erected between Muswellbrook and Tamworth to provide stand-by for New England.

The long range developments initiated by the newly-formed Electricity Commission included new coal fired stations to generate a total of 900 MW in Sydney, Tallawarra (Port Kembla), Wallerawang (Lithgow) and Wangi Wangi on Lake Macquarie. The Wangi Station with a capacity of 300 MW* — six generating units of 50 MW — was the largest of the new stations and was the first of the Hunter Valley stations which were to eventually dominate generation for the State from the coalfields. (* Revised during construction increasing the second set of three units to 60 MW each at higher temperature and pressure.)

Wangi commenced generating in 1957. Just thirty years later, by 1987, the expected installed capacity of power stations on the Northern Coalfields, at over 7000 MW, will be nearly twenty-five times larger and will supply more than three-quarters of the State's electricity requirements. The one new aluminium smelter at Tomago will use about seven times the final capacity of the Zaara Street station!

Liddell Power Station — the first of the Upper Hunter electricity generating stations, equipped with four 500 MW units. 10,000 KPa 540°C/540°C. First set commissioned 1971. NRL

Distribution — City and County Councils

By far the greatest engineering effort in the region was required for the distribution of electricity from the bulk supply points to the final consumer. The first twenty years saw problems with street lights — incandescent lights which "merely glowed a dull red" were frequently reported. Once expansion began in 1911 there was continuous redesign of the main high-tension arteries to meet both increasing loads and new residential and industrial areas. Guy Allbut, followed in 1950 by N.E. Nash and in 1952 by A. Campbell as Engineer-Managers of NESCA were responsible for administration of the whole undertaking, including promotion and sales and service. Extension of supply was designed and constructed both to fast growing industry and as far as Morisset, West Wallsend, Raymond Terrace and the outskirts of Maitland, taking Railways bulk supply at Newcastle, Cockle Creek and Morisset. Overhead wires were replaced by underground cables within the city. The 2200 volt high-tension system was replaced by 6600 and then 11000 volts. Early in the second World War the demand for increased food production required urgent extension of supply into rural areas. Guy Allbut started a

custom, continued by his successors, of following week-end excursions round the district with a Monday morning note for his Distribution Engineer listing a few defects noticed in poles and wiring.

For the Electricity Supply Department of Maitland City Council, Electrical Engineers E. Tudor, E.W. Thorncroft and D. McVea faced similar tasks (as did the men in smaller centres). Following the huge floods of 1955, McVea's department had the task of replacing flood-damaged equipment and of assisting customers with drying-out and repairs. For many months the electrical staffs of the coal-mines of the South maitland field assisted in this task.

With the formation of County Councils in 1957 Dungog and Gloucester were incorporated with Newcastle into Shortland County Council. Much of the administrative work passed to the County Clerk. Mr. A.S. Campbell became Chief Electrical Engineer to be followed in 1962 by Mr. A. Donaldson, in 1973 by Mr. A. Brown and in 1979 by Mr. J. Tubb, all of whom, like Campbell, had developed their professional careers in NESCA. Incorporation of the new areas, provision of a new main bulk-supply point by the Commission at Merewether in 1969, further development of 33 kV distribution (particularly by underground cable) and developments in protective and control systems kept engineers busy.

Maitland was combined with Singleton and "The Coalfields" into the Hunter Valley County and D. McVea followed by J. Smith had the task of amalgamating the various colliery supplies into a comprehensive system.

The area from Muswellbrook through Scone to the heads of the Valley became the Upper Hunter County and Col Robinson followed by Terry Burns had the task of consolidating supply through a vast rural area.

The open-cast coal development of the 1970's brought a tremendous increase in demand in the Hunter Region with electrical design problems in coping with the heavy intermittent loads of large draglines and shovels. The incorporation in 1980 of these two councils into Shortland County Council, as one, serving the whole valley, has enabled a more efficient use of engineering expertise. The enlarged County Council has accepted the responsibility of constructing and operating a system of 132 kV lines and substations to supply the heavy electrical load for coal-mines still developing in 1982. This is a $40 million project.

The Expansion of the NESCA and SCC Supply

	Customers connected	Millions of units sold, (kWh)
1910	380 (with about 400 street lamps)	NA
1918	2,308	0.07
1928	23,463	30.9
1957 (SCC established)	72,417	417.7
1970	103,415	1,082.9
1981	179,820	2,357.5

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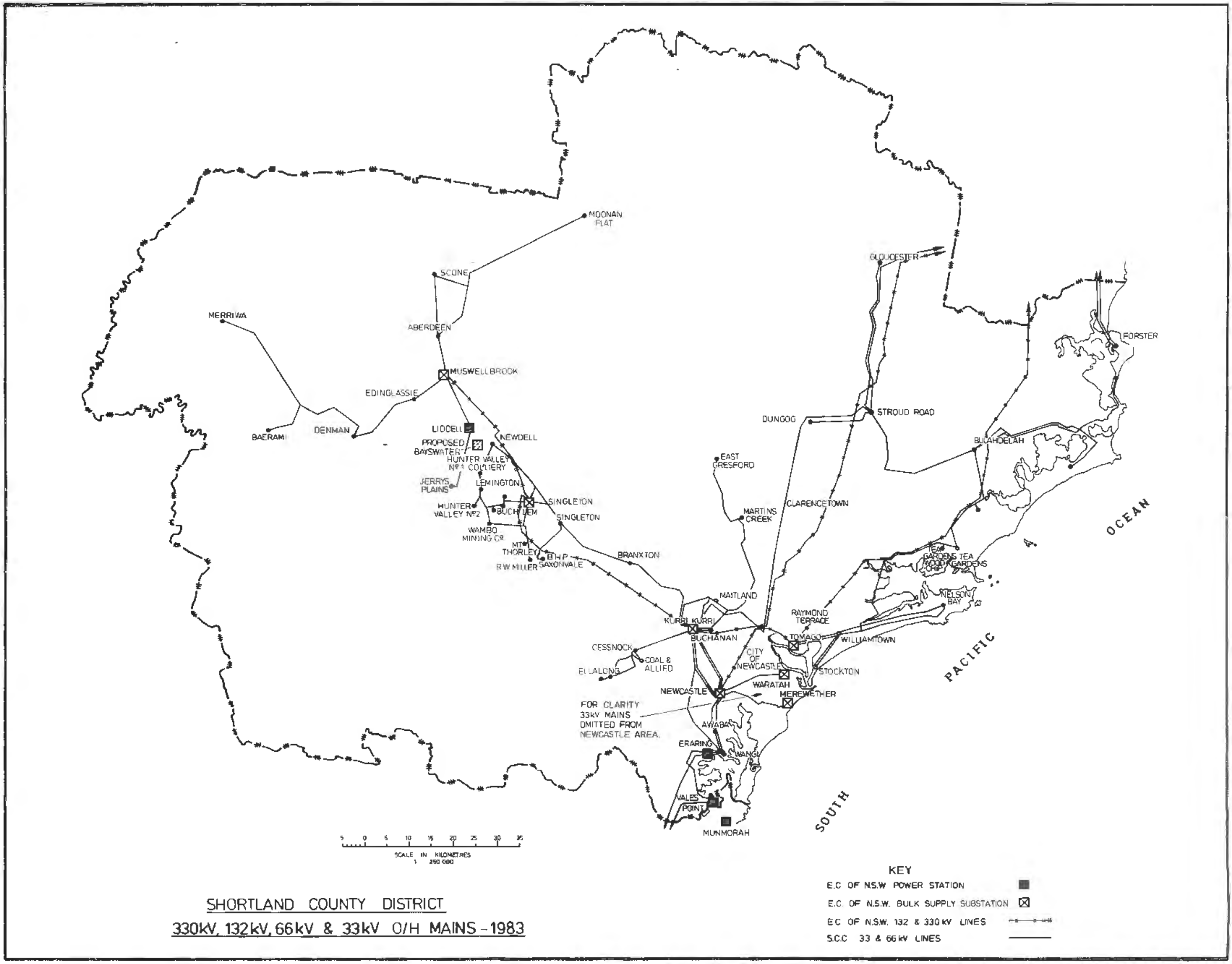
Acknowledgements

I am most grateful to Aub Donaldson who was Chief Engineer of NESCA, and Norm Letcher who was personal assistant to Guy Allbut and then Asst. Regional Transmission Engineer for the ECNSW and to Phil Cooper, Chief Engineer 1983 and staff of Shortland County Council.

The Hunter Valley high tension distribution system, 1983. Power stations and feed points shown. Sixty years ago power distribution was confined to just the inner Newcastle City area and villages adjacent to the coal mines. *SCC*



SHORTLAND COUNTY DISTRICT
330kV, 132kV, 66kV & 33kV O/H MAINS - 1983

NEWCASTLE STEEL WORKS

by John Bunton

(With technical assistance from Haydn Payne and Bert Ley)

Building a steelworks in a pond seemed a nigh impossible task to the Board of Directors of the Broken Hill Proprietary Co. Ltd. in 1913. In fact, they seriously questioned the advisability of such a project when they visited the Newcastle site in May of that year. But the engineers were more than equal to the task and modern, integrated iron and steel works quickly grew on the site and the first steel was tapped on April 9, 1915.

Selection of the Newcastle site had come only after extensive investigation and research.

The Company began with a syndicate of seven on Mt. Gipps Station, Western New South Wales, and the succeeding Broken Hill Co. of 14, which in 1885 controlled the majority of the famous lode of the "great barrier reef" called Broken Hill. It developed markets in Europe and established its lead smelter and refinery plant at Port Pirie, South Australia. Flux was obtained by possession of Iron Monarch and Iron Knob on Spencers Gulf, also in South Australia.

As early as 1802, a British Government report had said that iron works should be established with Port Stephens ore. In 1900, the Company's General Manager, Mr. G.D. Delprat quietly visited Newcastle and inspected from the river the old copper smelter site at Port Waratah.

The Company was producing about 400 tons a day of lead-silver bullion carrying a certain amount of gold and had built up an important export trade. But no attempt was being made to utilise its large deposits of iron ore, other than as flux for the lead smelters. The import of pig iron, rails, billets, bars, shapes, wire products and sheets during 1909 were valued at more than £40 million.

About this time the Board of Directors began to consider the advisability of utilising its large assets of iron ore to supply the demand in the country for iron and steel products. So, in 1911 they sent Mr. Delprat to Europe and the United States to visit iron and steel works and get

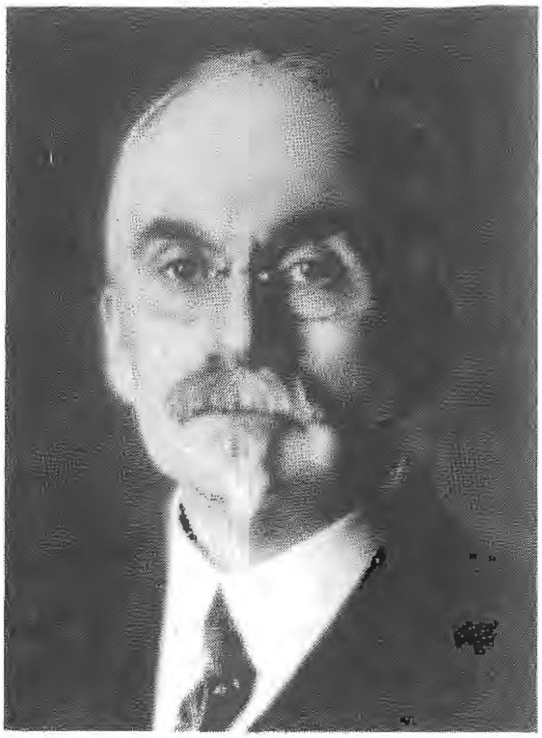
Newcastle Steel Works in 1975, the Iron Hunter *at the ore receiving wharf.* *BHP*

information to help them make a decision. As a result, Mr. David Baker was engaged to come to Australia to investigate and report on the advisability of undertaking the project. Baker had graduated from the prestigious mining school at M.I.T. in Cambridge, Mass., then accepted a bottom-of-the-ladder job with Pennsylvania Steel labouring at relining Bessemer converters. He rapidly moved up the ladder and acquired a reputation. In Australia he examined raw material sites and possible works locations and was enthusiastic about his findings.

In 1912, he recommended to the Board that an iron and steel works be constructed on Company land near Newcatle. His report was accepted and Baker was engaged as Newcastle's first Manager. Baker was a modest man — he travelled from Newcastle by penny tram to Carrington and walked a mile to the works.

The site had the advantage of being on tidal water close to harbour facilities and was virtually on top of the Northern Coalfield. The proposal was for a works with an annual capacity of 150,000 tons of rails — equivalent to the tonnage of rails imported in 1910.

Baker had rejected a site close to iron ore in South Australia, but had looked at Port Kembla as well as Newcastle, testing the Borehole coal seam and Bulli coke. At Newcastle, he had checked the foundation possibilities of the swampy site by examining the condition of the piles under the old high stack of the smelters. Significantly, the project was to be an American design. At the



David Baker. *BHP*

time, American practice was reputedly a decade ahead of practices in other countries. The high melting shop type of open hearth installation, for example, was typically American, and building large open hearth furnaces in batteries and using machine charging were new and radical techniques.

The initial plant comprised a battery of Semet-Solway by-product coke ovens, one 350-ton blast furnace, three 65-ton open hearth furnaces, one 35in blooming mill and a 28in heavy rail and structural mill. The plans for the works were completed early in 1913 and the material ordered that year.

In 1913, the site chosen for the Steelworks was nothing but a series of puddles. Most of the land was under water. The bank was marked by a ridge of mud within which water oozed and fell according to the state of the tide. Visiting the site on May 11, 1913, the Board of Directors, while impressed with the activity on the property, were amazed to see the area for the open hearth plant completely under water and staked out with tall poles. Stakes were also placed showing the site for the blooming and rail mill and, on a low island near the river, stakes showed the site for the coke ovens.

The Board asked many questions on the advisability of building a steel plant in a pond. They were assured that good foundations could be built. The site, mainly mangrove swamp under tidal influence, was extensively reclaimed with sand pumped by dredges of the Department of Public Works in completing the State Government's undertaking to dredge the approach

G.D. Delprat. *BHP*

"Building a steelworks in a pond seemed a nigh impossible task". Pumping sand to form the foundations for the Open Hearth, 1914. *BHP*

channels. Solid piling was essential for every heavy structure of the new plant — actually some 600 nine-metre piles carried the first blast furnace and heating stoves.

To drive the first pile, a punt with a piledriver and engine was floated right on to the site of the blast furnace and the pile driven to a depth of 31ft. 5in. The blast furnace was underpinned with 225 piles in 15 rows of 15 each. With each heavy structure, the foundation was raised on piles and the actual base fortified with concrete. The foundation of the No. 1 blast furnace was a concrete block 44ft. thick. The engine that ran the blooming mill was laid on a concrete mass measuring 3,000 cubic yards.

The first cargo of material for construction arrived on January 1, 1914. The pile driving and concrete laying of foundations had been vigorously pushed until declaration of the First World War stopped all construction. The stoppage lasted only a few days, the Board of Directors deciding that completion of the works would make Australia independent of outside sources of supply for the principal part of its steel requirements and might render material assistance to the Allies in winning the war.

Construction pushed on so that the blast furnace was lighted on March 9, 1915 and the first steel was made on April 9, with the first ingot bloomed on the same day. Rail rolling began on April 24. The formal opening of the works under the direction of the Governor-General, Sir Ronald Munro Ferguson, was on June 2, 1915.

A big part in construction of the works was played by the BHP's Chief Engineer at Broken Hill, John Alexander Lindsay. He was transferred to Newcastle from 1913 to 1915. With David Baker he helped in the original planning of the works from a temporary drafting office on the site. He returned to Broken Hill just after the first steel works unit went into operation. The Steelworks Act had decreed that the works should be built in five years. It was completed in less than half that time.

John McMeeken, who had studied building construction and drawing in his native Scotland, was another who came with Baker and Delprat to Newcastle in 1912. After helping plan and build the works, he stayed on at Newcastle, filling various responsible positions and took an active part in the community as an Alderman, Chamber of Commerce President, Chamber of Manufacturers Vice-President, Hospital Board member and Show Society committeeman.

Arthur K. Hacke, later Chief Engineer to the Company, was also one of the first to journey from the "Hill" to join Baker's staff and had the task of preparing plans of the proposed works to submit to the Board in Melbourne. When construction began he became Chief Draughtsman at the steelworks, then, in 1921, Mechanical Engineer. In 1935, he was appointed Chief Engineer for the Company and the years before and during the Second World War proved exacting with extensive plant development. An indication of his outstanding service to the steel industry was the presentation of the 1950 Kernot Memorial medal to him by the then Vice-Chancellor of Melbourne University, Sir George Paton. The starting of the works early in the First World War enabled Australia to push ahead and complete the strategic line from Kalgoorlie, in Western Australia, to Port Augusta at the Head of Spencers Gulf, thus connecting by rail Perth and Fremantle with all the major cities in the East.

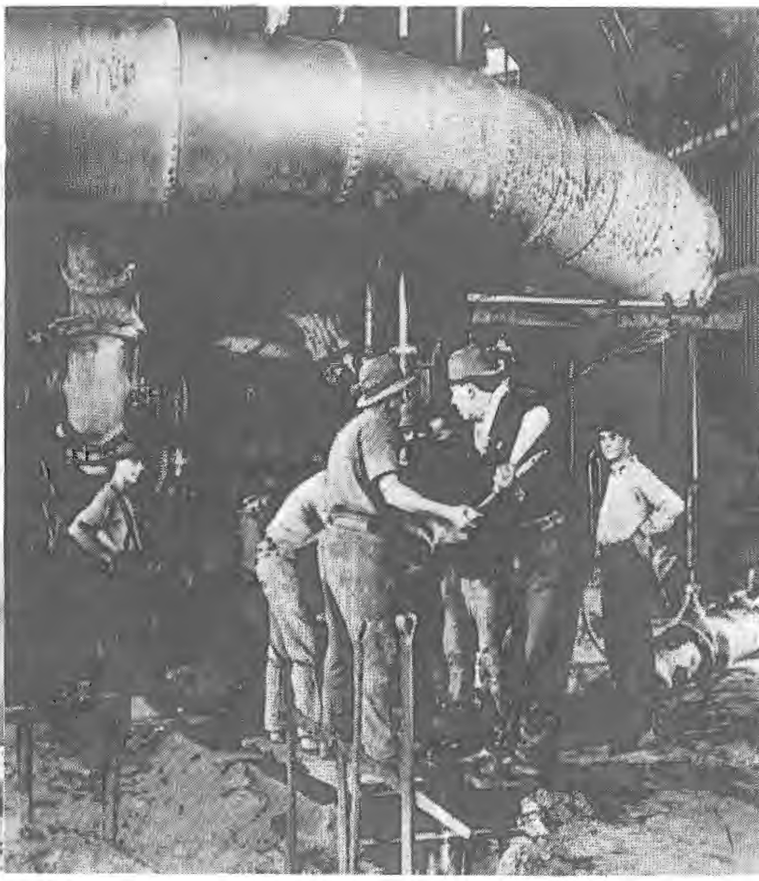
In addition, BHP furnished rails for South Africa to replace lines torn up to supply equipment for France, also rails and munition bar to the British War Department and modified its plant to roll plate and sections for shipbuilding in Australia. The wartime effort meant a doubling of the works' capacity and brought the second major construction programme at Newcastle from 1916.

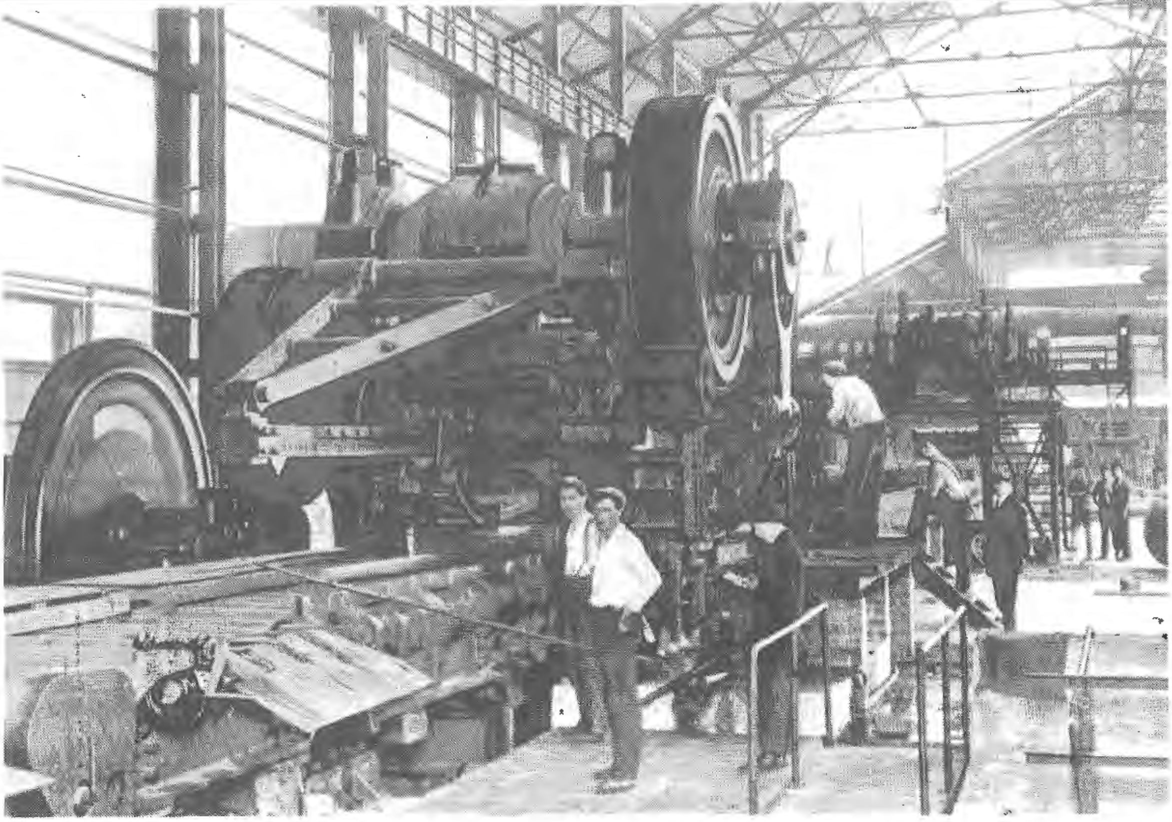
The man who took charge of this construction under David Baker was already seen in some people's eyes as a kind of heir presumptive to Delprat. He was, of course, Essington Lewis. Having served in the mine at Broken Hill, then the Port Pirie smelters, his training was as a mining engineer. Foreshadowing his part in the Second World War, Lewis was appointed Manager of Broken Hill Munition Co. Pty. Ltd., a wartime subsidiary set up to supervise the manufacture of shell steel for the Australian Defence Department and later the British War Office. In 1918, he left Newcastle to become right-hand man to Delprat at Head Office in Melbourne.

Essington Lewis and World War I

In a paper, *Iron and Steel Industry in Australia,* presented to the 1929 Engineering Conference at Newcastle, Essington Lewis said Newcastle Steelworks had come into existence at a critical period in the affairs of the nation. "The World War was raging in Europe", he said. "Shipping was disturbed, Australia lacked many iron and steel requirements and the Federal Government decided to push on with the trans-continental railway. Rapidly the BHP order book was filled for more than a year ahead. In a little over four months from the date of commencement of smelting operations the plant produced 36,214 tons of pig iron, 17,134 tons of steel blooms and billets and 11,574 tons of rails. The Company had entered contracts to supply over 106,000 tons of rails to the Federal and State Governments, apart from having to meet the pressing requirements of Australian manufacturers and distributors. On formation of the Federal Munitions Committee in 1915, it was arranged that Newcastle Steelworks should undertake the manufacture of rail urgently required in France, together with munitions steel ... Actually, during the progress of the war, the BHP Co. supplied 16,000 tons of steel rails for war purposes abroad and 16,000 tons of munitions steel, the quality of which brought forth laudatory remarks from the Imperial Munitions Authority and other eminent steel experts in England. This rush of orders necessitated immediate extensions of plant, including the erection of four additional open hearth furnaces, extensions to the by-product coke ovens plant, together with a large quantity of minor plants ... This plant was duly installed, but the demand for steel was overwhelming. The blooming mill and rail mill were virtually tied down to the production of blooms, billets and rails, and, in order to meet the urgent requirements of structural steel, light rails, merchant bar and wire rods, orders were placed for the installation of an 18in. structural mill, 12in. and 8in. merchant mills, and also a modern Morgan

Below: No. 1 blast furnace at Newcastle Steel Works, 1915. The furnace was not retired until 1982. *BHP*
Below Right: Opening the tap hole for the first cast, 1915.





Bloom Mill shears, 1915. *BHP*

rod mill. By August 25, 1916, the capital expenditure on the Works amounted to £1,814,617 and the additional rolling mills were under construction. The Company arranged for the erection of a second blast furnace and additional by-product coke ovens, together with a 'mixer' of a thousand tons capacity to act as a storage reservoir for molten pig iron prior to its conversion into refined steel".

The 18-inch structural rolling mill was put into commission in October, 1916.

In June-July, 1917, the 12in. and 8in. rolling mills for production of merchant bar began operating. Later in 1917 a steel foundry was laid down, equipped with a 20ton acid open hearth steel furnace for production of forging ingots, rolls and heavy steel casting required throughout the plant. Towards the end of the year, the shortage of steel plates in Australia became pressing — they were needed urgently for the wartime ship building scheme, then in progress at a number of Australian ship yards.

The Company also needed plates for its second blast furnace. Hurried arrangements were made to cast steel housings, each weighing more than 40 tons, for the conversion of the heavy rolling mill into an improvised plate mill, with the result that more than 13,000 tons of steel plate were manufactured. The Company also supplied steel joists and bulb angles required for steamers built at Australian ship yards during the war. To allow ample reserve stocks of coal against possible dislocation in the mining industry and provide a scheme for regular blending of coal, the Company, in 1918, laid down an extensive storage depot, traversed by a 200 ft. span travelling bridge.

Expansion, Recession, But Always Development

In July, 1918, a small blast furnace was blown in capable of producing about 100 tons of foundry pig iron a day. Periodically this furnace smelted manganese ore for production of ferro manganese, necessary in the refining of steel, this alloy being unprocurable because of the war. This furnace was really erected at the request of the then Federal Government to ensure adequate supplies of foundry iron for the Commonwealth of Australia. Building in 1918 included a modern engineering shop to handle adequately the machining of castings and general repairs to the growing plant. The Morgan rod mill for production of wire rods began operations on August 30, 1918, working as a single-strand mill and capable of producing more than 1,000 tons of five gauge steel rods a week. "At this stage of the Company's history, effect was given to the policy of encouraging the establishment of secondary industry in close proximity to the steel works", said Lewis.

"The Austral Nail Co. Pty. Ltd. erected a plant for production of drawn steel wire, whilst Messrs. John Lysaght Ltd. later installed sheet rolling mills. The second large blast furnace, the completion of which was delayed during the war awaited a turbo-blower from England, went into commission on December 5, 1918. For the first 20 weeks of its operation, it produced an average of 3,040 tons of pig iron a week. The by-product coke ovens plant was extended in keeping with the growth of the blast furnace". Steam buffs will be interested to note that all the main rolling mills were steam-driven. The blooming mill, which was a 35in. geared Mackintosh and Hemphill design, had two steam cylinders, 66in. by 42in., with steam pressure at 150psi, giving 11,000hp at 140pm. The rail mill also was driven by two similar steam engines. The exhaust from these engines could be clearly heard throughout the whole City of Newcastle.

Activities in 1920-22 included the erection of a third large blast furnace, followed by a third battery of 63 coke ovens and necessary by-products apparatus (bringing the total number of by-product coke ovens to 224), the erection of a plant for recovery of benzol products from coke ovens gas, duplication of the Morgan rod mill from a single strand to double strand mill, and erection of a modern office building for the works.

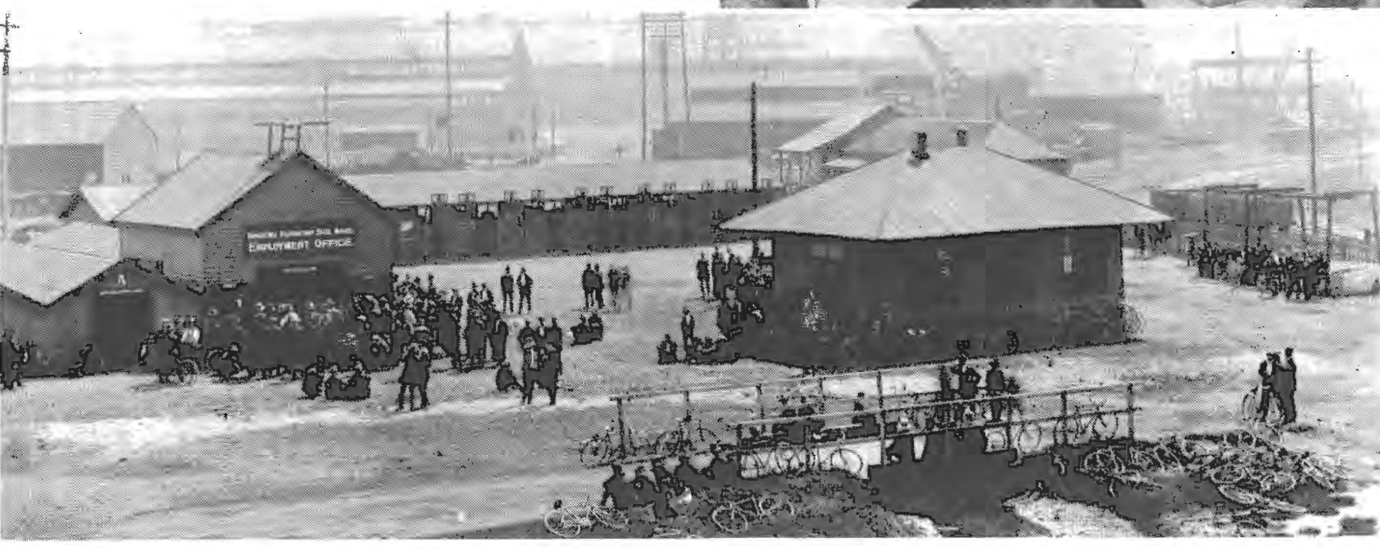
In February, 1921, G.D. Delprat, who had been General Manager of the BHP Co. since 1889, resigned his position. He was succeeded by Essington Lewis.

The third large blast furnace was completed and put into commission on August 15, 1921. The additional blast furnace necessitated considerable extensions to the Company's original wharfage, which was increased to 1,800ft.

Early in 1922, the output of the Works decreased because of the reduction in the selling price of iron and steel following deflation abroad in the cost of manufacturing. In April and May, large sections of the BHP plant were forced to close down because of the severe overseas competition. The Board of Directors made a public statement on June 15, 1922, and pointed out that instead of employing more than 5,500 men, the number had been reduced to 840. During the enforced shut down, which lasted more than nine months, the Company did not hesitate to spend money in effecting economies wherever possible in an effort to meet the intense foreign competition. The cost of coal, which had risen excessively in preceding years, coupled with the hours and wages operating in Australia compared to overseas countries, intensified the position.

In March, 1923, after the Company obtained certain concessions in the price of small coal together with slight wage adjustments, operations at the Works were resumed. The plant output for the year ended May, 1923, fell to 63,344 tons of pig iron, but in the next 12 months rose to 306,258 tons — for the first time in its history the plant had an uninterrupted run. In 1924, two additional 65-ton open hearth furnaces were installed and two additional steamers were bought to transport raw materials and finished products.

David Baker resigned his position as Newcastle Manager late in 1924 and management of the



In the early days, men travelled to the Steel Works by ferry or bicycle. *BHP* works was handed to Leslie Bradford, a metallurgist by training. Bradford had given many years of yeoman service to the Company and had originated and patented processes for the flotation of silver-lead-zinc ores during his time at Broken Hill. At Newcastle, he had been Chief Chemist, Testing Engineer, Open Hearth Superintendent, Production Superintendent and then Assistant Manager to Baker.

In 1925, a modern AC power plant, comprising two 5,000kW turbo-alternator sets was installed, steam for these units being generated by blast furnace gas. In 1926, a well equipped fabricating shop was added and in 1927, the 8in. mill was converted into an electrically driven mill and a second open hearth steel furnace, complete with electric charging equipment, was added to the steel foundry. Two pig casting machines were installed, a brick plant to produce chrome and magnesite bricks and a direct metal foundry. A DC power station, service departments, slag crushing plant, ore wharf and cargo wharf extensions, and boiler plant extensions were also added during this period. Albert Goodwin had joined the Company in 1920 as an electrical draftsman and then took over as Chief Electrical Engineer soon after from Mr. Watkins. Goodwin was responsible for modernising, buying and installing much of the power plant and equipment.

By 1925, the Company was on the way to establishing its own sea lines of communications. A parallel policy of making secure the supply of raw materials had always been followed and, in 1925, the Company decided to establish its own coal mines. This major step forward was realised with establishment of the Elrington and John Darling Collieries. Elrington, operating on the Maitland coalfield, mined high volatile coal and John Darling operated the Newcastle or Upper coal measures to win a coal suitable for conversion into coke in the modern by-product coke ovens. In this period, a battery of 106 new coke ovens was built of the Wilputte design with a by-products plant. This extension consisted of No. 1 and No. 2 batteries of coke ovens. Because of the Depression, they did not come into use until 1931 for No. 1 battery and 1933 for No. 2 battery. In 1934, the merchant, skelp and strip mill was constructed and in 1935, the plate finishing plant, steel foundry extensions and a pig mill. In 1936, the No. 3 ore bridge was built and the blast furnace and coke ovens gas systems were stabilised by the erection of two gas holders. The steelmaking plant was enlarged by the introduction of Nos. 11 and 12 open hearth furnaces and the steel foundry roll shop was added.

Leslie Bradford. *BHP*

Expansion of the plant during 1937 saw the addition of No. 3 battery of coke ovens under construction, the billet and sheet bar mill and extensions to the AC power station consisting of two additional turbo-alternators and a new high-pressure boiler house. The boilers were capable of being fired by blast furnace gas or pulverised fuel, with coke ovens safety torches. The bloom mill electrification was also being planned and constructed, as were wharf extensions and salt-water pumps and pumphouse and No. 13 open hearth furnace. No. 3 battery of coke ovens was completed in 1939 and also, the coal washing plant. During this time, part of the Newcastle design office had been engaged in the layout and design of the Whyalla Steelworks. By 1940, the blast furnace and wharf at Whyalla were completed. To enable coke to be supplied at Whyalla, a coke handling and shipping plant was built at Newcastle. The cold rolling mill was commissioned in 1935 and a box strapping line.

The Chief Engineer of the time, Arthur Hacke, has already been mentioned. Others connected with the early years of the Newcastle Works included W.P. Power, who came to Newcastle in 1917 and was soon General Master Mechanic. By 1922 he was Superintendent of Construction and played a big part in the development of the 1930s. Mr. H.J. Sticpewich joined the Company in 1920 in the master mechanic's drawing office and rose to Chief Draughtsman by 1937. Twenty years later he was appointed Chief Engineer.

Robert Menzies came to Newcastle in 1915 to work on construction of the iron and steel works and in 1917 became foreman mechanic in the Blast Furnace Department. Later he was foreman-in-charge of the outside fitters gang erecting new machinery for the plant. In 1928, he went to Whyalla to supervise construction of the ore crushing plant and on his return became Assistant Master Mechanic, taking over as Master Mechanic in 1937.

Frank Ford began as an apprentice in the mechanic shop in 1923 and in 1937 became Assistant Master Mechanic. During World War II he was in charge of a great deal of plant expansion needed for munitions production. He pioneered the building of barges for the American Army at Newcastle. In 1944, he went abroad in relation to the manufacture of turbine machinery for the Company's Yampi class ships. In 1948, he became Master Mechanic and Superintendent of Construction, a title that was subsequently changed to Superintendent of Engineering Workshops and Construction.

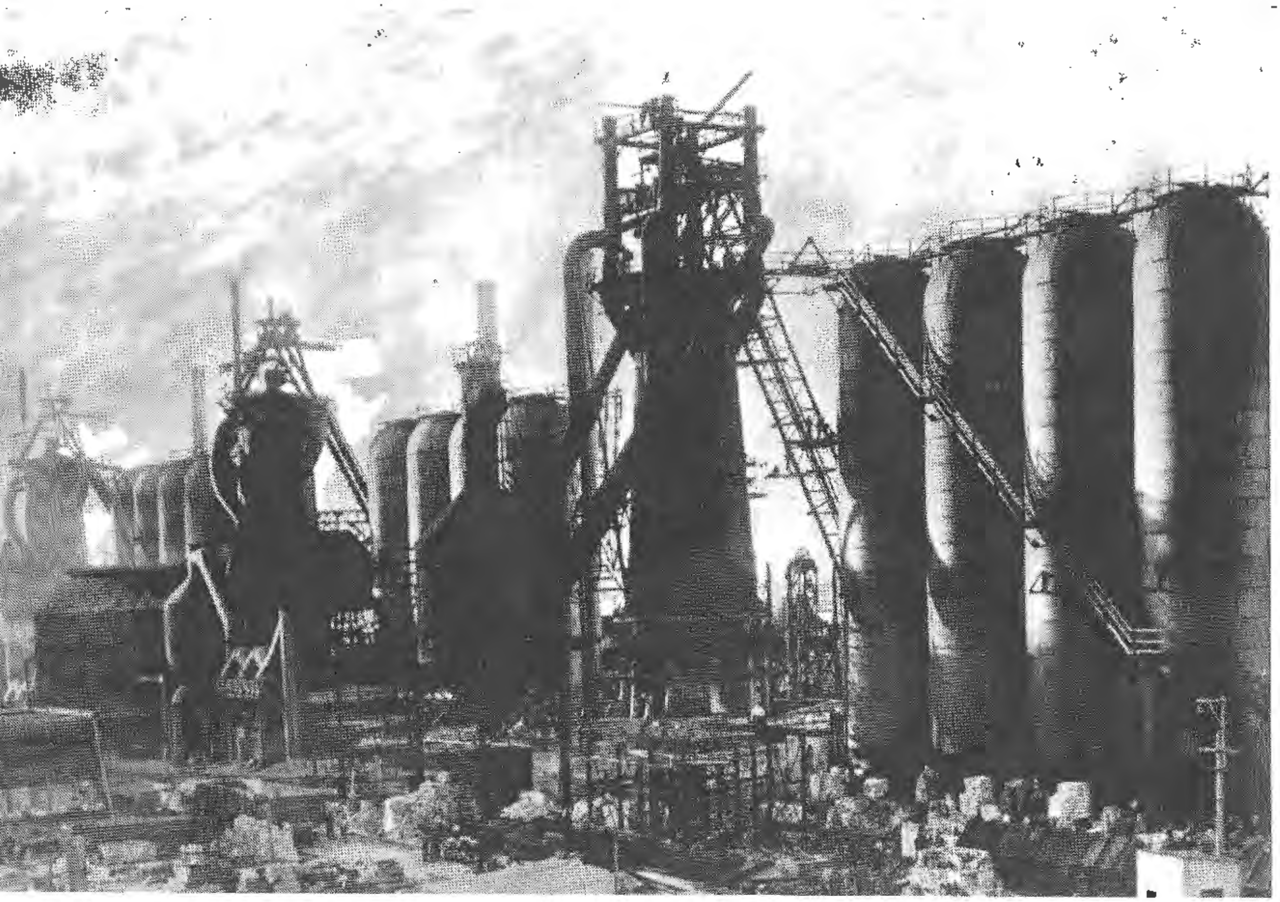
Hugh Ewing Mitchell joined the Company in 1913 as a draughtsman and became Chief Design Engineer, visiting America in 1937 to study operations on behalf of the Company. He was continually engaged in plans for expansion of the steel industry.

W.G. Wileman was Chief Civil Engineer and K.G. Pullen Chief Mechanical Engineer.

In 1935, there was a development of far reaching importance. An agreement was reached between Australian Iron and Steel Ltd. and The

Essington Lewis. *BHP*

Nos. 1, 2 and 3 Blast Furnaces, 1929. *BHP*



The Steel Works constructed many of its own locomotives, like these from 1934. *BHP*

BHP Co. Ltd., with BHP acquiring the whole of the 2,000,007 issued ordinary shares in AIS, which was manufacturing iron and steel at Port Kembla. This Company had been formed in 1928 by the Hoskins family, of Lithgow, and other interests. Between 1935 and 1939 a policy of expansion was pursued at Port Kembla, with the result that productive capacity there at the end of 1939 was about two-thirds that of Newcastle. Although AIS was the most important subsidiary acquired in the 1930s, the Company also acquired a number of other subsidiaries with which it had already been concerned financially or supplied basic materials. These included the Titan Manufacturing Co. Pty. Ltd., in 1933, The Australian Wire Rope Works Pty. Ltd. in 1935, Bullivants Australian Co. Pty. Ltd. in 1935 and Commonwealth Steel Co. Ltd. in 1935. The two wire manufacturing companies, Ryland Bros. (Aust.) Pty. Ltd., of Newcastle, and Lysaght Bros. and Co. Pty. Ltd., of Sydney, had been acquired earlier. In addition, a leading part was played during the 1930s with other large companies in the formation of a number of new Australian ventures. These included Stewarts and Lloyds (Aust.) Pty. Ltd. in 1934, Commonwealth Aircraft Corporation Pty. Ltd. in 1946 and The Newcastle Chemical Co. Pty. Ltd. in 1940.

By taking part in these ventures, BHP took an active hand in the further industrialisation of Australia, by which this country gained a major tubeworks, an aircraft factory and a chemical plant based on the by-products of the steelworks. In each case the new company was the first in its field in Australia.

In 1939 an interest was also acquired in two recently established organisations, Rheem Australia Pty. Ltd. and the Wiltshire File Co., which was to lead to their rapid expansion.

The mid, and late, 1930s also saw important developments in other directions. Additional coal sources on the Newcastle fields were obtained in the Burwood and Lambton Collieries. Iron ore deposits at Iron Prince and Iron Baron were developed. There were further additions to the fleet in 1936, 1937 and 1938.

With steelmaking capacity now expanding so rapidly, a surplus was available to meet the growing demand in East Asia for Australian-made steel. Markets appeared in what were then The Netherlands East Indies, Straits Settlements, Federated Malay States, India, Hong Kong and even Japan. In 1939, the Company opened an office in Singapore in response to the growing interests in its products throughout East Asia. With the outbreak of the Second World War, the Australian iron and steel industry was in a position to make a positive contribution to the war effort. Rapid development of the industry had tremendous significance — the capacity had more than doubled in the 1930's. Australia had developed a heavy industry which, in terms of

During the Second World War small ships were built by several Newcastle industries. This tug was built by the BHP Co. Ltd. for the United States Army in 1943. *BHP*

production per head of population, approached that of the United Kingdom.

The Newcastle Works had reached a high level of efficiency. The Open Hearth Department was matched with pig iron capacity, and the rolling mills were able to handle the expanded flow of raw steel. Coke making was equal to the demands on it. The steady reduction in the ratio of coal used to products manufactured was an indication of the economies resulting from plant efficiency and rationalisation. A measure of the Company's self-sufficiency was the extended workshop facilities which could meet the demands of both Newcastle and Port Kembla. These engineering workshops represented an important war potential as the machines normally used to meet the needs of the Company's own construction and maintenance programmes could produce guns and ships' parts, ammunition and marine engines, build tugs and barges, machine aircraft cylinders and so, in fact, produce many of the weapons of war.

Altogether, BHP's plant had been developed to a point where, in 1939, it compared favourably with modern units in the United Kingdom and the United States. And with this development of the iron and steel works there had been a steady growth in the steel consuming and finishing industries. Castings, forgings, wire and wire products, tubes, pipes, sheets, containers, by-products — all were now produced and were important potentials of Australia's defence effort.

The Second World War

It was typical of the foresight of Essington Lewis, who was Director-General of Munitions and Director-General of Aircraft Production in Australia from 1940 to 1945, that well before the war he had seen the need to establish a munitions and aircraft industry in Australia. After his world tour in 1934 he was convinced that another world war was imminent and that Australia should prepare. One important result was the decision that the steel industry should acquire some experience in the actual business of making munitions. While to some people it still appeared that the important thing was not to offend Hitler, Lewis set about adding to productive capacity at the Newcastle and Port Kembla Works. At the time, shells were produced in Australia only at the Government Ordnance Factory at Maribyrnong, in Victoria. On the basis of the experience of the Ordnance works, an annexe was set up at Newcastle for shell making. The annexe was designed and built from a description only — no plans were available. New lathes were brought, tools and jigs prepared, and, in May, 1938, production of 18-pounder high-explosive shells began. Experience gained in shell making by the Company was to be invaluable when production of shells had to be stepped up to meet the demands of war.

Lewis had other ideas, too. Just as he was convinced of the need for a great expansion of

Frank Ford. *BHP*

steel capacity, so he was convinced of the need for an Australian aircraft for defence. In 1934 he urged the desirability, in view of Australia's vulnerability, of exploring the possibility of manufacturing aircraft in Australia. The idea was taken up and discussed with other companies. Out of these discussions and with Commonwealth encouragement came the formation in 1936 of the Commonwealth Aircraft Corporation Pty. Ltd., which began building at Fishermen's Bend, Melbourne, in 1937. The great war, and post-war, record of this company justified Lewis in every way. On March 27, 1939, the first locally built military aircraft, Wirraway No. 1, made its test flight. During the war, production was widened to include Wackett training aircraft, Boomerang fighters and Mustangs.

Production facilities to assist in the munitions drive were installed at all the steel industry's various plants, where many difficult technical problems had to be solved and new processes initiated. In particular, the successful manufacture of bullet-proof steel was a considerable achievement on the part of Newcastle metallurgists. The alloys required for manufacture of bullet-proof plate were not available in Australia, and could not be obtained from overseas. A substitute had to be developed. Within three months the problem was solved by the use of a local raw material. Magnesium was a strategic material of great importance to the aircraft industry. One year after the Company's specialists had left for the United Kingdom to study techniques, magnesium was being produced in Newcastle.

The manufacture of tungsten carbide was another contribution to wartime engineering. Overseas supplies were cut off by the war and the necessary technical information for its manufacture in Australia was not available. A small team of BHP technicians devised a suitable method of production of this material so essential in precision engineering as a cutting and shaping agent. Very little was known of the process when the small team, whose average age was under 22, was chosen for the task. They had to design their own equipment, their headquarters for a time was a change house at the coke ovens. One step in the process was solved with the aid of a Russian text translated into French and then re-translated into English. A ship bringing a furnace to Newcastle from Whyalla was torpedoed and sunk, adding to the difficulties. By October, 1941, the first successful steel cutting tips came from the pilot plant. The vital project was the responsibility of J.C. "Jack" Richards, Ron Lister, Ken Allen, John Higgins, Eric Wilson, Lindsay McIlwaines, Don Trevillien and Norman Mitchell. Richards had graduated from the University of Queensland as a Bachelor of Engineering and won a Rhodes Scholarship in 1933, gaining his B.A. (Engineering and Science) at Oxford. He designed furnaces for the tungsten carbide scheme. He was Executive Assistant to the Managing Director when killed in a car accident in February, 1969.

The BHP Company's wartime self-reliance was also extended to the manufacture of ferro-alloys — compounds of iron with other metals such as manganese, tungsten, silicon and so on — essential to the manufacture of steel. Australia had been dependent on overseas suppliers for its ferro-alloys, but in view of the trend in international events, the Company decided to produce them in Australia. By November, 1940, ferro-alloys were being produced at Newcastle and another essential link in the steelmaking process was added and the groundwork prepared for a rapid increase in the local production of a wide range of steels. Much special war work of great importance was done by Commonwealth Steel Co. Ltd. and by the wire-making and wire-processing plants.

Newcastle engineers played a big part in planning and expansion work at Whyalla, which occupied a special place in the Australian defence effort. There was an increasing awareness of the danger of concentrating industry on the exposed East Coast of Australia, and Whyalla, as a prospective third centre of the Company's iron smelting, offered the advantages of remoteness allied with continuity to the iron ore deposits. The man-made harbour and cargo wharf were completed by the second half of 1940 and by mid-1941 the blast furnace, modelled on Newcastle's No. 3 furnace, was blown in. The Company had been approached by naval authorities to establish a shipbuilding industry in Australia and the new Whyalla harbour was chosen as the site. During the war, Whyalla shipyard completed 10 vessels with a total deadweight tonnage of 54,324, including four corvettes for the RAN, two Chieftan class ore carriers and four River class cargo vessels. Whyalla also became the site for one of the Department of Munitions annexes, where 25-pounder shell bodies were forged and machined. Later the works' machine shop was enlarged and re-equipped to handle a variety of wartime tasks.

Vulnerability of the East Coast works was highlighted by the shelling of Newcastle by a Japanese submarine on June 7, 1942. Shells landed near the BHP Stores Department and in other industrial areas, but caused little damage. Shop window displays in Hunter Street, Newcastle, during 1941 brought home to the public the uses for Newcastle steel in Australia's armament production. Items included a great variety of machine guns, trench mortars, rifles, bayonets, shells and bombs of various sizes, engine connecting rods, cylinder barrels, engine mountings, Bren guns and tripods, models of Bren gun carriers and air-raid shelters, Vickers guns and mountings, anti-tank gun parts, Gypsy Moth engine gears, ammunition links, steel helmets, percussion fuses and barbed-wire entanglements. Bullet-proof steel plate was displayed, shell gauges, precision tools, aircraft landing gear and various other metal sections in "as rolled" condition as well as other finished and semi-finished articles. Owen and Bren guns were made from Newcastle steels, as were aircraft engine cylinders and gauges for production of engines for Beaufort bombers and Beaufighters.

Production of shells increased to 2,500 and later 3,500 per week.

Women entered the munitions industry. They learned quickly and played an important part in development of industrial processes being introduced at Newcastle.

The steelworks provided materials for Newcastle engineering industry. Forging presses, marine engines, electric colliery locomotives, ship boilers, stern frames for ships, tugs and barges were built in the area. The by-products industry also contributed to defence. Large quantities of coaltar were used to seal airfield

W.S.A. Tayler. *BHP*

runways and roads, toluol was used to make the explosive TNT and refined solvent naphtha and xylol were used in the manufacture of special insulating varnishes to protect shells and mortar bombs. Steel production at Newcastle soared to more than one million tons in 1941, but despite a continuing high demand for steel, output declined. There were manpower shortages and difficulties in transporting raw materials. Urgently needed furnace repairs had had to be delayed. Although a 14th open hearth furnace was added during 1944, production had declined to 830,000 tons by 1945. The immediate post-war years brought an anti-climax: efforts to expand were hampered by critical shortages of coal and manpower. But, by the early 1950s the frustration had been relieved by the mechanisation of most BHP

G.H. Bishop. *BHP*

collieries and the Government's successful migration scheme. The stage was set for an energetic programme of modernisation and plant development. War had its creative forces as well as the destructive ones. Australia emerged from the war with its industrial structure not only intact but also very much expanded. A vast technological advance had taken place, new techniques had been acquired, new industries developed, new resources tapped. These were to provide the basis for Australia's post-war expansion, its transition to one of the more highly industrialised nations of the world. They also made possible the smooth absorption into employment of large numbers of immigrants.

Post World War II

The story of BHP over the 1950s and 1960s is virtually the story of a man who began with the Company in 1933 and had been closely associated with the war-time developments in Newcastle — Sir Ian McLennan. The Depression brought an early disappointment when he graduated from Melbourne University as a Bachelor of Electrical Engineering in 1931. He had hoped to join BHP, but the Company was having its troubles and he went back to University for postgraduate work in mechanical engineering and commerce. A little more than a year later he got his job with BHP as a cadet at Whyalla. In 1935, with three other cadets, he was chosen for special training covering the Company's entire activities. He was appointed Executive Officer at Newcastle Works in 1940, then Production Superintendent and, in 1943, Assistant Manager. Sir Ian moved to Melbourne as Assistant General Manager in 1950 and, of course, ultimately became Chairman of the Company. He received his knighthood in 1963 for "service to industry". These services had begun at Newcastle where he was closely associated with the manufacture of ferro-alloys (1940), tungsten carbide (1941) and magnesium (1941) to ensure supplies during the war. Sir Ian played a big part in the introduction of basic oxygen steelmaking to Australia, a big step when it was comparatively new to the steel industry. The first furnaces, then the biggest of their kind in the world, were installed at Newcastle Works and were in themselves part of the rehabilitation, the virtual rebuilding from within, of the Company's first steelworks. Sir Ian liked to say he was an engineer who left the intricacies of finance to those trained for it, but he played a leading part in negotiations with Victorian and Federal Governments over leases and marketing arrangements for gas and oil.

Sir Ian McLennan. *BHP*

But back to 1950, when a new generation of builders went back to the swamps and mangroves in Newcastle. The Newcastle Works area of 330 acres was overcrowded and there was only one direction in which the plant could expand — westward along the Hunter River. Platt's Channel, a narrow strip of the Hunter River next to the existing plant, was a site which, if reclaimed, would provide land for further expansion. In April, 1950, the BHP Co. Ltd. (Reclamation and Exchange) Agreement Ratification Act became law. Under its terms the Company transferred to the New South Wales Government 337 acres of land owned by the Company, including 293 acres of fine building land at Shortland now occupied by the University of Newcastle, in exchange for 257 acres of Crown land. This comprised mainly Platt's Channel separating Spit Island from the mainland. Spit Island was already owned by the Company and work began immediately to enclose the whole area of reclamation by building an embankment on the northern boundary. In addition, the Company was required to remove an 11-acre bulge on the island to realign the river at that point. This involved pumping on to Spit Island about 200,000 cubic yards of mud and sand by cutter suction dredge.

Executives present when the first load of filling was tipped into Platt's Channel included the Works Manager, A.K. Butler; BHP Chief Engineer, A.K. Hacke; Newcastle Production Superintendent, G.H. Bishop; BHP Chief General Manager, N.E. Jones; Newcastle Assistant Production Superintendents, J.E. Lewis and I.K. Braidwood; Coke Ovens Superintendent, R. Carr; Newcastle Assistant Manager, J.C. Richards; Assistant Chief Mechanical Engineer, W.S.A. Tayler, and Master Mechanic, F. Ford.

Among the more important additions in the 1945-1955 period was a battery of 68 Wilputte by-product coke ovens. These came into operation in late 1954. This unit required capital expenditure of some $8 million and was a replacement for the older No. 2 battery, which by then had been in operation for more than 20 years. It was also apparent by 1955 that the No. 1 battery, which had seen considerable service, would have to be replaced.

In this period, too, there was considerable upgrading of capacity in the blast furnace, steelmaking and steel rolling departments. New materials handling equipment at the wharf, a new turbo blower at the blast furnace plant and further improvements to the blast furnaces themselves made possible a much larger output of pig iron. In the Open-Hearth Steelmaking Department, oil firing was incorporated in furnace heating practice, again with subsequent increases in output. New soaking pits were added to the Bloom Mill Department and the oil-firing of reheating furnaces in some of the rolling mills raised the potential of these units. There were also additions and improvements in the steel foundry, the machine and roll shops and other service departments. As a result of these various efforts, in 1954 and 1955 Newcastle produced record tonnages of ingots and semi-finished and finished steel products, the steel ingots produced being more than one million tons per year.

Throughout the first post-war decade, the Newcastle Works continued to grow in importance as a source of semi-finished steel. The Port Kembla Works, on the other hand, were beginning to take on the shape of a plant where the emphasis in the future would be on the manufacture of flat steel products. In 1955, it was decided to install a new skelp mill at Newcastle. The associated company, Stewarts and Lloyds, needed a much larger tonnage of skelp to meet the rising demand for pipes and tubes. Total cost of the new mill was about $9.5 million. By the end of 1955 construction of the mill was under way. The skelp mill was commissioned in 1958 with a capacity of 500,000 tons and allowance made for this to be increased to 850,000 tons. Provision was made

The retaining built as part of the Platt's Channel reclamation scheme, 1953. Lysaght's can be seen at lower left and Stewarts & Lloyds Pty. Ltd. above it. ***PWD***

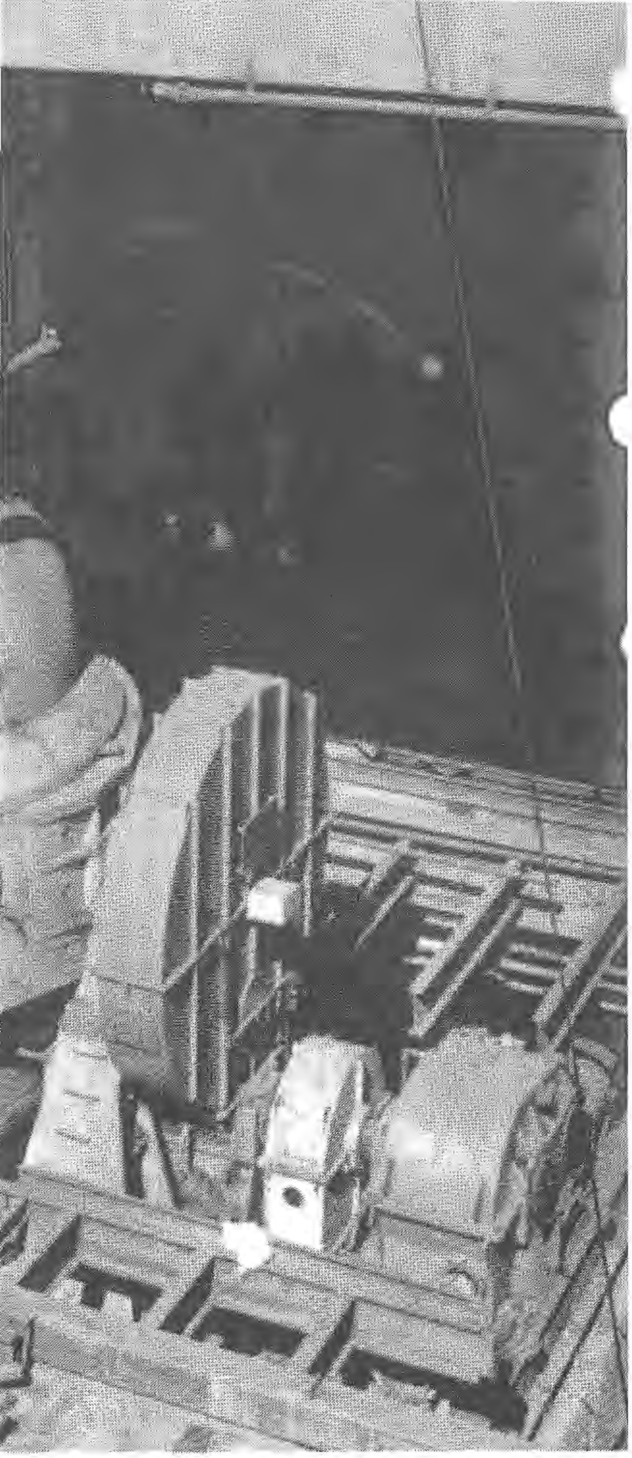
No. 1 BOS Furnace under construction in 1962. This 200-tonne vessel, incorporating a great deal of local design and a construction, brought to BHP Co. Ltd. to the top ranks of world technology. *JA*

for a 10th stand, which has since been added. Concurrently with the erection of the skelp mill, No. 1 battery of coke ovens was being rebuilt. The 57 coke ovens were completed in December, 1957. Additional blending bins were installed in 1956 to provide a suitable blend of coal as feed for the coke ovens. The coal cleaning plant was upgraded.

The need to rebuild and enlarge the blast furnaces had already been foreseen and for use in blast furnace construction works at all centres a special tower crane, capable of lifting 60 tons, was designed at the works. Completed in March, 1957, it was for some time the pride and joy of engineering departments. No. 2 was the first of three blast furnaces at Newcastle to be rebuilt. The hearth diameter was extended and rated capacity increased to 950 tons of basic iron a day. Work was completed within scheduled time at a cost of $2.4 million and the furnace blown in on June 5, 1957. Enlargement of No. 3 furnace to the same size and capacity as No. 2 was begun in January, 1960 and completed in April at a cost of $2.6 million.

A second and much bigger sinter plant was commissioned in 1961 to treat the growing proportion of finer, more powdery ores that were being mined. The machine was the world's third largest, with a weekly capacity of 35,000 tons, and it is highly automated. Until several years after the war, steelmakers throughout the world still used the methods on which the industry had been developed more than 100 years ago. Only the electric furnace had been added to the Bessemer converter or the Siemens open hearth and the former was not adopted in Australia.

In the early 1950s, a new process was developed in Austria — LD steelmaking. It was introduced at Newcastle in 1962 and is now known by the more general name of basic oxygen steelmaking, or BOS. When the technique was evaluated, a new steelmaking plant was designed and constructed at Newcastle. It was a huge concept — new skills were required and buildings and equipment on a large scale. The engineering task was immense. Two 200-ton furnaces were installed. The building was designed in such a way that it could be erected over the original open hearth structure. There were 14 open hearth furnaces at Newcastle in 1962. While the BOS building was under construction, eight of the old furnaces were removed. Steelmaking continued in the remaining six and the remaining portion of the open hearth building contained in the much larger BOS structure. The new plant was built from east to west and required the erection of a large holding bay, almost 400 m long, to enable the changeover to be made without loss of steel production. The holding bay, an elevated rail marshalling yard, was on a level with the charging floor of the Open Hearth Department and enabled cold charges for



the furnaces to be held ready to reduce delays. Commissioning of the new plant increased the capacity of steelmaking at Newcastle to 1.6 million tons per year. The time taken to produce a 200-ton heat in a BOS furnace, from tap to tap, is about 70 minutes. Each heat of oxygen-made steel required about 400,000 cubic foot of gaseous oxygen. To provide these quantities a tonnage oxygen plant with daily output of 420 tons was commissioned in 1962. It was on the newly reclaimed Platts Channel land. With more steel being made it became essential to replace and enlarge a number of production units.

In 1962, a rehabilitation of the bloom mill was done with minimum delay to production. The old unit, which had rolled millions of tons of ingots since being commissioned in 1915, was removed and a larger 44in. mill was installed in its place. A high-speed rod mill was brought into production, also in 1962, in the Platts Channel area. It replaced a mill that had been in service since 1918 and its installation meant that more of the extra steel could be used for rod making.

In 1963, No. 4 blast furnace was blown in to meet the increased requirements of molten iron for the BOS furnaces. Late in 1967, a four-strand, curved mould continuous casting plant was commissioned. This cast billets from molten steel which was produced by an associated 50-ton BOS furnace, commissioned in the same year. The plant supplied billet feed for the huge new merchant bar mill which came into production early in 1968. No. 5 battery of coke ovens incorporating the most advanced features of oven design was commissioned in 1971, replacing the old No. 3 battery.

In the 20-year period from the 1950s, almost $300 million was spent on modernisation and expansion at Newcastle. When the first two BOS furnaces were commissioned with a nominal capacity of 200 tonnes each, they were among the world's largest. Most other BOS furnaces throughout the world were less than 100 tonnes capacity. As production from the new process grew, the remaining six open hearths were phased out, the last furnace being shut down in December, 1965. During the 50 years of open hearth operation, some 31 million tonnes of ingots were made in the shop.

Although plans existed for further expansion during the 1970s, the depressed domestic and overseas demand for steel made it difficult to justify the spending of large amounts of capital.

Newcastle Steelworks turned its attention to up-grading its existing plant when it could be justified on grounds of efficiency or improved product quality. Some major developments took place, notably the construction of a new computer centre, the installation of "no-twist" finishing trains at the rod mill, commissioning of two coke ovens batteries comprising 78 six-metre ovens and the building of the No. 2 bloom and billet mill complex. No. 2 bloom mill is large and modern with an initial capacity of one million tonnes, but designed to allow expansion to three million tonnes a year. Modifications were completed in 1979 to the steelmaking shop to lift raw steel capacity to 2.4 million tonnes per year. Total capital expenditure during the 1970s (to February, 1979) was $195.7 million. Attention to increasing efficiency rather than capacity is continuing in the 1980s.

Newcastle Steelworks is spending about $32 million on new manufacturing processes and quality control equipment to produce high grade special steels and generally lift product quality. This will enable the Works to produce its present range of carbon and special steels to tighter specifications and quality standards and move further into the production of high grade special steels. Main aspects of the plan include the desulphurisation of molten iron before it is delivered to the steelmaking furnaces to give better surface quality to the final steel product, a vacuum degasser to produce internally "cleaner" steel, an in-line billet inspection set-up employing equipment for detecting surface defects and ultrasonic equipment to detect internal defects. There is also in-line equipment to monitor the surface quality of special rounds produced at No. 2 merchant mill. Also in 1982, the Company was spending $6 million on introducing the Tempcore process at Newcastle and Port Kembla to produce a high strength reinforcing bar.

During 1981 it was decided that building a fifth blast furnace on Kooragang Island, across the Hunter River from the present Works, would be deferred. This would have lifted the raw steel capacity of the Works from 2.4 to 3 million tonnes per year. The decision was based on market projections indicating relatively small growth in the Australian steel market for some years.

Subsequently additional pressures from imported steel and increasing cost burdens have further weakened BHP's ability to compete in the export market. The Steel Division had no option than to reduce steel production. After careful consideration of options at Newcastle, No. 1 blast furnace and No. 1 coke ovens battery and the 60-tonne BOS furnace were closed in 1982, reducing raw steelmaking capacity from 2.4 to 2.1 million tonnes. As the market deteriorated, the decision was made later in the year to close another three major production units and to reduce the workforce to 8,000. In March, 1981, the workforce had been 11,550. The level of steelmaking was reduced to about 1.6 million tonnes a year and operations were reduced in departments other than steelmaking.

No. 3 blast furnace was closed down later in 1982, and No. 2 coke ovens battery taken out of service soon after. No. 1 bloom mill and continuous mill closed and also the brick plant and brass foundry. Operations in the direct metal foundry were decreased to supply the reduced need for moulds and stools.

Several investigations were under way when this book went to press, including one by McKinsey and Co., to lift productivity, yields and product quality to improve product competitiveness and ensure that plant development will adequately satisfy future Australian market requirements.

The continuous development outlined in this chapter required the expertise of many engineers for design, installation and manufacture. The Engineering Organisation at the Steel Works is also responsible for maintenance, improvement of production equipment, services and making forward planning submissions to Head Office. These duties account, in all, for one third of the total labour force. Newcastle steelworks is unlike many overseas steel plants in that the rolls used in shaping steel are manufactured on the site, where lime and basic refractories are also located.

The works' rail system comprises 93.8 km of standard gauge track and 6.2 km of narrow-gauge ingot track. This system is used by 27 locomotives, which transport about 16 million tonnes each year.

Two large INM30XX computers are linked to a number of small computers and about 150 terminals. Most of the Bloom Mill operations, from heating phase of procedures in the soaking pits to tracking the progress made by ingots in the rolling phase, are direct-digital computer-controlled.

Of particular community value is the work done by the Combustion Department, which includes an Environmental Control Section. The BHP Co. Ltd. spent more than $46 million to reduce dust and fuel emission and more than $17 million to control water-borne wastes in the 20 years commencing in 1960. A dramatic reduction in fallout was recorded by the Newcastle City Council over that period, despite an almost three-fold increase in steel production. The flow of contaminates into the Hunter River has been virtually eliminated as a result of the treatment and recirculation of fresh water used for dried cooling.

The Combustion Department was formed in 1922 when rising coal prices forced attention to be given to the prevention of energy waste. Mr. Essington Lewis appointed Mr. W.S.A. Tayler as first Combustion Engineer. Mr. Tayler had joined BHP in 1915 as an Engineering Draftsman and before receiving his appointment as Combustion Engineer was Steam Engineer. He moved on to an executive position in Melbourne in 1953. The results achieved by improving the performance of coal-fired boilers and replacing simple steam engines were dramatic. The Combustion Department expanded to take over the detailed control of by-product gas fuels and sophisticated intrumentation, with a continued increase in the efficiency of fuel use. As noted, Environmental Control is now a major activity.

Engineers are also involved in the multi-disciplinary activities of the Quality Control, Works Research, Customer Services and Training and Development Departments.

Right from the inception of the Steelworks, great emphasis has been placed on apprentice and professional training. In 1981, there were 260 degree trainees, 330 certificate trainees and 1,150 apprentices at the Works.

The Steel Works from Kooragang Island at night. *NRL*

SERVANT OF THE PEOPLE
Local Government Engineering

Local government engineers have the difficult task of persuading members of municipal and shire councils to face the facts of life. The ratepayers, as well as their representatives on local authorities, want rates to be low, but at the same time they want to secure better services and amenities. Mr. Eric Brown, retired Maitland City Engineer, put this wryly as:-

"Water won't run up hill, even for Aldermen".

Apathy Of The People

Local government first came to Newcastle and Maitland in 1843, when the Newcastle and Maitland District Councils were incorporated. However, there is little evidence of the councils exercising their powers. In fact, through the nineteenth century the people of New South Wales had little enthusiasm for local government. The Department of Works provided the essential connecting roads and bridges, whilst other State bodies provided the police and magistrates. The Churches, or the State, provided education. Under the Municipalities Act 1858, which provided for the Governor of NSW to incorporate municipalities on receipt of petitions each containing the signatures of at least 50 householders, the town of East Maitland was established in 1858 and Newcastle in 1859. West Maitland (1863) and Morpeth (1865) followed suit - after a great deal of obstruction by some residents. Between 1871 and 1889 eleven outlying suburbs of Newcastle were also incorporated to be combined into Greater Newcastle in 1939.

By early this century the NSW State Government had decided to introduce a general system of local government throughout the whole state of New South Wales, including the rural areas. Large areas of the Hunter Valley were not provided with local government until it was forced on them by the Local Government Acts of 1905-1906. The passage of the Acts for the extension of local government to the unincorporated parts of the state enabled the responsibilities of the Local Government Engineer to be officially laid down in ordinances and regulations. These can be summarized:-

- The control of all technical staff and supervision of works undertaken by the Council. These works can include —
  - Construction and Maintenance of roads and drains
  - Construction and Maintenance of water and sewer facilities, and
  - Construction and Maintenance of community and recreation facilities, such as swimming pools, public buildings;

Newcastle Region Art Gallery 1972 — designed by the Newcastle City Architect, Mr. V. Pile NRL

- The control of engineering and planning aspects of —
  - Land development and subdivision
  - Traffic management
  - Council and private sector building development
  - Flood investigation;
- The control of public services, such as waste collection and disposal and cleansing services.

Until well into the present century the standards of roads, drainage systems and sanitary services in areas outside the major cities did not require the skills of professional engineers; the N.S.W. Department of Public Works was available to carry out major projects.

Role Of The Engineer

Newcastle was an exception. The compilers of this book found evidence of engineers having been appointed to the staff of the old Newcastle Council. The compact little city, hemmed in by drifting sandhills, very steep seaward hills and muddy river flats and bordered by colliery railway lines, experienced difficulties with regard to drainage and roads maintenance. Mr. F.J. Fuller is the earliest City Engineer found in the archives. He is recorded as being in the position in 1879. Mr. John Sharpe C.E., the engineer from 1884 to 1906 was the first to possess professional qualifications.

There are no records of local government engineers in the Hunter Valley prior to 1906, and not many before 1920. In 1906 the Local Government Act first stipulated that these officers must have formal qualifications. Included in the requirements was success in a written examination, as well as approved experienced in the local government field.

To meet the increasing role of the Engineer prescribed in the Acts of 1905-6, the Local Government Engineers' Association of N.S.W. was formed in 1905 with these objects:

- To uphold and improve the status and protect the interests of those persons entitled under the law for the time being in force to occupy the position of Engineer to a Shire or Municipality.
- To insure to members reasonable working hours and conditions with a proper and sufficient reward for their work and to guard them against any hardship in the conduct of their professional duties.
- To consider and deal with all matters affecting the professional interests of Local Government Engineers, *interse,* in relation to other Local Government officers, their employers and the public bodies on whose behalf members' services are utilised.

The first ocean shore amenity — the Bogey Hole, constructed by convicts about 1820. IS

Above: Merewether Baths (50 m by 110 m). Work was commenced on the construction of the baths to provide work for the unemployed in the Depression. *IS*

Above Right: Maitland Baths in 1940. This was the first Olympic Pool in the Hunter Region. *JA*

Below Right: The seawall between Newcastle South Beach and the Bogey Hole. *IS*

- To secure and regulate such technical and other assistance as may be necessary.
- To provide recreation for members.
- To uphold and improve the status and protect the interests of those persons who having entered upon an approved course of instruction with the object of obtaining a Local Government Engineer's certificate are employed by a Municipal, Shire or County Council.
- The advancement of applied research and development in the field of Local Government engineering and the interchange of technical knowledge.

A Hunter Valley Branch of the L.G.E.A. was formed in 1977; Mr. Ivor Allomes, Lake Macquarie Ship Engineer, was Chairman and Mr. R.A. Lee, Maitland City Engineer, was Secretary.

The council engineer's principal tasks are unspectacular ones — maintaining, extending and improving roads and drainage within the available income and ensuring that wastes are safely disposed of. The Councils of the Upper Hunter, Gosford and Wyong are also responsible for water supply and sewage disposal.

Moreover, the work can involve battles with the elements. In Maitland and Singleton, after the big floods of 1949 and 1955, help was needed for the immediate clean up. Assistance was given by members of large, effective teams of coalminers who could not work because of flooded rail-links to the pits. Nevertheless the municipal engineers were faced with years of work restoring badly damaged roads and river banks.

Down came a few trees. A main road entrance to the city has succeeded them. *IS*

Floods have sometimes *assisted.* It is reported that West Maitland Council many years ago let a contract to cut a new channel between two bends in the Hunter River. The contractor started the work, which was interrupted by a flood, which, in turn, completed the job. The contractor considered that he should be paid for the full job, but the Council disagreed, maintaining that he should only be paid for the work he had actually performed. The dispute was referred to the Court, which found in favour of the contractor.

Battles With Cyclones and With People

Greater Newcastle was constituted by the State Government in 1939. The City of Newcastle was united with Adamstown, Carrington, Hamilton, Lambton, New Lambton, Merewether, Stockton, Wallsend, Wickham, Waratah and parts of Tarro and Lake Macquarie shires.

Stockton and Merewether served the public with beach amenities. The water playground of Merewether Baths was built for a very low cost as a relief work job in the Great Depression. Acting thriftily, Merewether Council used the excavated rock as base material for roads.

Newcastle has kept the Bogey Hole available to the public. This pool was convict-excavated for Major J.T. Morisset, Commandant of the convict settlement from 1818 to 1823, about 1820. The Ocean Baths was built in 1922 to replace the old Soldiers' Baths, roughly enclosed by rocks at a point slightly north of the baths.

Since the Forties swimming activities have moved inland with the construction of an increasing number of Olympic pools.

The sea has created many problems. In 1931 the Newcastle Engineer, Mr. L.J. Price, had the sea-wall under construction for the road connecting Newcastle South Beach and the Bogey Hole when heavy seas and torrential rain brought down a seven-metre section of newly-poured wall. The road was restored and has served well since.

Heavy seas attacked North Stockton Beach in 1951. The resultant erosion removed part of Mitchell Street and came within 35 feet of private property. In an emergency operation, all available supplies of rubble and the like were marshalled so that the sea might be held back until more effective measures could be constructed.

Given technical assistance by the Department of Public Works and the Soil Conservation Service, Newcastle City Council put dune stabilisation works over a length of Stockton Beach in hand to provide security against further attack by the sea. A similar thing happened at Merewether Beach in 1974: part of the beach was completely denuded of sand. The application of coastal engineering theory and experience resulted in approval being given for the construction of a stone wall right along Merewether and Dixon Park Beaches. By this means the restoration of the beach was reasonably assured and protection against further sea attack was maximised.

The construction of roads within cities in New South Wales is partly funded by the Department of Main Roads. However, construction, and, generally much of the design, of such roads is the responsibility of the Council's engineer. The Industrial Highway and Newcastle Road, Wallsend, are examples of the use of local authorities in road making. As Mr. L.M. Grayson, Newcastle City Engineer noted:-

> *"The work of the municipal engineer is forever in the public eye. His value judgement of what is best in the general interest will not necessarily gain initial public support".*

Very few citizens seem to be able to visualise a completed construction project. The broad, divided road section linking Croudace Street Lambton and Jesmond was built by Mr. J.G. Baddeley, City Engineer, Newcastle 1947-72 when the opportunity arose to obtain the land for the Southern pavement. For many years it was known as Baddeley's Folly. Finally the whole route was completed and its real value could be seen in relation to the whole Newcastle West to Wallsend Highway.

Subsequently there was fierce public controversy over the City Council's proposal to cut down two large Moreton Bay figs at the intersection of Stewart Avenue and King Street in Hamilton South. The City Engineer was required to analyse in detail a number of elaborate alternative plans submitted by citizen groups. Eventually *The Newcastle Morning Herald* on March 7, 1973, headlined **"Engineer's decision confirmed"** following a council meeting which was attended by a record group of protestors. It is the authors' view that few people have continued to disapprove of the removal of the trees, a project which has transformed a seedy park used by circuses and a few drunks into a delightful entrance to the city.

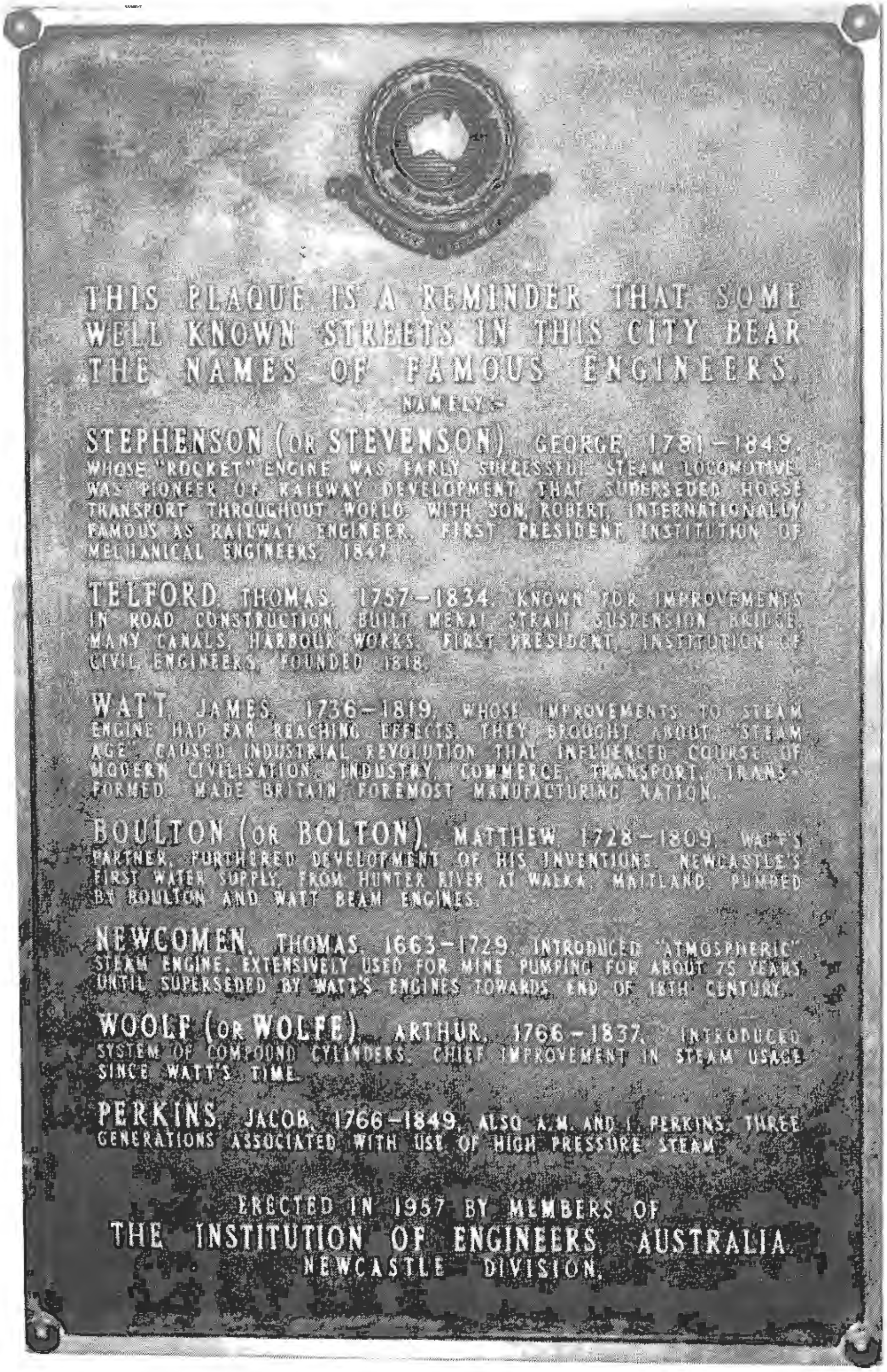
Mr. Ivor Allomes, Lake Macquarie Engineer, had a similar though less dramatic experience as a result of the proposal to establish a 2.2 km long park between Speers Point and Warners Bay on the foreshore of the lake. The work involved the reclamation of a strip 30m to 50m in width with dredged material and land fill. Although sand beaches and car parks were envisaged, the scheme was strongly opposed by some local residents, mainly on account of the earthen mounds shown on the plan. When partly completed in 1982, the scheme was widely praised despite the previous furore.

Newcastle City Council is sufficiently large to have an Architects' Branch as part of the City Engineers' Department. A building which has received praise from its inception is the Newcastle and Region Art Gallery in Laman Street, designed by the City Architect. This is a simple, low cost and very functional building, which is most attractive.

Local government illustrates the high degree of team-work evident in the whole engineering profession. Staff (if any) is allocated according to the normal work load. Large or specialised tasks are accomplished by making use of private consulting firms and Government agencies such as the Department of Main Roads, the Department of Public Works and the Water Resources Commission.

Acknowledgements: Thanks are due to Mr. Ivor Allomes, of Lake Macquarie, Mr. R.A. Lee of Maitland, and Mr. L.M. Grayson, of Newcastle, for providing most of the information used in this article and to W.C. Smith of the Newcastle City Library, for a search in their records of early engineer appointments in the region.

Foreshore improvements at Warners Bay, Lake Macquarie, showing mounds which angered some residents.



The plaque on the old Public Works Department building in Hunter Street, Newcastle, was presented by Newcastle Division of the Institution of Engineers, Australia. IEA

GROWTH OF THE PROFESSION

by Ian Stewart

Newcastle was founded in the great period of British engineering, which had converted England from a predominantly rural land to a bustling complex of large, mechanised factories, linked by railways and canals. The opinions, on any subject, of Stevenson or Telford or Smeaton were more valued than those of members of the Aristocracy and the Administrative Establishment. So it was that Surveyor Henry Dangar, who had his own problems with the Establishment, named the streets of Newcastle, in his map of 1824, for mechanical engineers - Watt, Bolton (Boulton), Newcomen, Woolfe and Perkins. As the city grew to the east Stevenson Place and Telford Street were named for the great civil engineers. Brief outlines of the careers of these men are commemorated in a plaque erected in 1957 on the old Public Works Building in Hunter Street, Newcastle, by the Institution of Engineers Australia.

Through most of the nineteenth century, the engineer was an ingenious, skilled and successful man who made things, including machines and large structures. Formal engineering courses were rare and were not widely supported. The scope of engineering science was limited. This, with the art, was learned by working with skilled craftsmen and senior engineers in a well reputed engineering firm. The engineers of greatest repute were highly sought-after by the students, some of whom reached the Hunter Valley. *Thomas Croudace,* who came out in 1861 to superintend the Scottish-Australian Mining Company's venture at Lambton, was said to have been trained by members of the bridge-builders branch of the famous Stevenson family and to have gained mining experience in the Earl of Durham's mines.

The practice of pupilage was continued well into this century. Even though courses at universities and schools of mines were available, some of the Hunter's leading coalmining engineers of this century were trained by this method. For example, Mr. *Stan McKensey* trained as a pupil of Mr. R.A. Harle, of the A.A. Company at Hebburn Pit with a final period in Durham, in England, where he gained a British Mine Manager's qualification in 1912. Mr. McKensey moved from Mine Manager to Superintendent, to General Manager, retiring as a Director in 1960. Mr. McKensey was a most competent and innovative mining engineer, a man worthy of the great tradition of English engineering.

When senior engineers formed the Institution of Civil Engineers in Great Britain in 1818 it embraced all engineering disciplines. The contribution of engineers to the prosperity and development of Britain through canals, bridges, railways, roads, docks, mills, engines and factories led King George IV to bestow a Royal Charter on the Institution in 1828. The Charter included the definition:

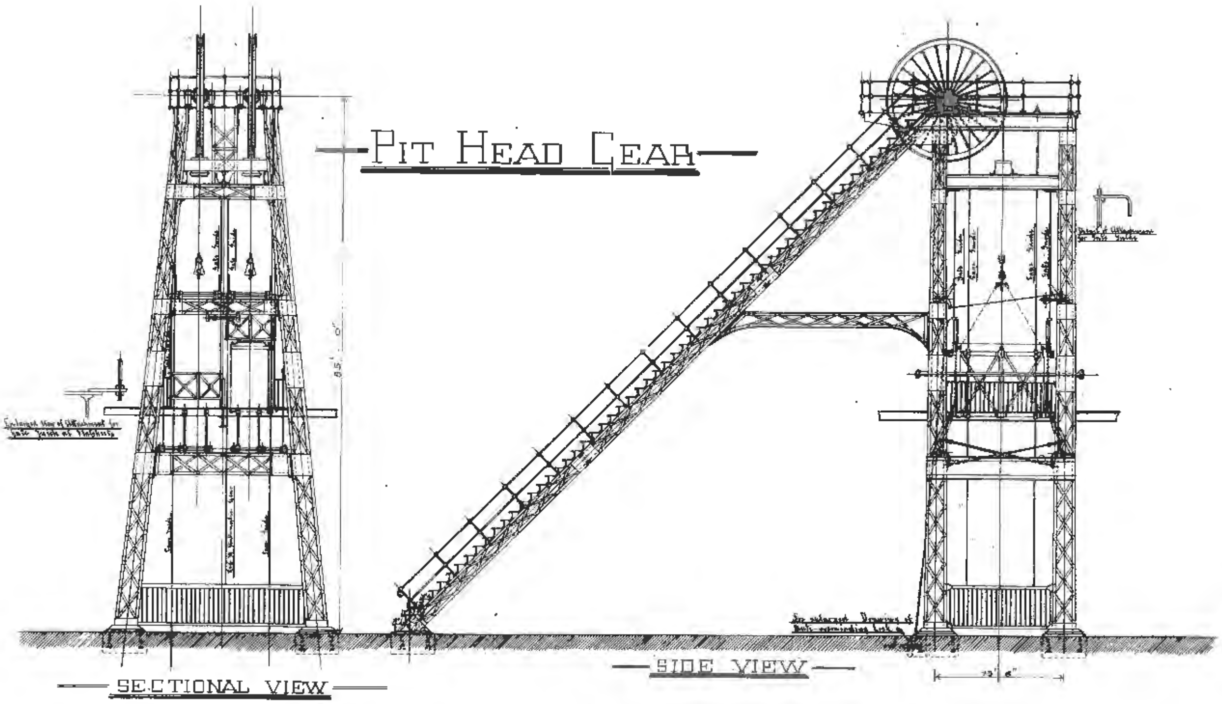
> *THE INSTITUTION OF CIVIL ENGINEERS, a Society established for the general advancement of Mechanical Science, and more particularly for promoting the acquisition of that species of knowledge which constitutes the profession of a Civil Engineer, being the art of directing the great sources of power in Nature for the use and convenience of Man.*

Membership of the Institution (M.I.C.E.) became an accepted indication of professional qualifications. Initially the sole requirement for membership was that the candidate should be acceptable to those who were already members. However, later the Mechanical Engineers, the Mining Engineers and, by the turn of the century, the Electrical Engineers formed independent institutions in Great Britain, each having its own methods of assessing qualifications for membership, including passes in examinations set by the Institutes. For men living outside Great Britain it was not easy to obtain membership of the Institutions. The membership list for the Northern Institute of Engineers in Newcastle (NSW) in 1917 showed only 10 members of British Institutions among its 186 members.

Formal Education in Engineering

The growth of knowledge in the field of engineering science and the increased demand for better qualifications indicated that there was a strong case for formal educational facilities to be provided.

The first lecturer in Engineering at the University of Sydney *Mr. (later Professor) W.H. Warren* gave his first lecture on March 27, 1883 in the Department of Physics. William Henry Warren gave a course which required a year's study in Arts, followed by two full-time years'



The work book of a pupil of Thomas Croudace, showing that fine drawing was considered to be an essential skill. JS

study in Engineering. Students opted for Civil Engineering, Architecture or Surveying. In 1892 a School of Mines was added. Using a bequest from Peter Nichol Russel, in whose works in Sydney several Newcastle engineers had trained, the Faculty was expanded in 1896 by the introduction of a full-time degree course in Mechanical and Electrical Engineering. Engineering courses were by then of four years' duration and incorporated much practical work.

A Board of Technical Education was set up by the New South Wales Government in 1893 to take over, and develop, courses at the School of Arts and to establish Sydney Technical College. Engineering courses were commenced by *Mr. S.H. Cox* (later Professor of Mining at the Royal School of Mines, London). From 1886 professional level courses were offered in Mechanical Engineering and from 1904 courses were offered in Electrical Engineering and Physics. From 1887 candidates were prepared for the examinations of the City and Guilds College of the University of London, but returned to their own examining in 1904. In 1908 *Mr. J.W. Turner,* Superintendent of Technical Education, made a comprehensive survey of both trade and professional training in Europe, Britain and the U.S.A., announcing on his return forthright recommendations for increased attention being given to engineering education.

There was apathy — and even opposition — to the initial introduction of classes and, in 1909, *Mr. Owen Blackett,* Head of the Mechanical Engineering Department at Sydney Technical College, wrote:

> *The term 'engineer' is a vague and misleading one, used by many tradesmen who . . . cannot even explain the working of a steam engine. Such men have the opportunity at the College of gaining a better right to use the name engineer because the study of Mathematics, Mechanical drawing and Applied Mechanics gives them a better insight . . .*

By 1909 a detailed four-level system of professional training had been established. Certificate or Diploma rank was available as a result of

The old Newcastle School of Arts building in Wolfe Street. *NRL*

examination. An Associateship was granted for Honours level work. An Associate with six years experience and a record of achievement in research, or engineering practice, was eligible for Fellowship. The system continued until Diploma courses were taken over by the University of Technology (now the University of New South Wales) in 1951. Many engineers still in practice are proud of their designation, A.S.T.C. (Associate Sydney Technical College).

The Committee of the School of Arts commenced classes in Elocution, Grammar, French and Mechanical Drawing in Newcastle in 1877. As soon as a Board of Technical Education had been set up in Sydney, a deputation representing citizens of Newcastle brought the claims of the Hunter Valley to the attention of the Minister. In 1884 the Department of Public Instruction appointed *Mr. John Pentecost,* Associate of the Royal School of Mines, as Science Master in control of technical classes in the Newcastle District. Classes in Chemistry and Mineralogy were given by Mr. Pentecost and those in Mechanical Drawing, Building Construction, Shorthand and Freehand Drawing were taken by Mr. W. Alsop.

The classes were initially held in School of Arts premises and later in the old Court House in Hunter Street. By 1896 the Technical College and the School of Mines had new buildings in Hunter Street West (still intact). They included a Technological and Natural History Museum.

Coal-mining classes were started in various nearby centres. By 1908 they were being held at Plattsburg, Minmi, West Wallsend, Teralba and Dudley. The Kurri-Kurri and Cesnock mining classes were serviced by a College at Maitland, which commenced from Art classes at the School of Arts in 1885, Mathematics classes in 1888 and Chemistry, Mechanical Drawing and Architectural Drawing classes in 1890.

By 1908 Newcastle had added classes in Applied Mechanics (taught by *Mr. D.N. Morison,* Head of Engineering Division of Morison and Bearby), Geometry, Metallurgy, Mineralogy, Geology, Mine Surveying and Trade Classes in

Technical College and Technological Museum, Hunter Street, West Newcastle, 1896. *NTC*

The old Wood Street Brewery — since 1925 a part of Newcastle Technical College. *IS*

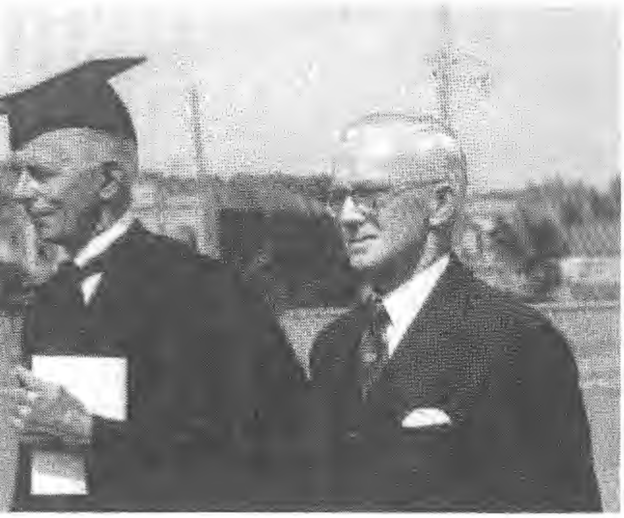
Fitting and Turning, Blacksmithing, Pattern-making, Plumbing, Shorthand, Dressmaking and Cooking. Apparently the only professional qualifications catered for until this time were those for Colliery Managers, (thirty eight certificates having been awarded by 1909), and Chief Engineers (British Board of Trade qualification for Marine Engineers).

The Technical College grew by taking over the old Trades Hall and the Great Northern Brewery in 1915 and the Wood Street Brewery in 1925.

Diploma-level teaching developed slowly. Most subjects were taught part-time by engineering staff from Industry. Until 1932, students had to move to Sydney to complete the course. Prominent teachers were *Mr. Mervyn Hughes,* a Lloyds ship surveyor, and *Messrs. Bert Ley, Stan Lee* and *Clarry Devitt,* from the B.H.P. Steelworks. One student (now an Associate Professor) recalled (in response to a complaint about Devitt's sparse use of the blackboard) that Devitt asserted: "Success is 1 per cent inspiration and 99 per cent perspiration. I'll supply the former, you sweat over textbooks for the latter".

Full-time Head Teachers had been appointed by 1932 for Electrical Engineering Diploma (*Mr. A.S. Plowman*), Metallurgy and Chemistry Diplomas (*Mr. H.L. Baguley*) and Mechanical and Civil Diploma (*Mr. J. Tainsh*) courses. John Tainsh envisaged the growth in demand for technical training and pressed for the development of a new site for teaching engineering courses, rather than the provision of extra buildings at Wood Street. He was doubtless motivated by the fact that some of his classes were held in a rented garage behind the Star Hotel! With strong support from Mr. D.P. Riddel, the Principal of the College, and from local industry, in particular the B.H.P. Co. Ltd., a 22-acre area site on reclaimed swamp at Tighes Hill was acquired. Work on the Edgeworth David Science Building was commenced in 1936, followed up by the John Darling Engineering Building in 1940. Mr. Tainsh's planning ability was recognised by his transfer to the position of Head Teacher of Mechanical Engineering at Sydney Technical College and his promotion to Superintendent of Technical Education. Mr. Tainsh started his career as a Patternmaker's apprentice in Scotland. By study at home he became Leading Hand Draftsman with John Brown's, of Clydeside, and supervised the design of triple expansion engines for six Royal Navy Cruisers. He came to Sydney to the Cockatoo Dockyard to design the engines for the warships

The new Newcastle Technical College, Tighes Hill, in 1940. *NTC*



Ralph Basden, Principal of Newcastle Technical College, with John Tainsh, Superintendent of Technical Education, at the opening of Newcastle University College in 1951. UN

H.M.A.S. Brisbane, H.M.A.S. Adelaide, H.M.A.S. Melbourne and H.M.A.S. Sydney. Later he worked on equipment for Bunnerong Power Station and he commenced full-time teaching in Newcastle in 1930.

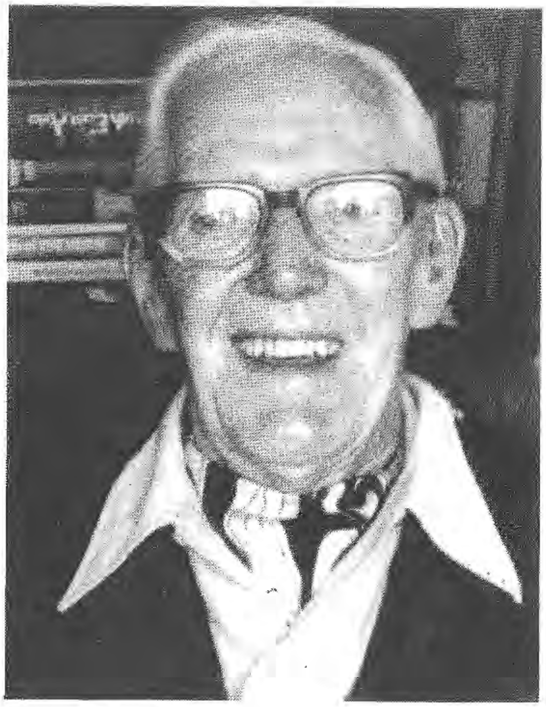
In 1941 Mr. Tainsh was succeeded in Newcastle by *Mr. W.M.S. Gower, M.I.Mech.E.* William Gower served his time with Yarrows, the firm that made marine water-tube boiler-makers in the U.K., and studied under the famous Mr. D.A. Low. After some years at sea as a marine engineer, he became a Designing Draftsman at Cockatoo Dockyard in Sydney and, then, a full-time teacher at Sydney Technical College. In Newcastle, Mr. Gower developed the Mechanical Engineering Diploma into a five-year course. Further, he oversaw the introduction of day-release for students at the Technical College. He became Vice-Principal of the college in 1941. He was Chairman of Newcastle Division of IEAust in 1950.

The Diploma staff accepted the challenge of training returned servicemen. One man apparently came into the examination room with his service rifle. "If those . . . pigeons outside make too much noise I'll shoot the . . .", he is supposed to have said.

The Diploma staff transferred to Newcastle University College of the New South Wales University of Technology when this was established in 1951. The University of Technology shortly became the University of N.S.W. and in 1965 the independent University of Newcastle was formed. From among the original college staff *Eric Betz* and *Kerr Johnston* became Associate Professors of Mechanical Engineering and *Tony Herzog* became an Associate Professor of Civil Engineering at the University of Newcastle. *George Haggerty* became head of the Engineering Division of the new New South Wales Institute of Technology, Sydney, and *Clarry Devitt* accepted the position of Principal of Wollongong Technical College. *Jack Radcliffe* became a Professor of Chemical Engineering at the University of New South Wales.

The Faculty of Engineering at the University of Newcastle is now a distinguished institution with international status. The Foundation Professors are *Eric Hall,* M.Sc., Ph.D., M.Inst.P., Professor in Metallurgy and a well-known physical metallurgist, *Ian Stewart,* M.E., S.M., F.I.E.Aust., F.I.E., Professor in Chemical Engineering, who built up a postgraduate school with a specialist reputation in pulverised coal combustion, *Graeme Jameson,* Professor in Chemical Engineering who succeeded Professor I. Stewart and who made a name for himself in the United Kingdom, *Rupert Valentine,* who became Dean of Engineering at the University of New South Wales, *Frank Henderson,* M.Sc., F.I.E.Aust., M.I.C.E., who was well-known for his work on river and stream flow and introduced a Surveying degree course in his Department of Civil Engineering, *Alan Carmichael,* Ph.D., A.S.T.C., F.I.E.Aust., F.C.Mech.E. Professor of Mechanical Engineering who became President of the Hunter District Water Board, *Alan Roberts,* Ph.D., A.S.T.C., F.I.E.Aust., who followed Professor Carmichael

W.M.S. Gower. OG



Professor J. Roderick, President of the Institution of Engineers, Australia, lays the foundation stone of the Faculty of Engineering Building at the University of Newcastle in 1969. Also pictured are (from left): Sir Alistair McMullin, Chancellor of the University, Professor J.J. Auchmuty, Vice-Chancellor, Professor A. Carmichael, Dean, and Brigadier J.M.C. Corlette, Honorary Doctor of the University. UN

and is internationally known for his work on handling bulk solids, and *Brian Anderson,* B.Sc., B.E., Ph.D., F.A.A., F.I.E.E.E., F.I.E.Aust., who is a brilliant specialist in control systems and introduced a Computer Engineering course to his Department of Electrical Engineering. The Faculty had an enrolment of 763 students studying for the B.E. degree and 79 postgraduate students in 1982.

The Profession Organises

In the Hunter Valley engineers began to organise themselves in 1889. On April 8 a meeting chaired by *Mr. H.J. Brown,* who was President of the School of Arts, determined, "to establish an Institute of ... Engineers ...". Of the 35 who attended the inaugural meeting, 21 were Mining Engineers. Membership was defined as:

> *... persons engaged in mining, civil or mechanical engineering, or architecture or some kindred profession or persons of known scientific attainments or other persons having or taking an interest in such matters of whom the Council may approve. Honorary members shall be persons who have distinguished themselves by literary or scientific achievements ...*

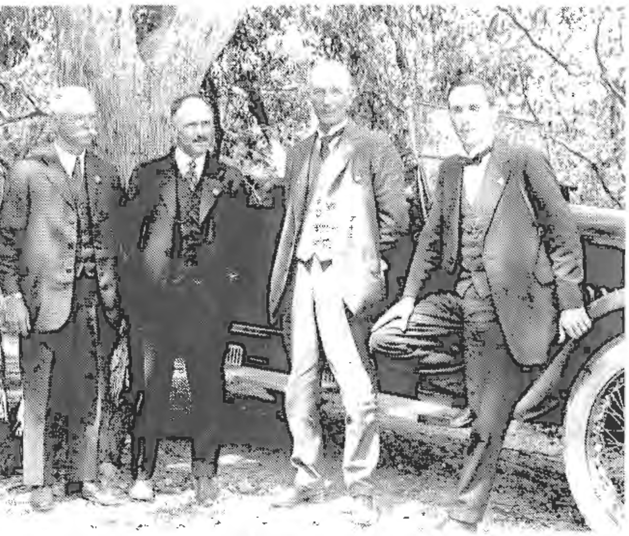
The closing words of the Chairman's inaugural address of 1890 might well be taken to heart by current members:

> *The reading of a paper will not only be a benefit to the audience but also to the reader or speaker... proposers of novel suggestions may have new light thrown on their schemes ... Students who have met difficulties in the course of their reading may have these removed by the explanations or reasoning of their experienced seniors.*

Eighty members, 11 honorary members and three students had by June, 1890, been enrolled together with a committee: President, H.J. Brown; Vice-Presidents, J. Dixon and A. Ross Jr.; Secretary, A.H. Clapin; Treasurer, T.L. Bates; Council, A. Gardiner, R. Morison, W.A. Smith, Jos. Croft, P. Bennett, J. Pentecost, J. Robison and W. Alsopp.

In the first two years the following papers were among those which originated in Newcastle:

A History of Newcastle's Industrial Development, *H.S. Brown.*



Members of the Northern Institute visit Adelaide. On left — W.A. Smith and D. McGeachie. *WMcK*

Testing and uses of cement, *W.A. Smith.*
The Paddle Vandervelde fuel economiser and smoke consumer, *Gardiner.*
Our coal fields, *Dr. Robertson.*
Colonial Timbers.
The Newcastle Electric Light Installation, *J. Robison, M.E.*
Colliery Ventilation, *W. Rensie.*

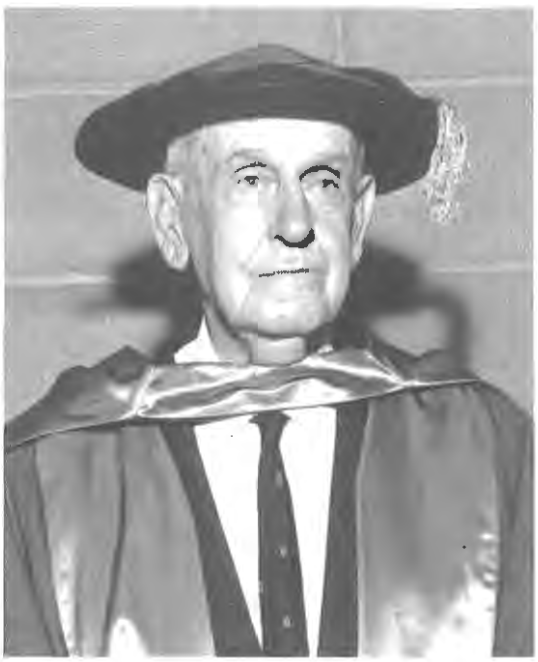
Professor Edgeworth David was elected an Honorary Member in 1890. The activities of the Institute lapsed during the depression of 1894. However, in 1908 the Institute was reformed, largely as a result of initiatives from *Mr. D.N. Morison* and *Mr. H.G. Trenchard,* enthusiastically backed from the mining side by *Mr. W.R. Pulver,* Civil Engineer and Chief Surveyor for the A.A. Company. Monthly meetings were held and a library was established for members to use. There was apparently a tremendous interest in papers presented by local members on a wide range of problems and achievements. A frequent note in the transactions is "Discussion was adjourned and will be continued at the following meeting". It was — and the meetings were held on Saturday nights!

An indication of the keen spirit of the group is that in 1915 and 1916 papers, written by *Major J.M.C. Corlette,* then on active service overseas in the A.I.F., were presented, and published. Major Corlette was in the Engineer Corps. One of his papers dealt with military bridge building in Egypt using lattice girders (like the Bailey bridges of the Second World War). The other was concerned with floating barrel jetties, which were built on ships for use at Gallipoli. "Monty" Corlette, born in 1880, graduated in Civil Engineering in the University of Sydney and joined the Hunter River Water Supply and Sewerage Board under Henson. He enlisted in the Engineer Corps and returned in 1919 with C.M.G., D.S.O., V.D., Chevalier de Legion d'Honeur. "Monty" rejoined the Board and became Chief Engineer in 1925. Thus he was able to complete the Tomago Water Supply Scheme, initiated by Mr. Henson.

Brigadier Corlette is remembered with admiration and affection by all who knew him. Engineering staff recalled how he required investigations to be very thorough; the whole range of technically feasible solutions needed to be assessed, long-term costs had to be determined and there was no alternative to a concise summary of advantages and disadvantages. He continued his Army associations through the Reserve, commanding the 2nd Division of the Engineer Corps and later the 1st Infantry Brigade. During the Second World War, as Brigadier Corlette, he was briefly Commandant N.S.W. He returned to the Water Board in 1944 and retired in 1945.

Brigadier Corlette was Chairman of Newcastle Division of the Institution in 1927-28. He was the first of two Newcastle members to become President of the Australia-wide Institution (in 1930). He was awarded the Warren Prize for the Institution in 1945 and the P.N. Russell Award in 1946. A lean, sparse man with a quiet sense of humour, he was a great tree lover and was mainly responsible for the beautiful plantings of trees and shrubs around Chichester Dam. He was

Brigadier J.M.C. Corlette, Hon.D.Eng. *UN*



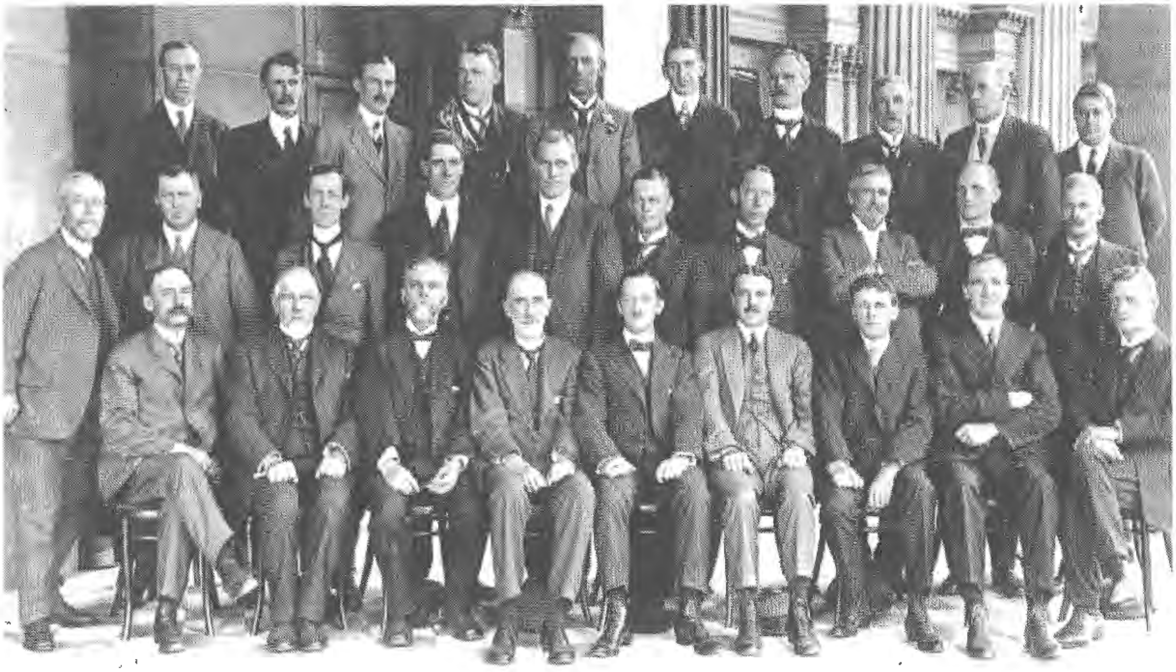
proud of the fine line of paper-bark ti trees alongside the canal at Newcastle Technical College. He selected this species because "they liked salt water near their toes". To save the Moreton Bay figs in Maitland Road, near the College, he battled publicly and told with a chuckle how he had heard "Tokyo Rose" broadcast "A special message for the people of Newcastle. We Japanese are great tree lovers and will preserve the fig trees in Maitland Road when we are ruling your country".

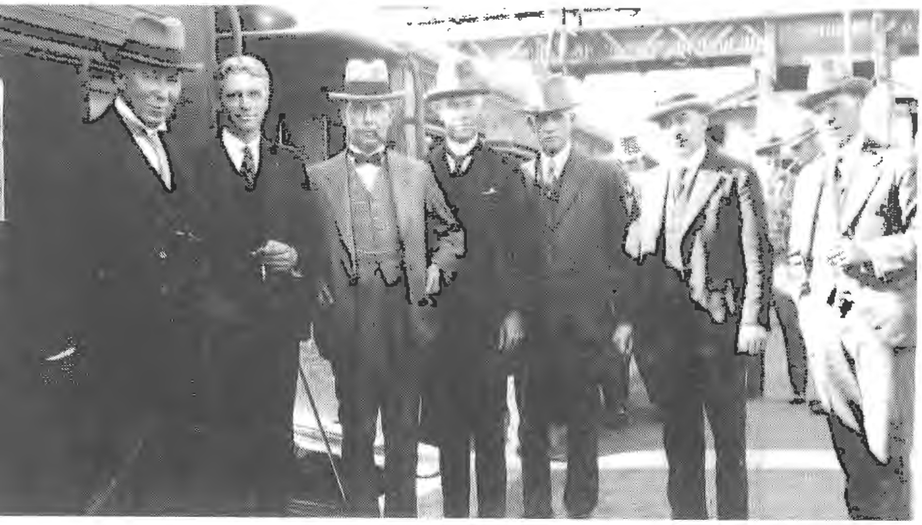
Brigadier Corlette remained till the end of his life a member of Newcastle Division Committee. In this forum his quiet comments were always appreciated. In 1966 he was awarded an Honorary Doctorate by the University of Newcastle and was elected Patron of the Engineering (Undergraduates) Fraternity. Aged 86, chauffeured by Professor Ian Stewart (for mutual protection), he joined in several of the students' beer-drinking functions with gusto. He died in Newcastle in 1969 at the age of 89. The fountain in the Engineering Courtyard at the University was erected by the Newcastle Division of the Institution in recognition of his contribution to the profession.

Another member of the Northern Engineering Institute is credited with taking the first medical X-ray photographs in Australia and being a very early Ecologist. *Mr. Walter Drowley Filmer* was born in Maitland in 1865 and, at the age of 11, was apprenticed to a bootmaker. However, electricity was young Walter's interest and, on completing his apprenticeship, he joined the Postal Department as Assistant Telegraph Line Repairer. In 1884 he joined the Railways Department. He studied Chemistry and Mathematics at the new Technical College. In 1890 Filmer was selected by the Railway Commissioners to make a study tour of Britain to look at developments in electrical signalling and communications equipment. While in Britain he added to his theoretical knowledge, was elected an Associate of Institute of Electrical Engineers, and brought back for his personal use a 10 inch spark coil and Crooks tube. Rontgens discovery of X-rays was described in little detail in the Australian press on February 15, 1896. Within days, however, Filmer had produced an X-ray photograph of his son's hand. He was immediately persuaded by his friend and neighbour, Dr. William Eames, to find a broken needle in the foot of one of Eames' patients. He offered his equipment to the Newcastle Hospital and in October, 1896, with his brother Bert, was made Honorary Electrician to the Hospital. Immediate steps were taken by the hospital to acquire X-ray equipment. He published two papers on investigations on X-ray tube performance.

Filmer commenced teaching at Newcastle

Group of delegates from Australian engineering societies to conference in Melbourne, February, 1918. Front Row: l. to r. A. Farrer, A. McCowan, Jas. A. Smith, Maurice E. Kernot, D.F.J. Harricks, A. McKinstry, G.A. Julius, Professor R.W. Hawken, W.R. Pulver (Newcastle). Second Row: l. to r. A.C. Mountain, W.J. Newbigin, Geo. A. Taylor, J.G. McEwin, J.P. Tivey, T.H. Kirkpatrick, A.E. Burgess, A.S. Kenyon, H.R. Harper, J.J.C. Bradfield. Top Row: l. to r. P.G. Tait, D.L. Stirling, C.E. Wright, H.J. Swain, Professor R.W. Chapman, F. Fairley, J. Vicars, A.G. Jackson, A.W. Tournay-Hinde, Press Representative.





Members of the Newcastle Division of the I.E. Aust. on their way to the National Conference in Perth in 1927. From left to right: B.A. Smith, T.M. Carey, H.C. McKenzie, R.J. Boyd, D.N. Morison, W.W. Robertson, and I.S. Glaskin.

Technical College in Electricity applied to Mining in 1909. A full-time appointment came in 1912, when he added Physics and Applied Electricity to his commitments. He retired in 1930. When he moved out to Lake Macquarie in 1898, Filmer developed biological interests and his contribution to world knowledge of spiders has been recorded. The paper he presented to the Newcastle Division of the Institution in 1920, The Physiography of Lake Macquarie, must surely be a very early contribution to ecological study. During the Second World War he taught Physics to airforce personnel. He died in 1944 at the age of 79.

The Institution of Engineers, Australia

The first definitive move towards a single Australian Engineering Association was a letter dated 1910 written by the newly-formed Western Australian Institution of Engineers to the numerous Engineering Institutes, Associations and Societies in Australia suggesting some form of amalgamation. The concept of an Australian-wide organisation was discussed in various states and, in 1917, a proposal from the South Australian Institute of Engineers for an interstate conference to be held was widely accepted.

From a preliminary meeting of the five New South Wales bodies it was reported, "a great diversity of opinions, some sharp others visionary, . . . were presented at this meeting". These may be gauged from the brief account given in the First Volume of Transactions:

> *On the one extreme were those who considered that a loose federation of councils would effect the purpose. On the other extreme were those who thought that the object could only be properly attained by forming an entirely new institution, outside and independent of all existing bodies. The latter view was supported by several very prominent and influential engineers, their chief reason being that the new Australian institution must be able to command the respect of engineers, public bodies and the general public (both at home and abroad), speak with authority on questions of engineering and raise, maintain, and, if necessary, defend the professional status of engineers (collectively and individually). In order to obtain this high objective, it was considered essential that both the status of membership and the official volume of engineering papers should be as high grade as those of the prominent national bodies of engineers in other parts of the world. It was pointed out that many existing Institutes did not command public respect, in that there were no standards of training or experience necessary for membership, there was very limited grading of members and many full members had an imperfect training or experience, or even one at all and therefore membership was no criterion of professional status. In support of the latter view it was pointed out that many prominent engineers in the Commonwealth had not joined any local body but usually belonged to one of the more prestigious London Institutions.*

To Mr. D.F.J. Harricks, of the Sydney-based Engineering Association, must go the credit "for the energy and tact to successfully effect an amalgamation". The Council of the Northern Institute passed a resolution on 1st February, 1918

"That we, as a Council, accept the three motions passed in Sydney and authorise our delegates to proceed to Melbourne, feeling confident that they will preserve the interests of this Institute".

Later a provisional council meeting in Sydney under Harricks, with representatives of every organisation, discussed a draft constitution. The Northern Engineering Institute was represented by Messrs. D.N. Morison and W.R. Pulver.

By August 1, 1919, 12 of the existing societies had accepted the constitution and the Institution of Engineers, Australia, had come into being. Unfortunately, the Australasian Institute of Mining and Metallurgy and the Local Government Engineers Association of N.S.W. chose to remain independents as non-qualifying organisations. (A branch of the AIMM was formed in Newcastle in 1947 and now caters for most of the Mining Engineers and Metallurgists in the region.)

Organisation of the Institution was to be on the basis of a national Council directing reasonably autonomous Divisions in each State. However, the Northern Institute, based in Newcastle, objected to government from Sydney (as Hunter Valley people often do) and fought, and won, their battle for autonomy on the basis that, with 186 members (plus two honorary members and eight students), Newcastle had many more members than any region other than Sydney or Melbourne. So, Newcastle Division, covering a triangular area from the Hawkesbury River to the Queensland border as baseline and West to an apex near Walgett, was, and still is, the only Division in the Institution not centred on a State (or Federal) capital.

The annual report of the Council of the Northern Engineering Institute of N.S.W. for 1918-19 included:

"The federation of the engineering associations of Australia has now been finalised, and, at the beginning of the new year the Northern Engineering Institute will become the Newcastle Branch of the Institution of Engineers of Australia. The final draft of the constitution of the new Institute was completed on 13th March 1919 . . . Under these new conditions the engineering profession enters upon an entirely new phase, one which should in every way better the conditions for the engineer in Australia".

The problem of requiring strong educational standards for membership and, at the same time,

Unveiling the plaque commemorating Newcastle's street names in 1957. From left: W. Whitford, the Governor of New South Wales, Sir John Northcott, W. Dunphy, and Charles Bastian. NH

incorporating all existing members of founding societies was overcome by the device of admitting all members of founder societies as Associate Members or Students or Graduates. Suitably-qualified Associate Members over 35 years of age became members immediately and, thereafter, professional qualifications were required for admission to corporate grades - Associate Membership and Membership (now Member and Fellow). Professor W.H. Warren, Foundation Professor of Engineering at the University of Sydney and pioneer of the testing of materials, was a worthy first President of the Institution.

From the beginning the Institution has been active both in engineering service to the community and in fostering adequate standards of engineering education. Early activities, in which Newcastle Division took its part, were the development of standard rules for safe electrical wiring and of engineering standards for materials and testing methods. These have now been taken over respectively by statutory authorities and by the Standards Association of Australia, fostered by the Institution.

Transactions were regularly published. A committee to produce a system of qualifying examinations for membership was set up immediately and the first examinations held in 1923. The Board of Examiners had close contact with Engineering Schools and the examinations of approved schools were accepted in lieu of Institution examinations until, in 1964, a system of Accreditation of Courses was formalized and the Institution examinations virtually phased out. The Board regularly checks courses at universities and colleges of advanced education and has played a major role in the development of Engineering education in Australia.

In 1968 the indeterminate title Associate Member — necessitated by conditions at formation — was phased out. All corporate members are now Members and a degree of achievement in the profession is recognised by the title Fellow.

The remuneration of professional engineers, particularly in government departments, was of concern, and considerable pressure was continued by the Institution up to the 1940s to bring this to an adequate level. In the 1940s it became clear that for Arbitration Court purposes a separate organisation was needed and the Institution sponsored the formation, in 1945, of the Association of Professional Engineers Australia for operation in the Commonwealth Court of Conciliation and Arbitration — with great benefit to employee engineers.

Another activity has been the maintenance of professional standards and accreditation of consulting engineers. Codes of practice and of ethics have been continually redrafted and in 1964 a document agreed by the Association of Consulting Engineers Australia brought that organisation also into close association with I.E.Aust.

A later development was the sponsoring of the Association of Engineering Associates. Concern for the development of the high technician level of the engineering support staff by the establishment of such a body was strongly pursued by *Mr. W. V. McKensey* A.M., A.S.T.C., (Chemical Engineering and Industrial Chemistry) Power Superintendent and later Chief Services Engineer at the B.H.P. Steelworks. McKensey was Chairman of Newcastle Division in 1965 and became President of the Institution in 1974. As a councillor of the Institution he was very active on the Board of Examiners of which he was Chairman from 1975 to 1982. Since 1973 he has represented the Institution of Engineers in UNESCO activities to foster Engineering education in developing countries, becoming President of the Association for Engineering Education in South-East Asia from 1979 to 1982. He was President of the Australian Council of Professions from 1974 to 1977.

With the increasing scope of Engineering, branches and technical committees were formed for various specialities. In 1974 the Institution established Colleges in the main branches — Civil, Mechanical, Electrical and Chemical — each responsible for a number of specialist national committees or panels. The system is still developing to maintain an organisation, envied by the British Institutions, in which provision is made for specialised work through the Colleges, while maintaining the unity of the profession as a whole.

Newcastle Division has taken part in all these activities. Regular technical meetings have from time to time, provided a forum for informed discussion of major developmental problems. For example, there were the 20 years' discussion on the need for an integrated electricity supply in this State, which culminated in the formation of the State Electricity Commission, and, more recently, there was a series of significant meetings on developmental problems in the Upper Hunter. National Conferences of the Institution were hosted in 1929, 1947, 1958, 1966 and 1974 and

Opening of the Institution of Engineers, Australia's National Conference at Newcastle City Hall in 1966. From left: Brigadier J. M. C. Corlette, H. Hodson (President of the Institute of Engineers, New Zealand), E. Crawford, Alderman D. McDougall (Lord Mayor of Newcastle), C. Moorhouse (President I.E. Aust.), W. V. McKensey (Conference Chairman), C. Harper (Sec. I.E. Aust.), J. Main (Conference Organiser) and Sir Alan Fairhall, MHR, Federal Minister. *WMcK*

W.V. McKensey at the inaugural meeting of the Association for Engineering Education in South-East Asia, Manila, The Philippines, 1973. On left: H. Nash (also from Australia), on right: Professor F. Juino (The Philippines) and C. Moorhouse (Australia). *WMcK*

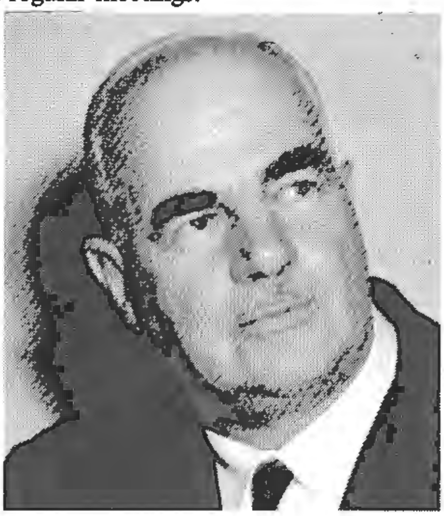
another will be held in 1983.

In 1972 Newcastle Division organised the first National Chemical Engineering Conference jointly with local members of the (English) Institution of Chemical Engineers and of the Royal Australian Chemical Institute. Following this a trend (now widespread in Australia) was pioneered by the establishment of a Chemical Engineering Group supported by all three organisations.

More recently the triennial Award for Engineering Excellence has attracted a number of high level nominations from throughout the area served by the Division. Excellence of design, innovation, workmanship, community service and environmental concern are assessed. The award in 1979 went to the coal loading facilities for Port Waratah Coal Services, designed by Planner, West, Docker and Smith. Particular reference was made to the detailed planning for dust suppression. Two awards were made in 1982:

- the major project award to BHP Central Engineering for the design and construction of the Saxonvale Open-cut Mine and associated plant; and
- an award for small equipment to the Maritime Services Board for "a Realtime wave measurement device" to assist navigation by fast measurement of wave intensity off Nobbys.

To cater for country members, regional groups have been set up for Northern (Tamworth-Armidale), Northern Rivers (Grafton), Central Northern (Kempsey) and Central Coast (Gosford). Branches for Chemical (combined group), Civil, Electrical, Geomechanics, Industrial and Management, and Mechanical hold regular meetings.



A particular concern has been the encouragement of young engineers to associate themselves with the profession through the Graduates' and Students' Branch. Very early, the Sarah Scott Trenchard Prize for a technical paper by a student or junior was established by Mr. H.G. Trenchard, a consultant in metaliferous mining who had been Secretary of the Northern Institute for many years and Honorary Treasurer of the Division for its first 12 years. Described by his colleagues as a "delightful man", Trenchard was Chairman in 1934-35. In 1974, the Scott-Trenchard prize was terminated and a new prize established with emphasis on oral presentation — the Henderson Award in memory of Mr. Ian Henderson (Chairman 1966-67), a senior Electrical Engineer with the B.H.P. Co. Ltd. who, for many years, had most successfully encouraged the Graduates' and Students' Branch.

Engineers of the Hunter District Water Board have throughout been active in the Division. Mr. J.B. Henson (Chairman 1924-25) was the first Chief Engineer of the Board. A man of vision, he had suggested the use of sandbeds for water supply in 1898 and foresaw both the need for storage dams on Hunter tributaries to ensure irrigation water supply and the potential of the eastern slopes of the Barrington region for Newcastle water supply. He was responsible for the Chichester Dam scheme and for initiation of the Tomago Sandbeds project. The group leaders of Corlette's team to develop the Tomago sandbeds water supply, Messrs. Henning, Attwood, Ewing and Jeater, all became Division Chairman as did Mr. Fred Cooksey, Chief Engineer and Board President, Professor Alan Carmichael, who became Board President, and Mr. Mal Hindley.

A number of mining engineers continued as active members of the Institution for some time. Mr. John Fallins, Superintendent of B.H.P. Collieries was Chairman in 1938-39 and Mr. Ian

D. Lyon McLarty. *HVR*

Balks, Secretary in 1955. The many other chairmen, as listed at the end of this chapter, represent a wide range of engineering activity, including two engineering surveyors, Messrs. W.H. Pulver and his son, A.P. Pulver.

After Brigadier M. Corlette, the most distinguished of our chairmen was Mr. D.L. (Lyon) McClarty O.B.E. (1947-48). McClarty trained on Clydebank and after dockyard management in Shanghai was brought out to steer Morison and Bearby through the depression from 1927-37. He left for engineering management positions in Melbourne but was appointed State Director of Engineering and Shipbuilding in 1941 to get the new State Dockyard into rapid operation to meet war demands. A good practical engineer, he was an outgoing man who was equally welcome in the top levels of government and business as on the workshop floor. Older workers at the dockyard recall with affection his interest in the men and their work on his weekly shop inspections. His jovial nature was illustrated when, after a long paper on some water supply system, he was heard to comment in broad Scots, "A verra interesting and illuminating paper indeed. But I canna understand why there should be so much blether about what is, after all, only an adulterant of a good Scots whisky".

Mr. McClarty became a foundation Board member of the Hunter Valley Research Foundation, a member of the University Council and was made a Commissioner of the State Electricity Commission when that formed in 1951.

Acknowledgements

The author is grateful to Mr. Astley Pulver and Mr. Colin Cutcher for information and helpful discussions regarding the Northern Engineering Institute and the Newcastle Division, to Mr. Ken Bridger for detailed information regarding Technical College Diploma courses and staff, to Ms. Julie Young, Technical College Librarian, for archival material, to Professor Arthur Corbett regarding the national Institution and to Mr. A.P. Pulver for early Northern Institute material.

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M. Owen, *"Walter Drowley Filmer; X-Ray Pioneer"*, J1. of College of Radiologists of Australia, February 1965.

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The Committee of the Newcastle Division of the I.E. Aust. with Branch Representatives, 1982. Seated: D. Beverley, Professor E. Betz, N. Robbie (Chairman), B. Johnston, F. Kelley. Standing: P. Moore, J. Gillard, M. Hindley, A. Reid, Professor I. Stewart, J. Edwards, B. Finlay and N. Birt. Not present: T. Roberts, H. Payne, G. Rigby, J. Burgess and R. Gilford. *IEA*

Chairmen of the Northern Engineering Institute

1908 P. Allan
Public Works Department

1909 P. Allan
Public Works Department

1910 A.W. Tournay-Hindes
Sulphide Corporation

1911 J.B. Henson
Hunter Water Board

1912 J.L.C. Rae
Mining Consultant

1913 A. Gardiner
Mining Engineer

1914 D.N. Morison
Engineering Manufacture

1915 H.J. Thomas
Coal Mining Engineer

1916 J. MacKenzie
Chief Engineer, Gas Co.

1917 W.R. Pulver
Chief Surveyor, A.A. Co.

1918 R. Thomas
Coal Mining Engineer

1919 C.A. Sussmilch
Principal, Technical College

During this period H.G. Trenchard, D.N. Morison, H.F. Newman and V.B. Collings were secretaries.

Institution of Engineers, Australia, Chairmen of Newcastle Division

Session	Chairman
1920-21	C.A. Sussmilch
1921-22	W.D. Wallace
	(A.J. Gibson [resigned 14.7.22])
1922-23	C.W. King
	(C.W. King died 20.1.24)
1923-24	D.N. Morison
1924-25	D.N. Morison
1925-26	J.E. McDougall [resigned May '25]
	J.B. Henson
1926-27	W.R. Pulver
1927-28	J.M. Corlette
1928-29	W.E. Clegg
1929-30	W.D. Wallace
1930-31	E.T. Henning
1931-32	A.K. Hacke
1932-33	J. Ewing
1933-34	H.D. Hill
	(J. McGeachie [resigned Oct. 34])
1934-35	H.G. Trenchard
1935-36	A.S. Plowman
1936-37	J.A.L. Shaw
	(D.L. McLarty [resigned 12.5.37])
1937-38	John Fallins
1938-39	John Fallins
1939-40	K.G. Pullen
1940-41	J.W. Webb
	(J.S. Oxnam [resigned 1.11.41])
1941-42	A.S. Campbell
1942-43	A.S. Campbell
1943-44	C.A. Devitt
1944-45	E. Jeater
1945-46	L.M. Allan
1946-47	E.W. Duus
1947-48	D.L. McLarty
1948-49	J.W. Attwood
1949-50	J.H. Mould
1950-51	W.M.S. Gower
1951-52	W. Gibb
1952-53	R.F. McAskill
1953-54	A.P. Pulver
1954-55	G.J. Haggarty
1955-56	E. Woodall
1956-57	R.S. Elsworth
1957-58	W.F. Whitford
1958-59	W.J. Dunphy
1959-60	F.E. Cooksey
1960-61	H.C. Bastian
1961-62	A.E. Rogers
1962-63	J.W. Attwood
1963-64	C.N. Lloyd
1964-65	N.R. Letcher
1965-66	W.V. McKensey
1966-67	I.F.G. Henderson
1967-68	A. Donaldson
1968-69	I. McC. Stewart
1969-70	R.J. Jackson
1970-71	J.A. Church
1971-72	I.D. Moon [resigned 2.8.71]
	G.R. Russell [appointed 2.9.71]
1972-73	A. Herzog
1973-74	A.J. Carmichael
1974-75	G.D. Butler
1975-76	J.D. Gillard
1976-77	E. Betz
1977-78	M.A. Hindley
1978-79	C.J. Melville
1979-80	F.R. Kelley
1980-81	T. Roberts
1981-82	B. Johnston
1982-83	N. Robbie

A mid-1960 view of Newcastle Harbour. *NMN*

One of the Stockton vehicular ferries passes underneath the new Stockton Bridge, which superseded the Newcastle to Stockton ferry service. *DMR*

KEY TO ILLUSTRATIONS

We are most grateful to the people and organisations listed below for having supplied photographs and diagrams and having given permission to reproduce them. They are identified in the text by the key letters indexed below:-

NH Newcastle Herald
NMM Newcastle Maritime Museum Society
NRG Newcastle Region Art Gallery
NRL Newcastle Region Library: Local History Collection
NTC Newcastle Technical College
AD Mr. A.J. Donne
AG A. Goninan & Co. Ltd.
AH Mr. Andrew Hamilton
AP Mr. Astley Pulver
AS Mr. A. Snowball
AWS Mr. A.W. Shoebridge
BHP The Broken Hill Pty. Ltd.; Public Affairs Division
CS Commonwealth Steel Co.
CW Mrs. C. Watson
DEP Department of Environment and Planning, N.S.W.
DM Department of Mineral Resources of N.S.W.
DMR Department of Main Roads of N.S.W.
EC Mr. E. Coulin
GC Newcastle Gas Co. Ltd.
HDW Hunter District Water Board
HE Hexham Engineering
HVR Hunter Valley Research Foundation
IEA The Institution of Engineers, Australia,
IS Professor I. Stewart
JA Mr. John Armstrong
JL John Lysaght Pty. Ltd.
JS Mr. John Shoebridge
NM Miss N. Morison
MSB The Maritime Services Board of N.S.W.
OG Miss Olive Gower
PG Mr. P. Goninan
PWD Department of Public Works of N.S.W.
RO Mr. J. Rodgers
RP Mr. R. Preston
SC Sulphide Corporation
SCC Shortland County Council
SEC State Electricity Commission of N.S.W.
SRA State Rail Authority
UN University of Newcastle (Auchmuty Library)
VA Varley Engineering
WA Mr. W. Anderson
WMcK Mr. W.V. McKensey
WRC Water Resources Commission of N.S.W.

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