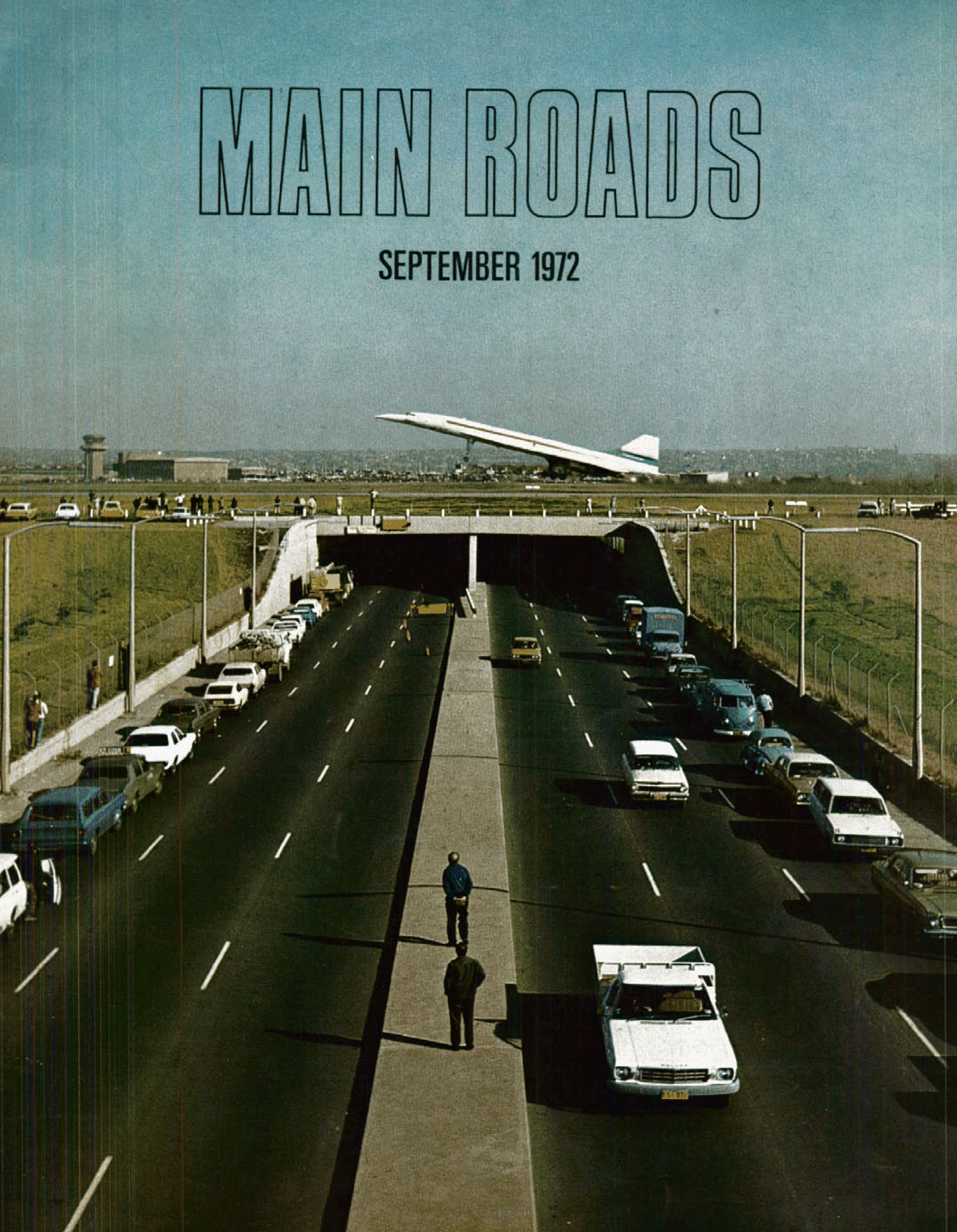
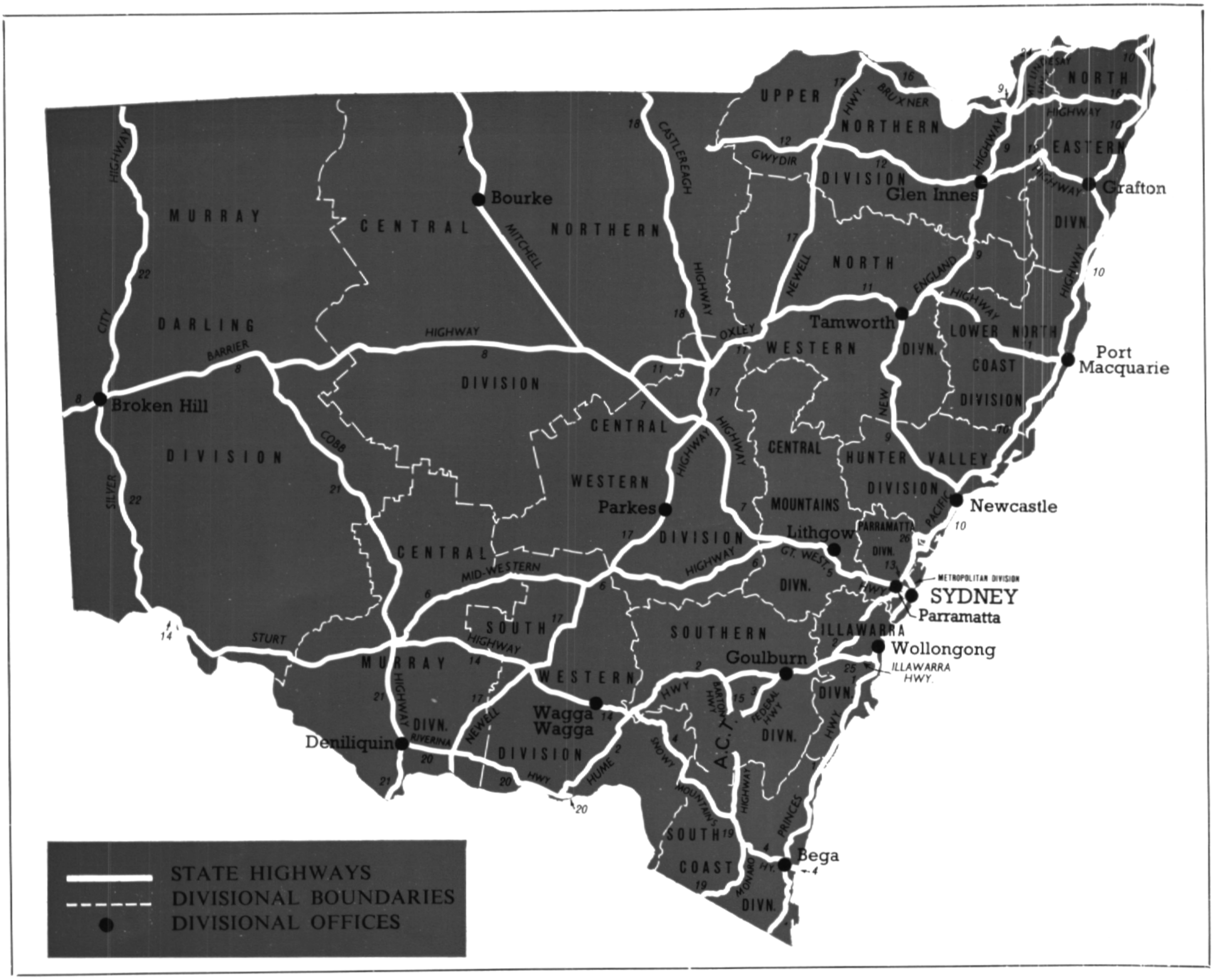
MAIN ROADS

SEPTEMBER 1972





Area of New South Wales—309,433 square miles

Length of public roads within New South Wales—129,745 miles

Population of New South Wales at 31st March, 1971—4,653,000 (estimated)

Number of vehicles registered in New South Wales at 30th June, 1971—2,009,831

ROAD CLASSIFICATIONS AND MILEAGES IN NEW SOUTH WALES

Mileage of Main, Tourist and Developmental Roads, as at 30th June, 1971

Expressways	27
State Highways	6,536
Trunk Roads	4,332
Ordinary Main Roads	11,513
Secondary Roads (County of Cumberland only)	170
Tourist Roads	243
Developmental Roads	2,670
	25,491
Unclassified roads, in western part of State, coming within the provisions of the Main Roads Act	1,569
TOTAL	27,060

MAIN ROADS

JOURNAL OF THE DEPARTMENT OF MAIN ROADS, NEW SOUTH WALES

SEPTEMBER, 1972

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R. J. S. Thomas

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CONTENTS

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Front Cover: Crowds gathered along General Holmes Drive on 20th June, 1972 to see and hear the controversial and spectacularly sleek new supersonic Concorde airliner taking off from Sydney (Kingsford-Smith) Airport for a demonstration flight during its first visit to Australia (An article entitled "Who was General Holmes?" appears on page 25)

Back Cover: "Weight-watching" at the Department's new weighbridge on the New England Highway near Murrurundi (see article on page 8)

UP FRONT

When we think of *pioneers* we generally picture a rugged, bearded individualist, facing the dangers of drought, hunger and heat and submitting to the hardships of living in the lonely, inhospitable outback—in an attempt to establish a homestead and holding for himself and for his children.

This picture is probably true of a lot of last-century settlers and Australians are becoming increasingly aware of the debt owed to the pioneers who cheerfully accepted the challenge of conquering this vast continent—and faced the physical discomfort and the special hazards of being the first to move into many areas.

Nevertheless, we should not presume that pioneering is prisoned in the past. It may no longer be a matter of isolation or deprivation but it still demands the qualities of adventure and perseverance. Neither should it be thought that present day pioneering is confined to the astronauts, physicists and doctors who are widening the frontiers of space, science and medicine. Road and bridge building are not the least of the activities in which pioneering still persists. In the Department's offices and laboratories, and in private research by individual officers, there is constant investigation into new methods of design, construction and administration.

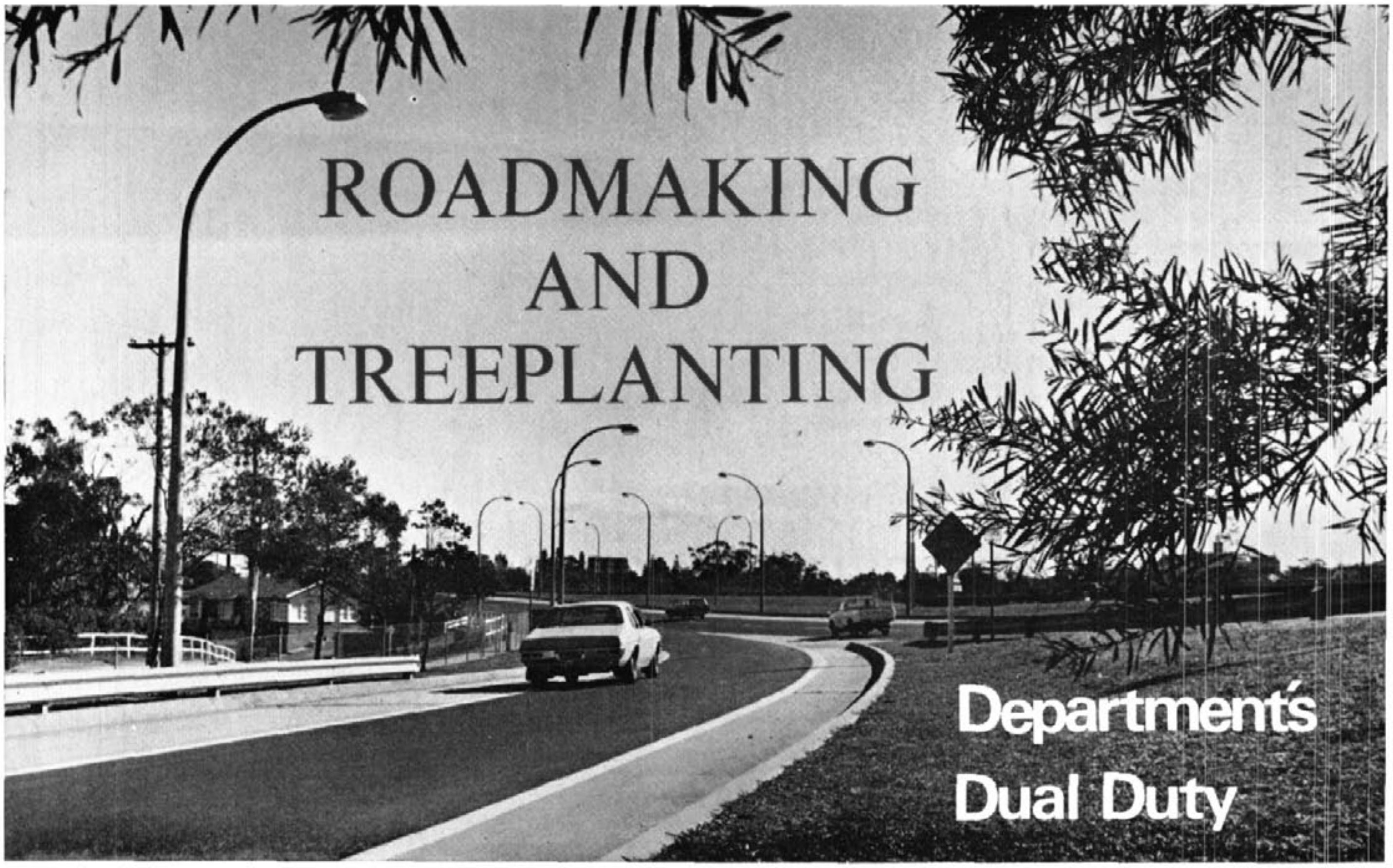
The Department recently pioneered the automated design and drawing of road signs using a computer-plotter combination (see article on page 7) and has *broken new ground* in its changing approach to road design (see article on page 9).

It is interesting to note that road builders were, in fact, the first *pioneers*—for, as the dictionary declares, "pioneer" is a centuries-old military term which originally referred to "one of a body of foot-soldiers marching in advance of an army or regiment with spades, pick-axes, etc., to clear the way and prepare a *road* for the main body".

A current T.V. commercial refers to "Yesterday's Australians" as "pioneers in a young country" and reminds us that "times change but deep down people don't". Today's road builders are still pioneers—and Departmental officers and employees carry out their work with the characteristic perseverance of their colonial counterparts. They tackle 20th century tasks and seek new techniques with traditional tenacity. They accept both the responsibilities and privileges of being *up front*, of searching for new ways and of making things easier for those who follow.

ROADMAKING AND TREEPLANTING

Department's Dual Duty



Framed with foliage—the view looking towards Victoria Road at the northern end of Gladesville Bridge, showing, on the left, the link road from Tarban Creek Bridge

"*He plants trees to benefit another generation*"—*Caecilius. Synephebi*

Quoted by Cicero in De Senectute VII

In work such as the Department undertakes, the disturbance of trees cannot be eliminated, but it can be minimized by replacing trees wherever possible.

In designing and constructing long ribbons of roads, the officers of the Department are particularly conscious of the need to integrate man-made structures into the environment and they acknowledge their responsibility to reduce natural disturbance to a minimum. By "recreating nature" along the Main Roads System of New South Wales, they are extending the Department's long standing policies of roadside beautification.

Older, established trees may be seen as a fitting preview to the State Government's "Grow More Greenery" Campaign, which is currently being sponsored by the newly established Department of the Environment.

On the other hand, the thousands of young trees at present being held at the Department's own nursery at Yennora emphasize that our work is not only for the pleasure of to-day's motorists, but that we are looking ahead and, in a continuing programme, we will go on planting trees "to benefit another generation".

* * * * *

As we drive along through the country, how often do we notice the trees by the roadside? Probably very rarely—but we would certainly notice if there were no trees, only ugly scars left by the construction work of an unconcerned authority.

The planting of trees to heal the almost inevitable scarring of landscape by roadworks is nothing new to the Department. Over the years, it has planted many thousands of trees in an effort to restore natural settings and to beautify the State's Main Roads System.

Prior to 1960, the landscaping undertaken by the Department consisted mainly of planting suitable trees in selected roadside areas. These were usually set out in rows, although group planting was often adopted for aesthetic reasons. Group planting was also carried out, particularly in semibarren areas, because of the support and protection offered by hardy varieties to the less vigorous species during the establishment period.

The pleasant results of these earlier plantings, combined with the preservation of indigenous trees, are now very much in evidence in many country districts in New South Wales.

Nevertheless, fashions change, and landscaping is no exception. Just as yesterday's formal gardens have given way to more casual arrangements, so highway landscaping is changing from regulated avenues of trees to irregular groups (or stands), in an attempt to recreate nature.

In the past, good road design has always acknowledged the need for "elegance" as well as utility in road construction. But now, major road projects are on such a vast scale, and involve such large and potentially destructive items of equipment, that the work of preservation and restoration of natural growth has had to be expanded proportionately to ensure that the roadside environment evokes pleasure and not dismay. Apart from the desire to restrict the disturbance of nature to a minimum, expressway construction and highway reconstruction projects are landscaped for aesthetic reasons—to subdue their bold outlines, wherever possible, and to present a pleasing transition from the "clean-cut" appearance of the road and bridge works to the natural irregularity of the surrounding terrain.

However, expressway and highway landscaping is not merely a matter of aesthetics—or of ecological concern. The planting of trees and shrubs in certain locations can contribute to road safety. The value of shrubs as screens against the glare of oncoming headlights is well known. It is now accepted that trees planted around the outside of curves can assist driver interpretation, while irregular groups of trees can break the monotony of long, open stretches of road and give motorists an awareness of their speed.

Furthermore, distinctive types of vegetation can be effective in drawing a driver's attention to crossings, junctions and narrow bridges, or in assisting him to distinguish roadside amenities, such as rest areas, from the surrounding bushland.

Dense groups of trees can also be used as a background for road signs or as "sighting boards", where approaching traffic has the setting sun directly behind it (particularly on long tangents climbing towards a westerly horizon).

The Department is achieving many good results in its landscaping activities, but this success is not a matter of luck. A great deal of research is undertaken before a single tree is planted, and the overall success of the tree-planting programme owes much to this meticulous attention to detail. The following paragraphs outline some of the ways in which the Department is planning for and proceeding with this increasingly important aspect of its work.

SELECTING THE SPECIES

Particular care is taken in the selection of trees and shrubs for individual areas. Each site is initially inspected, photographed, and soil types and conditions are observed. All trees in the area are identified to enable, as far as possible, the selection of the same or closely related species, so that a natural rather than a contrived effect is achieved.

The selected trees need not necessarily be indigenous to the area, as many introduced species have in time become "native". For example, trees planted in the Goulburn area recently include Yellow Box (*Eucalyptus melliodora*), Blakely's Red Gum (*Eucalyptus blakelyi*), Tasmanian Blue Gum (*Eucalyptus globulus*) and Cootamundra Wattle (*Acacia baileyana*). The first two species are indigenous whereas the second two were introduced many years ago. Nevertheless, these latter trees are suited to the area and complement its other vegetation.

Section of the semishade area at the Yennora Nursery, showing some of the wide variety of trees and shrubs, at different stages of growth. The young plants in the foreground are awaiting Spring "potting-on" by the nursery staff who also undertake weeding, fertilizing and fine-spray watering. Some larger trees, like those in the background, are kept in 9-gallon containers

The Yellow Box is a handsome tree with widespreading drooping, bluish-grey foliage. Its branches are smooth, but the bark on the lower trunk is rough. Growing to about 50 feet in height, the Yellow Box is regarded as the best honey tree of all.

Blakely's Red Gum is an excellent roadside tree growing to 50 feet. Its graceful crown and smooth mottled bark make it very distinctive.

The Tasmanian Blue Gum is a much larger tree, growing to 100 feet in height. With its ash-coloured juvenile foliage, it is very attractive and has been planted extensively on the southern and central tablelands. Closely allied botanically to the Tasmanian Blue Gum is the Eurabbie—a quick-growing tree, rising up to 50 feet and providing good shade.

The Cootamundra Wattle, well-known for its colourful yellow flower, is also fast-growing but is a relatively small tree. Flowering chiefly in August, it grows to around 20 feet and has been widely planted by the Department.

DEPARTMENTAL NURSERY ESTABLISHED

Until recently, the Department obtained trees and shrubs from outside sources, such as the Forestry Commissioner of New South Wales. With the extension of planting on such a large number of jobs, and to ensure there is an adequate supply of young trees to meet its needs, the Department recently established a "plant holding" nursery in one of Sydney's outer western suburbs. The nursery is in Orchardleigh Street (off Woodville Road—State Highway No. 13) at Yennora, near Fairfield, and is adjacent to the Department's Yennora Works Office. The first delivery of trees to the nursery was made in June, 1971.

At this nursery, which occupies an area of 2 acres, plants purchased (by tender from commercial nurseries) at the semi-advanced stage are advanced and made ready for

- transplanting into newly landscaped areas
- filling gaps in older plantings caused by vandalism, or
- replacing losses due to natural causes.

The trees are tended and repotted when necessary into polythene bags or larger containers, using a very lightweight potting mixture to facilitate transportation. The nursery has an automatic sprinkler system which is used both for watering and for leaf fertilization, and a

Plantings along the Great Western Highway near Prospect feature groups of Bracelet Honeymyrtle (Melaleuca armillaris)

"Potting-On"—a perennial task at the Department's Yennora Nursery. Plants are removed from their containers and repotted into larger polythene bags, to allow greater expansion of their roots

soil-mixing machine has been ordered to speed up the "potting-on" of plants and shrubs.

The maximum capacity of the nursery is 30,000 advanced trees and shrubs. At the beginning of the 1971 spring planting season, there were 29,000 trees in stock. During 1971–72, approximately 15,000 trees and shrubs were planted, which is an impressive increase compared with the figure of 4,030 for 1970–71, before completion of the nursery. It is expected that approximately 15,000 trees and plants will again be planted during 1972–73. As a result, the Department is developing into one of the major tree-planting organizations in the State.

There are over one hundred different species of trees and shrubs at the Yennora nursery and most of them are indigenous to Australia. Trees and shrubs are held ready for planting in the Coastal, Tablelands, Western Slopes and Western Plains areas of New South Wales. Their preferred climate, soil type, height and form are taken into consideration before allocation to a specific location. This classification helps in the selection of trees for a particular district and raises the chance of success when the critical time for transplanting comes.

PROBLEMS OF PLANTING

Not all trees thrive in the "coastal" climate at Yennora and, therefore, only a few Western Plains species are held at the nursery. Consequently, trees for landscaping in far western areas are usually purchased from the Forestry Commission just prior to the time of planting. This happened, for example, with plantings along the Barrier Highway near Wilcannia.

As conditions vary so much throughout the State, difficulties often arise over acclimatization of the trees. The weather is of major importance, especially during the period immediately following planting. Although forecasts are checked and studied, sudden and severe changes in the weather, or prolonged periods with too little or too much rain, can result in some losses of trees.

Sometimes, trees are held for some months at the nearest Departmental Works Office, to allow gradual adjustment to the more stringent climatic conditions of the district where they will be planted. As an example, 200 trees are being held at the Department's Works Office at Orange for later planting out in conjunction with new roadworks in that area. It is hoped eventually to establish holding nurseries throughout the State, in order to facilitate close supervision during the acclimatization period, and thereby help to combat the high mortality rate due to extremes of temperature.

Another problem in tree culture is maintenance and this means more than just growing grass under some trees and cutting it occasionally. It means the careful tending of young trees until they are established and it involves watering, loosening soil, fertilizing, and spraying (when required) to protect against pests or moisture-hungry weeds. It means that an extra range of duties becomes the responsibility of the appropriate Works Office in the area.

It should not be overlooked that the cost of treeplanting and of landscaping has to be drawn from available funds and that increased maintenance of pleasant grassed and wooded areas adjacent to Expressways and State Highways requires additional men, machines and money. Maintenance mowing is extensive and time-consuming work and will be the subject of an article in a later issue of "Main Roads".

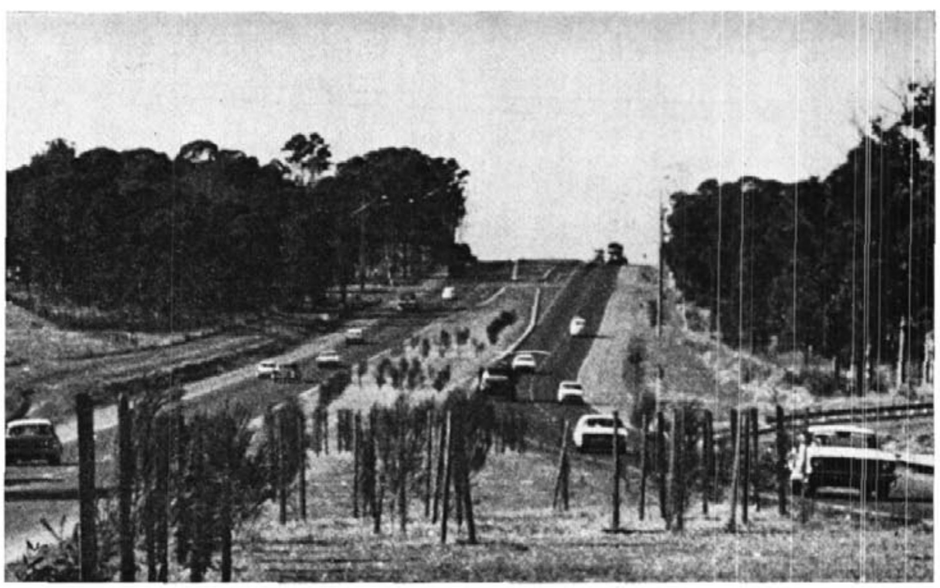
MORE THAN JUST "GREEN THUMBS"

The Department's landscape staff are well qualified and often work in conjunction with the architectural staff. The Landscape Officer holds certificates in horticulture and landscape design. Two Assistant Landscape Officers also hold or are studying for these certificates. These officers act primarily in an advisory capacity on matters of

- tree and shrub selection,
- planting and transplanting,
- and selection of grasses and ground cover.

One qualified assistant is stationed at the Yennora nursery where he supervises the staff of three and is in charge of the day-to-day functioning of the nursery. Administrative matters in connection with Yennora Nursery are the responsibility of the Divisional Engineer at Parramatta, through the Works Engineer at Yennora Works Office, except for the movement of trees in and out of the Nursery and the ordering of replacement tree stocks which are arranged by officers at Head Office.

Recent plantings in the wide median on the Great Western Highway near Prospect



RECENT PLANTINGS

The Department's tree planting and landscaping activities have increased substantially since the construction of expressways commenced. During 1970–71 over 1,300 trees were planted along the route of the Southern Expressway between Mount Ousley Road and Gladstone Avenue, Fig Tree, south of Wollongong. On the Western Expressway, over 3,300 trees have already been planted between St Marys and Regentville—1,800 along the outer roadside and 1,530 in the wide median. In addition, large numbers of shrubs and trees are to be planted as construction work continues. On the Cross Roads–Campbelltown section of the South Western Expressway, almost 800 trees were planted during 1971–72 and a further 800 have since been planted during the current spring planting season. A recent addition to the landscaping of the Sydney–Newcastle Expressway between Berowra and Calga has been the provision during 1971–72 of 150 waratahs.

The State's Highways have not been neglected as the following sample figures show

Hume Highway

- Approaching the new Federal Highway junction (see article on this work in June 1972 issue of "Main Roads" Vol. 37, No. 4, page 99)—730 trees planted in 1970–71, 1,600 in 1971–72 and more to follow.
- Between Boxer's Creek and Governor's Hill—760 trees planted in 1971–72. Further tree planting is proposed north of Boxer's Creek in conjunction with dual carriageway construction.
- Adjacent to Railway Workshops, Chullora—240 screen trees planted in 1971–72.

New England Highway

- Between 13 and 22·5 miles north of Singleton (Liddell Deviation)—3,150 trees were planted 1971–72.
- Between 0·5 and 6 miles north of Guyra —720 trees planted in 1971–72.
- Between 48 and 53 miles north of Tamworth—465 trees planted in 1971–72.

Great Western Highway

- Prospect Deviation—842 shrubs planted in the median during 1971–72 and further extensive planting is proposed.

Mitchell Highway

- Between 24·5 and 29 miles west of Wellington—930 trees planted in 1970–71, plus 90 in 1971–72 to replace those lost through frost.

TOWARDS MAXIMUM PRESERVATION

All trees within main road boundaries have long been protected from interference or removal by workmen of any public authority, except in cases where permission is granted by the Department for necessary work. Twenty-five years ago, this Department, in collaboration with the Department of Agriculture, produced a manual—for its own officers as well as those of Councils and other Authorities—entitled "Preservation of Roadside Trees—Trimming, Pruning and Lopping". This manual has since been revised to incorporate sections on the selection, arrangements and planting of trees and now includes a long list of trees suitable for roadside planting in specific areas (including details of their mature height, recommended spacing and special preferences for soil, position, etc.).

In spite of what is occasionally claimed, the Department is not a heartless "monster" which callously turns a deaf ear to pleas for preservation of our environment. It is as concerned about conservation as many of its critics, yet it has the unenviable and often thankless task of designing and building roads adequate to our expanding motoring needs—as economically as possible, while creating minimum damage to our very precious natural heritage.

Although every effort is made to avoid unnecessary disturbance to trees, ferns, wild flowers or any natural flora, in work as widespread as the Department's, it is unrealistic to suggest that no damage is done. Nevertheless, in each project, the Department endeavours to reduce any unfavourable impact that the roadwork might have on the natural environment and always seeks to find realistic and acceptable solutions to this problem of integration.

Both because of modern road engineering requirements and because of restrictions imposed by adjoining properties, it is *generally* not economically practicable to adjust a road proposal in order to miss a specific tree or group of trees, but, fortunately, *sometimes* it is—as the second of these two typical examples shows.

Firstly on the debit side, in 1965 a large Moreton Bay Fig Tree, previously hidden behind the old Orpheum Theatre at North Sydney, had to be removed before construction of the first section of the Warringah Expressway could proceed.

On the credit side, during 1961–62, when proposals were being considered for the widening of a section of Mona Vale Road at St Ives, the original plan was amended, after local representations, to preserve a large Sydney Red Gum known as the "Boundary Tree", which marked the corner of three old parish districts. (*See "North Shore, Sydney—From* 1788 *to today" by L. G. Thorne—published by Angus and Robertson Ltd in* 1968—*pages* 134–135)

In addition, other plantings have been recently undertaken

- along the Mitchell Highway, between 23·1 and 31·6 miles west of Bathurst,
- along the New England Highway, between 20 and 21 miles west of Maitland, and
- along the Barrier Highway, approaching Wilcannia.

Current spring planting locations proposed include

- the intersection of the Hume and Barton Highways, near Yass,
- the Mid Western Highway, between 4 and 8 miles west of Blayney,
- the Great Western Highway, between 24·4 and 27·1 miles west of Lithgow (Yetholme Deviation) and at the junction with the Mudgee Road (Trunk Road No. 55).

⁂

• *Colour photographs of the Department's nursery at Yennora and of recent roadside plantings are featured on pages* 16 *and* 17.

* *An article entitled "Success and Failures in Roadside Tree Planting—Past Experience as a Guide to the Future" was published in the December* 1950 *issue of "Main Roads" (Vol.* 6, *No.* 2, *pages* 44–52).

* *A reference to "Advanced Trees Transplanted", on State Highway No.* 13, *was included in the September* 1951 *issue (Vol.* 7, *No.* 1, *page* 29).

• *An article on "The Remembrance Driveway" appeared in the June* 1959 *issue (Vol.* 24, *No.* 4, *pages* 117–119).

NEW MINISTER FOR HIGHWAYS

On 19th June, 1972, the Hon. C. B. Cutler, E.D., M.L.A., Deputy Premier of New South Wales, was sworn in as Minister for Local Government and Minister for Highways, to succeed the Hon. P. H. Morton, M.L.A., who has retired from Parliament.

Mr Cutler was born at Forbes, New South Wales, and is a fifth generation Australian. He spent his early life on the land at Forbes and Orange, and completed his formal education at Orange High School.

Mr Cutler is married, and has one daughter and three sons. Prior to his entry into Parliament, he was engaged in primary produce marketing.

During World War II, Mr Cutler served with the Australian Military Forces in the Middle East and was wounded at El Alamein. After the war he continued to serve with the Citizens' Military Forces and retired as Lieutenant-Colonel after a period in command of the 6 N.S.W. Mounted Rifles.

In 1947, at 29 years of age, Mr Cutler was elected to the Legislative Assembly as Member for Orange and was, for several years, the youngest Member of the New South Wales Parliament. He has now represented the electorate of Orange continuously for 25 years.

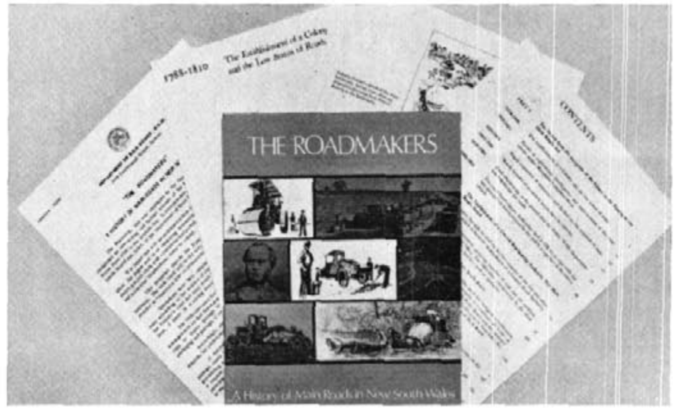
In 1958, Mr Cutler was elected by his colleagues of the Parliamentary Country Party as Deputy Leader, and in 1959 as Parliamentary Leader. In 1965, with the election of the Liberal-Country Party Coalition Government, he became Deputy Premier, Minister for Education and Minister for Science in the Askin-Cutler Ministry. During his service as Deputy Premier, he has acted as Premier on four occasions during the Premier's absence from Australia.

In his capacity of Minister for Education and Science, Mr Cutler piloted through Parliament major items of legislation in the education field, and initiated important administrative changes within the portfolio of Education. These changes included the establishment of the Education Advisory Commission, Higher Education Authority, Universities Board, Advanced Education Board, Board of Teacher Education, Youth Advisory Council, and Ministry of Education. To decentralize administration Mr Cutler also set up Directorates of Education for Central Metropolitan, Liverpool, St George and North Sydney districts. During his term of office, the following institutions were established. The Riverina College of Advanced Education at Wagga Wagga, the Mitchell College of Advanced Education at Bathurst, and Teachers' Colleges at Goulburn, Westmead, Lismore, Lindfield (to replace Balmain) and Shortland (to replace Newcastle).

As Leader of the Country Party, Mr Cutler has always had a vital interest in assisting local government and in improving the State's vast network of road communications. Both in his own electoral work and in dealing with various deputations and representations as Party Leader, Mr Cutler has already given consideration to many matters which have now become his direct responsibility ●

"THE ROADMAKERS"

A HISTORY OF MAIN ROADS IN NEW SOUTH WALES



The Historian who was employed by the Department, Mrs P. A. Griffith, has completed an interesting and factual account of the development of Main Roads throughout the State from 1788 to the present day. It incorporates, of course, the activities of the Main Roads Board and, later, of the Department of Main Roads.

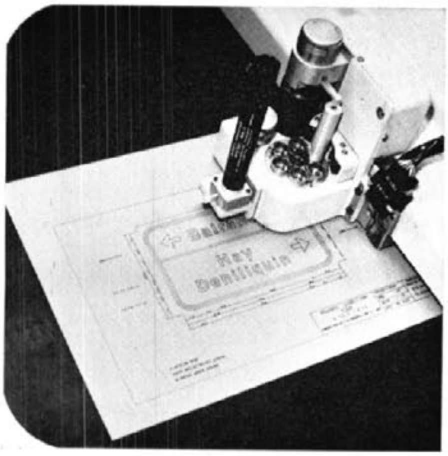
It is hoped that this history will be published in book form by mid-1973. The book will run to about 344 pages, will be of appealing dimension ($11\frac{3}{4}$ in x $9\frac{1}{2}$ in) and will be bound in a smart greyish cloth with a colourful dust jacket. Included in the history will be informative maps and diagrams, as well as numerous illustrations, many of which will be in colour. The publication will be of a very high standard and should be somewhat similar to "Australia 200" in presentation.

Tentative quotations have been obtained by the Department for printing and the costs will vary according to the number of copies printed. If only the minimum quantity is ordered, the printer's cost will be approximately $9.00 per copy, but this could drop to $6.50 or less, if there is a strong demand by prospective purchasers, as is expected.

The Commissioner for Main Roads, Mr R. J. S. Thomas, has been pleased to make arrangements so that interested persons and organizations outside the Department may obtain a copy or copies of the history at actual printer's cost—plus about 60 cents per copy for packaging and postage, if involved.

Pamphlets have been printed to depict the style of the book and to provide a descriptive list of the contents. These pamphlets, together with appropriate order forms, can be obtained by contacting the Department's Head Office or any Divisional Office. When completed, these orders should be mailed as soon as possible to the Secretary.

If desired, this offer to supply "The Roadmakers" at actual printer's cost (plus packaging and postage, where necessary) may be extended by our readers to other persons or groups who may be interested in purchasing a copy of this valuable and interesting book ●



FIRST AGAIN

DESIGN OF ROAD SIGNS BY COMPUTER

The Department has recently developed a computer programme to enable the IBM 1130 computer and the Gerber Plotter combination, located in the Advance Planning Section, to prepare workshop drawings of road signs.

The programme was tested earlier this year in the production of a set of drawings to enable the Department's Central Workshop at Granville to manufacture six direction signs which had been requisitioned by the Divisional Engineer, Goulburn for erection on the Hume Highway at Yass.

After the successful testing, this procedure was implemented on a wider scale and the Department now produces the majority of its routine sign drawings using the automatic plotter. Over 300 drawings have already been produced by this method.

This is the first use in Australia of automation in the design and drawing of road signs and is yet another example of the new time-saving techniques which are constantly being investigated and introduced by Departmental officers.

Following the initial preparation of coding sheets to instruct the computer, each drawing is produced entirely by machine and no hand drawing is necessary. The size of each sign is calculated automatically and the dimensions, scale, date, plan number, etc., are all recorded automatically on each plan.

Using this new technique, each drawing takes approximately 10 to 20 minutes of computer time, compared with 3 to 4 hours of a draftsman's time, which would be needed to produce a similar drawing by hand. The direct costs of computer hire and draftsman's salary are comparable, both being approximately $5.00 to $10.00 per sign.

Each year, the Department produces approximately 15,000 signs at its Central Workshop. As about 2,000 of these signs (being mostly large direction signs) require the preparation of separate drawings, the use of the new computer-plotter technique will speed up this important aspect of the Department's work.

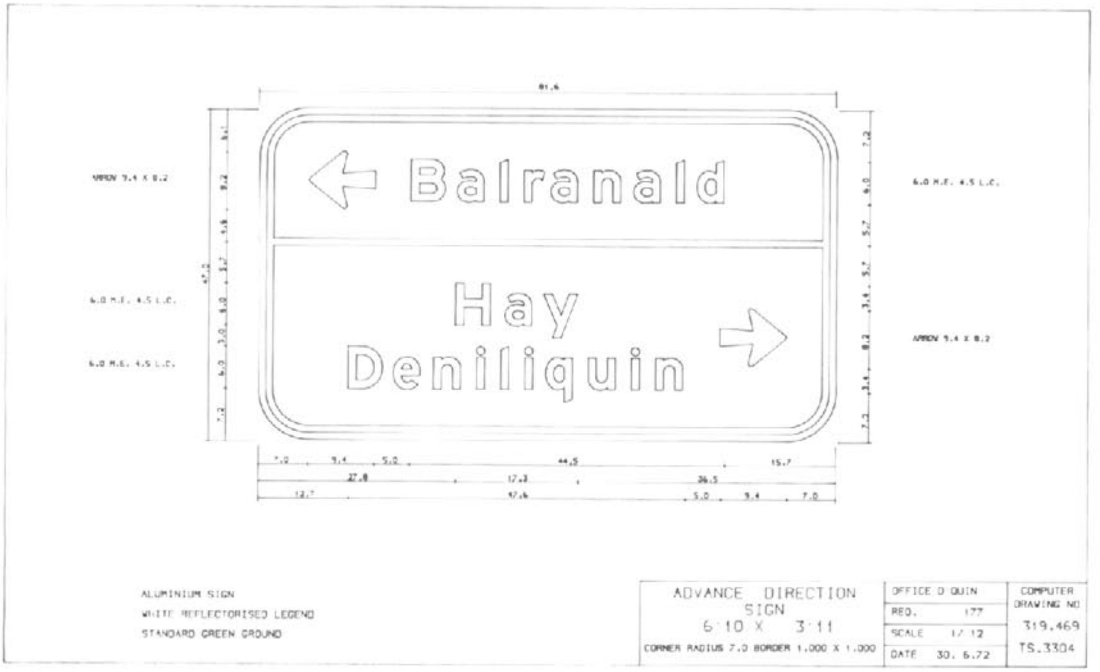
It is hoped to include a detailed account of the computer programme in a forthcoming issue of "Main Roads"●

*

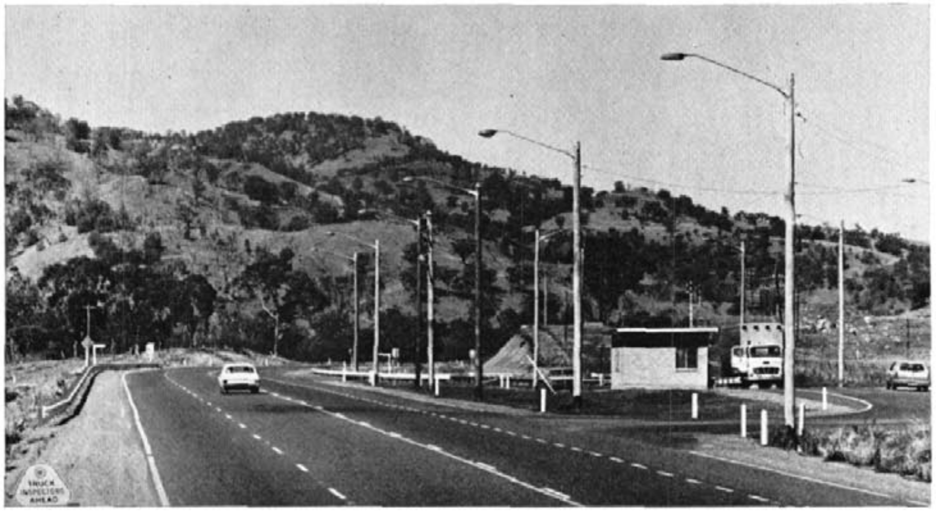
* *An article entitled "Manufacture of Road Signs" appeared in the March, 1967 issue of "Main Roads" (Vol. 32, No. 3, pages 79–81).*

• *An article on damage to road signs, entitled "S.O.S.—Save our Signs" appeared in the June, 1969 issue (Vol. 34, No. 4, pages 120–122).*

• *An article on "Reassurance Direction Signs" was published in the March, 1971 issue (Vol. 36, No. 3, pages 92–94).*



NEW WEIGHBRIDGE ON NEW ENGLAND HIGHWAY NEAR MURRURUNDI



A new weighbridge has been established by the Department on the New England Highway, approximately 7 miles north of Murrurundi, adjacent to the Kankool turn-off. It is a particularly suitable country location because of the heavy volume of Sydney–Brisbane traffic which uses the New England Highway and passes this point. Before completion of the new unit, the Department previously made use of the railway weighbridge at Willow Tree.

Four *Optograph* fully-automatic optical weighbridges, supplied by International Weighing Co. Pty Ltd of Melbourne have been installed at the site near Kankool. Each weighbridge measures 16 ft long by 10 ft wide and has a tested weight capacity of 35 tons. Set end to end, they provide a weighing platform 64 ft long by 10 ft wide with a tested weight capacity of 140 tons. Independent workheads give automatic optical weight readings in decimals of tons. The total purchase price of the four weighbridges was almost $22,000.

Construction work at the site was undertaken by the Department's own forces and included the provision of two 40 ft long concrete approaches to the weighing platform. Work was commenced early in 1971 and the completed unit was opened "for business" on 28th March, 1972.

This large modern weighbridge is one of four now operated by the Department. In the early post-war years, the Department purchased a weighbridge at Hexham and another at Gosford, both on the Pacific Highway. In 1965, the Gosford weighbridge was closed, in view of changed traffic patterns following the opening of an improved route from Calga to Ourimbah (via Peat's Ridge and the completion of the first section of the Sydney–Newcastle Expressway (from Hawkesbury River to Mt White). In 1970, the equipment at Gosford was dismantled, moved to Hexham and coupled with the existing weighbridge to form a two-plate unit. The Department also operates a weighbridge on the Hume Highway at Narellan and another on the Penrith–Richmond Road (Main Road No. 155) at Penrith.

In addition to these four permanent weighbridges, the Department's field inspectors use over 80 portable weighing devices, known as loadometers, for "on-the-spot" roadside checks.●

For further material on this subject, readers are referred to the following articles, which have appeared in past issues of "Main Roads".

* *"Weight of Load Regulation—A Brief History"* —*in the September*, 1956 *issue* (*Vol.* 22, *No.* 1, *pages* 17–22),
* *"Weight of Loads on Vehicles"* —*in the March*, 1967 *issue* (*Vol.* 32, *No.* 3, *pages* 90–93), *and*
* *"Vehicle Load Limits or Australian Roads"* —*in the December*, 1971 *issue* (*Vol.* 37, *No.* 2, *pages* 59–62).

WEIGHT WATCHING – A MATTER FOR CONCERN

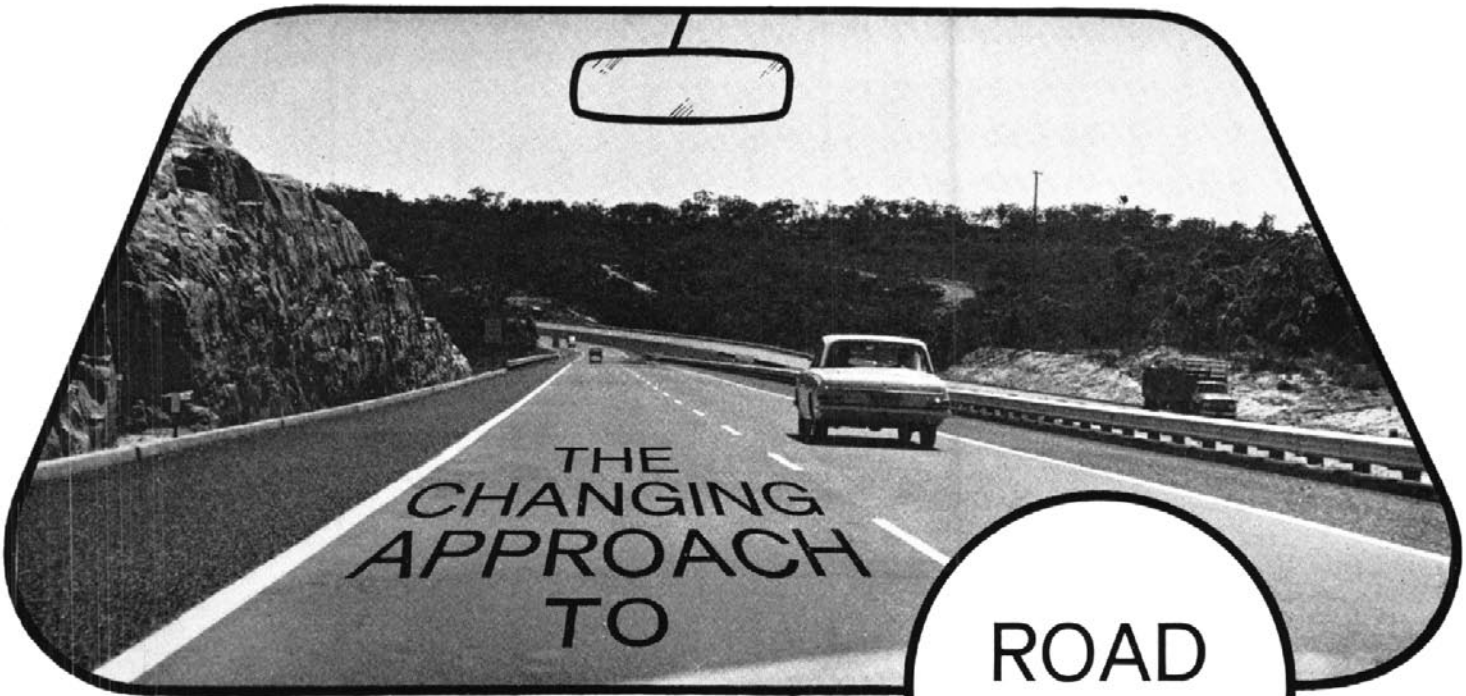
Being overweight is generally regarded as a personal problem, for which the solution centres around more exercise and fewer fatty foods. However, there is a field in which "being overweight" is a worry to the Department, because it has detrimental consequences for the whole community.

This worry relates to overladen vehicles which are the cause of serious damage to road pavements. Ordinance No. 30C of the Local Government Act, 1919 limits the gross load and the individual axle loads imposed on road pavements, bridge structures and ferry vessels by vehicles using Main Roads. The Department employs a number of field inspectors to check vehicles for overloading under this Ordinance. The Department's main concern in this regard is the protection of the pavements of Main Roads from damage.

Currently over 41,000 vehicles are stopped by Departmental inspectors each year and of these 24 per cent are found to be loaded in excess of the prescribed limits. Prosecutions are undertaken in the majority of these cases and approximately 6,000 convictions are recorded annually.

Despite the Department's efforts to reduce the cost of maintenance of road pavements and bridges from damage through overloaded vehicles, the present percentage of such vehicles still reflects a regrettable lack of co-operation from some owners and drivers.

It is also regretted that almost all Councils in the State neglect to police the loadings of vehicles using Main and Trunk Roads. There is no doubt that maintenance costs on these classified roads would be reduced if this were done. In spite of 103 Councils having members of their staff duly authorized officers for the apprehension of offenders under Ordinance 30C of the Local Government Act, only four Councils have taken positive steps to ensure that the assets created for normal travel by motor vehicles are protected from damage by unauthorized heavy loads ●



THE CHANGING APPROACH TO ROAD DESIGN

This article was prepared by the Department's Chief Engineer (Urban), Mr E. F. Mullin. As a paper entitled "Road Safety and Its Influence on Road Design" it was presented by Mr Mullin at a meeting of the National Road Safety Symposium held in Canberra in March this year.

The article relates to the design of expressways and rural roads. The Department now endeavours to design each section of road to match the speed at which a prudent driver will travel and not for a design speed. Consequently, the speeds used for design purposes vary with the standard of horizontal alignment. This change in attitude towards road design followed field tests which proved that

- **drivers tend to approach a horizontal curve at speed commensurate with the radius of the curve, provided it is visible, and that**
- **a percentile speed of entry for each radius curve can be established.**

In addition, the article discusses the complex design of combined horizontal and vertical curves, frequently found at crests. This design method was pioneered by the Department.

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Geometric road design developed in the 20th century, but in the beginning the approach to the subject was strongly influenced by the principles already established for railway track design. The two are comparable. The locomotive however follows a rigid track and the driver knows the maximum permissible speed and does not exceed it. His interest is the view ahead, principally of signals that give him long-distance warning of hazards; activities at the sides of the tracks are of little concern.

A road vehicle driver decides his speed of travel. The path his vehicle follows on a pavement is somewhat arbitrary and certainly not the rigid one of the rail vehicle confined by flanges to steel rails. Objects with which his vehicle may collide lie not only ahead but may move in from the side and often the driver's view (and hence warning) of a hazard is minimal.

It is the different speeds at which individual vehicles travel a particular length of road that make it difficult to design a road using procedures based on railway track design. The latest edition (1970) of "Policy for Geometric Design of Rural Roads" issued by the National Association of Australian State Road Authorities, quotes (on page 5) figures which show how wide can be the range of speeds at which individual vehicles travel a given length of road. With good travel conditions, the mean speed for one section of road was measured at 63·5 miles per hour and the 85 percentile speed at 74 miles per hour. (The mean speed is the arithmetical average and the 85 percentile speed is the speed at which or below 85 per cent of drivers travel.) The particular study also showed that the mean speed of cars on roads is increasing by 0·35 miles per hour per annum and the 85 percentile speed is even higher. This and other studies suggest the speed of travel (which is the major factor in determining road design values) is not constant, or even approximately so, for any one section of road. As it is the square of the speed figure that is often used in road design work (braking distance and circular acceleration for example) the effect of a difference in the numerical value between travel speed and design speed, is greater than the linear difference suggests.

The traditional approach to road design is to select a design speed for a section of road and ensure that all elements of design allow the section to be travelled safely at

DESIGN DATA FOR HORIZONTAL CURVES (All dimensions in feet unless otherwise indicated.)

Curve Radius	Minimum Length of Pegged Circular Arc	Design Speed (m.p.h.)	Sight Distance: Stopping 4 to 0.75	Sight Distance: Intermediate 4 to 4	Sight Distance: Overtaking 4 to 4	Superelevation (percent)	Transition Length: Plan	Transition Length: Superelevation	Max. Offset from Pegged C/L	Pavement Widening for Nominal Width of:— 18	20	22	24	Offset from Pavement C/L to give Sight Distance: Stopping	Intermediate
250	200	30	120	400	650	7	150	250	4	5	4	3	2	*	82
300															70
350															112
400	200	35	160	550	850	7	200	250	5	4	3	2	2	*	97
450															87
500													(No widening over 450 ft. radius)		108
550															99
600	300	40	200	650	1100	7	200	300	3	4	3	2		*	92
650															85
700															80
750														16	97
800	400	45	250	750	1300	7	200	300	2	3	2	2		15	92
850														*	87
900														*	82
1000												(No widening over 900 ft. radius)		16	96
1100	500	50	300	850	1600	7	200	350	2	3	2			15	87
1200														*	80
1300	600	55	360	925	1900	7	200	350	1	3	2			18	86
1400														17	81
1500						6								20	88
1600						6								19	83
1700						6								18	78
1800	800	60	420	1000	2300	5	200	350	1	3	2			18	74
1900						5								17	71
2000						5								16	68
2500						4	200		1	2	(No widening over 2000 ft. radius)			21	77
3000						4	200		1	2				18	65
3500						4	200		1	2				17	56
4000						3	(No plan transition over 3500 ft. radius)		(No plan transition offset over 3500 ft. radius)	2				15	50
5000						3				2				*	41
6000	800	70	560	1200	3300	3		300		(No widening over 5000 ft. radius)				*	35
7000						3								*	32
8000						3								*	28
9000						3								*	25
10,000						3								*	23
11,000						3								*	21
12,000 & Over	800	70	560	1200	3300	(Not required)		(Super-elevation transition may be used if apposite —300 ft. for 3%)						*	19

* in 2nd last column indicates that sight line for stopping distance falls within formation for pavements 18 ft. or wider.

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that speed. The design speed adopted is conditioned by terrain to a large extent. Broadly, this approach means that if the road is travelled at the design speed

- the curves have sufficient superelevation,
- the shift, widening and changing cross-fall enable the transition from straight to curve to be made comfortably, and
- the view of a hazard ahead is enough to allow the vehicle to be braked to a stop or steered around the hazard.

Within this broad framework certain departures from design requirements are usually acceptable. Visibility may be curtailed at an isolated crest to reduce earthworks; or a grade steeper than desirable for the particular speed value may be used. Usually, the standard of horizontal alignment required for the design speed is maintained, though often the sharpest permissible curve is used and superelevation steepened to match it. At isolated curves of large radius a higher speed is accepted for design purposes.

Design values and driver behaviour

Having settled a design speed, it is relatively easy to calculate the various design values needed for that speed and road authorities possess sets of tables or formulae developed for the purpose. **Though the designer knows the design speed of the road, the driver does not and he travels the road at a speed he believes appropriate to the conditions as he sees them on the road. There can thus be conflict between design speed and travel speed, a conflict which does not arise in railway operations. On a road, design speed is an analytical value, travel speed a conceptual figure—sometimes a clairvoyant one.**

The upper speed of travel on a level straight road is theoretically fixed only by the limitations of the vehicle. In practice, mean speed of travel and upper percentile averages are fixed apparently by the dislike of individual drivers to exceed certain speeds. As the speed figures quoted above show, a difference of 10 miles per hour can occur between mean and 85 percentile speed. This is a measure of the range of performance of vehicles and an indication of the fact that drivers select a speed of travel attractive to them.

The speed of travel on horizontal curves is the critical factor in road design. Unlike the straight road there is an upper limit of speed on a curve. Adopting a design speed and designing the curve to conform to that speed are a poor approach to road design if the 85 percentile speed of travel is likely to exceed the design speed. Tests made by the Department have shown that a driver approaching a horizontal curve which is plainly visible and without other traffic nearby to influence him, enters the curve at a speed *he* believes is appropriate for the radius of the curve. (See article entitled "The Behaviour of Drivers on Horizontal Curves", published in the June, 1969 issue of "Main Roads", Vol. 34, No. 4, pages 127–128).

COMBINED FRICTION AND SUPERELEVATION VALUES FOR GIVEN CURVATURE AND SPEED

$$E + F = \frac{0.067\,V^2}{R}$$

E – SUPERELEVATION FT PER FT
F – COEFFICIENT OF FRICTION
V – SPEED, M.P.H.
R – RADIUS, FEET

R	SPEED IN M.P.H. V													
	15	20	25	30	35	40	45	50	55	60	65	70	75	80
	VALUES OF E+F													
60	0·251	0·447	0·698	1·005	1·368	1·787	2·261	2·791	3·378					
80	0·188	0·335	0·523	0·754	1·026	1·340	1·696	2·094	2·533					
100	0·151	0·268	0·419	0·603	0·821	1·072	1·357	1·675	2·027					
120	0·126	0·223	0·349	0·503	0·684	0·893	1·131	1·396	1·689					
140	0·108	0·191	0·299	0·431	0·586	0·766	0·969	1·196	1·448					
160	0·094	0·168	0·262	0·377	0·513	0·670	0·848	1·047	1·267					
180	0·084	0·149	0·233	0·335	0·456	0·596	0·754	0·931	1·126					
200	0·075	0·134	0·209	0·302	0·410	0·536	0·678	0·838	1·013					
220	0·069	0·122	0·190	0·274	0·373	0·487	0·617	0·761	0·921					
250	0·060	0·107	0·168	0·241	0·328	0·429	0·543	0·670	0·811					
300	0·050	0·089	0·140	0·201	0·274	0·357	0·452	0·558	0·676					
350	0·043	0·077	0·120	0·172	0·235	0·306	0·388	0·479	0·579					
400	0·038	0·067	0·105	0·151	0·205	0·268	0·339	0·419	0·507					
450	0·034	0·060	0·093	0·134	0·182	0·238	0·302	0·372	0·450					
500	0·030	0·054	0·084	0·121	0·164	0·214	0·271	0·335	0·405					
550	0·027	0·049	0·076	0·110	0·149	0·195	0·247	0·305	0·369					
600	0·025	0·045	0·070	0·101	0·137	0·179	0·226	0·279	0·338					
650	0·023	0·041	0·064	0·093	0·126	0·165	0·209	0·258	0·312	0·371	0·436	0·505	0·580	0·660
700	0·022	0·038	0·060	0·086	0·117	0·153	0·194	0·239	0·290	0·345	0·404	0·469	0·538	0·613
750	0·020	0·036	0·056	0·080	0·109	0·143	0·181	0·223	0·270	0·322	0·377	0·438	0·503	0·572
800	0·019	0·034	0·052	0·075	0·103	0·134	0·170	0·209	0·253	0·302	0·354	0·410	0·471	0·536
850	0·018	0·032	0·049	0·071	0·097	0·126	0·160	0·197	0·238	0·284	0·333	0·386	0·443	0·504
900	0·017	0·030	0·047	0·067	0·091	0·119	0·151	0·186	0·225	0·268	0·315	0·365	0·419	0·476
1000	0·015	0·027	0·042	0·060	0·082	0·107	0·136	0·168	0·203	0·241	0·283	0·328	0·377	0·429
1100	0·014	0·024	0·038	0·055	0·075	0·097	0·123	0·152	0·184	0·219	0·257	0·298	0·343	0·390
1150	0·013	0·023	0·036	0·052	0·071	0·093	0·118	0·146	0·176	0·210	0·246	0·285	0·328	0·373
1200	0·013	0·022	0·035	0·050	0·068	0·089	0·113	0·140	0·169	0·201	0·236	0·274	0·314	0·357
1300	0·012	0·021	0·032	0·046	0·063	0·082	0·104	0·129	0·156	0·186	0·218	0·253	0·290	0·330
1400	0·011	0·019	0·030	0·043	0·059	0·077	0·097	0·120	0·145	0·172	0·202	0·235	0·269	0·306
1500	0·010	0·018	0·028	0·040	0·055	0·071	0·090	0·112	0·135	0·161	0·189	0·219	0·251	0·286
1600	0·009	0·017	0·026	0·038	0·051	0·067	0·085	0·105	0·127	0·151	0·177	0·205	0·236	0·268
1700	0·009	0·016	0·025	0·035	0·048	0·063	0·080	0·099	0·119	0·142	0·167	0·193	0·222	0·252
1800	0·008	0·015	0·023	0·034	0·046	0·060	0·075	0·093	0·113	0·134	0·157	0·182	0·209	0·238
1900	0·008	0·014	0·022	0·032	0·043	0·056	0·071	0·088	0·107	0·127	0·149	0·173	0·198	0·226
2000	0·008	0·013	0·021	0·030	0·041	0·054	0·068	0·084	0·101	0·121	0·142	0·164	0·188	0·214
2100	0·007	0·013	0·020	0·029	0·039	0·051	0·065	0·080	0·097	0·115	0·135	0·156	0·179	0·204
2200	0·007	0·012	0·019	0·027	0·037	0·049	0·062	0·076	0·092	0·110	0·129	0·149	0·171	0·195
2300	0·007	0·012	0·018	0·026	0·036	0·047	0·059	0·073	0·088	0·105	0·123	0·143	0·164	0·186
2400	0·006	0·011	0·017	0·025	0·034	0·045	0·057	0·070	0·084	0·101	0·118	0·137	0·157	0·179
2500	0·006	0·011	0·017	0·024	0·033	0·043	0·054	0·067	0·081	0·096	0·113	0·131	0·151	0·172
2600	0·006	0·010	0·016	0·023	0·032	0·041	0·052	0·064	0·078	0·093	0·109	0·126	0·145	0·165
2700	0·006	0·010	0·016	0·022	0·030	0·040	0·050	0·062	0·075	0·089	0·105	0·122	0·140	0·159
2800	0·005	0·010	0·015	0·022	0·029	0·038	0·048	0·060	0·072	0·086	0·101	0·117	0·135	0·153
2900	0·005	0·009	0·014	0·021	0·028	0·037	0·047	0·058	0·070	0·083	0·098	0·113	0·130	0·148
3000	0·005	0·009	0·014	0·020	0·027	0·036	0·045	0·056	0·068	0·080	0·094	0·109	0·126	0·143
3500	0·004	0·008	0·012	0·017	0·023	0·031	0·039	0·048	0·058	0·069	0·081	0·094	0·108	0·123
4000	0·004	0·007	0·010	0·015	0·021	0·027	0·034	0·042	0·051	0·060	0·071	0·082	0·094	0·107
4500						0·024	0·030	0·037	0·045	0·054	0·063	0·073	0·084	0·095
5000						0·021	0·027	0·034	0·041	0·048	0·057	0·066	0·075	0·086
6000						0·018	0·023	0·028	0·034	0·040	0·047	0·055	0·063	0·071
7000						0·015	0·019	0·024	0·029	0·034	0·040	0·047	0·054	0·061
8000						0·013	0·017	0·021	0·025	0·030	0·035	0·041	0·047	0·054
9000						0·012	0·015	0·017	0·023	0·027	0·031	0·036	0·042	0·048
10000						0·011	0·014	0·017	0·020	0·024	0·028	0·033	0·038	0·043
11000						0·010	0·012	0·015	0·018	0·022	0·026	0·030	0·034	0·039
12000						0·009	0·011	0·014	0·017	0·020	0·024	0·027	0·031	0·036
15000						0·007	0·009	0·011	0·014	0·016	0·019	0·022	0·025	0·029
20000						0·005	0·007	0·008	0·010	0·012	0·014	0·016	0·019	0·021
25000						0·004	0·005	0·007	0·008	0·010	0·011	0·013	0·015	0·017
30000						0·004	0·005	0·006	0·007	0·008	0·009	0·011	0·013	0·014
35000						0·003	0·004	0·005	0·006	0·007	0·008	0·009	0·011	0·012
40000						0·003	0·003	0·004	0·005	0·006	0·007	0·008	0·009	0·011
45000						0·002	0·003	0·004	0·005	0·005	0·006	0·007	0·008	0·010
50000						0·002	0·003	0·003	0·004	0·005	0·006	0·007	0·008	0·009
	15	20	25	30	35	40	45	50	55	60	65	70	75	80

MAX. VALUES OF F BIT. SURFACE	
M.P.H.	F
20	0·20
30	0·17
40	0·15
50	0·14
60	0·13
70	0·12
80	0·11

"E" VALUES
1 in 10 = 0·10 ft per ft
1 - 12 = 0·083 - - -
1 - 16 = 0·062 - - -
1 - 18 = 0·056 - - "
1 - 24 = 0·042 - " "
1 - 32 = 0·031 - " -
1 - 36 = 0·028 - " -
1 - 48 = 0·021 - " "

He assesses in advance the degree of curvature by the apparent movements of objects around the perimeter of the curve and changes accordingly his speed as he nears it. He may change again as he enters the curve and "feels" the combination of curve and superelevation. Although the tests were not extensive it was possible to establish a mean speed of entry and an 85 percentile speed for particular radii.

The discovery of this aspect of driver behaviour has recently led the Department to abandon the idea of designing lengths of road for a single design speed and instead, to design each curve for the maximum speed at which a prudent driver is likely to enter it. This change in approach to design carries the corollary that the driver must be able to see the beginning and part of the horizontal curve he is about to enter. If he is to be the arbiter of the speed of travel on the curve, some part of it must be visible to him before he makes his decision. The horizontal curve must not be hidden by a crest.

On a road with changing radii (i.e., with sharp curves at difficult places interspersed with larger radius curves on easier sections), design speed values for the road change as each radius changes. The assumption is that a vehicle checked at a small radius curve will, when a larger radius curve is encountered, speed up possibly only for a short distance and travel at a comparatively high speed. If the vehicle does not increase its speed the larger curve will more than accommodate the low speed. The tests suggested that a maximum superelevation of 7 per cent is all that is needed on curves to match the speed of entry of vehicles and this figure is the one used for maximum superelevation. The comparatively flat superelevation has the advantage that slow speeds can be accommodated without a driver having to resist the centripetal force acting on his vehicle brought about by the superelevation being too steep for the speed of travel.

Simplified standards

This approach to road design has simplified design standards. Because each curve is designed for one speed of travel, only one set of values for transition length, shift, widening and superelevation is required for each radius and these values having been calculated once, later calculations are not required. The table entitled "Design Data for Horizontal Curves" (on page 10) shows how the few values required for setting out horizontal curves and transitions can be conveniently assembled. It shows too that curves of 2,000 feet radius or smaller are marginal for 60 miles per hour travel and should be avoided. The 85 percentile speed of travel on open rural roads in Australia at places where conditions are favourable exceeds 70 miles per hour and to match speeds of this magnitude, curves of radius of 2,500 feet or larger must be used.

Another desideratum in road design is that vehicles travelling at speeds above 50 miles an hour should not need to rely on side friction between pavement and tyre to keep them on a circular path, or the reliance should be minimal. The centripetal force should be provided by superelevation and preferably by superelevation not exceeding crossfall, say three per cent. This approach may seem utopian for it suggests curves of radius of 8,000 feet for 60 miles per hour and 11,000 feet for 70 miles per hour, if three per cent superelevation is used, and 3,000 and 4,500 feet respectively if seven per cent superelevation is used.

The relation between friction, superelevation, curve radius and speed is shown in tabular form on the diagram on page 11. The critical superelevation values, three per cent and seven per cent, have been scored. If a vehicle has to rely on steep superelevation and side friction to retain it in its path on a curve, on wet pavements the frictional force needed may be inadequate. There is also the fact that if the engine is used as a brake or rapidly accelerated on cars equipped with torque converters and standard differentials, one rear wheel may lift and the other dig into the pavement resulting in the vehicle slewing if it is already relying on a high co-efficient of side friction to constrain it in a path.

The facts discussed in the preceding paragraph show large radius curves must be a prime aim in road design. It is surprising how often this aim can be achieved, although at first sight the terrain seems far too difficult for it even to be contemplated.

The Department has had successes using this approach. On the Sydney–Newcastle Expressway the southern approach to the Hawkesbury River is in extremely difficult country, yet the smallest radius on the road is 1,800 feet and in general the radii are 2,500 feet or better. The 1,800-foot curve is in plain view of drivers. The Waterfall–Bulli Pass Tollwork (i.e., part of the Southern Expressway between Sydney and Wollongong) is now being built and in 15 miles the smallest curve is 4,000 feet radius and the remainder 5,000 or better, yet the earthworks are not exceptional. More than half of the road is in broken sandstone country.

In both examples the approach was to adopt generous curves in the location stage unless earthworks ruled out this course. By steepening grades to a maximum of 6 per cent, good alignment with reasonable earthworks was achieved. Locations using slightly flatter grades and poorer alignment were examined but they did not materially reduce earthworks.

Sight distance values

Sight distance values adopted by the Department on rural roads as distinct from expressways are less than those recommended by the National Association of Australian State Road Authorities. A reaction time of $1\frac{1}{2}$ seconds is used in calculations and a height of eye of 4 feet, not the figures recommended by NAASRA, namely $2\frac{1}{2}$ seconds reaction time and 3 ft 9 in height of eye. Crests are thus sharper than they would be were the generous sight distance values of NAASRA used.

In broken country, a Departmental design, say for 60 miles per hour sight distance, has earthworks approximating those of a design using NAASRA 50 miles per hour values. Long flat crests, the product of generous reaction time, give good minimum visibility. On the other hand, a vehicle tops a sharp crest earlier than it would the flatter profile and the driver enters earlier the zone of unrestricted view ahead.

The Department prefers to build climbing lanes or widen the formation of the crest rather than lower an occasional crest at great cost and still not achieve overtaking sight distance. This approach allows more miles of road to be reconstructed for a given outlay.

Many miles of classified road in Australia are more or less in the state in which they were built years ago when standards were less exacting. The principal change is that their pavements have been sealed. Road construction, possibly more than any other branch of public works, is distinguished by "hydra-headed" wants and limited means. It seems preferably to improve the alignment of roads to a high standard, accepting a curtailment of sight distance at crests, and incorporate measures to reduce the change of a head-on collision, rather than to concentrate on building a few miles of heavy cuttings.

On the expressway-type of road with a central median the Department uses the longer sight distances recommended by NAASRA. On these roads, although a view of oncoming traffic is unimportant,

- drivers are less alert,
- there are usually several lanes of traffic travelling in the same direction masking the view of the pavement ahead, and
- it is important that a driver receives a long view of an unloading ramp if he intends to leave the expressway.

For these reasons, a larger reaction time is used in expressway design than in ordinary rural road design.

Sight distance and visibility are vexed questions in road design. In the final analysis it is the failure of the driver to perceive (i.e., to record and interpret) a hazard in time that leads to the accident. This failure may arise from a road imperfection, a vehicle defect such as inefficient brakes, or a human failing such as a driver so fatigued or under the influence of alcohol that he sees the danger but is slow in interpreting it and reacting to it.

Driver visability at crests

Visibility over a crest is inadequate compared with visibility at a horizontal curve. One comes around a horizontal curve say out of a cutting and the road is visible ahead instantly. One can see the whole of an oncoming car or the "nine inch high object" lying on the ground. (In passing, the "nine inch high object" on the road must be the most ethereal object in civil engineering. Tomes have been written about it and its influence on road design is considerable. Few have seen it. Where low kerbs are used to channel traffic, or pavement markings exist, the Department prefers to use a height of object of zero.)

At a crest, the unfolding of the view is a slow process. The first foot of an approaching vehicle will take over 1 second to appear. Paradoxically, the flatter the crest the longer the time it takes for a sizeable piece of an oncoming vehicle to be apparent. It is easier to assess the speed of an oncoming vehicle if it is moving across the observer's eyes than if it is coming direct without side movement. Indeed on a level road beyond the range of human binocular vision, it is not possible for a human being to gauge the speed of an oncoming vehicle unless it is ascending or descending a grade, or moving left or right on a horizontal curve.

The observer must have objects in apparent sideways or vertical motion to give him a lead on estimating the speed of an approaching vehicle. The overtaking sight distance values used in road design assume a driver can assess the speed of an oncoming vehicle over half a mile away. These assumptions are too broad. In any event, a road authority could not afford to cut crests or bench curves even in easy country to ensure that sight distance values of over half a mile in length were available to the driver who wished to overtake.

The Department is now using "Intermediate Sight Distance" for overtaking design purposes. These values allow an overtaking driver, halfway through the manoeuvre, to break off and return to his lane, should an oncoming vehicle appear. On roads with sight distance less than "Intermediate", overtaking is forbidden by double lines on the pavement. Alternatively, the road formation may be widened at crests, or slow speed lanes built.

Pavement drainage problems

The surface drainage of rural roads, especially the drainage of wide pavements of expressways is causing concern. Friction values reduce when a pavement is sheeted with water. Fortunately, expressways usually have flat longitudinal grades which reduce longitudinal flow and increase discharge sideways.

Crowned pavements are now frequently used on each side of the median instead of single crossfalls, which means about half the water that falls on each pavement is turned toward the median. Longitudinal drainage is necessary in the median area to collect and carry the water from the pavement. Indeed, one aspect of rural road design that is comparatively novel is longitudinal drainage. Formerly transverse drainage was all that was required; now pits in the median and watertables may be frequent—with links to a longitudinal drainage system.

The transition sections of a road create special drainage problems. Unless collection pits are arranged so that water is trapped at the edge of the pavement at the beginnings of the transition, it is possible for rainwater to flow from a pavement toward the outside shoulder in the approach to a horizontal curve but before being collected, the same water reverses in direction of flow and sweeps back to the median as the pavement warps to superelevation. From the air this effect is visible and as cars enter or leave a curve there is a "slosh" as they pass through water changing direction. Irrespective of the number of pits provided, some water will reverse flow and pond on the pavement at transitions. Some authorities reduce sheet flow at transitions by superelevating the pavement lane by lane. If a pavement has crossfall from the median in one direction, the median lane is first superelevated and a crown developed a lane width from the median. Water is then flowing in two directions across the pavement, some to the median and some to the shoulder. The middle lane is next superelevated and the crown moved nearer the outside shoulder. Finally, the shoulder lane is superelevated. This practice conflicts with one of the shibboleths or sacred cows of road design —the design of the plan transition curve.

Plan transition curve

An extraordinary amount has been written on the subject of the plan transition curve, its form, its radius at any point, and the degree of crossfall that should be established at various points, so that a driver passing from a straight to a curve and vice versa has a comfortable passage provided he does not exceed the design speed.

The approach to the subject has been coloured by railway practice. The calculations usually depend on a specific radius and a set design speed. As shown earlier, there is a considerable difference in travel speeds, hence transition curves suitable for a vehicle travelling at design speed will be unsuitable and may be inadequate for a higher speed. Vehicles do not always travel a horizontal curve on the true radius but follow their own, often crossing the centre line. The Department places emphasis on appearance in the design of transition curves and does this by lengthening transitions to reduce the rate of change of grade on the outside edge of the road as it goes from crossfall to superelevation. Transition curves designed for appearance are usually longer than plan transition curves designed for comfort.

The superelevation transition may not match the design speed but, being longer than a plan transition curve calculated for comfort of travel at design speed, it will suffice for the maximum speed at which the curve is likely to be travelled. After all, the critical factor in plan transition design, the acceptable rate of change of circular acceleration, is a subjective figure and slight variations in speed, radius and acceptable rate of change of acceleration can lead to considerable differences in the calculated length.

Non-collision accidents

About one-quarter of accidents on rural roads are the non-collision type, the type where a single vehicle runs off the road and often collides with an object on the roadside or turns over. If pedestrian deaths are excluded, one-third of road deaths on rural roads occur in non-collision accidents. The fatality rate is higher in the non-collision or "off-the-road" type of accident that it is in the collision type. As road designs improve and conflict areas between vehicles are reduced by central medians and interchanges, the run-off type of accident is likely to become relatively more important.

The cause of the run-off type of accident is often unknown and is frequently attributed to the driver falling asleep. In America, suicides by this method are believed not to be uncommon. If the verges of the road are kept free of trees and other obstacles, a driver has a chance of directing his vehicle back to the pavement. The cost of such work can be high and is usually beyond the capacity of a road authority to arrange. Flattening batters reduces the number of run-off types of accident. The maximum batter which will enable a driver to retain control of an errant vehicle appears to be one in six (one vertical to six horizontal). Slopes as flat as this greatly increase the size of earthworks. The Department is using 10-feet-wide shoulders on the more important roads, and at low fills and cuts, flattens the batter to prevent vehicles overturning. On a divided rural road it endeavours to make the median at least 50 feet wide, clear of encumbrances, with a shallow V in the centre for drainage. Drainage pits are built flush with the median surface.

It is important to delineate the edge of a road, as a driver can lose his sense of location on a high speed road if there is no background to which he can relate. The edge of pavement is not a sufficient guide for a driver. The walls of cuttings help and small bushes (too small to harm a vehicle if struck) are suitable guides. In situations where the Department seals the 10-feet-wide shoulder, it uses aggregate sufficiently coarse to cause a rumble if the vehicle inadvertently runs on the shoulder and so warn the driver he has left the main pavement.

Formerly, the profile of roads matched the profile of the country, i.e., the crest of the road coincided with the top of the hill and the road sag coincided with the natural valley. On major roads now a crest curve may span two hills and an intervening valley, and no longer need the natural cycles of hills and depressions coincide with the road cycle of crests and sags.

This arrangement leads to crests coinciding with valleys and drivers may, at the top of a crest, run out of background owing to the road being on fill. If this situation is combined with a horizontal curve the driver is "lost". He needs a definite background to direct him around the curve, especially at night. Paradoxically drivers in such situations do not always reduce speed. The same forces which compel some to maintain speed in fog (witness the motorway accidents in England) operate in these "lost" circumstances. Deprived of positive stimuli, external to the body, the human mind rapidly ceases to function normally and accelerates toward hallucination and breakdown.

Ramp roads

Considerable attention has been given in the past to creating smooth junctions where ramp roads leave expressways.

Abrupt changes of grade have been avoided at these places as they look unsightly. It has been found recently that while an abrupt change of grade where a ramp leaves an expressway may be unsightly, it is eyecatching and easier to discern than the long gradual separation.

Schedules of levels

In the design of roads, details are usually presented in three views, the plan, longitudinal section, and cross-section. A number of designers replace the cross-section by schedules of levels, usually calculated by computer. The occasional cross-section is handy in the design stage to illustrate problems associated with batters, drainage, and benching. From a table of levels an appreciation of the changes intended cannot be made.

In the construction stage, the cross-sections are usually not sufficiently close for accurate setting out of formation and pavement, so the Department augments the levels shown on the drawings. Schedules of levels at 25 feet intervals are supplied for the use of the constructing engineer covering shoulders, median formation, base courses and pavement. They aggregate thousands of levels a mile. Accuracy in setting out the building pavements is essential on high speed roads, for one of the assumptions in road design is that the finish will be "true".

The designer as driver

Although the details of a road are readily visible to the designer looking at the plan, the motorist drives along the line of cross-sections and has a view different from that of the designer. He cannot necessarily see far over a crest or around a corner and has a shorter time to appreciate the road ahead when it is revealed than the designer who has viewed the drawings for weeks.

Few motorists anticipate a hazard. They must see it before they will take action. On the approach to a crest vertical curve there are few guides to indicate the degree of curvature. A driver can assess the radius of a horizontal curve if he can see it by the apparent movement of objects on the periphery. Approaching a crest it is difficult for him to make a similar assessment. Few drivers feel the need to reduce speed. There is not a need anyhow to slow down at a crest vertical curve if the alignment beyond is direct or of large radius.

Visibility at a crest is unimportant if vehicles keep to the left and if a hazard does not exist immediately beyond the crest. **On the completion of a design, a designer should endeavour to "drive" the road and check what he could see were he a driver, and check what hazards are hidden.** Islands, kerbs and traffic markings make a brave showing on a coloured plan but may be invisible to a driver until it is too late for him to be influenced by them.

If a horizontal and a crest curve are in close proximity it is essential that the layout be arranged so that part of the horizontal curve is seen in advance of the crest. For the same reason, a road junction, a level crossing or a similar hazard should not be hidden by a crest. This type of hazard and the crest should be well apart or, if that cannot be arranged, should be located at the top of the crest. Horizontal curves and crest curves frequently overlap because in road location it is often convenient to change the direction of the road as the hill is topped.

Where the combination occurs, lowering the crest to improve sight distance will, paradoxically, not always do so. If the line of sight falls outside the edge of formation then, to improve sight distance, it is the surface at the side of the road that has to be lowered, not the pavement. This results in a form of construction known as under-benching.

Under-benching

The methods of design of such benching were developed in the Department in 1937 and the subject is discussed in "Policy for Geometric Design of Rural Roads" (NAASRA 1970 edition). Under-benching design can be complex. If benching seems needed it is better to discard the idea of benching and enlarge the horizontal curve and move it into the area that would have accommodated the bench. Visibility across a chord is inefficient owing to the inability of a moving driver to perceive objects on the side as clearly as ahead and a "blind" larger radius curve can be a better safety measure than a sharp one with benching.

Sag vertical curves

Formerly the design of sag vertical curves was confined to making them long enough to give smooth riding. Now it is realized that at nighttime long curves are required for sight distance purposes. In a sharp curve, the headlights of the vehicle disappear into the pavement a short distance ahead of the vehicle. In designing sag curves for sight distance (i.e., lengthening them to extend the point where the lights disappear), it was assumed that night travel speeds were 10 miles per hour less than day travel speeds. This assumption allowed smaller sag curves to be used. As mentioned in "Policy for Geometric Design of Rural Roads" (1970 edition, page 6) Victorian studies have proved this assumption to be incorrect. Speeds were measured at seven places by day and by night under similar conditions. The mean speed of cars was slightly higher at night than by day (approximately 52 miles per hour) and the 85 percentile night speed was 1 to 2 miles higher than the corresponding values of 61 miles per hour by day. Extreme speeds were 8 miles per hour higher at night than the daytime values of 77 miles per hour.

The cost of lengthening and flattening sag curves to match high travel speeds would be colossal. Few head-lights would light the road clearly at the distance required for such speeds. Another restriction to visibility at night arises when a horizontal curve coincides with a vertical curve. At the horizontal curve, irrespective of the length of the vertical curve sag or crest, the headlights shine off the road. At crests at night headlights shine tangentially into the air reducing considerably the view obtainable of an unlit object ahead.

A development in the form of road standards is the abandoning of the word "should" in the text and its replacement by the emphatic "must". "Radii should exceed *x* feet" becomes "must exceed". Road designers have a predilection for adopting minimum values instead of generous figures. A combination of two minima is unacceptable in design work. If, for example, the minimum radius curve is used, other factors such as sight distance must not be minimum.

The approach to road design continues to change. It is surprising how frequently assumptions made in the art have later to be discarded. Road design, being the link between vehicle performance and driver behaviour, is not a static process but a changing one as speeds increase and volume of traffic grows. It is an interesting study. A successful solution of the problems associated with it can be of great, sometimes vital, benefit to persons using the road ●

☆ ☆ ☆ ☆ ☆ ☆ ☆

Reference has been made in this article to the NAASRA publication "Policy for Geometric Design of Rural Roads"—1970 edition. This interesting, 88 page, technical book can be purchased for $1.00 from the Department's Plan Room, lower ground floor, Head Office. Other NAASRA publications are also available.

ALL SET FOR A CLEAN SWEEP

While everyone is talking about pollution and cleaning-up the environment, it seems a good time to show some of the modern equipment used by the Department to sweep up dirt and rubbish along metropolitan main roads.

If you do not drive late at night or in the early hours of the morning, it is unlikely that you will have seen these machines in operation or noticed the men who nightly provide a virtually "unseen" service to the motoring public of the city.

Photographed in what is, for them, rather unfamiliar sunlight are two types of street sweepers. The truck-mounted vacuum unit (top and centre left) has a suction fan which is driven by a separate diesel engine. Dual steering, dual suction boxes and dual gutter brushes are fitted, with an extension brush for left and right hand sweeping. The mechanical sweeper (centre right and bottom) uses brushes and a conveyor system to pick up rubbish, etc., and load it into a four cubic yard hopper. The compact overall dimensions of this unit and its small turning circle allow good manoeuvrability. It also has dual equipment to enable it to sweep on either side of the roadway.

These machines are operated by the Department as part of a metropolitan road maintenance programme, by which it undertakes sweeping along the medians of main roads, as well as along kerbs and gutters on sections of expressway and on bridges for which the Department is responsible.

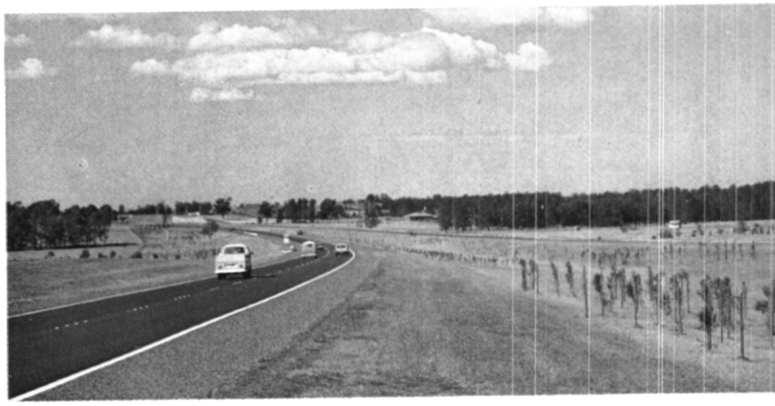
BITUME AND BL

▲ Wattle

▲ Flowering Gum

▲ Waratah – our State's floral emblem

▲ Reflections at Department's plant-holding nursery, Yennora



▲ Western Expressway

▼ Shelter and shade help plants progress

▼ Greenery on the move

, BARK
SSOMS

▲ Bottlebrush

The Department's love for trees is not a new affair. It has long realized that "greenery improves the scenery" and for over 25 years it has undertaken tree planting beside main roads throughout the State.

It would be naive not to admit that some disturbance to the natural landscape is an almost inevitable side-effect of the roadworks which the Department has to carry out. Nevertheless, the Department takes positive action and adapts its plans to ensure that this disturbance is kept to a minimum.

The recent establishment of a plant-holding nursery, with a capacity for 30,000 advanced trees and shrubs, and the expansion of a statewide treeplanting programme (described in the article commencing on page 2) show the Department's concern in action. This concern covers the need for conserving existing trees as well as for beautifying the road environment through new plantings.

By combining our talents with nature's, we hope that tomorrow's motorists, as well as today's, will be able to drive along pleasant tree-framed expressways and highways and so reap the scenic benefits of this aspect of our work.

▲ North Western Expressway, Hunters Hill

Western Expressway, near Nepean River

KINGS CROSS ROAD

Few areas of Sydney conjure up such varied images as Kings Cross and mean so many different things to different people.

To residents, the Cross is a pleasant place to live, close to the city, only a "hop, skip and jump" to sunny harbourside parks at Elizabeth Bay and Rushcutters Bay and not far from surfing beaches further east. It has all the homely suburban amenities plus an almost unique cosmopolitan "flavour" of its own.

To visitors, tempted by tourist brochures and coaxed by appealing publicity, the Cross has an aura of the exotic and exciting. It seems to have something for everyone – from quiet tree-lined parks to gaudy neon-framed nightclubs, floor-shows from the flashy to the fashionable, shops from the cheap to the expensive and restaurants from the plain to the plush.

Above all, it has other people – lots of them. For pedestrians, there is always the comfort of the crowd and the fascination of just watching what others do. But, for motorists, other people mean other cars and other cars invariably bring confusion. Cross traffic at the Cross can strain the calmest temper. How often do drivers find their feelings falling from exhilaration to frustration while traffic conditions climb upwards from "comfortably crowded" to chaotic?

Motorists approaching Kings Cross in anticipation of a night of dining and dancing often have the "edge" taken off the evening by the irritation of a bumper-to-bumper crawl at the top of William Street. The tourist passing through Kings Cross, either on his way into the city to see the sights or going out to view the attractions of the eastern suburbs, generally has to weave his way slowly through a mass of other motorists each manoeuvring towards different destinations. Residents living nearby and travelling to and from the city daily have the same problem – only more often.

Therefore, for the many motorists who want to know what is being done to improve Kings Cross traffic movements, details on the following pages explain the design of the Department's road tunnel project and how it will soon help them. It is an article which is intended to outline "what is going on Down Under up at the Cross". There have always been plenty of "happenings" at Kings Cross, and now the Department has joined in the action – with this impressive project.

Top left:

El Alamein Fountain . . .
evening lights . . .
and the fascination of
falling water.

Top right:

Footpath refreshments . . .
warm sunshine . . .
autumn leaves . . .
and a background of pavement
publicity.

Left:

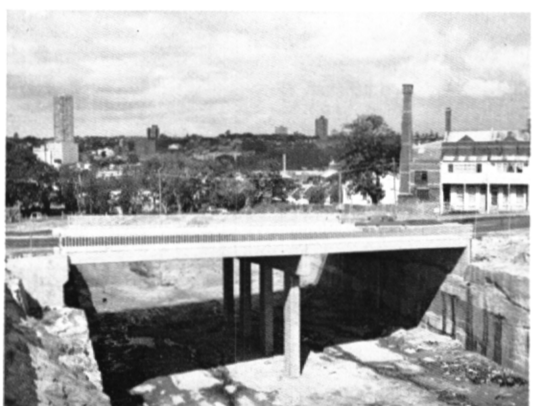
Looking west to the city
over the centre of the Cross . . .
showing William Street
in the middle distance,
Bayswater Road on the right,
with the tunnel roadworks
(and the completed Craigend
Street bridge) on the left.

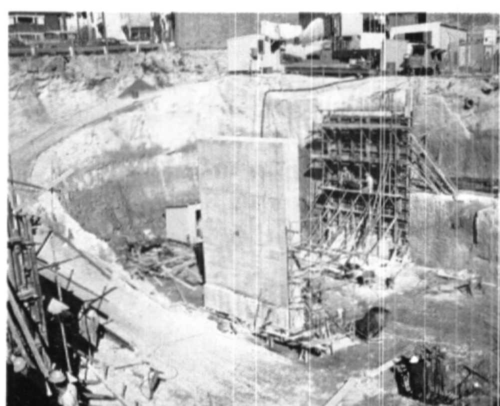
Bottom left:

This bridge at Craigend Street
(looking east) will form the
eastern portal of the tunnel.

Bottom right:

The first pier of the Victoria
Street bridge rises out of
deep excavations at the top
of William Street.





An Outline of the Project

The feasibility of constructing a road tunnel under Kings Cross has been under consideration by the Department for a number of years. Various proposals have been investigated, including a review of the respective "virtues" of a long deep tunnel and a shorter shallower tunnel. Following consideration of various factors including estimated cost, technical problems, and likely effect on properties, it was determined that a shallow tunnel would be the best solution. The proposal was publicly announced by the Minister for Highways on 17th February, 1969, and was reported in the March, 1969 issue of "Main Roads" (Vol. 34, No. 3, pages 74–75).

Artist's impression of completed project, looking west

TUNNEL PROJECT

The purpose of the Kings Cross Road Tunnel is to provide an improved route for through traffic travelling between William Street and New South Head Road. It will eliminate conflict between through traffic and local vehicular and pedestrian traffic at Kings Cross by separating it into different levels. In particular, the large volumes of traffic travelling north and south along Victoria Street and Darlinghurst Road will be carried over traffic travelling east and west through the tunnel.

In the tunnel, dual carriageways will each carry two lanes of traffic. Eastbound traffic will leave William Street near Dowling Street and enter the tunnel at Darlinghurst Road. After leaving the tunnel near Craigend Place this traffic will join Bayswater Road near Roslyn Street. Westbound traffic, proceeding to the City, will leave New South Head Road near New Beach Road, and continue along a new road to be built under the Eastern Suburbs Railway Viaduct at Rushcutters Bay. This traffic will enter the tunnel at Craigend Place and, on leaving, it will join William Street, near Dowling Street (see map on page 20). In the tunnel, a continuous breakdown lane will be provided beside each carriageway.

It is proposed that the area over the tunnel (bounded by Kings Cross Road, Victoria Street, Craigend Street and Craigend Place) will be available for redevelopment on completion of the roadworks. If implemented, this scheme will enable some of the cost of the original land acquisitions to be recovered.

Investigation and Design

The first aspect of the investigation work involved consideration of how long, and at what depth, the tunnel should be built. Both technical and economic factors were taken into consideration. The technical factors included

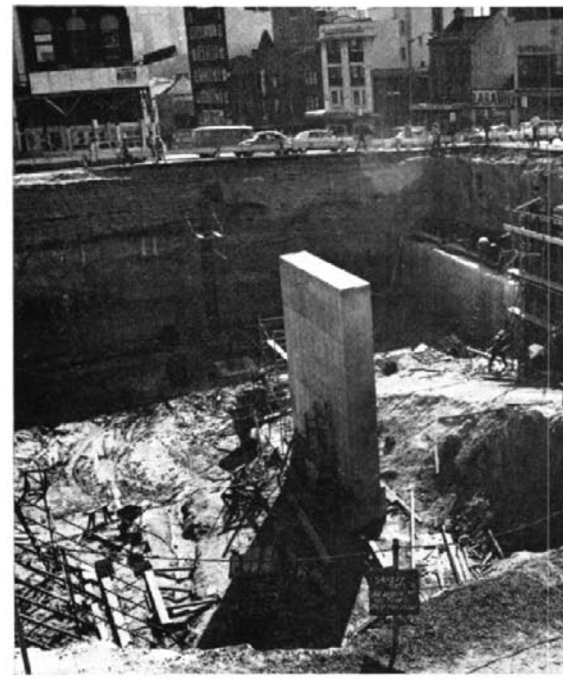
- geological studies of the rock which would be encountered, to check such details as its hardness and uniformity,
- projected traffic volumes, and
- the possibility of using a tunnel-boring machine.

The economic factors included the cost of detailed estimates, for alternative schemes of

- construction adjustments to public utilities, and
- costs of acquisition of necessary properties.

Following consideration of these factors, the decision was made to adopt a short tunnel at a relatively shallow depth—to be constructed by the "cut and cover" principle, rather than by boring or mining methods.

Before detailed design could proceed, it was necessary for a large amount of subsurface exploration to be carried out. This involved drilling and coring at over 50 test sites, to depths of up to 65 feet. The cores from these drill holes were subsequently examined to determine structure foundation levels and appropriate excavation batter slopes. In addition, unconfined compression tests were carried out on the rock at foundation levels to determine their bearing capacity. The rock is Hawkesbury sandstone, with some layers of shale and clay.



Work is in progress on the construction of the bridge to form the western portal of the tunnel at Victoria Street. This photograph is looking west to the junction of Darlinghurst Road and William Street.

The road design provides for large radius curves to ensure safe conditions and to give a pleasing appearance. The design of the tunnel roadway and the immediate approaches is to expressway standards. Pavement construction is designed to carry heavy traffic and to require only a minimum of maintenance. Alterations to the intersections of surface roads have been designed to allow for anticipated future traffic volumes, and have been finalized following consultations with other traffic authorities.

There has also been close liaison with the Department of Railways to co-ordinate proposals at the eastern end where the Eastern Suburbs Railway (now under construction) will emerge from a tunnel and continue along a viaduct to Rushcutters Bay.

The structural design for the project is being carried out by the Department. Consulting Engineers, Burn, Griffiths and Associates, have been engaged to design mechanical and electrical services required for the ventilation and lighting of the tunnel, while MacDonald, Wagner and Priddle Pty Ltd, are assisting in the design of foundations for proposed future development over the tunnel. To lessen the effect of a sudden change from full sunlight to tunnel lighting, consideration is being given to the construction of a sunscreen over each tunnel entrance. Each screen will be about 90 feet long and will allow only part of full sunlight through to the roadway.

Each portal of the tunnel is designed as a bridge to carry cross traffic over the tunnel. At the eastern portal, the bridge is at Craigend Place, linking Craigend and Surrey Streets on the south to a new extension of Kellett Avenue (between Bayswater Road and Kings Cross Road) on the north. At the western portal, another bridge will carry Victoria Street and Darlinghurst Road. Both of these bridges will be approximately 90 feet long, having two 45-feet spans and having abutments and centre piers of reinforced concrete. Rock anchors up to 40 feet long will stabilize the abutments. The decks of both bridges will consist of precast, prestressed planks covered by cast-in-place concrete, and will be stressed transversely.

Special provision for public utilities is being made in the bridge at the western portal (Victoria Street) and over part of the tunnel adjacent to the bridge. Ducts covering a width of 30 feet have been designed to meet the requirements of all the public utility authorities. Some services will also be carried across in the bridge at the eastern end (Craigend Place).

Between the two bridges, the tunnel will be approximately 700 feet long. Structurally it will consist of two outside walls and a central wall between the two carriageways. The ceiling will be suspended from prestressed concrete roof beams. Service ducts and a control room for tunnel lighting and ventilation will be located between the ceiling and the roof. The proposed future development over the tunnel will be supported on footings and columns located in the central wall and beyond the outer walls.

Special consideration is being given to the design of the ventilation and lighting of the tunnel and to the type of wall-lining to be adopted. The reflective nature of the wall-lining has to be fully considered, as well as its "washable" qualities—for ease of maintenance.

To enable pedestrians to cross the eastern approaches to the tunnel, a prestressed and reinforced concrete foot-bridge, 380 feet long, will be constructed from Roslyn Street on the north to Oswald Lane on the south.

This eight-span bridge will consist of two prestressed concrete spans (each 113 feet) and six reinforced concrete approach ramp spans (each 25 or 26 feet in length). The main spans will be constructed using a central "T-shaped" cantilever unit, the top horizontal section of which will extend for 106 feet, i.e., 53 feet on either side of the central pier. This "T" unit will be cast-in-place and will support one end of two suspended precast concrete girders (each 61 feet long). The other end of these girders will rest on piers situated at the junctions with the approach ramps. The width of the footway will be 6 feet and it will be flanked by steel handrailing.

In order to fit in with the planning and environmental needs of this densely populated area of Sydney, special attention is being given to the landscaping of medians and batter slopes. Grass and tree planting will be undertaken to create a pleasing appearance along the tunnel approaches.

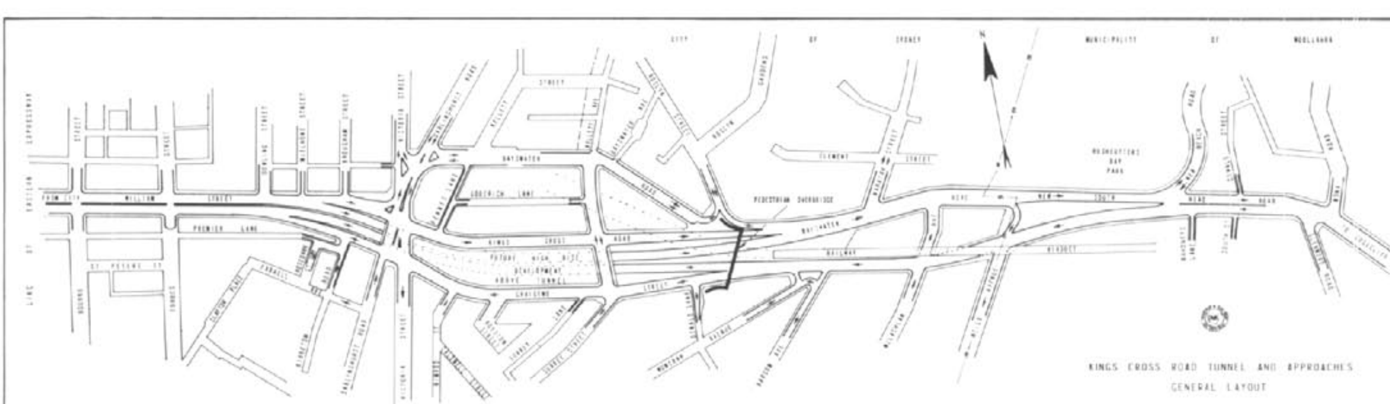
Property Acquisition

Before any construction work was commenced, acquisition of the required land was necessary and, consequently, 118 properties were resumed by notification in the Government Gazette of 28th February, 1969. All owners were advised by letter of the effect on their properties and were invited to lodge a claim for compensation. The claims were assessed by the Valuer-General's Department and these valuations (which were based on the market value of the properties at the date of resumption) formed the basis of the Department's negotiations.

As well as the property owners, approximately 600 tenants were affected by these proposals. Tenants who had a compensable interest were able to submit a claim for compensation and these claims were also assessed for the Department by the Valuer-General's Department. A number of tenants received special consideration by the Housing Commission and were allocated alternative accommodation.

To allow property owners and tenants to discuss problems "on the spot" (and also to allow the general public to view artist's impressions of the completed work), the Department set up a temporary office in a vacated shop in Darlinghurst Road. This office was established in March, 1969 and operated until July, 1971.

Following the vacation of properties by owners and tenants, demolition was carried out for the Department by contractors and the cleared areas were



progressively fenced to eliminate any danger to the passing public or to inquisitive children.

Public Utility Adjustments

In the populous Kings Cross area, there is a particularly large number of public utility mains. Before any construction could be commenced, relocation of these mains was necessary. As previously mentioned, public utility services are being carried across the tunnel in special ducts on the bridges at each portal. Other services, running parallel to the tunnel, will be located in surface streets. Public utility services will not be laid in the tunnel roadway and this will avoid any future interference to through traffic by the utility authorities. The public utility authorities which have co-operated with the Department in relocating and adjusting their services include the Metropolitan Water, Sewerage and Drainage Board, the Sydney County Council, the Australian Gas Light Company and the Postmaster General's Department.

Construction

In order that interruptions to vehicular and pedestrian movements be kept to a minimum (especially in such a popular and busy area), and also to enable necessary adjustments to be made to utility services, construction of the tunnel project is being carried out in several stages. These stages have been devised to create as little inconvenience as possible to members of the public who may be visiting or residing in the area, driving or walking, sightseeing and shopping or just passing through.

New bridge structures and some sections of new roadway will be brought into use as soon as they are completed. To maintain a smooth flow of traffic around the work, all stages of construction and proposed traffic re-arrangements have been closely co-ordinated with the various traffic authorities (including the Police Department, the Department of Motor Transport, the Department of Government Transport, and the Council of the City of Sydney).

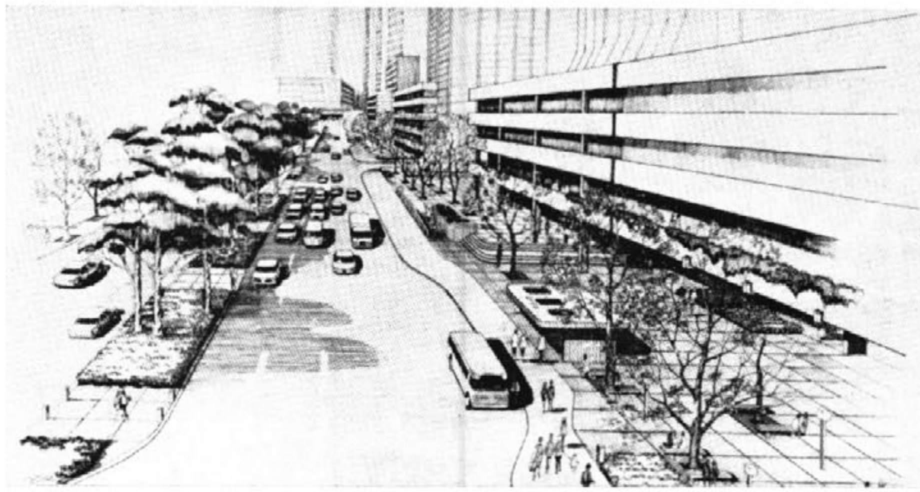
Signs will be displayed at appropriate locations to guide motorists and the Police Traffic Branch will issue the necessary directions and control traffic to ensure that the altered arrangements operate efficiently.

Some sections of the tunnel project will be constructed by the Department's own forces while other sections will be

(Continued on page 22)

The Council of the City of Sydney's

WILLIAM STREET ACTION PLAN



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The William Street Action Plan represents a concerted effort on the part of the Council of the City of Sydney and of its landscape and architectural consultants to conceive a master plan for redevelopment.

This plan envisages a coherent integration of all the potential elements of the new streetscape from the smallest details to the facades and envelopes of the buildings themselves.

The aim is to achieve a visual and functional unity appropriate to a busy and important city spine.

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On 15th December, 1969, the Council of the City of Sydney adopted a series of proposals which provided for the development of William Street as a beautiful tree-lined boulevarde with wide pedestrian footways and colonnaded buildings.

After conferences with this Department, Council resolved on 26th October, 1970 to further widen William Street to provide four lanes of traffic in each direction and to increase the median strip from a width of 6 feet to 16 feet. This would provide turning bays, as well as a refuge for pedestrians crossing the roadway. By giving better scope for landscape treatment, it would have resulted in the creation of an impressive boulevarde.

To assist Council officers in the formulation of the concept, Council engaged Bruce McKenzie and Associates, Landscape Architects, as consultants, and encouragement and assistance was also sought and received from the Royal Australian Institute of Architects.

The major part of the widening would have taken place on the southern or sunny side of William Street. The depths of the existing buildings fronting the southern side are limited by a series of narrow lanes, and if this widening had been effected it would have left a residue of about 27 feet. Council therefore resolved on 19th July, 1971 to incorporate this residue of land with the already approved 20-foot-wide southern footway to permit this combined area to be developed as a wide, terraced, landscaped pedestrian mall extending from Yurong Street to the top of William Street.

By these actions the present width of 100 feet between building fronts will be increased at ground floor level to 193 feet, including a 62-foot-wide pedestrian mall on the southern side.

As a gateway to and from the Eastern Suburbs, the Department's Kings Cross Road Tunnel Project will be a fitting forerunner and an appropriate "end piece" to Council's plans for the development of William Street into an attractive road and pedestrian link with the City ●

constructed by contract. Preliminary works, including the southerly extension of Kellett Avenue from Bayswater Road to Kings Cross Road, were commenced by the Department at the end of 1970. The bridge at Craigend Place has already been completed by the contractor, R. M. and B. Coceancig, at a cost of approximately $80,000 (*see announcement on calling of tenders in the June*, 1971 *issue of "Main Roads", Vol.* 36, *No.* 4, *page* 122). In view of the difficulties associated with stage construction and traffic re-arrangements, the bridge at Victoria Street is being constructed using the Department's own forces. Excavation for Stage I of Victoria Street Bridge and the structure carrying the utility ducts is completed and foundations, piers and abutments are well advanced on these bridges (*see colour aerial photograph appearing on page* 17 *of the September*, 1971 *issue of "Main Roads", Vol.* 37, *No.* 1).

It is expected that tenders for the main contract, which involves major excavation and tunnel construction between the two portals, will be called later in 1972. Most of the ancillary roadworks will be constructed by the Department's own forces.

The total quantity of excavation for the tunnel and its approaches is estimated to be 160,000 cubic yards. The volume of concrete in the various structures will total approximately 9,000 cubic yards and the area of new road pavement will be approximately 45,000 square yards. The entire project, after allowing for the disposal of surplus lands, will cost approximately $10,000,000.

Although this project is not part of the planned expressway system for Sydney, construction is being supervised by Mr J. A. Neeson, who in June, 1972, succeeded Mr H. B. Korff as the Department's Engineer for Inner Expressway Construction.

William Street (eastwards from Palmer Street), Bayswater Road and New South Head Road are at present proclaimed as part of Main Road No. 173.

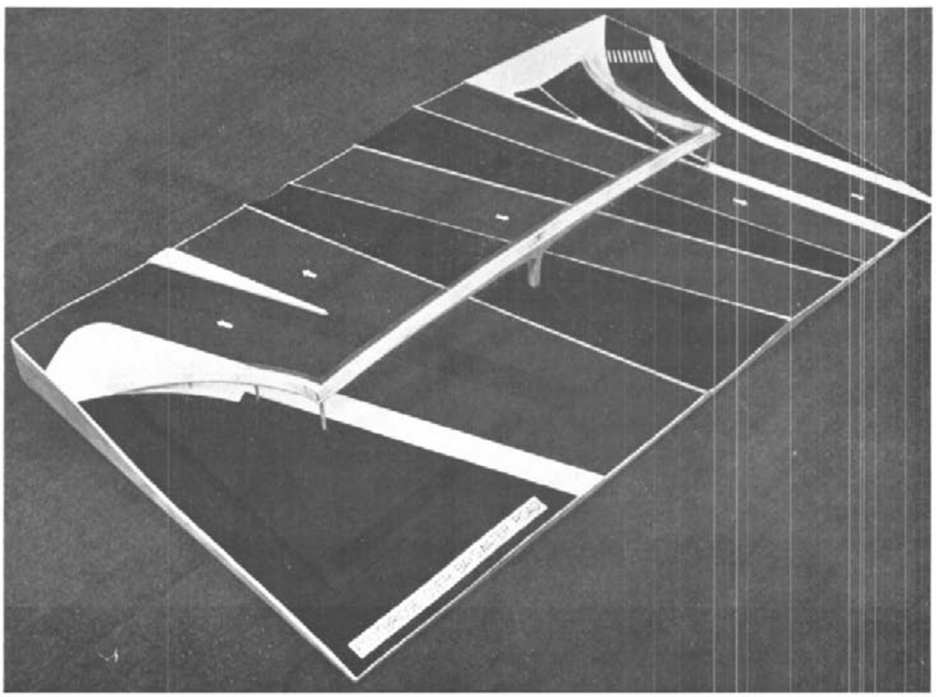
Artist's impressions and a "photo-mosaic" model of the project are on display in the Model Room at the Department's Head Office. Members of the public are invited to come in and view these, together with scale models of other major works, during office hours (8.30 a.m. to 4.30 p.m.) by calling at the Public Relations Section (third floor).

* * * * *

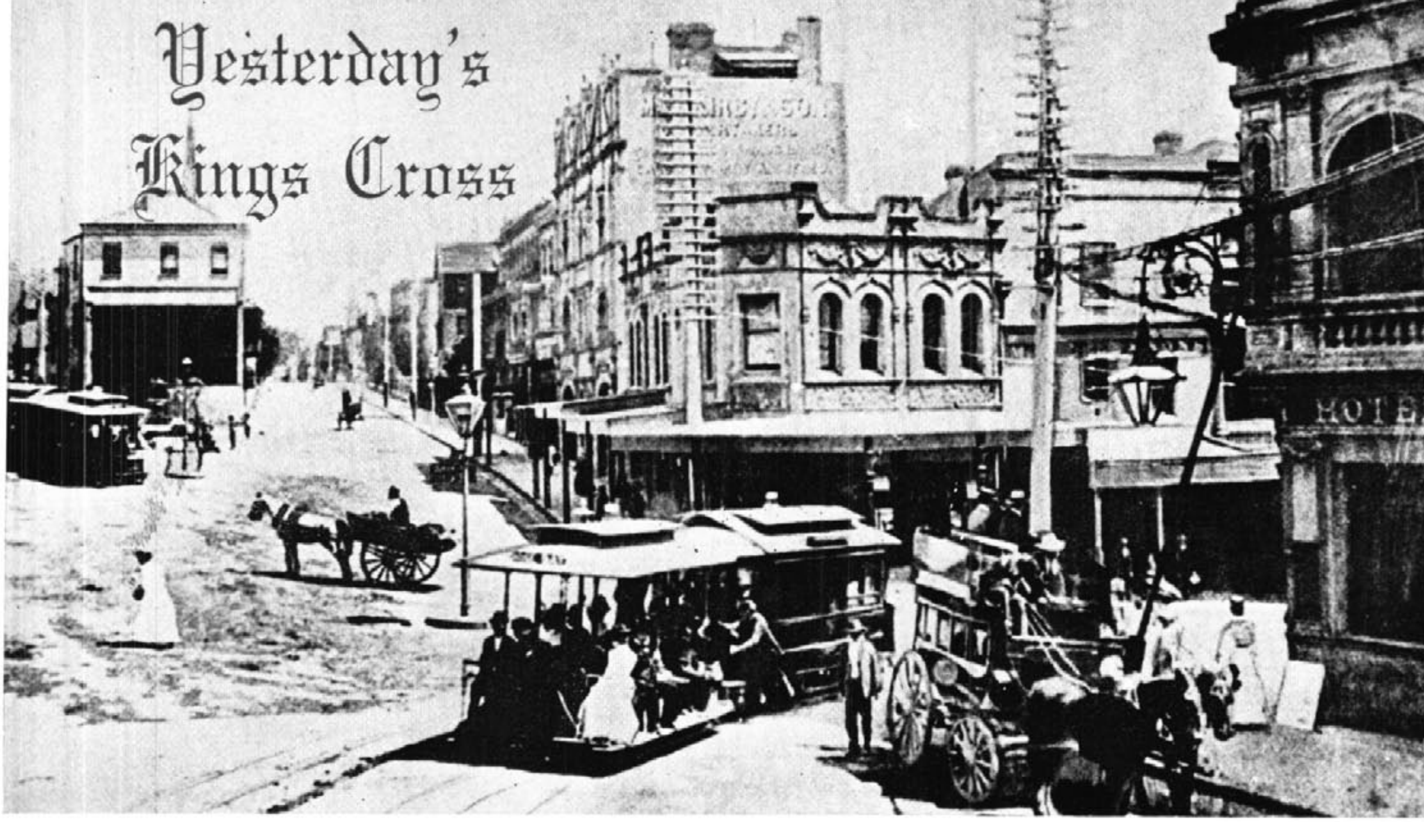
This article has been edited from material prepared by Mr G. Percival, who is Resident Engineer at the Department's Kings Cross Tunnel Construction Office, at the corner of Kings Cross Road and Kellett Avenue.

Aerial view (looking north) showing the area to be excavated for the tunnel—from the completed bridge at Craigend Place (on right) to the bridge under construction at Victoria Street (on left).

Scale model of proposed footbridge which will provide pedestrian access over eight lanes of traffic near eastern end of tunnel (looking west). Extending from near Oswald Lane (on left) to near Roslyn Street (on right), the overbridge will cross Craigend Street, the two carriageways leading to and from the tunnel, and Kings Cross Road.



Yesterday's Kings Cross



Queen's Cross in 1894—*during that gracious, gas-lit era when bustles and boaters were in fashion and life had a more leisurely pace*

Reproduced by courtesy of "The Sun"

By separating traffic at Kings Cross, the Department is changing the feature from which the area originally derived its now famous name.

In June 1897, the Municipal Council of the City of Sydney considered some proposals for celebrating the Diamond Jubilee of Queen Victoria. One of the recommendations which were passed was

> "That the roadway at the top of William Street, being the junction of Victoria Street and Darlinghurst Road and William Street and Upper William Street be named and hereafter known as Queen's Cross."

The name Queen's Cross remained in use after Queen Victoria's death on 22nd January, 1901. However, in October, 1905, to avoid further confusion with Queen's Square (which is situated at the northern end of Hyde Park and just east of St James Church of England), the name was changed to Kings Cross, in honour of Queen Victoria's son—King Edward VII, who reigned from 1901 to 1910.

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A host of history lies almost forgotten behind the names of the streets which are associated with the Department's present roadworks at Kings Cross. Almost all of these names commemorate fine old mansions, long since demolished but once familiar as the homes of famous officials (some of whom were connected with early road and bridge building).

WILLIAM ST

In the early part of the last century, the area from Woolloomooloo up to the present Kings Cross was known as Henrietta Town—Henrietta being the second christian name of Governor Macquarie's wife.

The part around what is now Elizabeth Bay was known for a while as Blacktown because Macquarie had it reserved for the aborigines. The name of the Bay itself perpetuates Mrs Macquarie's first christian name.

Land grants in 1831 referred to "the hamlet of Darlinghurst", which appears to have been named in honour of another Governor's wife—Elizabeth Darling—whose husband held office from December, 1825 to October, 1831.

About this time, William Street was also named, presumably after the King of England, William IV—the "Sailor King"—who reigned from 26th June, 1830 until his death in 1837 (when he was succeeded by his niece, Victoria).

In the early 1830's the Surveyor-General, Major Thomas Mitchell, submitted plans to the Colonial Secretary for the re-routing of section of South Head Road. Mitchell suggested two lines of road, either of which could replace the route then in use. His alternative lines detoured to the north and south of the sandhills on the descent to Rushcutters Bay and offered easier grades. He appears to have had a scheme for continuing his southern proposed line westerly to link up directly with William Street. Mitchell's map suggests he may also have considered re-routing William Street further to the south. These proposed lines of road can be seen on a copy of one of his maps, which accompanied his letter dated 24th July, 1832 to the Colonial Secretary. This map has been reproduced in the book "Before Kings Cross" by Freda MacDonnell (between pages 30 and 31).

Unfortunately Mitchell's proposals interfered with the property interests of a number of influential grant-holders. Before he set out in November, 1831, to explore the western rivers system, he prepared a model showing the obstruction caused by "Woolloomooloo Hill" and pressed hard, but unsuccessfully, for the adoption of a new line.

When Mitchell returned 8 months later, he found that the private interests of affected property-owners had frustrated his proposals. For example, Thomas Barker (see under "Roslyn Street" on page 24) grieved that his gardener's cottage would be cut off from his holding and refused to accept other land in exchange.

Alexander Macleay, the Colonial Secretary and next in rank to the Governor, had an extensive grant nearby on which he built Elizabeth Bay House in 1836. (This fine house is still standing in Onslow Avenue and is about to be restored by the State Planning Authority. It was designed by the architect, John Verge.) Macleay ordered the Deputy Surveyor-General (Perry) to ignore Mitchell's instructions and make the road straight up the sandhill.

On hearing of this, Mitchell was upset and he wrote: "On my return from the interior I found that the road had been cleared according to a different plan, submitted by my deputy acting in my name during my absence".

This was yet another frustration for the forthright Major Mitchell who, throughout his career, was embroiled in "personality" clashes with other officials (see under "Kellett Street," this page).

GODERICH LANE

In looking at the history behind this street name, Freda MacDonnell's book "Before Kings Cross" is again a source of interesting information.

> "*The chunk of buildings . . . which turns the broad highway of William Street into a blind alley, owes its genesis to the grant of land made to a one-time Sheriff of New South Wales, T. Macquoid . . . on 19th October*, 1831.
>
> *On his land Macquoid had a handsomely finished stone mansion built which he named Goderich Lodge, in honour of the patron who had secured his appointment.* (Viscount Goderich was Secretary of State for the Colonies, in England . . . in 1827 and from 1830 to 1833.) *Goderich Lodge was designed and erected under the supervision of John Verge who prepared the original plans in* 1830. *It had the beautiful cedar fittings characteristic of the time, stone verandahs, and all 'the features of a first class family residence'. In* 1832 *the Macquoid family moved in.*"

Macquoid committed suicide in 1841 and his son was drowned in the wreck of the "Dunbar" at South Head in 1857. For a period Bishop Broughton lived at Goderich Lodge and later it was purchased by Frederick Tooth, who with his brothers ran Tooth's Kent Brewery. When the house was demolished about 1915, Hampton Court Hotel was built partly on the land it had occupied.

This name recalls Roslyn Hall which stood in Roslyn Avenue, near St Luke's Hospital, and was built for Thomas Barker about 1834. Barker, who had originally been apprenticed to an engineer, established flour mills in the Kings Cross area and in Sussex Street and became one of the richest millers in the colony. He had "retired" from business by 1835 but was active in many executive positions, including Director of the Sydney Railway Company. In 1853 he founded the Sydney University scholarship which bears his name.

Roslyn Hall had a famous iron staircase —said to be wide enough for a coach and pair to be driven up it—and the architect was Ambrose Hallen. Hallen and his brother Edward, each married a daughter of the explorer Lieutenant William Lawson, each received grants and lived at Darlinghurst and each received a recommendation from the famous English road, bridge and canal builder, Thomas Telford. It is claimed that in acknowledgement of his high esteem for Telford, Edward Hallen named his residence in Darlinghurst Road, Telford Place.

Ambrose Hallen became Colonial Architect and Town Surveyor but appears to have completed little of lasting merit. He prepared designs for a number of bridges, but these remained only on paper. Mitchell had a poor opinion of Hallen's talent and suggested that he would be better employed as engineer in charge of the proposed semi-circular quay at Sydney Cove. Hallen resigned in 1835, and in 1836 was associated with the formation of the Australian Gas Light Company.

Edward Hallen was also involved in architectural and engineering work. He began construction of Argyle Cut to improve access through the Rocks district, and designed the original central building of Sydney Grammar School, where his name can still be seen on a plaque facing College Street.

Craigend was probably the first of the great houses to be built at Darlinghurst and was the home of Major (later Sir) Thomas Mitchell, Surveyor-General, explorer and roadbuilder. Mitchell himself did some of the carved embellishments on the stone pillars of his new home which was named after his birthplace in Stirlingshire, Scotland. Less than six years later, in January 1837, Mitchell divided his Craigend estate into allotments and sold them by auction. He then moved further east to Darling Point where he built Carthona, almost on the water's edge, and here he died of pneumonia on 5th October, 1855, after catching a cold while surveying the mountain road between Batemans Bay and Braidwood.

This name also commemorates a fine old residence, Kellett House, which stood on the northern side of Bayswater Road. The house was originally named Bona Vista by the first owner, Deputy Surveyor-General, Samuel A. Perry, who, like Mitchell, was associated with our early roads. In 1836, the property was sold to Richard Jones, pasturalist, whaler and businessman, who changed the name to Darlinghurst House. About 1843, it was acquired by Stuart Donaldson who gave it the name Kellett House. Donaldson was later knighted and became the first Premier under Responsible Government in New South Wales (although he only held this position for less than 3 months from June to August, 1856). Donaldson was also a member of the original Senate of the University of Sydney and donated the fine clock in the front tower of the main building. Kellett House estate was sub-divided in 1864 and the house was subsequently demolished.

* * * * *

In 1851, Donaldson criticized government extravagance, making specific reference to Mitchell's Surveyor-General's Department. Mitchell was furious and the feud came to a head on 27th September with an illegal duel, fought with pistols in what is now Centennial Park. Neither contestant was severely hurt, neither was satisfied and they left still unreconciled. This is but one episode of the many associated with the history of the Cross and with the personal lives of the famous and often controversial early road-builders ●

For more information about past happenings and recent changes at Kings Cross, interested readers are referred to the following books, which were of valuable assistance in the preparation of this article.

* "*Before Kings Cross*" *by Freda MacDonnell—published by Thomas Nelson (Aust.) Ltd, Melbourne*, 1967.
* "*Life at the Cross*". *Text by Kenneth Slessor. Photographs by Robert Walker—published by Rigby Ltd, Adelaide*, 1965.
* "*Kings Cross Calling*" *by H. C. Brewster and Virginia Luther—printed by Liberty Press, Glebe*, 1953.

NEW BRIDGE AT SYDNEY AIRPORT

On 19th April, 1972, a new bridge over Cook's River at Arncliffe was opened to traffic. The new bridge provides access from the Prince's Highway, via West Botany Street and Marsh Street, to the International Terminal at Sydney (Kingsford-Smith) Airport. There was no official opening ceremony, although some workmen held a brief unscheduled celebration before removing the barriers.

The six-span prestressed concrete structure is 691 feet long and carries four lanes of traffic and two footways. At a later date, extensions will be constructed from the centre of the eastern end of the bridge to provide a direct link to the elevated roadway which leads to and from the upper level of the airport terminal. This extension will be built by the Commonwealth Authorities. The proposed layout can be seen in the above photograph of a scale model prepared by the Commonwealth Department of Works.

Designed by this Department, in consultation with the Department of Civil Aviation and the Commonwealth Department of Works, the new bridge was built under contract by Central Constructions Pty Ltd. The total cost, including approach roadworks, was $2,219,000 of which the Department's share was $1,615,000, the Commonwealth paying the balance. The Department paid the full cost of the southern approaches ($809,000), while the Department of Civil Aviation paid the full cost of the northern approaches ($110,000). The cost of bridgeworks ($1,300,000) was divided between this Department and the Department of Civil Aviation on a 62 per cent to 38 per cent basis.

The Department will provide, in the future, a new road link from General Holmes Drive, via Tancred Avenue, Kyeemagh, to Marsh Street (which has already been widened and improved) ●

* *A locality sketch showing the bridge site was published in the December,* 1969 *issue of "Main Roads"* (*Vol.* 35, *No.* 2, *page* 32).

* *Readers with access to back issues of "Main Roads" may be interested in comparing the past and the present layout of the area (in particular, the old routes of Cook's River and General Holmes Drive) as shown on the map published with the article "Main Road Re-arrangement at Mascot—Result of Kingsford-Smith Airport Enlargement", in the March,* 1952 *issue* (*Vol.* 17, *No.* 3, *page* 45).

Who was General Holmes?

Of the thousands of motorists who daily drive along General Holmes Drive, as it curves around the northern foreshores of Botany Bay, probably very few have any knowledge of the man behind the name.

Major-General William Holmes, C.M.G., D.S.O., V.D., was a distinguished Australian soldier who served in the Boer War and the First World War. Born at Victoria Barracks in 1862, he began his military career, when only 10 years old, as a bugler in the 1st Infantry Regiment (N.S.W. Forces). In 1899, he sailed with the first N.S.W. contingent to the Boer War. Before the war was over, he was wounded, mentioned in despatches, awarded the D.S.O., and promoted to be brevet-Lieutenant-Colonel. Invalided home, he took part in the ceremony of Federation and led returned soldiers in a procession through Sydney streets on 1st January, 1901.

In August, 1914 Holmes was chosen to command the Australian Naval and Military Expeditionary Force, consisting of reserves and volunteers, recruited and organized within one week and despatched to take action against German colonies in the Pacific. After capturing German New Guinea, Holmes moved his forces on to seize Rabaul on 12th September and to proclaim military occupation of New Britain and other German possessions. Certain provisions of the terms of surrender gave rise to severe criticism in Australia but the orders given to Holmes (i.e., to seize German wireless stations, occupy their territory, undertake temporary administration and not annex it) were not widely understood at the time. It is clear that Holmes acted in strict accordance with his instructions and international law.

Returning from New Guinea, Holmes was given command of the 5th Australian Infantry Brigade which landed at Gallipoli in August, 1915 and remained until the evacuation. Subsequently, he was with the Brigade in all its fighting in France from April, 1916 until January, 1917 when he was promoted to major-general and given command of the 4th Australian Division. He remained in charge of that division until he was mortally wounded on 2nd July, 1917, while taking the Premier of New South Wales, Hon. W. A. Holman, M.L.A., to view the battlefield at Messines. He died on the way to a field hospital and was buried in the British cemetery near Armentières.

It has been written of Holmes that he was "an experienced administrator who possessed fine moral qualities, transparent sincerity, energy, and great courage, and was one of Australia's most eminent citizen soldiers".

The latin inscription on the plaque at the southern end of General Holmes Drive (see details below) states "Dulce et decorum est patria mori" . . . "It is sweet and glorious to die for one's country".

However, soldiering is not the only activity in which his talents were valued. In civil life, Holmes was secretary of the Sydney Metropolitan Water, Sewerage and Drainage Board for 22 years from July, 1895 until his death. In recognition of this remarkable period of senior administrative service, a special plaque has been erected inside the Pitt Street entrance to the Water Board's Head Office, near the Honour Roll (see photograph on previous page).

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In 1918, the Water Board also erected a bandstand in Gladstone Park, off Darling Street, Balmain (over Balmain Reservoir) and on the plinth placed a memorial tablet to Major-General Holmes. Unfortunately, when vandals caused frequent damage to the bandstand later, Balmain Municipal Council was forced to demolish it. The memorial tablet was returned to the Water Board and was placed in storage. In October, 1952, the Board suggested that the Department might accept it for erection in a suitable position on the new route of General Holmes Drive, which was then being relocated because of extensions to Sydney Airport (see article in March, 1952 issue of "Main Roads").

After discussions with Rockdale Municipal Council concerning possible locations, it was agreed to erect it in the small triangular area of land bounded by General Holmes Drive, The Grand Parade and Sellwood Street, Brighton-le-Sands. This work was completed by Rockdale Council later in 1954. The cost of setting up a low concrete block and fixing the plaque to it was shared equally between Council and the Department.

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It has not yet been possible to trace any specific reference to the naming of General Holmes Drive. Particulars about this have been elusive although the following information from various sources seems to fit the story together.

Prior to the closure of the North Brighton Sewerage Farm (Treatment Works) in 1917, agitation commenced for the construction of a road through the area. The road was proclaimed a National Work on 5th April, 1917 and construction was undertaken by the New South Wales Department of Public Works to link Botany Road, Botany and The Grand Parade, Brighton. The necessary land was resumed by notification in the Government Gazette of 21st June, 1918 and the plan accompanying the notices of resumption apparently showed the proposed road as General Holmes Drive.

Much of the land through which the road was to be built had been previously administered by the Metropolitan Water Sewerage and Drainage Board. Furthermore, as Major-General Holmes, during his early married life, lived at Botany near the route of the new road, it seems probable that the Water Board, for whom he served so long, initially suggested that the road be named after him.

General Holmes Drive now forms part of Main Road No. 194 which extends from Botany Road, Mascot to Prince's Highway, Kogarah and provides a vital route for traffic travelling to and from the southeastern suburbs. It is an attractive and interesting drive, incorporating Endeavour Bridge over Cooks River (see details in the June, 1970 issue of "Main Roads", page 83) and a tunnel under the runway of Sydney Airport (see technical details in September, 1966 issue of the Journal of the Institution of Engineers, Australia). It also provides access to the Maritime Services Board huge research establishment on the northern foreshores of Botany Bay where wave behaviour in the Bay is being simulated and measured to assist in assessing port development requirements.

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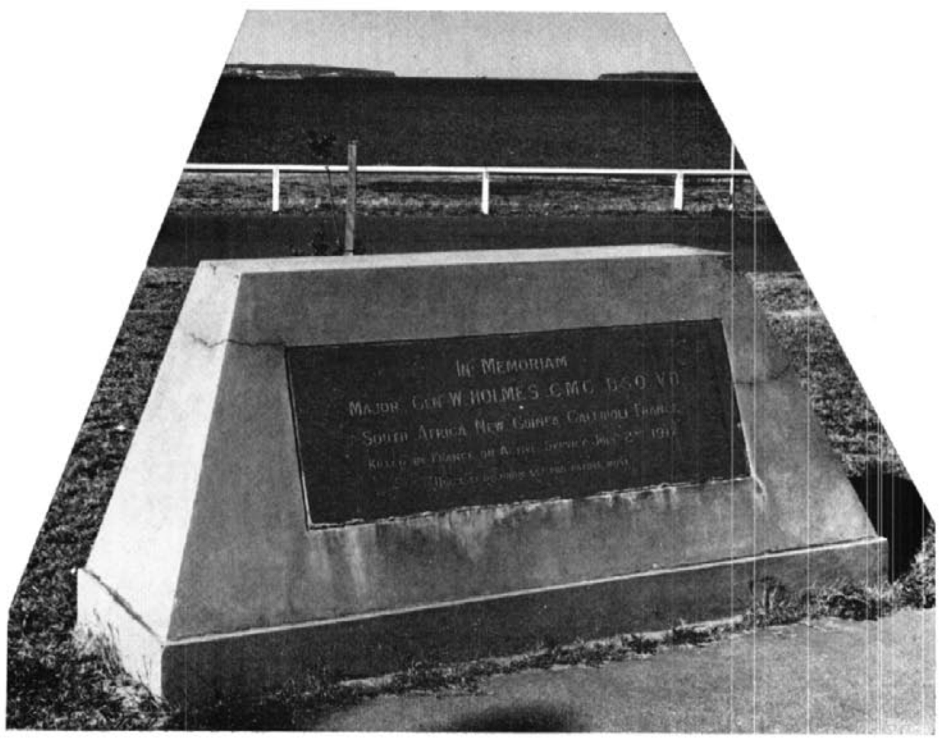
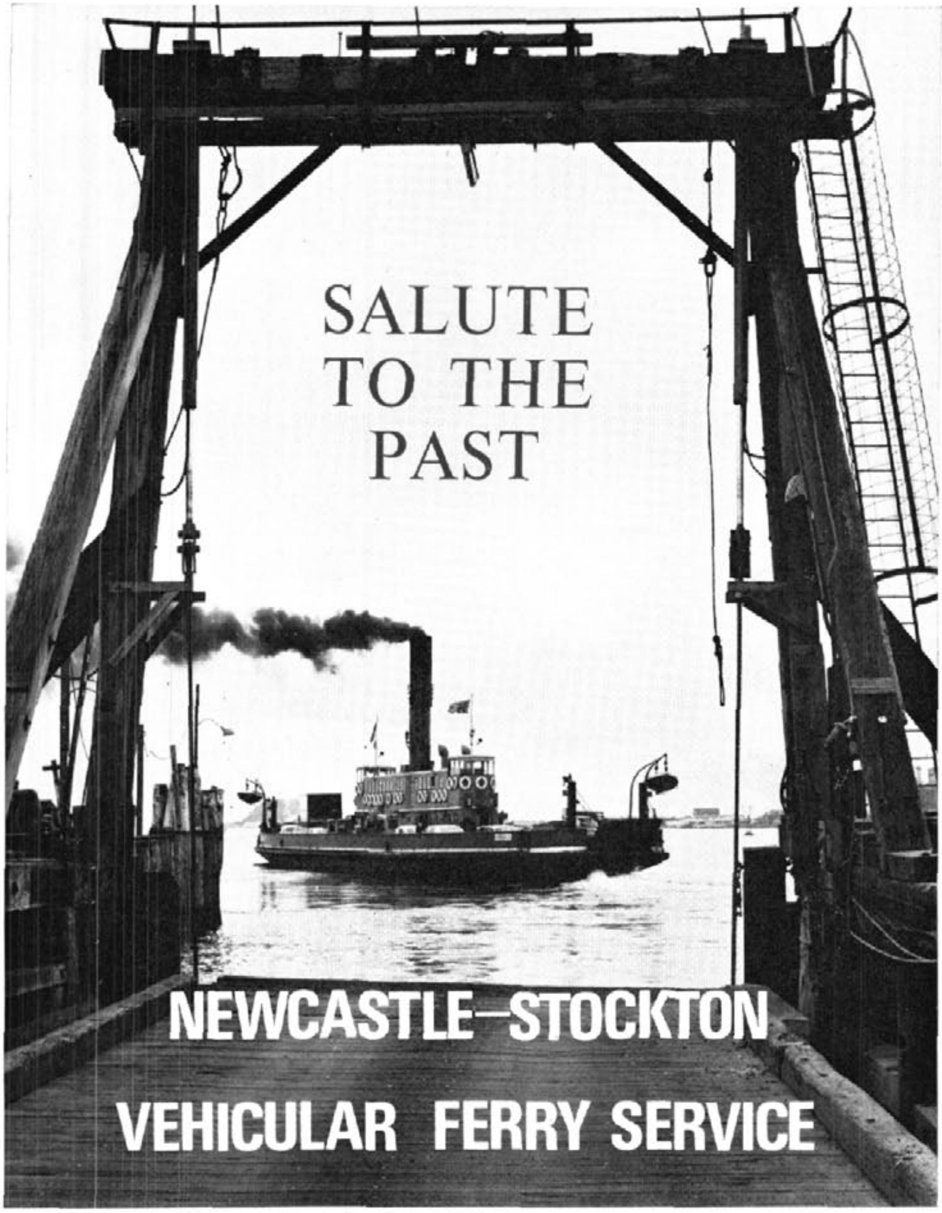
Additional information about Major-General Holmes is given in the Australian Encyclopaedia and his military work in New Guinea is detailed in "The Official History of Australia in the War of 1914–18, Volume X"—published by Angus and Robertson (1927).





s.s. "Koondooloo" approaching Stockton dock

The Newcastle–Stockton vehicular ferry service "passed into history" almost 12 months ago so, for the record and before the details become too blurred, here are some notes on how they were operated and some historical statistics about the vessels themselves.

Much of the material on which the article is based was provided by ex Senior Ferry Master, Captain A. P. Wilson, who is one of the many people, both passengers and crew, who look back on the ferries with nostalgic affection. These smoky, throbbing, rolling vessels had none of the rigidity, constancy or streamlined beauty of the new Stockton Bridge but, nevertheless, there was a certain fascination, as well as occasional frustration, in their independence and in the feeling of freedom that their journeys frequently engendered.

It was inevitable that modern-day motoring needs (and perhaps even anti-pollution protests) would eventually demand their replacement by something faster, cleaner, less capricious, less trouble and less costly to maintain. As for many years they gave passengers a few moments to pause and find refreshment in just watching the waves—so we pause for a few moments now to acknowledge their valuable contribution and the service of their crews.

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At the time of its termination in November, 1971, the Newcastle–Stockton vehicular ferry service consisted of three ferry vessels, s.s. "Koondooloo", s.s. "Lurgurena" and s.s. "Kooroongaba". Under normal circumstances the two larger vessels, the "Koondooloo" and the "Lurgurena" maintained the service. When either one of these vessels was taken off the service for overhauls or repairs, the smaller vessel, the "Kooroongaba", was brought in as the replacement ferry. The service was maintained by two ferries simultaneously, except between midnight and 5.45 a.m., when only one ferry was used.

GETTING UP STEAM

When a ferry vessel was taken out of service at midnight it was moored at the Department's Mooring Berth, on the Stockton side of the Port of Newcastle. Steam was maintained at an even pressure to allow cleaning of boiler tubes, back ends and condensors, as well as general maintenance and cleaning. Before commencing service again at 5.45 a.m., it was necessary for the fireman to stoke the fire, and for the engineer to warm up the engine. The vessel was then ready to take its place on the ferry run. Approximately one hour was needed to build up sufficient steam to operate and, thereafter, the furnaces were stoked half-hourly by the fireman.

TAKING ON COAL AND WATER

A contractor supplied coal to the ferry service each day of the week by using a truck to tip coal into the ships' bunkers. Twelve tons of coal per day were used for each of the vessels in service.

A supply of water was taken on board each vessel several times a day. This was done by means of a hose connected by a valve to the docks' water pipes, and leading to the ferry's water tank, which had a capacity of approximately 500 gallons.

SAILORS ALL

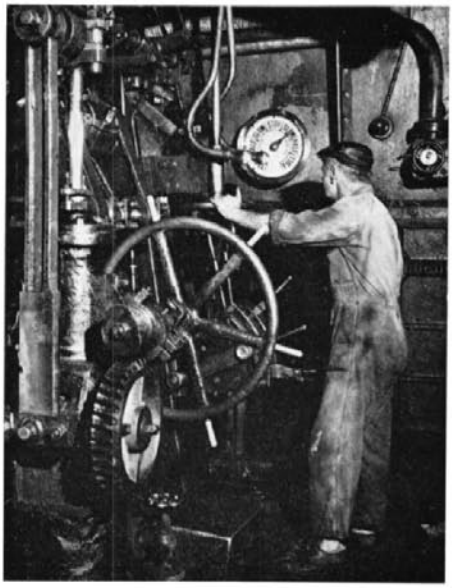
Six crew members operated each ferry (see photographs on page 28). These were:

- One Master—holding a Harbour and River Masters' Certificate. His duties consisted of complete supervision of the vessel, steering the vessel across the harbour and into the docks, checking the traffic embarking and disembarking, and recording the number of vehicles and passengers per trip.
- One Engineer—holding a 3rd class Marine Steam Engineers' Certificate. His duties were the control and operation of all machinery, oiling and checking all the moving parts of the engine and keeping all bilges pumped out.

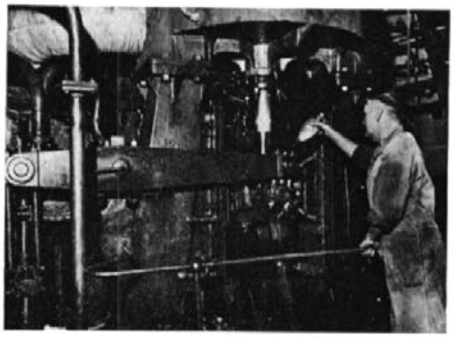
- One Fireman—whose duties included the stoking of fires, maintaining steam pressure at 160 psi and cleaning the boiler tubes and back ends.
- One Fireman-Deckhand—whose duties were to assist the fireman, clean the brasswork and to wipe down all auxiliaries and engine room plates. His work also included relieving the deckhand during meal breaks and performing other duties, as instructed by the Master or Engineer.
- Two Deckhands—whose duties consisted of controlling traffic on the deck of the vessel, operating hydraulic ramp gear, raising and lowering the flap on the vessel, removing ashes from the stokehold to the ash dump on Newcastle side and cleaning the decks and passengers' cabin.

LOADING AND UNLOADING

It was the responsibility of the Master to ensure that the vessel was securely moored at the docks before any vehicles were allowed to embark or disembark.

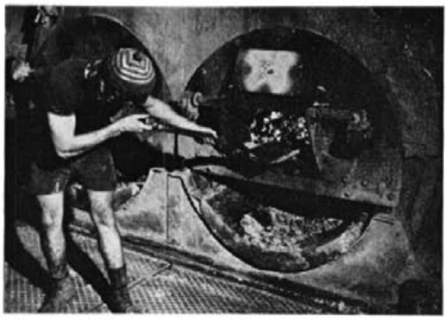


Engineer at the controls below deck receiving directions from Master in wheelhouse



Engineer oiling link gear in the "Lurgurena"

Master in the wheelhouse of the "Lurgurena"



Fireman "keeping up the pressure"

During this operation the engines were kept running at a slow speed—as a safety precaution.

One deckhand fixed a 5 in sisal rope to the mooring pile on the wharf and to the ship's bollards. The ship's flap was then lowered by a treble and double block (using 2 in sisal rope), one situated on each samson post (one for lifting and one for lowering). This was performed by the two deckhands. One deckhand then remained on board the vessel to direct traffic, while the other left the vessel in order to operate the controls of the hydraulic ramp on the docks. When the ramp was adjusted to a suitable height, the deckhand beckoned the driver of the vehicle at the head of the queue to proceed onto ferry. The other deckhand directed drivers of vehicles to their respective positions on board the ferry.

When the Master was satisfied that the vehicles were safely loaded, he rang the ferry's bell. At this signal, the toll collector closed the gate on the docks while the deckhands raised the flap and removed the mooring line. The Master then proceeded to the front of the vessel to pilot it to the other side of the crossing.

When the vessel reached the other side the same procedure for lowering the flap and adjusting the ramp was carried out. A deckhand then proceeded to call vehicles to disembark, one from the left and one from the right of the deck alternatively, until all vehicles were cleared. The other deckhand remained at the controls of the hydraulic ramp, in case it was necessary to adjust the height of the ramp to accommodate any vehicles with heavy loads. The weight of the ramp was at all times placed on the steel safety pins inserted into safety bars.

MAINTENANCE AND REPAIRS

- Annual overhauls—at the State Dockyard Floating Dock. These comprised an engineering and shipwright survey and all repairs as instructed by Maritime Services Board ship surveyors. The Board fixed the maximum number of vehicles and passengers which could be carried, specified the life-saving equipment required and issued an annual certificate to show that the vessels were in safe working condition in accordance with its statutory regulations.
- Six monthly overhauls—at the Department's Stockton Mooring Berth. These comprised an underwater survey, washing down, scraping and painting of the hull, as well as maintenance and necessary repairs to machinery. During its own overhauls (commenced in 1956), the Department employed a senior engineer, a maintenance engineer, a leading hand fitter, a boilermaker, a shipwright, three painters and dockers and nine casual fitters.
- Between overhauls, minor repairs were often necessary to remedy such faults as leaking boiler tubes, damaged sponsons and breakdowns in electrical equipment.

HARBOUR HAZARDS AND HIGHLIGHTS

Shipping movements in the harbour, fogs, strong tidal waters, heavy swells, strong southeasterly winds, and flood debris (from the Hunter River system) often made the Newcastle–Stockton crossing quite an adventurous journey. The narrow channel on the approach to the Stockton Docks was frequently the cause of ferry vessels running aground on a mud bar.

In spite of these difficulties, no fatalities and few serious mishaps occurred on this busy crossing. Back in 1934, a cyclist who fell from the ferry into the harbour was rescued by the quick and courageous action of one of the crew. Since then only two similar accidents have occurred.

- In July, 1952, two motor cyclists slipped off the ferry flap into the water, and
- in November, 1968, a station sedan slipped from the ferry flap into the water. Only one occupant was in the vehicle and he was able to free himself and climb to safety.

Several collisions between ferries and other ships are recorded in Departmental files and these include collisions

- between s.s. "Lurgurena" and the tug "Heroic",
- between s.s. "Lurgurena" and s.s. "Koondooloo" in September, 1961,
- between s.s. "Lurgurena" and the s.s. "Tatana" (owned by Union Steamship Co.) in February, 1964,
- between s.s. "Lurgurena" and the Stockton passenger ferry "Newcastle on Hunter" in December, 1966 and
- between s.s. "Koondooloo" and s.s. "Kooroongaba" in fog in May, 1967.

Emergency trips were frequent—with ambulance, police and maternity cases featuring prominently. There have been at least two occasions (in 1959 and 1965) when babies were born in vehicles being ferried across Newcastle Harbour.

THE FLEET

Recent research and discussions with elderly citizens in the area suggest that a vehicular ferry service operated between Newcastle and Stockton before 1916. It appears to have been a flat top barge towed by a tug named the "Pinafore" and probably only carried a few sulkies or drays. The service is said to have been run by Mr Peter Callen, who also operated a sawmill and slipway at Stockton in the vicinity of the dock (and, incidentally, constructed the second bridge—a timber structure—over the entrance to Lake Macquarie at Swansea, between 1908 and 1910). It must have been a somewhat infrequent or irregular service as the tug was also used for towing barges in the harbour and for taking the garbage punt "Polly" out to sea daily.

s.s. "Mildred"

With the opening of the steel works in 1915, Newcastle began a period of rapid expansion and there was need for a regular service to link the City and Stockton.

In 1916 a service was commenced by the Department of Public Works. The first ferry vessel used was the s.s. "Mildred" which had been specially built at Walsh Island Dockyard (now the State Dockyard). It had a steel hull, 100 ft long and 27 ft wide, with a draught of 7 ft. The vessel's displacement was approximately 200 tons and its speed 10 knots. It carried 15 vehicles and 70 vehicular passengers. (13 passengers in the lower deck cabin and 12 in the upper deck cabin.)

To accommodate the new ferry, the Department of Public Works built docks at Merewether Street, Newcastle and at Stockton (east of the now disused docks). As the demand for the ferry became greater, the timetable was increased from an hourly service to a 40-minute service and was later improved to provide a half hourly crossing.

When the "Mildred" was taken off the run for three weeks each year for its regular overhaul, the service had to be carried on using a large flat-topped punt, tied to a steam tug. The punt was temporarily equipped with flaps and a handrail and could accommodate 16 vehicles. However, this punt-tug combination was extremely slow and only an hourly service could be maintained.

By the time the Department of Main Roads took over the service in 1930, the increase in traffic was causing long delays on both sides of the harbour and consequently a second vessel (s.s. "Kooroongaba") was purchased in 1932.

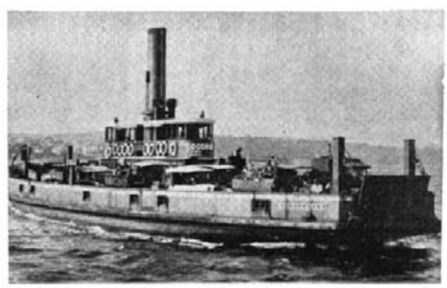
In 1942 the "Mildred" was moved down to the Hawkesbury River to operate at Peat's Ferry in place of the vessels "George Peat" and "Frances Peat", which had been taken over for war operations. On the completion of the bridge on 5th May, 1945, the "Mildred" returned to Newcastle. Following the purchase and re-fitting of the "Lurgurena", the "Mildred" was sold by public tender in 1946 to the Phillip Island and Westernport Shipping Company for £9,250 ($18,500).

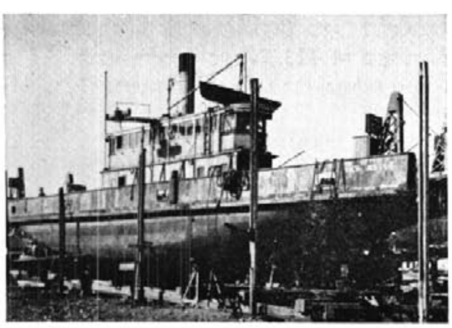
s.s. "Kooroongaba"

To cope with increased traffic, s.s. "Kooroongaba" was purchased by the Department in 1932 for £7,500 ($15,000). This vessel was originally built at Walsh Island Dockyard in 1921 for Sydney Ferries Ltd and used on the Bennelong Point–Milson's Point vehicular ferry service. It became available for purchase after the closure of that service on 1st April, 1932, following the opening of Sydney Harbour Bridge on 19th March, 1932.

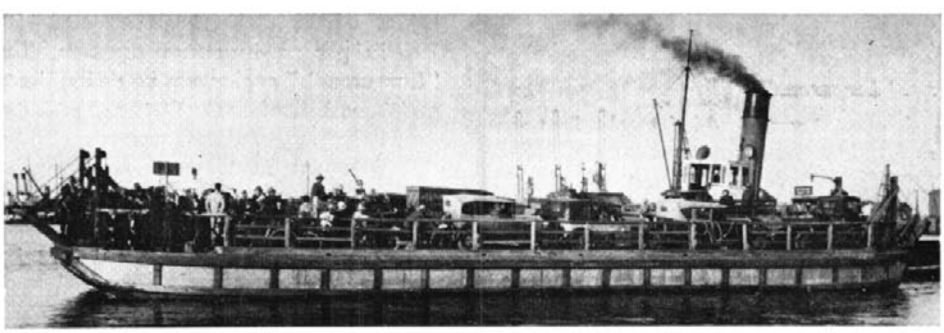
The "Kooroongaba" carried 28–35 vehicles and 190 passengers and had a steel hull (and timber deck) 145 ft 6 in long and 38 ft 6 in wide, with a draught of 8 ft 6 in. It was screw-propelled and driven by a reciprocating triple expansion steam engine of 750 indicated hp. Its gross tonnage was approximately 313 tons and its speed 10 knots. It is interesting to note that the "Kooroongaba", like all Sydney ferries at that time, was fitted only

The "Kooroongaba" on Sydney Harbour, prior to its purchase by the Department and transfer to Newcastle in 1932

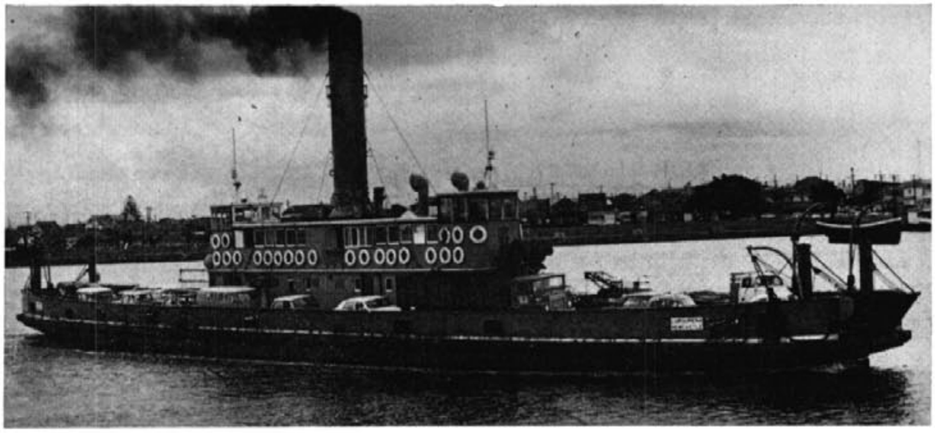




The "Mildred" on slips for overhaul (1932).



Punt attached to tug and used to relieve the "Mildred" in the 1920–30'*s.*



The "Lurgurena"

with kerosene lighting until 1924, when some 1914–18 war disposal generators were installed to provide electric lighting.

Before the "Kooroongaba" was placed in service it was necessary to construct new docks, as the existing ones were too narrow. On the Newcastle side, a new site was chosen in Wharf Road, east of the previous docks which were situated at the eastern end of Lee Wharf (on the site now occupied by the Water Police). The new Stockton docks were built a little upstream, about 150 yards west of the previous docks. These new locations simplified approach manoeuvres both for the ferries and for the vehicles waiting to board them.

It was originally intended that the "Kooroongaba" would also operate at Peat's Ferry on the Hawkesbury River, when the two ferries there were unable to cope with peak weekend traffic, but this was soon found to be impracticable. Because of austere wartime restrictions, the "Kooroongaba" maintained a continuous service across Newcastle Harbour throughout World War II, without having a major overhaul.

"Kooroongaba" is said to be an aboriginal name meaning "pelican". The following aboriginal words and their meanings are also of interest because of their application to ferry activities. "Kooroo" means "firestick", "gabba" means "water", "koorong" means "boat" or "pine tree", and "kooronga" means "boomerang".

s.s. "Lurgurena"

The next vessel added to the fleet was s.s. "Lurgurena". This vessel was built at Saltney Shipyard, Chester, England, by J. Crichton & Co. Ltd in 1925, for the vehicular ferry service between Hobart and Bellerive on the Derwent River in Tasmania. When the Derwent River pontoon bridge was opened to traffic in 1944, the "Lurgurena" became available for purchase. In view of the advancing age of the "Mildred", the increasing cost of overhaul and its limited capacity, the Department took the opportunity to purchase the "Lurgurena" (and subsequently sold the "Mildred" in 1946).

Considerable repairs were necessary before the "Lurgurena" could undertake the voyage to Newcastle and these repairs were carried out by two Hobart firms. Arrangements for protection of the vessel from waves were similar to those for the original voyage of the vessel from England to Hobart. A contract was let to Mr G. Newell of Sydney for delivery to Newcastle and the vessel arrived there on Christmas Eve 1945.

An extensive overhaul and re-fit was then put in hand, including the fitting of life boats and the provision of better visibility from the wheelhouse. Furthermore, as the "Lurgurena" had a deeper draught than the "Kooroongaba", dredging had to be undertaken on the Stockton side. A trial run was made at high tide during October and the "Lurgurena" commenced service on 6th December, 1946.

The "Lurgurena" was a double-ended single screw propelled vessel with a capacity of 38 vehicles and 280 passengers. It had a steel hull, 187 ft long and 35 ft 6 in wide, with a draught of 11 ft 6 in. The gross tonnage was 576 tons and power was supplied by a triple expansion steam engine developing 1,150 indicated hp at 180 lb per sq in steam pressure. The "Lurgurena's" engine was made by Plenty and Sons Ltd of Eagle Works, Newbury, England and the boiler was made—appropriately, in view of such similar location names—by Rucy Bros of Stockton-on-Tees, England.

s.s. "Koondooloo"

The fourth and largest ferry to operate between Newcastle and Stockton was the s.s. "Koondooloo". This vessel was launched in March, 1924 at Leith, Scotland and sailed to Sydney under its own power. It arrived on 22nd July, 1924 and joined the Bennelong Point–Milson's Point vehicular ferry service, under the control of Sydney Ferries Ltd. When Sydney Harbour Bridge was opened in 1932, this vessel became surplus and in 1936 it was converted to run as the first Sydney "Showboat". It was later remodelled as a three-decker and sailed on hundreds of pleasure cruises around Sydney Harbour until September, 1942, when the Department of Navy requisitioned it.

The Navy fitted out the vessel as a floating repair ship (No. S.181) for the small ships section of the Army. Before being used by the Army the "Koondooloo" was converted to a single-ended vessel, the bows at the forward end being built up for work outside Sydney Harbour. It undertook the transport of Army vehicles and equipment in the Pacific war-zone and sailed unescorted to Port Moresby and New Britain. In 1945, it sailed back to Sydney from the Admiralty Islands and in October, 1946 it was returned to its original owners, Sydney Ferries Ltd.

Departmental investigations of traffic needs at Newcastle in 1948 indicated that the combined capacities of the "Lurgurena" and the "Kooroongaba" were inadequate to meet peak demands and it was decided that another large vessel was required. The "Koondooloo" was offered to the Department by Sydney Ferries Ltd and the purchase was completed in December, 1950. Extensive work had to be carried out on the vessel to make it again suitable for use as a vehicular ferry and it commenced service in 1952.

The "Koondooloo" carried 42 vehicles and 283 passengers. It had a steel hull, 191 ft 7 in long and 35 ft 8 in wide, with a draught of 11 ft 6 in. The gross tonnage was 526 tons and the vessel was screw-propelled and powered by a triple expansion steam engine developing 1,150 indicated hp. Steam was supplied by two gunboat-type boilers with a working pressure of 180 lb per square inch. After being taken over by the Department, the original steam steering was replaced by a "Donkin" hydraulic steering system.

"Koondooloo" is an aboriginal word for "emu".

TIMES AND TRAFFIC

In the 1950's traffic needs made it essential for the two largest ferries (the "Koondooloo" and the "Lurgurena") to run a ¼ hourly service from 6.45 a.m. to 6.30 p.m. daily. This was later extended to 7.45 p.m. and then from 5.45 a.m. to 11.45 p.m. Between 11.45 p.m. and 1.15 a.m. and between 2.15 a.m. and 5.45 a.m. a ½ hourly service was provided while between 1.15 a.m. and 2.15 a.m. an hourly service was sufficient.

In 1947 it was calculated that these vessels ran a combined average of 645 trips each week and carried 6,777 vehicles. By 1961 these weekly figures had risen to about 1,100 trips (4,400 per month), 24,000 vehicles (96,000 per month) and 6,250 pedestrians (25,000 per month). In 1970, the annual average daily traffic volume recorded at this site was 4,060 vehicles.

THE END OF AN ERA

On 1st November, 1971 Stockton Bridge was opened to traffic and the vehicular ferry service was discontinued (see article in the March 1972 issue of "Main Roads", Vol. 37, No. 3, pages 68–69). After making its final run across Newcastle Harbour (departing Stockton at 3.30 p.m.), the "Koondooloo"—the "flagship" of the service—steamed north under Stockton Bridge in a symbolic farewell voyage. The "Lurgurena" made her last trip from Newcastle to Stockton at 4.00 p.m.

After the ferries were moored at Stockton for the last time, a special function was held in a hall near the docks. The then Minister for Highways, Hon. P. H. Morton, M.L.A., and the Commissioner for Main Roads, called in to say "good-bye" to a party of 65 "ex" crew members, 23 of whom were to remain with the Department in different avenues of work. Earlier, following the official opening of Stockton Bridge, the Premier of New South Wales, Sir Robert Askin, presented the bell of s.s. "Koondooloo" to the Senior Ferry Master, Captain A. P. Wilson, who had joined the service as a deckhand and had become a Master in 1939.

DRIFTING INTO THE HEADLINES

Later in November, 1971, the three ferry vessels were sold by public tender to Goldfields Metal Traders for $12,000.

The company proposed to sell the vessels in the Philippines for conversion into timber barges and it was intended that, together with the former showboat "Sydney Queen", they be towed 4,000 miles by tug to Manilla. However, the smallest vessel at the end of the long towing cable was s.s. "Kooroongaba" and on 3rd January, 1972, after taking in water, it foundered in about 60 fathoms of water, 10 miles off Crowdy Head (near Taree) and less than 90 miles north of Newcastle.

The remaining three vessels were towed into Trial Bay (northeast of Kempsey) for inspection and repairs to hatches etc. However, a few nights later, on 9th January s.s. "Koondooloo" broke loose from the oil terminal buoy to which they had been moored and ran aground on the beach at South West Rocks. While s.s. "Koondooloo" defied all attempts to free it, the "Sydney Queen" broke away and became similarly beached. On 13th January, s.s. "Lurgurena" was also blown from its moorings by strong northeasterly winds and joined the other two, wedged solidly into the sand.

Early next morning, s.s. "Lurgurena" was refloated on the high tide and towed back to the moorings by the tug. But, soon after, the vessel was found to be leaking badly and had to be deliberately beached again to save it sinking.

This "saga of the sea" threw the old ferries into the sudden spotlight of publicity in press, radio and T.V. news. Shipwrecks are now seldom seen along the Australian coastline and, without the overtones of tragedy, these grounded vessels developed a sudden and remarkably magnetic fascination for tourists. Crowds, estimated sometimes to have been more than 3,000 people, gathered at the beach and surrounding vantage points to just sit and watch. Joy flights have even been available from Port Macquarie to give visitors an aerial view of the scene at South West Rocks. At one stage, some former crewmen of the vehicular ferries offered to "fire up" the boilers and attempt to sail the vessels off the sand under their own steam. Auxiliary pumping and other attempts to tow them off the beach have been abandoned and the three vessels are now slowly breaking up.

Still beached, the final performance of the stranded ferries goes on amid the sound of surf on sand, as they continue to draw crowds of weekend sightseers and holidaymakers to watch the drama of their last days.●

The following articles in earlier issues of "Main Roads" contain additional information on this service:

* *November, 1932, Vol. 4, No. 3, pages 37–38 "The Newcastle–Stockton Vehicular Ferry".*
* *June, 1947, Vol. 12, No. 4, pages 126–127 "New Vessel for Newcastle–Stockton Ferry Service".*
* *December, 1948, Vol. 14, No. 2, pages 43–47 "Main Road Ferries—Their operation and maintenance".*

PRICE INCREASE

As from this issue, individual copies of "Main Roads" will cost 50 cents each instead of 30 cents and the subscription rate will rise from $1.20 to $2.00 per annum, post free.

This is the first price increase that has taken place in over eleven years, despite the added production and postage costs which have been incurred during that period. Colour covers and centre pages have also been introduced and are now a regular feature of the Journal.

By now, all subscribers will have received individual advice of these new rates and how they affect their current subscriptions. In thanking our subscribers for their continued interest, we also express the hope that they will continue to enjoy the articles on the varied activities of the Department and to consider the Journal to be good value for their money.

TENDERS ACCEPTED BY COUNCILS

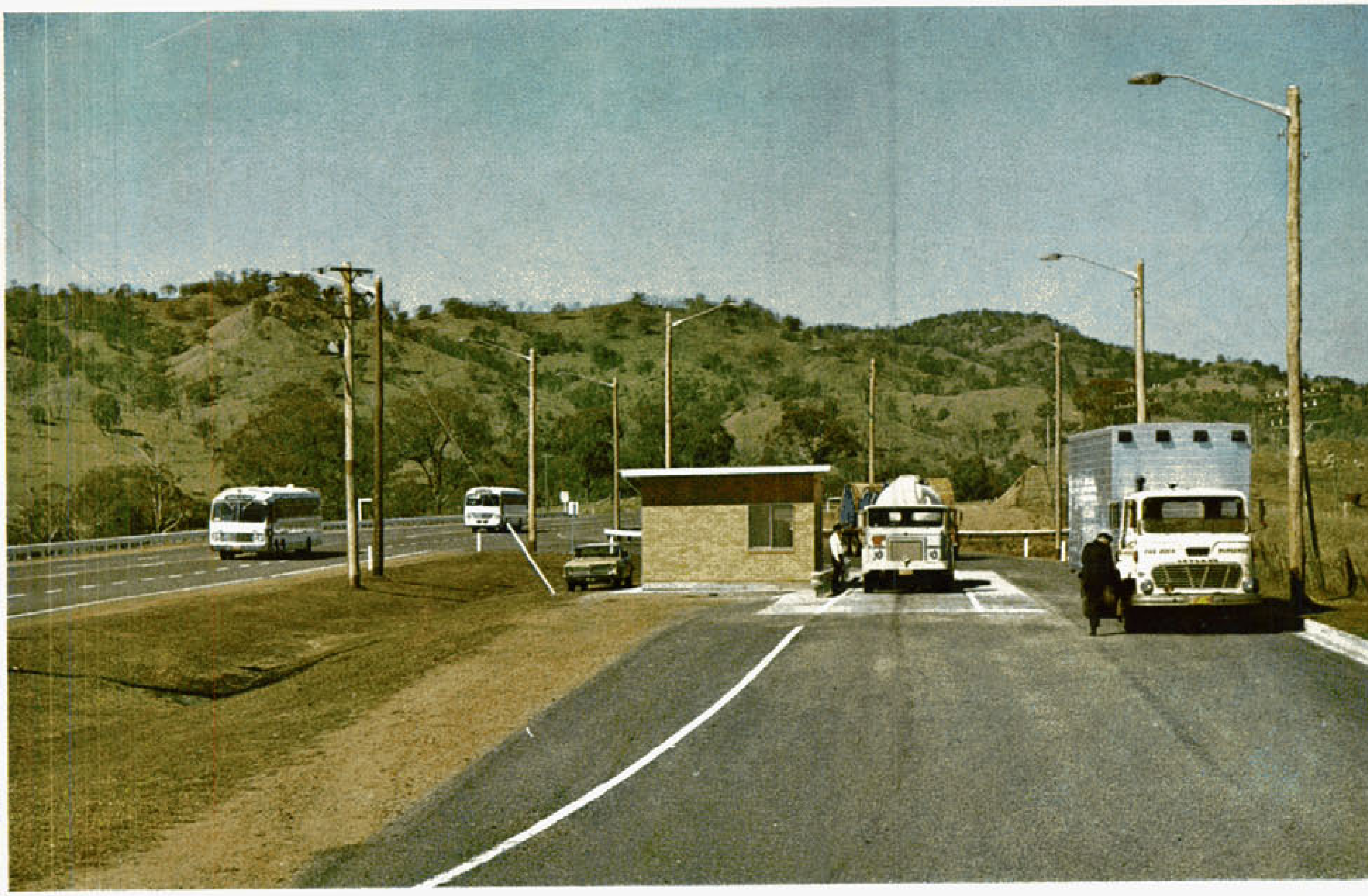
The following tenders (in excess of $10,000) for road and bridge works were accepted by the respective Councils during the three months ended 30th June, 1972.

Council	Road No.	Work or Service	Name of Successful Tenderer	Amount $
North Sydney	Various	Replacement of deteriorated or deformed asphaltic concrete on various roads.	Bituminous Pavements Pty Ltd	12,181.50
Port Stephens	M.R. 108	Construction of 3-span prestressed and reinforced concrete bridge over Cox's Lane between Fern Bay and Main Road No. 302.	Convar Pty Ltd	46,638.00
Wentworth	T.R. 68	Supply and delivery of ½ in sealing aggregate between 21·24 and 34·53 miles north of Wentworth.	Mildura Quarries and Ready Mix Pty Ltd	15,624.00
Wentworth	T.R. 68	Supply, spray and rolling of bitumen and flux between 21·24 and 34·53 miles north of Wentworth.	Allen Bros. (Asphalting Contractors Pty Ltd)	12,883.17

TENDERS ACCEPTED BY THE DEPARTMENT OF MAIN ROADS

The following tenders (in excess of $10,000) for road and bridge works were accepted by the Department during the three months ended 30th June, 1972.

Road Number	Work or Service	Name of Successful Tenderer	Amount
			$
Western Distributor	City of Sydney. Supply and erection of seven high mast lighting units.	James Watt Engineering Pty Ltd	55,921.00
Western Expressway	Municipality of Blacktown. Manufacture and erection of 72 pretensioned and prestressed concrete girders for bridge over Western Expressway at Wallgrove Road.	Peter Verheul Pty Ltd	89,820.00
South Western Expressway	Cities of Liverpool and Campbelltown. Construction of 2-span prestressed and reinforced concrete bridge, 303 ft long, over South Western Expressway, 1 mile south of Cross Roads.	Transbridge Pty Ltd	224,990.00
Southern Expressway	City of Wollongong. Excavation of trenches for longitudinal and subsoil drainage from 32·6 to 33·2 miles south of Sydney.	Australia Wide Excavators	14,510.40
Southern Expressway	City of Wollongong. Construction of two reinforced concrete box culverts over Byarong Creek on link road to Southern Expressway.	Citra Constructions Pty Ltd	231,030.00
Southern Expressway	City of Wollongong. Excavation of drainage trenches approximately 29 miles south of Sydney.	Mr S. Barahanos	22,784.30
Southern Expressway	City of Wollongong. Construction of 3-span prestressed and reinforced concrete bridge, 179 ft long, to carry Mt Ousley Road (M.R. 513) over loading ramp from Prince's Highway to Southern Expressway at top of Bulli Pass.	Central Constructions Pty Ltd	166,392.00
Southern Expressway	City of Wollongong. Construction of 8-cell 12 ft x 12 ft reinforced concrete box culvert over American Creek, 53·4 miles south of Sydney.	The Hornibrook Group, Southern Division.	258,514.00
Southern Expressway	City of Wollongong. Construction of 3-span prestressed concrete box girder bridge, 412 ft long, to carry Appin Road (M.R.177) over Southern Expressway near top of Bulli Pass.	Transbridge Pty Ltd	499,275.32
State Highway No. 2	Hume Highway. Shire of Gundagai. Construction of 4-span prestressed and reinforced concrete bridge, 140 ft long, over Big Ben Creek, 4·5 miles south of Gundagai.	Allan Tessier Pty Ltd	41,303.75
State Highway No. 2	Hume Highway. Shire of Goodradigbee. Construction of twin, 3-span, 90 ft long, prestressed and reinforced concrete bridges over Bowning Creek at Bowning.	Siebels Concrete Constructions Pty Ltd	72,027.70
State Highway No. 7	Mitchell Highway. Shire of Molong. Construction of 6-span prestressed and reinforced concrete bridge, 362 ft long, over Bell River at Three Rivers, 14 miles north of Molong.	A. Cipolla and Co. Pty Ltd	157,743.00
State Highway No. 7	Mitchell Highway. Shire of Molong. Construction of 3-span prestressed and reinforced concrete bridge, 170 ft long, over Molong Creek at Larras Lee, 7·5 miles north of Molong.	Emoh Ruo Court Pty Ltd	78,703.80
State Highway No. 7	Mitchell Highway. Shire of Canobolas. Widening of bridge over Gosling Creek, 4·4 miles east of Orange and bridge over Frederick Valley's Creek, 8·5 miles east of Orange.	Campbell Earthmoving and Engineering (Orange) Pty Ltd	59,804.30
State Highway No. 10	Pacific Highway. Shire of Hastings. Construction of 15-span prestressed and reinforced concrete bridge, 1,836 ft long, over Wilson River at Telegraph Point, north of Port Macquarie.	Pearson Bridge (N.S.W.) Pty Ltd	1,432,000.00
State Highway No. 11	Oxley Highway. Shire of Warren. Construction of 4-span prestressed and reinforced concrete bridge, 220 ft long, over Gunningbar Creek at Warren and demolition of existing timber bridge.	Peter Verheul Pty Ltd	138,154.45
State Highway No. 16	Bruxner Highway. Shire of Kyogle. Manufacture, supply and delivery of 24 prestressed concrete girders for construction of new bridge over Deep Creek at Piora, 13·2 miles west of Casino.	Humes Ltd	34,400.00
State Highway No. 17	Newell Highway. Municipality of Narrabri. Construction of 5-span prestressed concrete bridge, 325 ft long, over Namoi River at Narrabri.	M. & E. Firth Civil Constructions (Tamworth) Pty Ltd	195,195.00
Main Road No. 173	City of Sydney. Kings Cross Tunnel Project. Manufacture and delivery of 68 precast, pretensioned concrete bridge planks.	Peter Verheul Pty Ltd	30,600.00
Main Road No. 177	City of Campbelltown. Construction of superstructures of two 3-span prestressed and reinforced concrete bridges, each 232 ft long, over South Western Expressway 4 miles south of Cross Roads.	Transbridge Pty Ltd	405,468.00
Main Road No. 513	City of Wollongong. Widening of bridge over Bellambi Creek at Colliery Dam.	Western Bridge Constructions Pty Ltd	41,500.00
Unclassified (proposed Main Road)	Municipality of Bankstown. Northern approach to bridge over George's River at Alfords Point. Construction of 3-span reinforced and prestressed concrete bridge, 347 ft long, over Henry Lawson Drive at Padstow	John Holland (Constructions) Pty Ltd	442,641.00

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