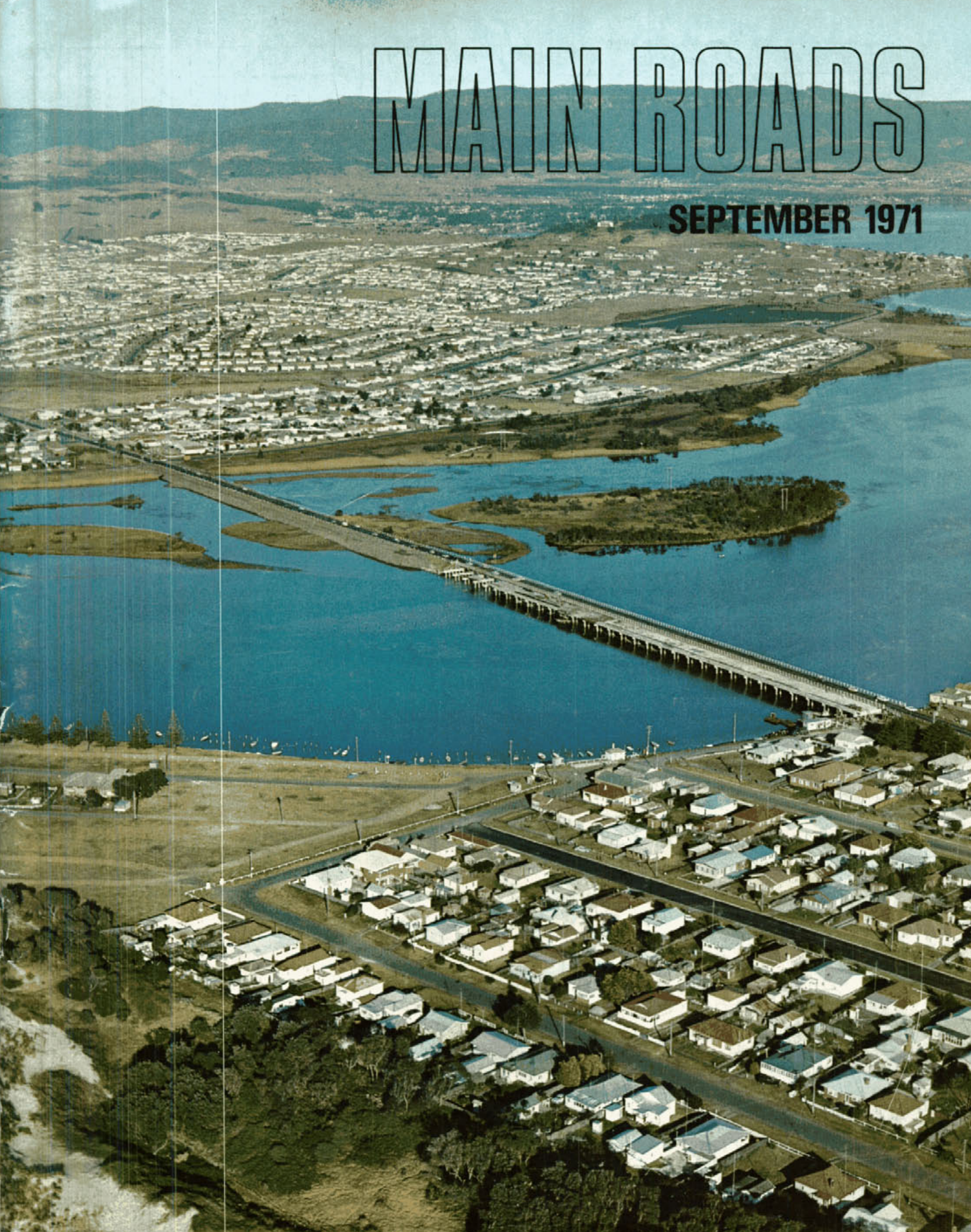
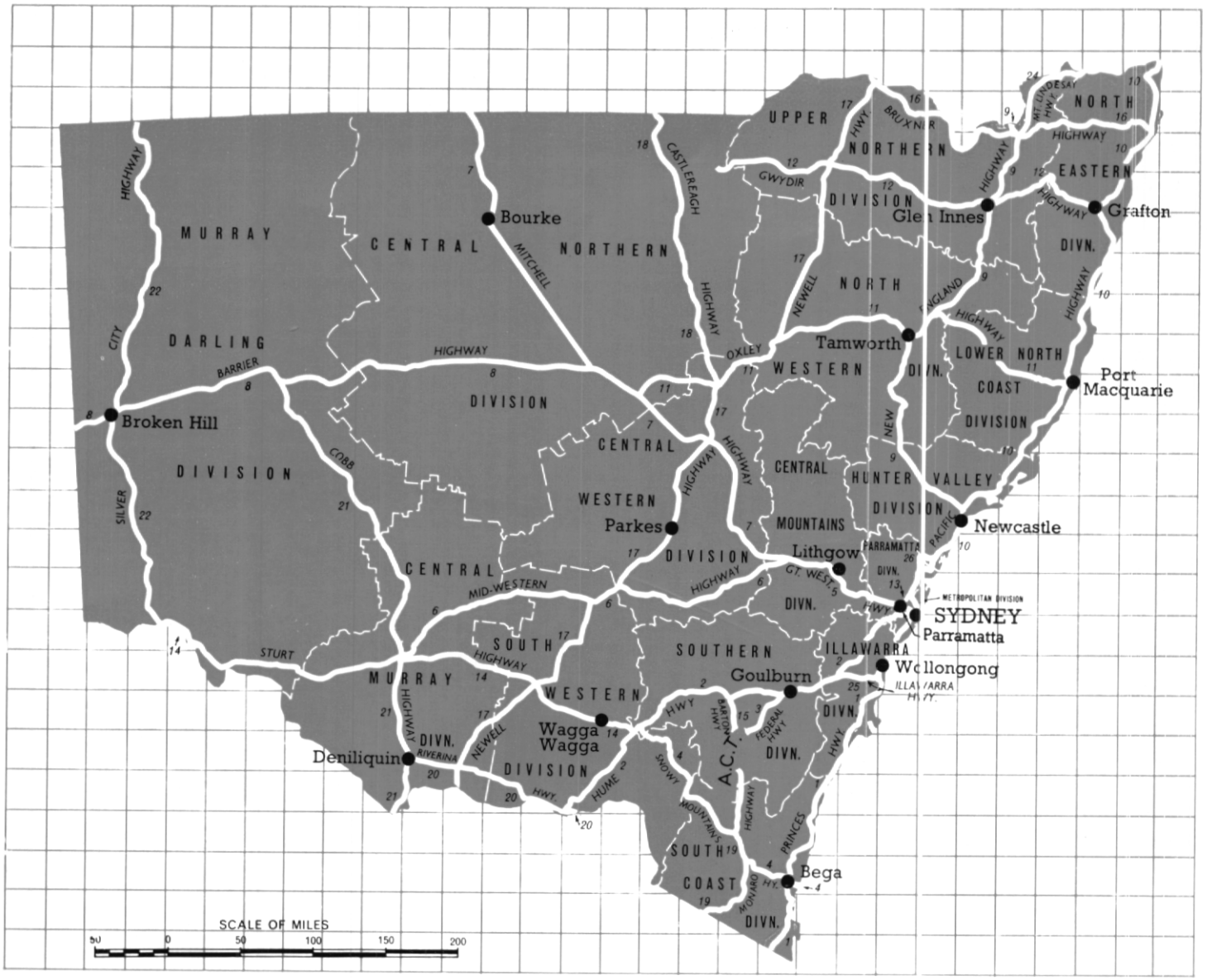
# MAIN ROADS

## SEPTEMBER 1971






# HIGHWAY SYSTEM OF 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 |

*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*

STATE HIGHWAYS
DIVISIONAL BOUNDARIES
DIVISIONAL OFFICES

# MAIN ROADS

JOURNAL OF THE DEPARTMENT OF MAIN ROADS, NEW SOUTH WALES

SEPTEMBER, 1971

VOLUME 37 NUMBER 1

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R. J. S. Thomas

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CONTENTS



*Front Cover: Construction of new bridge, 983 feet long, adjoining present structure over entrance to Lake Illawarra at Windang, on Port Kembla-Shellharbour Road. Later, the superstructure of the old bridge will be replaced and the two bridges combined into one four-lane structure.*

*Back cover: Some of Samuel Elyard's paintings of Nowra in the late 1800's, with similar present-day views. Reproduced by courtesy of Shoalhaven Shire Council (see article on page 18).*

*Top: Looking south to Presbyterian Church and old Empire Hotel (on left), near junction of present Kinghorne and North Streets, which both form part of Prince's Highway.*

*Upper centre-left: St Andrews Presbyterian Church (opened 1875) and Manse, situated on Prince's Highway at junction mentioned above.*

*Upper centre-right: Looking south along Kinghorne Street, showing corner of Marriott Park on left.*

*Lower centre-right: Approximately the same location, as depicted in Elyard's painting of "Tory's Terrace" in Kinghorne Street.*

*Lower centre-left: The site of Bridge Road, showing Graham Lodge (right), Shoalhaven River (left) and Coolangatta Mountain in the background.*

*Bottom: A similar "seventy-one" view, looking east from near West Street.*

# ADVENTURES IN SPACE

A milestone in motoring history, and surely the ultimate in weekend driving, was reached on Sunday, 1st August, 1971, when two American astronauts undertook the first vehicular journey on the moon's surface in a $10 million lunar *buggy* called Rover. The technical precision of the whole Apollo 15 mission, performed so efficiently and so successfully before an audience of millions of "on-the-spot" T.V. viewers, was a remarkable achievement. It makes many more mundane tasks, such as road-building, pale by comparison.

However, astronauts are not the only ones exploring new frontiers—they just go further and faster. Not wanting to remain timidly earthbound, the Department has taken to the air to do some *space* exploration of its own. In 1964, a helicopter was purchased and it soon revolutionised road location investigations. But the Department's work initially "got off the ground" back in 1937, when it first made use of aerial photography instead of conventional ground survey methods. The first of three articles on this fascinating facet of the Department's aerial exploration appears in this issue.

Because his final assignments are so complex and so critical, an astronaut's life is one of severe training, learning to do automatically what is, at first, unusual and unfamiliar. Photogrammetrists similarly spend many years in learning the skills necessary for their own complex and important projects. To ensure the highest standards in this specialist work, the Department recently sponsored two photogrammetrists to study at the International Training College in Holland. This is part of the continuing story of training officers to develop new skills and widen our technical horizons.

Building better roads is a *down-to-earth* job but their planning is previewed by extensive aerial investigations. In its own *sphere*, exploration which culminates in improved driving conditions is as interesting and as valuable as moon motoring.

# NORTH WESTERN EXPRESSWAY
## Sydney to Glebe

It was announced in June, 1971, that the Department will soon begin construction of section of the North Western Expressway between the City of Sydney and the suburb of Glebe.

The North Western Expressway will form part of the planned expressway route between the cities of Sydney and Newcastle. It will extend from the City at Druitt Street via Glebe, Balmain and Drummoyne to Huntley's Point where it will connect with the Lane Cove Valley Expressway which, in turn, will join the Sydney-Newcastle Expressway at Wahroonga.

A major section, consisting of the Gladesville, Tarban Creek and Fig Tree bridges, the Huntley's Point overpass and associated roadworks has already been built and has provided considerable relief for traffic.

The Department is now ready to proceed with the complex city end of the facility.

* * * * *

The design for the section from the City to Glebe is being undertaken for the Department by consulting engineers, De Leuw Cather of Australia Pty Ltd. This firm also designed the first section of both the Warringah Expressway and the Western Distributor for the Department.

Construction of this section of the Expressway, is scheduled for commencement during the next financial year, and will extend from the city street system, between Bathurst and King Streets, to the street system of Glebe, in the vicinity of Bridge Road.

Connections will be made with several city streets, namely Bathurst Street, Druitt Street, Market Street, King Street and Day Street. In the vicinity of King Street, the Expressway will join the first stage of the Western Distributor, which is now being built to provide improved access to and from Sydney Harbour Bridge.

Its general route will be around the southern end of Darling Harbour on an elevated ring road over the wharves operated by the Maritime Services Board, by a bridge over the Darling Harbour railway marshalling yards, in a cutting through Pyrmont and then by a bridge over Wentworth Park to Glebe.

A further section will be constructed later through a tunnel under Glebe emerging in the vicinity of the Harold Park Raceway and proceeding through Rozelle to a new bridge to be built downstream from the existing Iron Cove Bridge. From this point, the Expressway will link with the section already provided between the Gladesville, Tarban Creek and Fig Tree bridges.

The construction of the North Western Expressway from the City to Glebe will be difficult and expensive. The work in the vicinity of Day Street will involve adjustments to an extraordinary number of public utilities. The various link roads have to be arranged so that the continuation of the Western Distributor to Ultimo can be built across them later. For this reason, the pier positions for the full length of the Western Distributor must be fixed before work on the North Western Expressway commences.

The crossing of the railway yards at Darling Harbour presents a special problem. These marshalling yards operate continuously and construction work will have to be programmed to suit railway requirements. Because of the complexities of the work through the railway yards, the driving of piles and other foundation work will be done by the Department with its own forces, in close co-operation with the Department of Railways. Contracts will be let for the balance of the work.

Another major problem is interference to the wharf area at the southern end of Darling Harbour. The design of the Expressway requires a crossing of some of the wharves, which could cause inconvenience to the operation of that part of the Harbour. This can be tolerated provided Pyrmont Bridge is later removed to provide easy access for shipping. The North Western Expressway is therefore being designed to accommodate the closure and removal of Pyrmont Bridge as the work nears completion.

The construction of the Expressway through Pyrmont will not be as complex as that over Darling Harbour but will involve changes in local traffic routes and the adjustment of utilities. At Wentworth Park, the North Western Expressway will be on a viaduct high above the park and, until the next section is built, it will be brought to ground level at the junction of Colbourne Avenue and Bridge Road, Glebe.

The scheme will provide an efficient method of overcoming the difficulties now

being experienced by motorists on the western approaches to the City. Close co-operation between the many Authorities that will be involved in the various phases of the work will ensure that inconvenience to the public and to the operation of the City will be reduced to a minimum.

All relevant aspects of the proposal have been fully considered by the Department of Railways and the Maritime Services Board, in view of its effect on their land and property. The Commissioner for Motor Transport has indicated that bus services can be suitably adjusted.

It is expected that construction of the Expressway will commence towards the end of 1971 and that some of the work will be in use by 1975.

The associated roads, which will provide for local traffic, are expected to be completed by 1978 allowing Pyrmont Bridge to be closed to traffic.

Construction will be carried out generally by contract, except for the work in the Darling Harbour railway marshalling yards which will be undertaken by the Department's own forces.

The cost of the whole project, including property acquisitions, is estimated to be approximately $30 million.

* * * * *

The removal of Pyrmont Bridge will be made possible by an alternative route to be constructed for Pyrmont traffic. This will be done by building two roads, flanked by footways, on a structure adjacent to the main Expressway, from the City to Harris Street and Pyrmont Street.

The elimination of Pyrmont Bridge will resolve a problem for both shipping and road traffic. The old timber bridge, which was opened in 1902, has performed an important function, but now, at the end of its economic life, it causes frustrating delays to traffic and great inconvenience to port management.

The Maritime Services Board is pursuing comprehensive plans for the general improvement of the Port of Sydney and the removal of Pyrmont Bridge will permit the Board, in its redevelopment of Darling Harbour, to provide an additional area of about 20 acres of long-shore wharfage. This area will be an extremely valuable adjunct to the port, as shipping will, of course, be free from the restriction now caused by the present narrow and hazardous passage through the opening span of the bridge. This freedom will permit ships of considerable size to be accommodated at the new wharfs ●

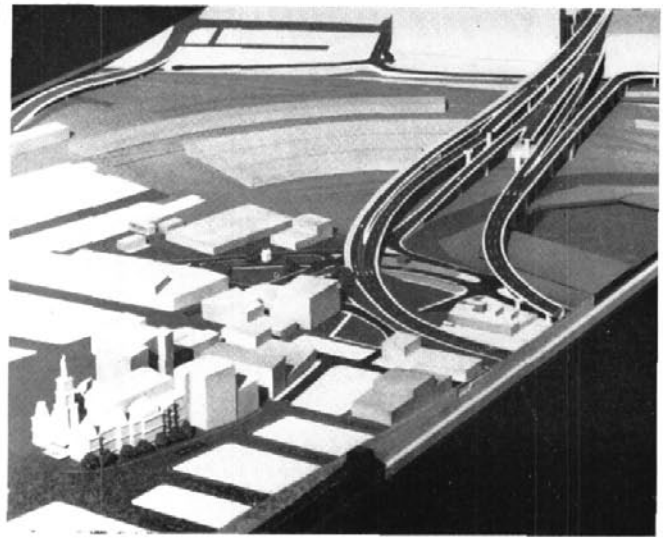
1. *View of scale model showing early stage of proposed North Western Expressway between the City and Glebe (looking west)*

2. *View of later stage, showing access ramps to and from Druitt Street, which runs past Sydney Town Hall (left foreground)*

3. *Another view of the same model (looking southwest) over an extension showing the links to Market and King Streets (centre foreground) and to the first stage of the Distributor (right foreground). The dotted line represents the approximate position of Pyrmont Bridge, which will be removed. The bridge in the background is the existing William Henry Street Bridge. This model is on display in the Department's "Model Room", Third Floor, Head Office*

4. *Photo-mosaic model showing the route of the North Western Expressway from the City (left), across Darling Harbour, past Wentworth Park to Glebe (right)*

1



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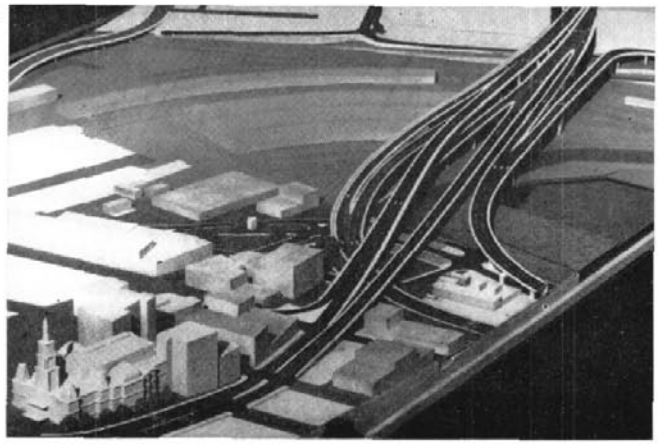

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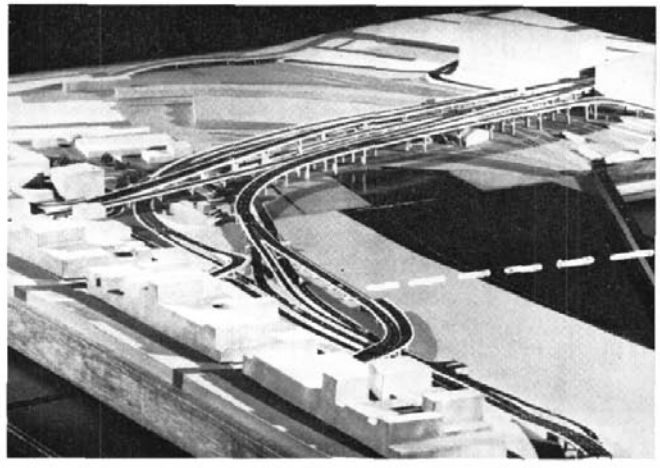

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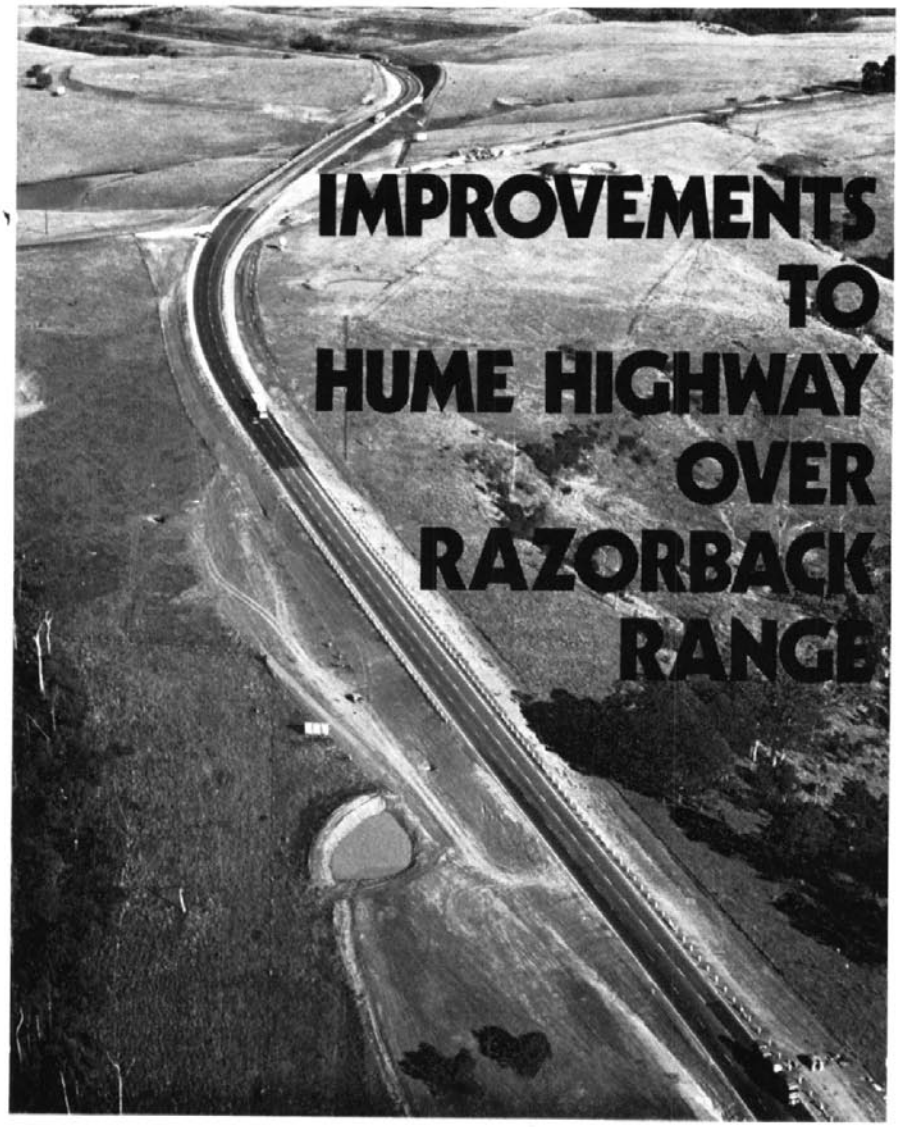
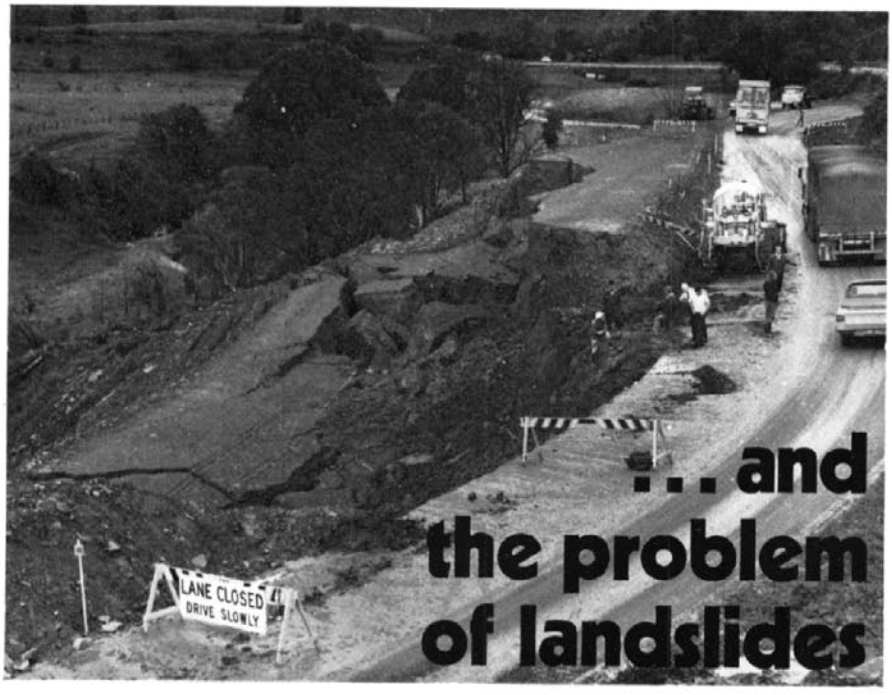


# IMPROVEMENTS TO HUME HIGHWAY OVER RAZORBACK RANGE




## ... and the problem of landslides

The Razorback Range is a dissected plateau with a general elevation of about 900 to 1,000 feet above mean sea level. The Range is crossed by the Hume Highway at about 45 miles southwest of Sydney, between Camden and Picton. The strata of shale and argillaceous sandstone are practically horizontal, but dip gently towards the north. The slopes are covered with thick clayey soil which is derived, principally, from the weathering of the shale with a proportion of stones and boulders fallen from the sandstone layers above. During wet weather the lower layers of the clayey soil become soft where the downward percolating water is blocked by the impervious underlying shale. After protracted periods of wet weather, slips occur due to the flow of the saturated overburden. Many slips of this nature have occurred over the Range in geologically recent times.

Prior to undertaking recent road improvements over Razorback Range, the Department investigated the possibility of deviating the Hume Highway via Finn's Road, at the northern foot of the Range, and thence via Main Road No. 179 to Maldon, and across roadless country to rejoin the Highway in the vicinity of Myrtle Creek, south of Picton. Such a major deviation would have necessitated large scale expenditure and it would have been several years before a new road could have been put into service. On the other hand, improvements to the established route of the Highway over Razorback Range have provided immediate benefits as they have been completed and have cost much less. Furthermore, proposals for a "parallel" facility, the South Western Expressway, have been an obvious influence against the adoption of an alternative and more expensive Highway route.

Having regard to future traffic needs, and the availability of funds for the construction of the South Western Expressway between Campbelltown and Bargo, the Department decided in 1966 to carry out improvements to the existing route of the Hume Highway between Camden and Bargo. The work included the provision of climbing lanes and improvements to alignment on Razorback Range between Finn's Road (at 43·1 miles south of Sydney) and Apps Corner (at 47·7 miles south of Sydney), along a section of Highway which was originally constructed in 1925. This work is now nearing completion and it is planned to commence improving the existing alignment and providing climbing lanes on the section between Apps Corner and Picton.

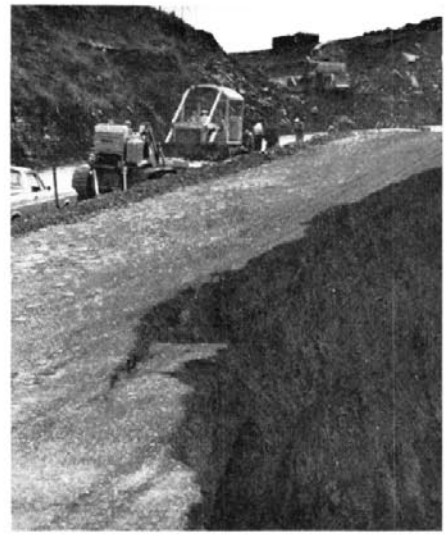
For the work over the Range, an improved alignment was adopted commensurate with the terrain being traversed. As well as selecting an alignment which would meet the requirements of reasonable cost, it was also necessary to select an alignment which would place the new road on stable ground. All these factors placed restraints on the standard of alignment which could be adopted.

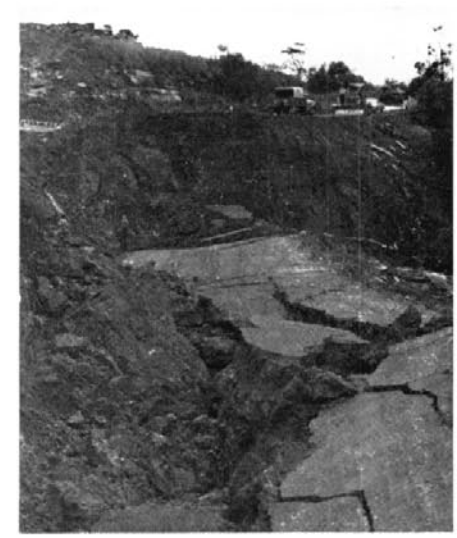
The improvements were designed to minimum 40 mph speed standards, with climbing lanes provided on both ascents. The cross section adopted provides for one 12-feet wide travelling lane on the downhill side together with one 11-feet wide travelling lane and one 10-feet wide lane for slow-moving vehicles on the uphill side. Gravel shoulders 5 feet wide have been provided on the downhill side while 4 feet wide shoulders have been provided on the uphill side, adjacent to the climbing lane. In cuttings on steep grades, the table drains are 2 feet 6 inches wide and concrete lined. The shoulder is sealed to the lip of the gutters. Batters have been designed generally at 1:1 in cuts and 1½:1 in fills.

The first mile of the northern ascent is on a fairly uniform grade varying between 4 per cent and 5 per cent with minimum horizontal curve radii of 400 feet and a maximum radius of 1,500 feet. On the remainder of the work horizontal curve radii vary between 600 feet and 2,000 feet. Grades are generally steeper than on the northern ascent, with a maximum instantaneous grade of 6·5 per cent for southbound vehicles. Vertical curves are designed to provide minimum stopping sight distance for the design speed adopted, with an overall minimum of 400 feet.

A sub-base has been provided having an average thickness of 6 inches of selected indurated shale, or crushed sandstone, supporting a pavement course of 6 inches of fine crushed rock or stabilised blast furnace slag. A seal was then applied with 80/100 penetrated bitumen and ½-inch gauge crushed basalt. This temporary pavement was allowed a period of about six months under traffic (the 1970 Annual Average Daily Traffic Volume was 5,410 vehicles) before the final running course, of 1-inch of ⅜-inch gauge asphaltic concrete, was applied.

The earthworks were undertaken by the Department's own forces using its own equipment assisted by hired plant. The pavement materials were generally supplied by contractors. The whole of the work was carried out by the Department's Works Office at Picton under the supervision of the Divisional Engineer at Wollongong. The total cost of the improvements is estimated to be $950,000.





*Main landslide on 14th November, 1969 at the foot of Razorback Range on the southern side (looking north)—where a newly constructed fill subsided*

* * * * *

During November, 1969, when reconstruction was in progress, 855 points of rain were recorded at Picton; including 100 points on 13th and 500 points on 14th November, 1969. On 14th November, 1969, two major and several minor landslides occurred and necessitated the closing of the Highway. Traffic was detoured from Picton via Trunk Road No. 95 through Maldon thence, because of flooding of the Nepean River at Camden, via Wilton and Broughton Pass to Appin, and via Main Road No. 177 to Campbelltown and the Hume Highway at Cross Roads, near Liverpool.

On 16th November, 1969, when floodwaters had receded and Camden Bridge was re-opened, the traffic was detoured via Main Road No. 179 and Finn's Road to rejoin the Highway at the northern foot of Razorback Range. Consequently, special attention had to be given to this road by Wollondilly Shire Council, at cost to the Department.

The Highway, which had been closed for a period of 20 days, was re-opened to traffic on 4th December, 1969.

*At the same location as above, showing undermining of the existing road and a culvert broken by this slip. Work was in progress on the cutting in the background at the time of the slip*

*Reconstruction and the provision of a new pavement involved alteration to the levels of the existing road*

The largest slip occurred approximately ½ mile from the foot of the Range on the southern descent, at 46·9 miles from Sydney. Here, a newly constructed fill, on a sidling adjacent to the existing road, subsided and at the same time undermined half of the existing road. Photographs of this slip are included on pages 4 and 5.

The materials at this location consist of weathered shale and clay, overlying black clay at deep levels. A water bearing fault is also apparent in the shale. As far as possible, sound foundations had been established during construction and the fill keyed into the existing road formation by benching and compaction.

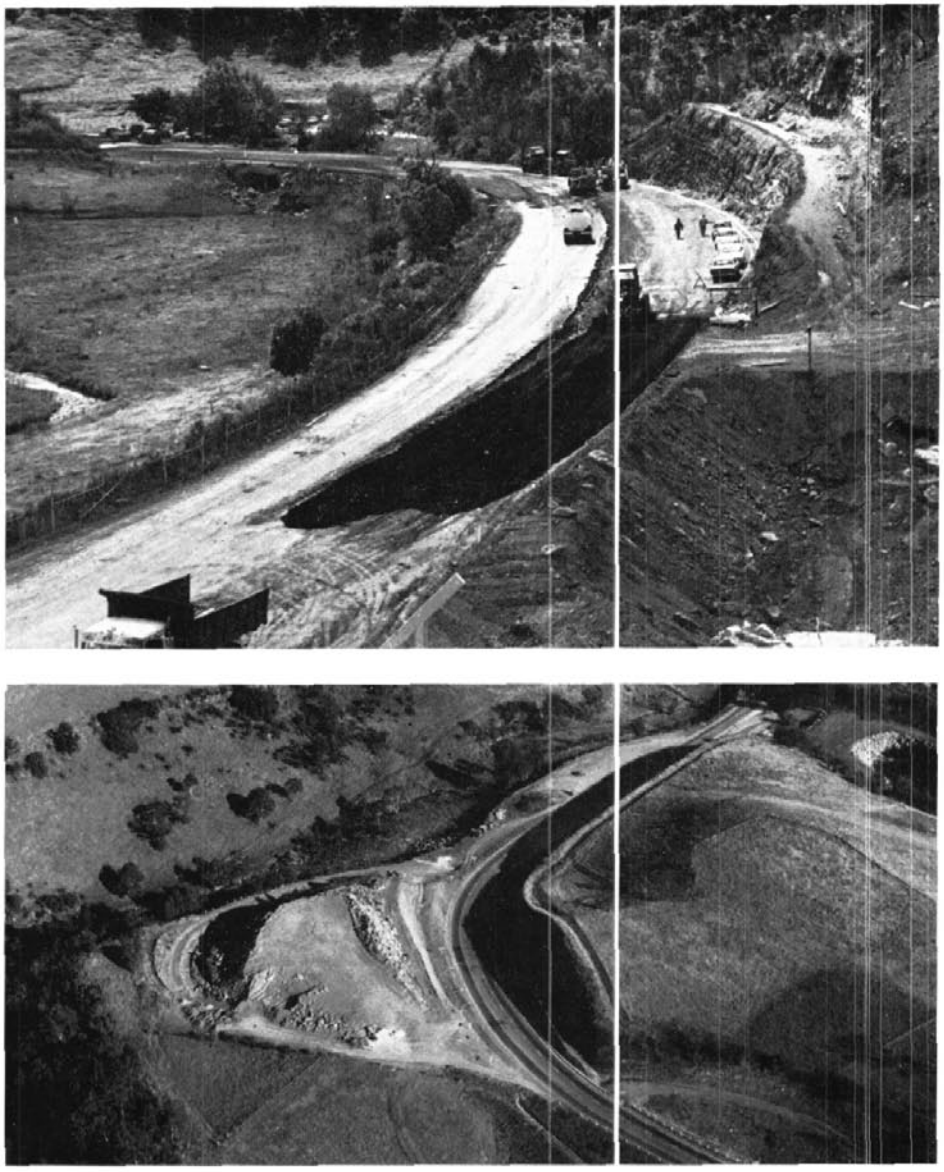
As a result of the extended period of wet weather, the fault and other strata in the weathered shale allowed the passage of water into the old and new road formation, and also into the underlying black clay. The additional surcharge on the underlying clay from the new constructed embankment caused subsidence and displacement downhill. This resulted in downhill areas rising between 10 and 15 feet.

Considerable excavation was done to remove the collapsed fill in an endeavour to find a solid foundation. However, this was unsuccessful, although the excavation did serve to drain water away from the failed area. Deep test holes were drilled in the approximate position of the original fill toe and these penetrated approximately 20 feet of black clay, at which level free-flowing water was encountered.

It was concluded that a solid foundation would not be found in this location. Subsequently, it was found necessary to shift the centreline of the road 70 feet into the hillside where the slip had occurred. This entailed the excavation and removal of large quantities of material.

A second slip occurred in a high cut batter at Apps Corner near the southern foot of the Range, at 47·5 miles south of Sydney. At this location, the materials consist of a strata of fissured fine-grained sandstone ("mudstone"), overlaying weathered shale and clay. The batter had been constructed at approximately ½ : 1 in the rock strata and 1 : 1 in the shale.

Failure occurred along a plane of weakness when a large triangular wedge of material in the batter became saturated, slumped approximately 4 feet and spilled onto the new road formation.



*Improved location of the Highway through the new cutting on right eliminated the sharp curve on the left*

Water had apparently entered the failed area by percolating down through the underlying mudstone strata, as well as soaking through the exposed batter face. This water served both to increase the weight of the slumped section and to lubricate the failed plane. Since the initial slip in November, 1969, the failed area has continued to slump further. Difficulties in obtaining additional land have delayed flattening the batter slopes.

The cause of the slips is attributed to the ingress of water, either through the face of the cut or from unlined catch drains at the top of the cut. Accordingly, it is essential that further measures be taken to reduce the ingress of water and to provide outlet drains in the material along aquefers where slips are likely to occur. To this end, the Department is proceeding with investigations into batter protection and the placing of slotted pipes in the batters. It is proposed to place these slotted pipes in the batters at intervals of approximately 5 feet. They will stand perpendicular to the centreline of the road and slope towards the road with their outlets as close to the road surface as possible. In addition, all catch drains will be lined to reduce the ingress of water.

It is hoped that these measures will lessen the likelihood of further landslides, and reduce road damage and disruption to traffic on this important highway route●

*The following articles have appeared in earlier issues of "Main Roads":*

- *Razorback Deviation—November, 1929, pp. 36–40.*
- *Landslides—August, 1940, pp. 137–141.*
- *Landslides on the Razorback Range and near Wollongong, 1949 and 1950—March, 1952, pp. 77–83.*

# ROAD OVER RAZORBACK

## "... that pandemonium of weary bullock-drivers"

Author Frank Clune, in his book "Journey to Kosciusko", wrote:

> "*Nowadays the Razorback has no terror for the traveller on the bitumen of the Hume Highway, who feels that his car is a crock unless he can make the grade in top gear; but in olden times it was a terrible climb for puffing neddies and grunting bullock teams, especially when rain lubricated the slippery clays.*"

Yet even in 1844, at least one commentator had a kind word for the road "over the formidable heights of Razorback" when he wrote that it

> "*now scarcely merits the reputation of steepness and difficulty which attaches to the name, for although the height of the mountain is great, the ascent on either side is so gradual that it is but little felt, and it is quite a relief for passengers by the mail to stretch their limbs by a short walk in order to ease the horses.*"

However, not all early travellers saw it in the same light and the rough, rugged conditions of over a century ago are echoed in the two contemporary extracts from the Sydney Morning Herald which are quoted in full on this page. To twentieth century readers, the unfamiliar terminology of the "Razor-back Rhymes" can present quite a test in comprehension at particular points, although its general message is obvious.

"From this village (Camden) to the foot of Razorback, a distance of about five miles, the public road passes through the magnificent estate of Camden Park—it then attains that pandemonium of weary bullock-drivers, who ever and anon, with bitter jibe and horrid blasphemy, goad their unwilling teams against the hill—with many a weary halt from morn till noon, they reach the summit, where, improvident of water-kegs, they sit and pant and think of Lakeman's ale or Brennan's beer—then furiously assail the pipe, and resume their course to the streamlet at the foot of the other side, where they encamp for the night at whatever time of the day they reach the spot.

On both sides of the road, so far as it passes through the estate of Messrs Macarthur, the land, of excellent quality, has within the last few years been opened up and cultivated by a sort of primitive pioneers who take farms on clearing leases. The land, on the Razorback belongs to the Church, and is partially cultivated at the very summit, though not on the side. This range can scarcely be called a mountain—it is in fact a tract of excellent arable land of whinstone and trap formation, every road of which might be planted with the vine and the orange; it is lightly wooded by nature, except in the deep dells which intersect it where thick jungles of flowering shrubs breathe a delicious fragrance—while the view from the summit well repays the traveller for the fatigue of ascending.

All that part of the road which falls within the space we have described is in rapid progress of repair—a sum of money placed by the Government in the hands of the Warden is being judiciously expended by him in such a way as to obtain the greatest amount of labour at the least possible cost—and a desirable advantage has arisen—a good road, especially down the southern descent, where it was recently quite dangerous for vehicles, and the saving from actual want of many poor families in the neighbourhood, who, during these times of scarcity are too glad to obtain a few days work, which they can leave at pleasure to return to the cultivation of their farms when anything requires their attention at home."

*From "The Sydney Morning Herald", 30th September, 1847.*

* * * * *

Details of the development of the route over Razorback are given by historian James Jervis in an article on "The Great South Road", which was published in the Journal of the Royal Australian Historical Society, Volume XXV, part V, 1939, page 421.

## "... and bulls-eye for budding poets".

### RAZOR-BACK RHYMES

June 22nd, 1854

To J. Martin, Esq., M.C., (*per favour of the Sydney Morning Herald*) mover of a Resolution before the Council for mending the Roads.

Do you want your joints to crack!
Go, ride in a coach on the Razorback—
Or would you wish to kill your cattle,
And cause your beeves and calves to fat ill,
Just drive them all at a thundering rattle
Over that weary and dangerous track—
One will drop here, two will bog there,
You set out with a score, you get in with a pair.
You lose your temper, and curse, and swear,
By Polly-tolly and Jingo Jack.
As sure as the white man's debil is black,
And the blackfellow's debil is white,
Old Boney had ne'er such a desperate battle
When his marching men made the tall Alps rattle,
Was never in such a piteous plight,
Was never in such a horrible fright,
Saw never such an oudacious sight,
As you—upon that ill-starred night
Which found you, with nerves upon the rack,
In fear of mudholes, and bandit's attack.
(You'd more easily sat on the side of my stack,)
*Perched* on the top of the Razor-Back.

'Tis fortunate Lupton's Dragon is a mail—
No female thing on such perils could venture;
To deliver her cargo she surely would fail
Spite of bonded sureties and witnessed indenture;
And even now, we move men's laughter,
*Passing jeers* on our *passengers* half a mile after
Warily toiling through greasy mud,
And bog holes left by last week's flood,
And often indeed, without any reproach
Our kind-hearted pilgrims help *carry* their coach;
In this country, Dame Nature such wonders enacts
We travel on much as men did in the Acts,
Who, when bound to their neighbour's christenings and marriages
Were wont, as we read, to "take up their carriages".*
And know, kind sir, though Tom paid his Five Pounds†
To ride in the Coach through Fitz-Arthur's grounds
'T would be as much as his neck was worth
That vehicular trip on his mother earth—
And if you ever, with pipe in your teeth
Botanized over an English heath
The manners you'll know of the *Beni* Goose.
When *Abu Gosling* leads on their vanguard—
Just so, all unrestrained and loose,
Cackling and spluttering like the doose,
That Royal Drag, and her tail, do wag
(Carrying often a heavy swag)
Over the hollow, and under the crag,
As both themselves best can guard,
Because events upon the way,
Are thick as mice in a rick of hay.
Here a dray overturned—here a camp fire half-burned,
Here a bull, from the Lachlan that pulled like a brick
By the side of Old "Marquis", his journeyworn carcase
Flings down, and expires with a yell and a kick.
Here a squad for the diggins who strive to ascend
Counter-jumpers, they soon cry out "Bellows to mend"—
Here a cart, that a jib drew up just fifty yards,
Stern foremost, rolls back on the

RAZORBACK BARDS.

* Acts XXI 15.

† Fare from Goulburn to Sydney, see Advertisement.

*From "The Sydney Morning Herald", 24th June, 1854.*

# TECHNICAL TRAINING OF ENGINEERS AND FOREMEN

Some critics denigrate roadworks as simply a matter of "cutting the tops of the bumps and using them to fill in the pot holes". In some circumstances it still is a *pick and shovel* job, but then so is collecting sample rocks from the moon's surface. However, building better roads is becoming less and less a matter of muscle power, and more and more a matter of machine and brain power.

The technology of highway engineering is advancing rapidly, but it is always under pressure from the demands of increasing volumes of vehicular traffic. The training and up-dating of the technical and administrative talents of the Department's staff is therefore a continuing and necessary task.

To keep pace with the technological advances that are taking place to-day, the Department has an expanding programme of training, not only for engineers, but also for the other very important "men-on-the job", the foremen.

## Engineers

### OUTLINE OF RECRUITMENT AND TRAINING

The Department recruits trainee engineers from students leaving school with the Higher School Certificate. University traineeships are offered to the successful applicants, whereby the Department pays all university costs and provides a living allowance. During the *long* university vacation, trainees work in the Department's design offices and laboratories, as well as with surveyors and on construction jobs. In this way they develop valuable *job* knowledge parallel with their university training.

The majority of the Department's engineering staff are recruited as trainees. However, from time to time, some graduate and experienced engineers are appointed. Occasionally, officers become qualified engineers by undertaking part-time studies while working with the Department as draftsmen.

Cadetships in Engineering are available at the New South Wales Institute of Technology in a "sandwich" course. These cadetships are allotted in pairs, one of the pair working while the other attends lectures.

After graduation, engineers are appointed as assistant engineers at one of the Department's Works Offices. Here they gain experience in road and bridge construction and maintenance. Twelve months after graduation, engineers attend a two-week residential course on construction, maintenance, job administration and job management.

Follow-up training is given in the form of two-day conferences held at centres around the State every year. These conferences cover both technical and administrative subjects.

Many post-graduate courses are available and the Department sponsors engineers to a wide variety of these courses each year.

### THE TRAINING PROGRAMME—IN DETAIL

*Undergraduate Training*

In-service training begins at undergraduate level for the Department's trainees. At the end of their first year at university, they are assigned to a drawing office where they gain experience in plotting survey data, elements of road design and culvert design. At the end of their second year, they are assigned to testing laboratories for experience in pavement testing and concrete testing, and to survey parties for experience in survey procedure and practice. At the end of their third year, they are attached to a Works Office where they gain experience in construction and maintenance. They graduate at the end of fourth year and are immediately posted as assistant engineer in a Works Office.

*Induction*

On graduation, engineers receive a one-day induction course, at which the structure and operation of the Department are explained. The newly qualified engineers also have the opportunity to meet senior Departmental staff.

*Formal In-service Training Course*

This consists of a two-week residential course at which new engineers receive instruction in detail about the construction and maintenance of roads and bridges, job management and office administration. They are also given an introduction to management training. The lectures are prepared and delivered by officers who have specialised in the particular subject.

Notes are printed and sent out to participants a month before the course. They are expected to read these and to be prepared to discuss them. Lecturers encourage discussion and it is often found that the new engineers learn more from these discussions than they do from the lectures. It has been found beneficial to include a few more experienced engineers in the course to promote discussion.

Approximately 30 engineers attend the course each year. They are divided into five groups of six and each group represents one of the following divisions: Metropolitan, Coastal, Mountains, Western Slopes and Western Plains.

Throughout the course, the groups are given problems which they solve in "syndicate" sessions, each division solving the problem in the context of that division. When the solutions are presented to the whole class the differences between the regional divisions became apparent.

The engineers attend this course twelve months after graduation. At graduation their experience is too limited for them to be able to gain much benefit from the course. However, after twelve months in the field, they have been confronted by many of the problems being discussed and the significance of the content of the course becomes real to them.

The course is held at the Residential Centre of the University of New South Wales Institute of Administration, in the grounds of Prince Henry Hospital at Little Bay.

A typical course timetable is given in Table I on page 10.

*Divisional Office Induction Course*

After a number of years in charge of construction and maintenance works at a Works Office, engineers are transferred to a Divisional Office. At this point their role changes from direct construction to administration. The Department has commenced a one-day induction course designed to outline the function of administration in the Department and to give the engineers concerned an opportunity to discuss any problems or doubts which they may have about the change.

*Regional Conferences*

Each year a number of key subjects are selected and detailed notes about them are printed for distribution to all engineers in Works and Divisional Offices. A series of two-day conferences is then arranged at various centres around the State, so that every engineer has the opportunity to attend one and discuss, in detail, any problems related to the printed notes. Formal answers to all problems are obtained from the appropriate officers in Head Office. These answers are printed and distributed to all who attend the conferences.

The subjects for the 1971–72 series of seminars are:

- ☐ Pavements.
  - ● Stabilisation.
  - ● Artificial gravel pavements.
  - ● Testing of pavements and interpretation of results.
  - ● Subgrade shape.
  - ● Asphaltic concrete surfacing.
- ☐ Road Design
  - ● New standards.
  - ● Waterway calculations.
  - ● Selection and stability of batters.
- ☐ Bridges
  - ● New construction techniques.
  - ● Investigation of foundations.
  - ● Bridge maintenance.
- ☐ Responsibilities of Departmental Officers.

Apart from direct training, a number of other benefits arise from these conferences:

- ● Practical ideas and solutions to problems developed in one part of the State can be circulated around the whole of the Department.
- ● Problems about the interpretation of Departmental policy can be explained.
- ● Departmental policies and procedures can be amended as a result of problems brought up at the conferences:
- ● Common gaps in knowledge can be identified.

*Post-graduate Courses*

The post-graduate courses to which engineers may be sponsored by the Department on a full-time basis are:

*University of New South Wales*

Master of Engineering Science

- ● Highway Engineering.
- ● Transportation and Traffic Engineering.
- ● Engineering Construction.
- ● Structural Engineering.

*University of Sydney*

Master of Engineering Science

- ● Structures.
- ● Concrete Structures.

*Management Training — Residential Courses*

Australian Administrative Staff College at Mount Eliza, Victoria—
Intermediate and advanced course.

University of New South Wales—
Course for Executives—
and Construction Management Course.

*Future Training Courses*

The most important development under consideration is the introduction of management training for all officers who supervise other staff. This would include all engineers and foremen, as well as clerical staff in administrative positions.

The aim is to cover the basic subjects:
Planning and job management, training, review of work methods, human relations (motivation, etc.).

Additional instruction would be given on methods for specific "on-the-job" training of staff.

*The following articles have appeared in earlier issues of "Main Roads":*

- *Sponsored Technical Training—June, 1967.*
- *In-service Training of Engineers—June, 1965.*

# Foremen

## OUTLINE OF RECRUITMENT AND TRAINING

*Road Foremen*

The Department at present employs approximately 140 Road Foremen, the majority of whom are promoted from among the gangers on the job. Some are recruited following press advertising and applicants usually come from within the construction industry.

Part-time certificate courses are available at the larger technical colleges but the academic requirements of these courses are too high for some of the Department's foremen.

In-service training is given to all foremen in the form of three one-week sessions which include lectures on technical, management and administration matters.

Because there are no educational entrance requirements for Road Foremen, it has been necessary to provide a correspondence course in order to refresh their knowledge of mathematics and report writing, prior to their attendance at the formal lectures.

At present "on-the-job" training is limited to instruction in specialist subjects such as drilling and blasting, and landscaping. The Department is now considering a programme of "on-the-job" training for foremen.

Although no formal qualifications are necessary for appointment or promotion to the position of Road Foremen, a minimum period of satisfactory service and successful completion of the in-service training course are necessary to achieve promotion from Grade 3 to Grade 4.

*Bridge Foremen*

Approximately 100 Bridge Foremen are at present employed by the Department and they are recruited from among the ranks of bridge carpenters. They are usually tradesmen, but not all Bridge Foremen have completed a formal trade course. Their training and promotion follow the same pattern as for Road Foremen.

*Plant Foremen*

Plant Foremen are tradesmen recruited from among the fitters in the workshops and their training and promotion follow the same pattern as mentioned above. The Department at present employs approximately 50 Plant Foremen.

## IN-SERVICE TRAINING OF FOREMEN

*"On-the-job" development*

Any "on-the-job" development of foremen is received from more experienced foremen or engineers who supervise their work. However, these groups have not yet been trained to carry out effective "on-the-job" development of staff and consequently, such development is not as effective as it should be. It is planned therefore to introduce courses of management training in the future.

*Correspondence Course*

Because of the lack of higher schooling of many of the Department's foremen, the Department has introduced a correspondence course with the intention of refreshing their knowledge of, and expanding their skill at, mathematical calculations and report writing.

Subjects include weights and measures, fractions, decimals, ratios, areas, volumes, plan reading, levelling, costing, earthworks, setting out, report writing and contracts. For Bridge Foremen, special subjects include levers and moments, safe working loads, concrete mix calculations and diving.

The lessons are mailed to the foremen, three at a time. They work their way through each lesson, do the exercises at the end of the lesson and mail these back to Head Office. The exercises are marked by officers under the Engineer for Technical Training and then returned to the foremen with appropriate comments. With difficult questions, printed answer sheets are produced. The next three lessons are mailed to the foremen at the same time as the marked exercises are returned.

The correspondence course commences about three months before the formal lectures. The foremen are expected to work their way through it at their own speed and the course should be substantially completed by the time they attend the formal lectures.

*Formal Lectures*

Formal training of Road and Bridge Foremen commenced at the beginning of 1970. The third group of Road Foremen is receiving lectures and the third group of Bridge Foremen will commence in October, 1971. Each group consists of 25–30 foremen. The first group consisted of the Department's most experienced foremen. This gave the Department the opportunity to use their knowledge to improve the course.

Parallel courses are conducted for Road and Bridge Foremen. Each group receives three one-week sessions of lectures, exercises, site inspections and films. The sessions are separated by periods of five to six weeks back on the job. This gives the foremen time to think about what they have learnt and to experiment with new techniques.

Each week begins with a general discussion session to help the foremen settle down to the lecture-room atmosphere, and ends with written tests to check their knowledge in key areas. Typical programmes are given in Tables 2 and 3.

Site visits include observation and note-taking at the site so that, when they return to the lecture room, they can prepare reports on the works which they have inspected. These reports are collected and marked, and form part of the assessment of their performance.

Formal training of Plant Foremen consists of one week of lectures each year on technical and administrative subjects and these are conducted on a similar basis to that outlined above.

## FUTURE FIELD TRAINING OF FOREMEN AND GANGERS

There is a need for follow-up training of foremen after completion of their formal course. There is a parallel need for "on-the-job" training of gangers. Consideration is being given to combining these two training programmes into one course. Simple lecture notes would be prepared on two or three key subjects and these would be sent to all foremen and gangers in the field. Each division would call all the foremen and gangers in the division to a central location for a two-day conference. Half the total number of foremen and gangers in each division could probably attend at one time. These conferences would include discussion of the lecture notes, site visits and demonstrations of techniques and testing methods. At these sessions, the foremen would have the opportunity to pass on to the gangers any new information which they had acquired at their formal course ●

*An article entitled "In-service training of Plant Foremen" appeared in the December, 1969 issue of "Main Roads".*

TABLE 1
**TYPICAL TIMETABLE—RESIDENTIAL COURSE FOR FIELD ENGINEERS**

FIRST WEEK

| Time | Monday | Tuesday | Wednesday | Thursday | Friday | Saturday |
|---|---|---|---|---|---|---|
| 8.15 a.m. to 9.15 a.m. | Introductory "Job" talks by course members | "Syndicate" report | "Syndicate" report | "Syndicate" report | "Syndicate" report | Job inspection at construction site in Sydney Metropolitan Area |
| 9.20 a.m. to 10.30 a.m. | Official opening by Commissioner | Drainage and culverts | Road design .. | Job safety .. | Plant selection .. | |
| *Morning Tea* | | | | | | |
| 11 a.m. to 12.30 p.m. | Explanation of how a "syndicate" works<br>Setting out | Clerical duties in a works office | Gravel search .. | Critical path methods | Bituminous plant mix | Job inspection at construction site in Sydney Metropolitan Area |
| *Lunch* | | | | | | |
| 1.30 p.m. to 2.30 p.m. | Fills .. .. | Estimating and costing | Traffic facilities .. | Critical path methods | Bituminous plant mix | Free |
| 2.35 p.m. to 3.15 p.m. | do .. .. | Clearing .. .. | Provision for traffic | Report writing .. | Plant calculations | |
| *Afternoon Tea* | | | | | | |
| 3.30 p.m. to 5.00 p.m. | Pavement testing and interpretation of results | Department's organisation and staff conditions | Gravel pavements | Explosives .. | Plant calculations | Free |
| *Tea* | | | | | | |
| 7.15 p.m. to 8.00 p.m. | Film on materials testing | Film—"Introduction to Highway Hydraulics" | Film—"Understanding Motivation" | Films on explosives | Free .. .. | Free |
| 8.00 p.m. to 10.10 p.m. | Pavement testing (syndicate) | Estimating and costing (syndicate) | Provision for traffic (syndicate) | Explosives (syndicate) | | |

SECOND WEEK

| Time | Monday | Tuesday | Wednesday | Thursday | Friday |
|---|---|---|---|---|---|
| 8.15 a.m. to 9.15 a.m. | Report on job inspection held on Saturday | "Syndicate" report | "Syndicate" report .. | "Syndicate" report .. | Divisional office administration |
| 9.20 a.m. to 10.30 a.m. | Bridge construction foundations | Rock excavation .. | Stabilisation .. .. | Bridge construction techniques | Bridge maintenance |
| *Morning Tea* | | | | | |
| 11.00 a.m. to 12.30 p.m. | Care and maintenance of plant | Road maintenance and pavement investigation | Compaction .. .. | Bridge construction superstructure | Bridge maintenance |
| *Lunch* | | | | | |
| 1.30 p.m. to 2.30 p.m. | Workshop administration .. | Job planning .. | Land caping .. .. | Bridge construction prestressing and post-tensioning | Review of course |
| 2.35 p.m. to 3.15 p.m. | Road maintenance organisation | do do .. | Film on bridge maintenance | do do .. | do do |
| *Afternoon Tea* | | | | | |
| 3.30 p.m. to 5.00 p.m. | Road maintenance methods | Bituminous sprayed works | Industrial matters .. | Employer-employee relations | Free |
| *Tea* | | | | | |
| 7.15 p.m. to 8.00 p.m. | Tape programme | Film on bituminous surfacing | Management (role play) | Free .. .. .. | Free |
| 8.00 p.m. to 10.00 p.m. | Road maintenance (syndicate) | Bituminous surfacing (syndicate) | Job planning (syndicate) | | |

TABLE 2
**TYPICAL TIMETABLE—TRAINING COURSE FOR ROAD FOREMEN**

FIRST WEEK

| Time | Wednesday | Thursday | Friday | Monday | Tuesday |
|---|---|---|---|---|---|
| 8.30 a.m. to 9.25 a.m. | Introduction to course<br>Address by Engineer-in-Chief | Structure and income of Department | Job management | Inspection of expressway construction site | Signposting<br>Roadside furniture |
| 9.30 a.m. to 10.25 a.m. | Role of the foreman—(discussion with slides) | Gravel pavements | Job management (exercises) | do do .. | Excavation |
| *Morning Tea* | | | | | |
| 10.45 a.m. to 11.35 a.m. | Introductory "Job" talks by foremen | Setting out .. .. | Setting out .. .. | Inspection of expressway construction site | Fills (Part 1) |
| 11.40 a.m. to 12.30 p.m. | do do | Clearing .. .. | Setting out (exercise) | do do .. | Film on expressway construction |
| *Lunch* | | | | | |
| 1.30 p.m. to 2.20 p.m. | Plan reading<br>Photo reading | Surveying .. .. | Provision for traffic .. | Inspection of expressway construction site | Tests on<br>—Job management |
| 2.25 p.m. to 3.15 p.m. | Plan reading (exercises)<br>Photo reading (exercises) | Survey instruments .. | do do .. | do do .. | —Gravel pavements |
| *Afternoon Tea* | | | | | |
| 3.30 p.m. to 4.30 p.m. | Plan reading (exercises)<br>Photo reading (exercises) | Survey instruments (exercises) | Plans (exercises) .. | Inspection of expressway construction site | —Fills |

SECOND WEEK

| Time | Wednesday | Thursday | Friday | Monday | Tuesday |
|---|---|---|---|---|---|
| 8.30 a.m. to 9.25 a.m. | Revision and questions from first week | Foremanship—review of methods | Compaction (Part 1) | Inspection of road maintenance jobs in Sydney Metropolitan Area (foremen to take notes) | Maintenance methods |
| 9.30 a.m. to 10.25 a.m. | do do .. | Foremanship—human relations | Plant maintenance | do do .. | Film |
| *Morning Tea* | | | | | |
| 10.45 a.m. to 11.35 a.m. | Foremanship—planning the job | Maintenance of road pavements<br>Investigation of pavement failures | Roads—maintenance | Inspection of road maintenance jobs in Metropolitan Area (foremen to take notes.) | Sealing and resealing operations (Part 1) |
| 11.40 a.m. to 12.30 p.m. | Foremanship—training the men | Maintenance of road shoulders | Maintenance organisation | do do .. | Film on bituminous surfacing |
| *Lunch* | | | | | |
| 1.30 p.m. to 2.20 p.m. | Drainage .. .. | Drilling and blasting | Compaction and gravel pavements (exercises) at Materials and Research Laboratory, Milsons Point | Preparation and presentation of written reports by foremen on morning's inspection | Tests on<br>Sealing (Part 1) |
| 2.25 p.m. to 3.15 p.m. | do .. .. | Drilling and blasting (exercises) | do do .. | do do .. | Drainage |
| *Afternoon Tea* | | | | | |
| 3.30 p.m. to 4.30 p.m. | Drainage (exercises) .. | Film on drilling and blasting | Compaction and gravel pavements (exercises) at Materials and Research Laboratory, Milsons Point | Preparation and presentation of written reports by foremen on morning's inspection | —Plant maintenance |

TABLE 2—*continued*

THIRD WEEK

| Time | Wednesday | Thursday | Friday | Monday | Tuesday |
|---|---|---|---|---|---|
| 8.30 a.m. to 9.25 a.m. | Revision and questions from second week | Fills (Part 2) | Inspection of road construction jobs in Sydney Metropolitan Area (foremen to take notes) | Asphaltic concrete | Compaction (Part 2) |
| 9.30 a.m. to 10.25 a.m. | do do | Landscaping | do do | Timekeeping Storekeeping | Review of course |
| *Morning Tea* | | | | | |
| 10.45 a.m. to 11.35 a.m. | Pavement preparation | Industrial matters employees | Inspection of road construction jobs in Sydney Metropolitan Area (foremen to take notes) | Costing | Public relations |
| 11.40 a.m. to 12.30 p.m. | Sealing and resealing operations (Part 2) | Film—"Lost Production in Highway Engineering" | do do | Industrial matters — contract haulage | Visit to Head Office exhibition of scale models |
| *Lunch* | | | | | |
| 1.30 p.m. to 2.30 p.m. | Sprayer testing at Central Workshop | Selection of plant | Preparation and presentation of written reports by foremen on morning's visit | Job safety | Tests on Road maintenance |
| 2.25 p.m. to 3.15 p.m. | do do | Selection of plant (exercises) | do do | Control of materials | Sealing (Part 2) |
| *Afternoon Tea* | | | | | |
| 3.30 p.m. to 4.30 p.m. | Sprayer testing at Central Workshop | Selection of plant (exercises) | Preparation and presentation of written reports by foremen on morning's visit | Films | Compaction |

TABLE 3

TYPICAL TIMETABLE—TRAINING COURSE FOR BRIDGE FOREMEN

FIRST WEEK

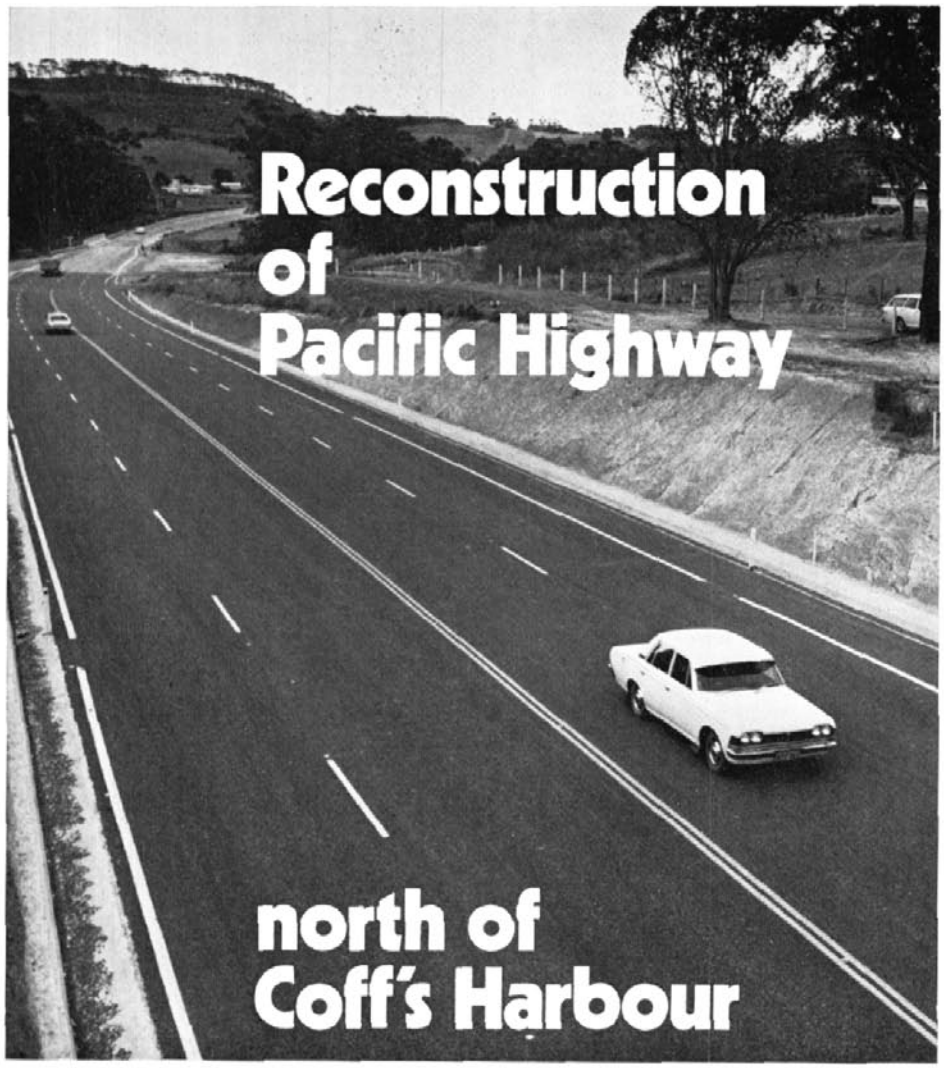
| Time | Wednesday | Thursday | Friday | Monday | Tuesday |
|---|---|---|---|---|---|
| 8.30 a.m. to 9.25 a.m. | Introduction to course Address by Chief Engineer (Bridges) | Organisation of bridge construction | Contract supervision | Demonstration of formwork erection | Maintenance of timber bridges |
| 9.30 a.m. to 10.25 a.m. | Introductory "job" talks by foremen | Plan reading Setting out | Pile construction (Part 1) | do do | Concrete technology (Part 1) |
| *Morning Tea* | | | | | |
| 10.45 a.m. to 11.35 a.m. | Introductory "job" talks by foremen | Maintenance methods | Pile construction (Part 1) | Demonstration of formwork erection | Concrete technology (Part 1) |
| 11.40 a.m. to 12.30 p.m. | do do | Steel inspection | Epoxy resins (Part 1) | do do | Industrial matters (Part 1) |
| *Lunch* | | | | | |
| 1.30 p.m. to 2.20 p.m. | Sampling and testing at Materials and Research Laboratory, Milson's Point | Plan reading Construction techniques Setting out Quantities | Use of survey instruments | Steel inspection Metal coating Stud connectors at Central Workshop, Granville | Test on Bridge maintenance |
| 2.25 p.m. to 3.15 p.m. | do do | Bridge plans (discussion and exercise) | do do | do do | Steel inspection |
| *Afternoon Tea* | | | | | |
| 3.30 p.m. to 4.30 p.m. | Sampling and testing at Materials and Research Laboratory, Milson's Point | Bridge plans (discussion and exercise) | Use of survey instruments | Steel inspection Metal coating Stud connectors at Central Workshop, Granville | Concrete technology |

SECOND WEEK

| Time | Wednesday | Thursday | Friday | Monday | Tuesday |
|---|---|---|---|---|---|
| 8.30 a.m. to 9.25 a.m. | Revision and questions from first week | Foremanship — planning | Foremanship — review | Inspection of bridge maintenance and construction jobs in Sydney Metropolitan Area (foremen to take notes) | Storekeeping Timekeeping Costing |
| 9.30 a.m. to 10.25 a.m. | do do | Foremanship — training | Foremanship — human relations | do do | Scaffolding |
| *Morning Tea* | | | | | |
| 10.45 a.m. to 11.35 a.m. | Bridge equipment | Maintenance truss repairs | Concrete technology (Part 2) | Inspection of bridge maintenance and construction jobs in Sydney Metropolitan Area (foremen to take notes) | Scaffolding |
| 11.40 a.m. to 12.30 p.m. | Formwork (Part 1) | Film on bridge repairs | do do | do do | Bridge details (Part 1) |
| *Lunch* | | | | | |
| 1.30 p.m. to 2.20 p.m. | Prestressed concrete pretensioning | Maintenance of bridge plant | Job management | Preparation of written reports by foremen on morning's inspection | Tests on Storekeeping —Timekeeping —Costing |
| 2.25 p.m. to 3.15 p.m. | Maintenance — painting | Calibration of high tensile bolts | Job management (exercise) | Discussion | —Job management |
| *Afternoon Tea* | | | | | |
| 3.30 p.m. to 4.30 p.m. | Job safety | Calibration of high tensile bolts | Visit to Head Office exhibition of scale models | Film on bridge construction methods | —Pretensioning |

THIRD WEEK

| Time | Wednesday | Thursday | Friday | Monday | Tuesday |
|---|---|---|---|---|---|
| 8.30 a.m. to 9.25 a.m. | Revision and questions from second week | Correspondence and report writing | Inspection of bridge construction job (using Department's own forces) in Sydney Metropolitan Area (foremen to take notes) | Inspection of prestressing yard | Epoxy resins (Part 2) |
| 9.30 a.m. to 10.25 a.m. | do do | Rigging | do do | Stressing of units | Industrial matters (Part 2) |
| *Morning Tea* | | | | | |
| 10.45 a.m. to 11.35 a.m. | Bridge details (Part 2) | Rigging | Inspection of bridge construction job (using Department's own forces) in Sydney Metropolitan Area (foremen to take notes) | Test loading of T15 beam | Formwork (Part 2) |
| 11.40 a.m. to 12.30 p.m. | Prestressed concrete post-tensioning | Steel erection | do do | do do | Pile construction (Part 2) |
| *Lunch* | | | | | |
| 1.30 p.m. to 2.20 p.m. | New construction techniques | Contract supervision—overcoming problems between contractors and superintending officers (role play) | Preparation of written reports by foremen on morning's inspection | Inspection of post-tensioning on a bridge job in Sydney Metropolitan Area | Tests on Bridge equipment |
| 2.25 p.m. to 3.15 p.m. | Public relations Publications | do do | do do | do do | Post-tensioning |
| *Afternoon Tea* | | | | | |
| 3.30 p.m. to 4.30 p.m. | Film | Contract supervision—overcoming problems between contractors and superintending officers (role play) | Preparation of written reports by foremen on morning's inspection | Inspection of post-tensioning on a bridge job in Sydney Metropolitan Area | Review of course |




*Recently opened section of Pacific Highway near Kororo*

The Pacific Highway between Coff's Harbour and Woolgoolga is situated generally within one mile of the coast. The countryside rises steeply to the west of the Highway and is particularly suitable for banana growing; in fact, it is the largest banana producing area in the Commonwealth.

The area to the east of the Pacific Highway is generally low lying and contains numerous swamps. However, the coastline has excellent surfing beaches, and the land between the coastline and the Highway is suitable for development as caravan parks and housing estates.

In order to prevent extensive ribbon development along the Highway, it was decided to reconstruct the Highway as part of a future dual carriageway and to proclaim it a *motorway* under section 27B of the Main Roads Act. When a section is proclaimed a *motorway* the land is vested in the Commissioner for Main Roads and access to the *motorway* is controlled and limited to specific points. In general, only one access is permitted to and from each lot or portion. Restriction of the number of access points reduces traffic movements and contributes to the safety of motorists using the *motorway*. When acquiring property for the construction of a *motorway*, the Department compensates the owners for the restriction on access as well as for the portion of property acquired. North of Coff's Harbour, the Department is acquiring sufficient area to allow two carriageways to be constructed, although only one is being built in the first instance. Later, this will become the northbound carriageway of the *motorway*.

## LOCATION

Reconstruction of the Highway is at present being undertaken by the Department between 3·1 and 9·4 miles north of Coff's Harbour, and sections of the work are already open to traffic. The new location follows the old route of the Highway, apart from a number of minor deviations and one major deviation between 3·3 and 4·6 miles north of Coff's Harbour.

## DESIGN

The design of the present work (which will be the first carriageway of the *motorway*) has been based on a 60 mph standard with a bituminous surface 24 feet wide and gravel shoulders 10 feet wide. The maximum grade will be 6 per cent and climbing lanes are being provided where the grade exceeds 4 per cent. The sight distance available will be in excess of 800 feet.

## ACQUISITIONS

It has been necessary to acquire the land needed for the full width of the *motorway* and for the provision of access roads to properties. This has involved a total of 64 acquisitions and the land has been acquired or is still being acquired by direct negotiation. The cost of acquisitions and property adjustments up to 30th June, 1971, was approximately $60,000. The final cost of acquisitions, property adjustments and compensation for restriction on access to the *motorway* is estimated to be $100,000.

## FENCING

The *motorway* boundary is being fenced and, as this fence is located within the *motorway*, it will be maintained by the Department. As already mentioned, access to the *motorway* from adjacent properties will be limited to specific sites. There are 35 approved access points in this 6·3 mile section which is less than 6 access points per mile. These access points are not evenly spaced but are located to ensure safe access at minimum cost.

## CLEARING

Clearing of the road reserve requires special treatment in areas where bananas are growing. In New South Wales it is an offence to permit bananas to grow wild and the following method has been adopted in the Department's North Eastern Division for destroying banana plants which are growing on land acquired for road reserves. The banana stems are injected with a hormone called Methoxine 30, using a special gun supplied by the Department of Agriculture. Six pumps of the gun are applied to each stem. Ten days after the hormone treatment, growth is affected and the banana plants start to die. After 2–4 weeks, depending on weather conditions, it is necessary to spray any regrowth which may occur by using the same hormone and a knapsack sprayer. As a further guarantee against re-

growth, the bulbs of the banana plants are broken up using a pulvimixer. The topsoil containing the broken-up bulbs is then stripped and set aside for later use on batters, where it encourages the growth of vegetation and thus prevents erosion.

The clearing of timber has been achieved by the use of chainsaws and a tractor-dozer. The fallen trees are pushed to one side and later burnt. Sump oil from plant items is salvaged and poured on to the timber to facilitate complete burning.

## DRAINAGE

The work at present being undertaken involves the construction of three bridge-size structures, having a total length of 250 feet and costing approximately $180,000. The bridges are being built by the Department's own forces. Due to the topography of the country, it has been necessary for the bridges to be designed for horizontal curves and vertical grades. In addition, six reinforced concrete box culverts are being constructed, their size varying from a single cell 4 feet by 4 feet culvert to a three cell 7 feet by 7 feet structure. The smaller culverts are being used under fills of up to 30 feet and, consequently, have necessitated special designs, due to the enormous dead load. The pipe culverts, which are being provided, vary in size from 18-inch diameter to 72-inch diameter and total 2,700 lin. feet in length.

Due to the permeability of the soil in the area, the streams carry water for long periods after rain and it has been necessary in many cases to by-pass the flow of water to allow the culverts to be constructed. It has been necessary to excavate the wet material until a firm dry bed is reached before placing a sand bed or concrete cradle for the pipes. Selected filling is placed around the pipes and near the culverts. It is then compacted in layers using wacker rammers and a Departmental 30-cwt tandem vibrating roller. The maximum depth of fill used over a pipe culvert on this section is 25 feet.

## EARTHWORKS

The geological formation encountered during earthworks has been the Fitzroy series of the Clarence-Morton Basin of Silurian age comprising phyllites, greywackes and silicified mudstones.

The major portion of the material is being shifted with Departmental tractors and scrapers of 15–20 cubic yards capacity. One tractor-dozer is being used for ripping and for push-loading two tractors and scrapers. The length of haul for the tractor-drawn scrapers has been up to 1,000 feet. For hauls longer than this, the material is carried by contract trucks and loaded by Departmental loader. A self-loading scraper has recently been hired by the Department and this is proving to be very effective. It is expected to eliminate the need for a loader and trucks and may also eliminate the use of tractor-drawn scrapers, except for very short hauls.

Where swampy material has been encountered, it has been removed, allowed to dry out and later used for spreading on the batters of fills. One grader is used for spreading on the batters of fills. One grader is used for spreading the material and another for trimming the batters and catchdrains.

The material is compacted by a grid roller towed by a rubber-tyred tractor and by two flat steel 10–12-ton rollers and two 4-ton 72-inch wide vibrating rollers which are towed by two Departmental tractors. Soil densities are regularly checked by Departmental staff using the sand replacement method. The naturally-occurring material generally required 16 inches of cover to support a bituminous seal.

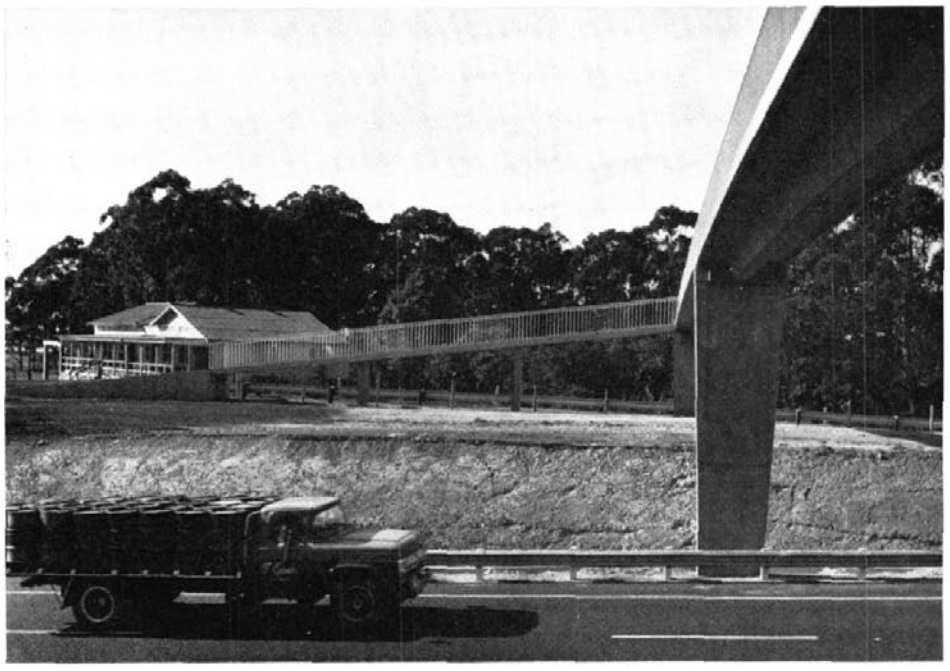
## BASE COURSE

The base course material being used is a phyllite of Silurian age from the Fitzroy Bed and is being obtained from the Bellbird Pit. The cover requirements of the phyllite have varied from 4 to 6 inches, depending on the location of the pit and the amount of preparation and grading given to the material on the road.

*New work has included the provision of climbing lanes and guard-railing as well as centre, lane and edge lines*

The material is being won with a hired tractor-dozer with rear-mounted rippers. Exceptionally hard areas of the pit have had to be shattered with explosives prior to ripping. The material is loaded using a Departmental loader, hauled approximately 10 miles by contract trucks and then spread by graders. It is then broken up using a grid roller and flat steel roller. When the material is sufficiently broken up, it is compacted by six passes of a flat steel roller and four passes of a vibrating roller towed by tractor at a speed of 3 mph. Usually, this has been sufficient to give 100 per cent relative density.

*Pedestrian overbridge provided adjacent to Kororo Public School*

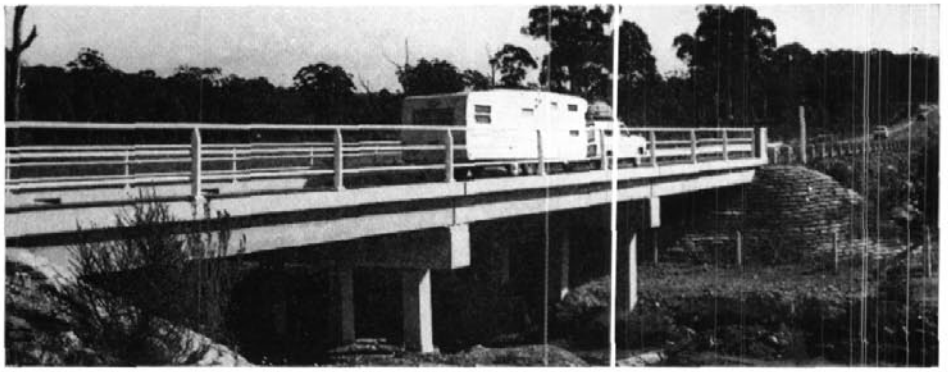


## SURFACE COURSE

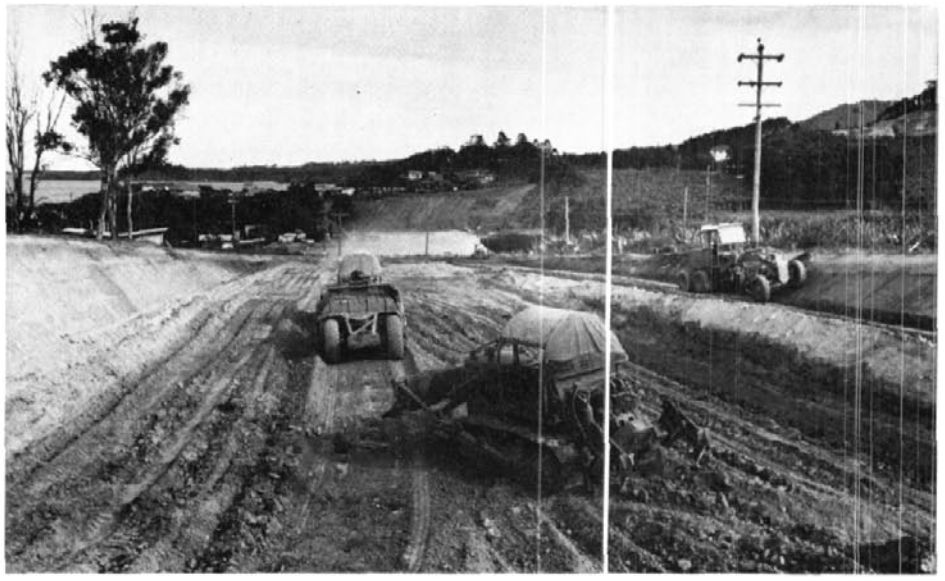
Generally a depth of 6 inches of material is being used to provide adequate cover over the base course. This surface course material is being obtained from Dirty Creek Pit, north of Corindi, and is part of the Layton's Range Conglomerate of Mezozoic age. Typical test results of the material are as follows:

| | |
|---|---|
| Retained on $\frac{3}{4}$-inch sieve .. | 2 per cent |
| Passing $\frac{3}{8}$-inch sieve .. | 70 per cent |
| Passing $\frac{3}{16}$-inch sieve .. | 52 per cent |
| Passing No. 7 sieve .. | 38 per cent |
| Passing No. 36 sieve .. | 22 per cent |
| Passing No. 200 sieve .. | 11 per cent |
| Less than 0·0135 mm .. | 7 per cent |
| Liquid Limit .. .. | 20 per cent |
| Plastic Limit .. .. | 15 per cent |
| Linear Shrinkage .. .. | 1 per cent |
| Maximum Dry Weight (lbs/cu ft) .. .. | 142 |
| Laboratory Optimum Moisture Content .. | 7 per cent |
| Field Optimum Moisture Content .. .. .. | 5 per cent |

In order to win this material, the overburden is first pushed aside with a bulldozer. Holes 20 feet deep are drilled at intervals of 5 feet and loaded with Ammonium Nitrate Fuel Oil. The explosive is detonated with electric detonators, Cordtex and one stick of gelignite A.N. 60 per hole. Various patterns have been tried in an attempt to reduce the amount of secondary blasting required. However, no satisfactory pattern has yet been determined which eliminates the need for secondary blasting. After secondary blasting has taken place, the material is further broken up by the bulldozer stockpiling the material in the pit, before it is loaded onto trucks. The material is tipped and spread on the road and further broken up using a grid roller. The number of passes required to split up the surface course material ranges from ten to thirty. When the material is sufficiently broken up, it is watered and shaped and given 15 passes of the grid roller, 6 passes of the vibrating roller and 8 passes of the flat steel roller. This is usually sufficient to achieve 100 per cent laboratory density. However, as this initial surfacing was found to be extremely open textured, a finished surface is now achieved by lightly grading a windrow of material backwards and forwards across the pavement until all the fines from the windrow have filled in the open pores of the surface. The material is being compacted in two layers in order to achieve satisfactory results, and to prevent the fines segregating and moving to the bottom of the layer.



*New concrete bridge over Moonee Creek*



*Reconstruction in progress approximately 6 miles north of Coff's Harbour*

The pavement is being given an initial prime seal of hot R.90 bitumen, cutback with 7 per cent power kerosene applied at 0·15 gallons per square yard. The primer seal is covered with $\frac{3}{8}$-inch aggregate to give a final running surface for traffic. Sealing with hot bitumen is being carried out two to three months after each section is opened to traffic.

## TRAFFIC FACILITIES

Guide posts and guard rail protection fencing are being erected in accordance with the usual Departmental standards. Additional "storage" lanes for vehicles waiting to turn are being provided at a number of intersections where they are warranted by the amount of traffic. A pedestrian overbridge, costing approximately $22,000, has already been built opposite Kororo Public School to allow school children to cross the *motorway* safely and without interference to or from traffic.

The total cost of the work is expected to exceed $2,000,000 ●

*Reconstructed section of Pacific Highway, approximately 7 miles north of Coff's Harbour.*

*New section under construction. 3.5 miles north of Coff's Harbour.*

# SERVING THE BANANA BOWL

The image in most people's minds when they think about the Coff's Harbour district of New South Wales would probably most frequently focus on two types of persons – tourists and banana-growers. These two groups will both benefit greatly from the improvements now being carried out by the Department to the Pacific Highway, just north of "Coff's".

*Tourists and bananas thrive on Coff's Harbour sunshine* ▷

△ *Earthworks in progress*

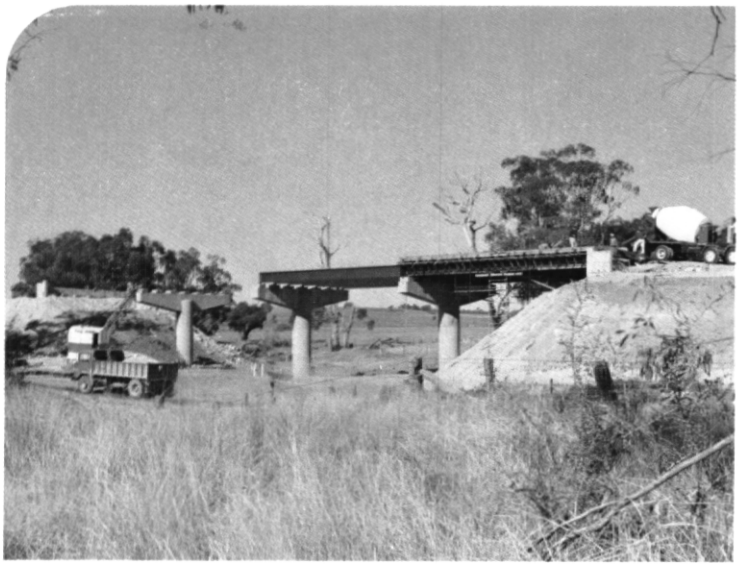
Tourists come to surf at sun-drenched beaches, to fish in pleasant rivers and estuaries, to stroll through silent tropical rain-forests, to visit picturesque plantations and to sample the delightfully fresh flavour of locally-grown bananas.

Although Coff's Harbour is the largest timber port in Australia, banana-growing is the chief source of local wealth. Plantations spread along the hillsides for over 20 miles, penetrating almost every nearby valley and covering the contours of the slopes surrounding the town with a symbolic lush green colour.

Banana-growing in the Coff's Harbour Shire covers almost 6,500 acres and produces over one million bushels of bananas each year, worth over $3.5 million. Improved road conditions are of vital importance to growers concerned with getting their product to local railheads as soon, as safely and as smoothly as possible.

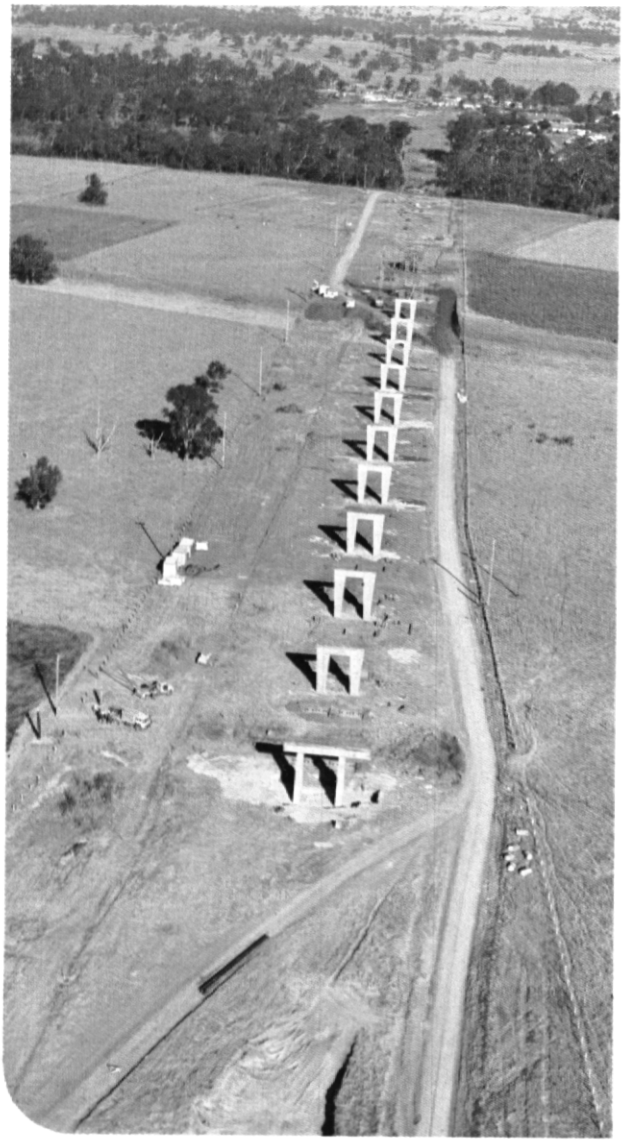
Tourists are equally concerned with fast, safe and comfortable travelling conditions and are generally more attracted to areas having ease of access. So from the point of view of both encouraging tourism and expanding primary production, better roads mean better business, not only for Coff's Harbour but for many similar centres in the State.

▽ *Traffic using new section of Pacific Highway – at same location as shown above (top right).*



△ *Near Dubbo — Construction of new bridge over Willandra Creek, 8.5 miles west of Dubbo, on Mitchell Highway*

▽ *Near Camden — Looking along the line of piers which will carry a huge new bridge over the Nepean River and its flood channel, on a new deviation of the Hume Highway*



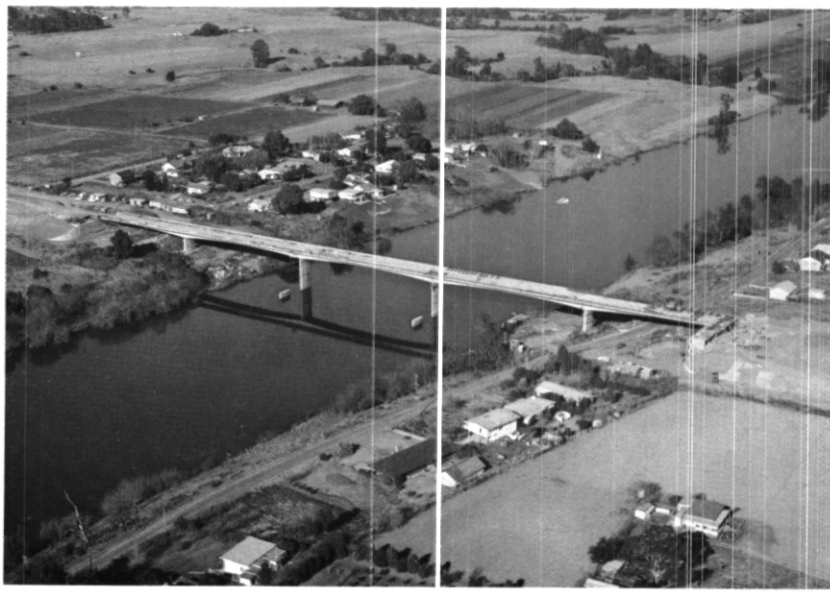
# CONCENTRATION ON CO

"Looking-in" on construction work is such a popular pastime that provision is usually made in city jobs for "observation windows" to be incorporated in the safety fences surrounding the sites. Small lunch-time crowds generally gather to see construction equipment in action and watch new building methods.

It is not as easy to view the Department's roadworks which run in long ribbons and often extend for a number of miles. Bridgeworks are not so spread out, but the major ones are generally on new road deviations and few are within the lunch-time range of city "sidewalk supervisors". New sections of expressways go unnoticed by the majority of the community during the years of their construction and are frequently seen for the first time when opened to traffic.

With such widespread work it is hard to provide any sort of

▽ *At Regentville — Construction nearing completion on new bridge to carry first stage of Western Expressway over Nepean River*



◁ *Near Regentville — Department's new automatic trimmer spreader in action during construction of Western Expressway*

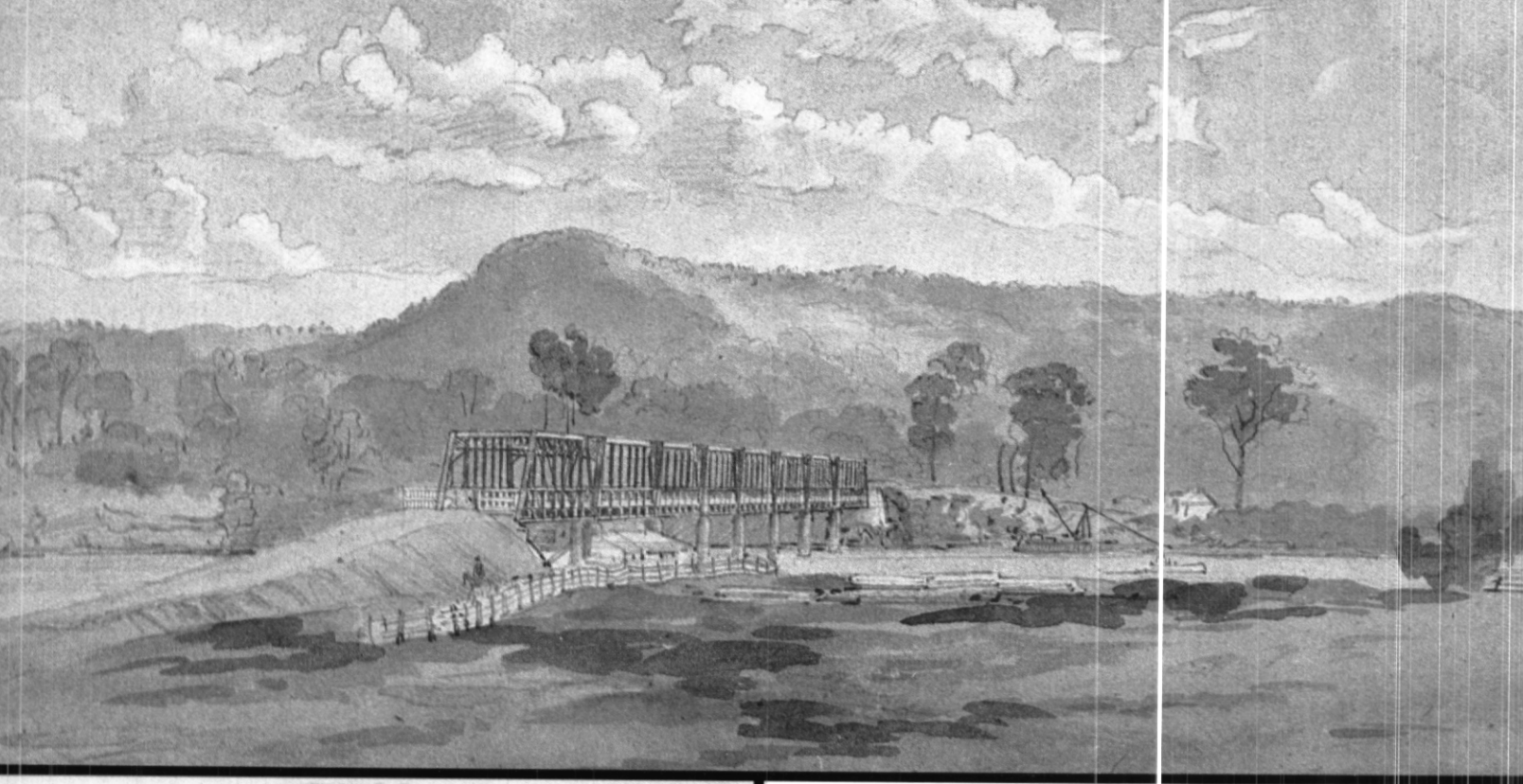
▷ *At Kings Cross — View looking east (towards Rushcutters Bay, top left) showing area where properties have been demolished and excavation has commenced for Department's road tunnel project*

# STRUCTION

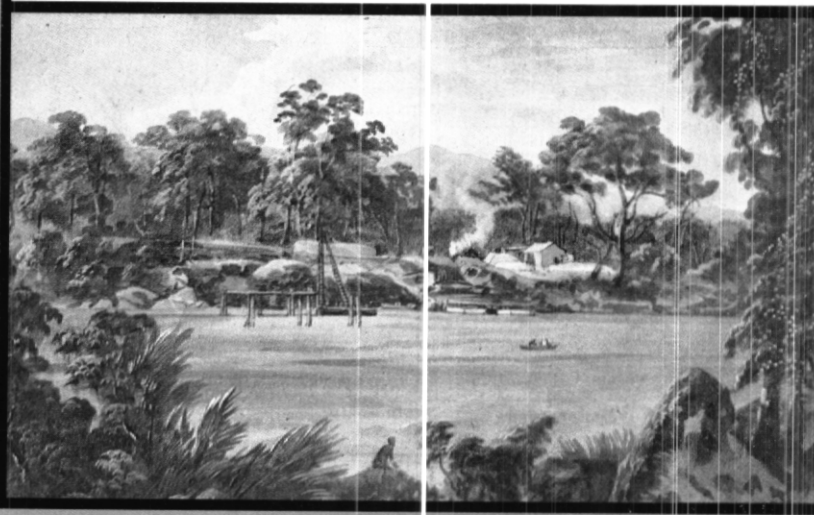
"observation window", where interested persons can watch. So, to show the ways in which the Department works and to record major construction projects, the Department produces colour movie films and keeps an extensive photographic library . . .

. . . and here, on these pages, the spotlight has been focussed on the action at some of the Department's current construction sites.


▽ *At Urunga — A new bridge being built beside the old, over Bellinger River on Pacific Highway*



# THE ARTIST



*Opposite page: Elyard's paintings of the construction of the bridge over the Shoalhaven River at Nowra, showing the commencement of construction on the Bomaderry side (centre left) and cylinders being discharged from Mr David Berry's brigantine, "Moena" on 29th September, 1879 (centre right)*

*Below: A present-day photograph of the bridge, from the southeast bank*

IN the Shoalhaven Shire Council Chambers at Nowra is a rare collection of watercolours by the artist, Samuel Elyard. Included in the views painted by Elyard are three showing the construction of the bridge over the Shoalhaven River at Nowra and others showing streets and roads which have since developed into major thoroughfares.

With the kind permission of the Shoalhaven Shire Council, the Department has reproduced a selection of Elyard's paintings on the back cover of this issue and on the page opposite.

A short biography of Samuel Elyard, to whom we are indebted for such an attractive record of earlier bridge building methods, is included in acknowledgement of the value of his work.

As it is the ninetieth anniversary of the opening of the bridge at Nowra, it is also appropriate to record some details of its construction and opening, especially as one of the spans had the unusual honour of being exhibited at the International Exhibition in Sydney in 1879 and won for its designer a special merit award.

# AND THE BRIDGE

For well over 25 years after the establishment of a village at Nowra, traffic across the Shoalhaven was compelled to use a punt at Bomaderry. In 1876 the sum of £12,000 was placed on the Estimates for the construction of a timber bridge. However, in 1878 an additional sum was added to the Estimates, and it was decided to erect an iron structure.

The following extract from the Sydney Morning Herald of Wednesday, 3rd August, 1881, describes the opening ceremony held on 1st August, 1881, and gives construction details.

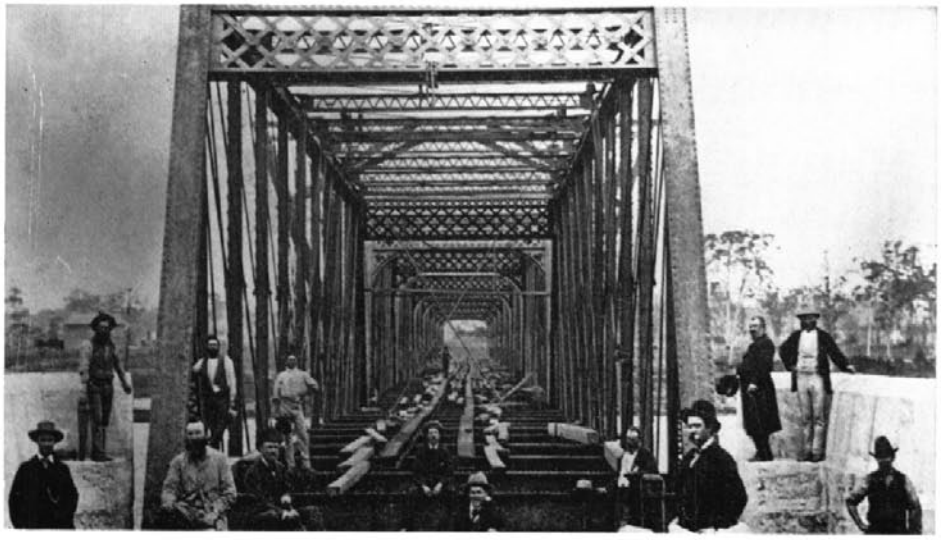
*

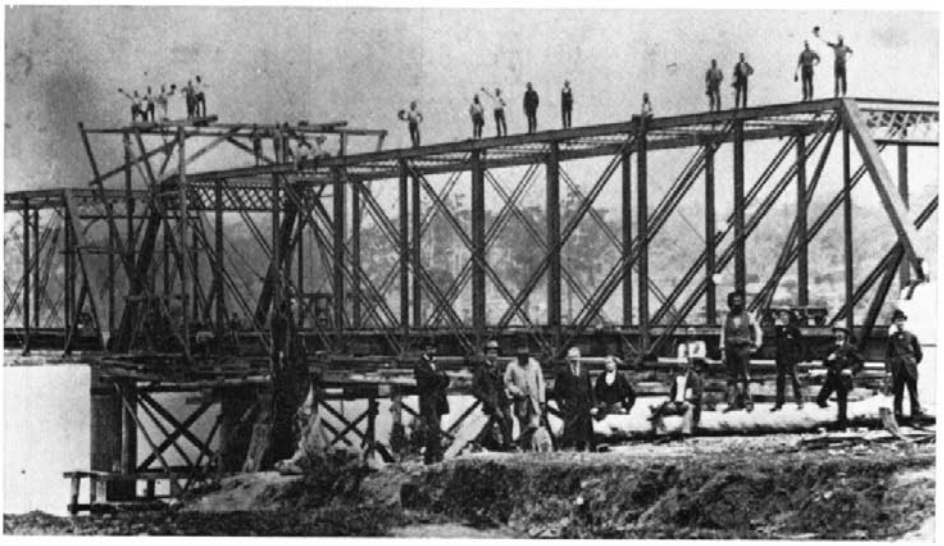
"(By telegraph, from our own reporter.)
Nowra, Tuesday.

The ceremony in connection with the opening of the bridge at Nowra was performed yesterday, by the Hon. John Lackey, Minister for Works, in the presence of 6,000 or 7,000 people, who assembled from all parts of the district. The affair was very successful.

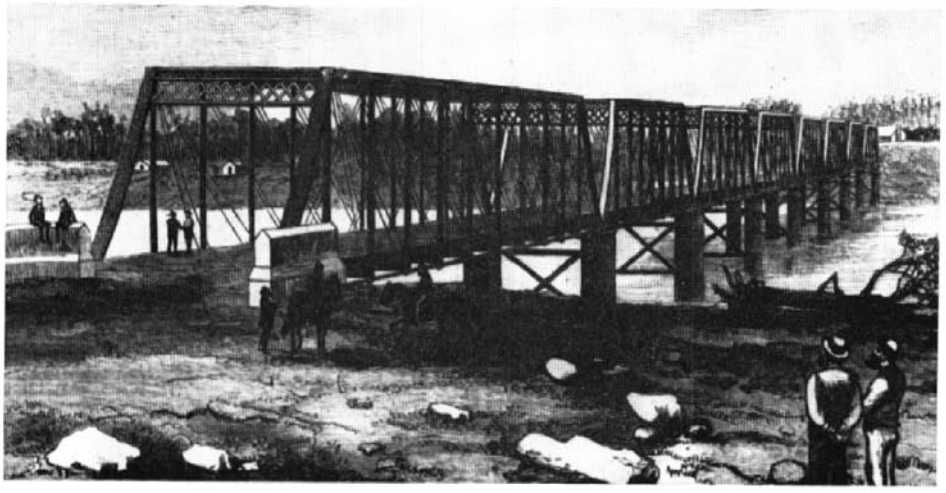
Mr Lackey left Austermere on Sunday, staying at Mr Osborne's residence, Kangaroo Valley, on Sunday night and riding the rest of the distance yesterday morning. Messrs Roseby, Kidd, and C. Withers, Ms.L.A., left Moss Vale on Sunday, by special coach, and accompanied Mr Lackey into Nowra. A large number of horsemen met the Minister some miles on the road, and accompanied him to the new bridge, where the people were assembled and where flags and other decorations were displayed in a manner that made the general view of the reception arrangements very striking and pretty.

On arriving on a small bridge, which forms the approach to the bridge over the river, Mr Lackey was met by a reception or presentation committee, consisting of Mr John McKenzie, Mayor of Broughton Creek and Bomaderry; Mr Green, Mayor of Nowra; Mr W. Lovegrove, C.P.S., Mr J. Thomson, J.P., Mr R. Finlayson, and Mr H. G. Morton, J.P., Mr Wells, Acting-Commissioner for Roads and Bridges, was also present. After a few words of welcome, Mr Lackey, in an appropriate little speech, and by breaking a bottle of champagne, opened the bridge, and named it the Bomaderry Bridge. Cheers followed and music from the Shoalhaven brass band, and a procession was then formed, and marched to the principal bridge. On arriving there, an address was presented to the Minister, and he having replied to the address, expressed a hope that the work would realise the most sanguine expectations of the well-wishers of the district. He broke a bottle of champagne upon the bridge and named it the Nowra Bridge. Cheers were again given and the band played "God Save the Queen". The Minister for Works, with Mr Roseby and the reception committee, then walked across the bridge and were followed by Messrs Withers and Kidd, Ms.L.A., who were the first to cross the structure in a vehicle, and then by the people in a continuous stream. Mr Lackey was welcomed upon the other side of the river by Mr Green, Mayor of Nowra, and there was more cheering, including cheers for the Ministry. This brought the principal ceremony to an end, and the visitors were then invited to partake of a light luncheon, and afterwards were taken in a steamboat up the river. Boat races and foot races were held all the afternoon, and the day was kept as a high-holiday. At night a banquet was held at Moss's Central Hotel, at Green Hills.





*Construction of the bridge over the Shoalhaven River at Nowra.*
*These photographs are from an early Department of Public Works album, which is now held in the archives section of the Department of Main Roads.*



*"The New Nowra Bridge"—from the Sydney Mail, Saturday, August 6, 1881.*
*Reproduced by courtesy of the Mitchell Library, Sydney.*

This morning some deputations waited upon the Minister, and Mr Lackey then left on his return journey. He expects to reach Sydney about 11 o'clock on Wednesday morning.

The bridge, which has a light appearance to an English eye, but which is designed on a principle stated in America to be of approved strength, was constructed by the Edgemoor Iron Company, of Delaware, and placed in position under the direction of Mr Onward Bates, recently their representative here. It is the longest the department has had built, the length being 1,103 feet, while the width is 20 feet, and the clearance about 22 feet. It is situated within half a mile of the town of Nowra, to which also it will lead. The bridge is a high level one, having no opening for navigation, but admitting of river steamers passing under it without inconvenience. There are in its construction seven spans of 124 feet 6 inches each, one span of 181 feet 6 inches, and one of 50 feet; and, with the exception of the timber planking, the materials used are of iron. In connection with the shortest spans, the iron cylinders upon which the structure rests are twelve in number, and 5 feet in diameter. In the long span the cylinders are four in number, and 7 feet in diameter. On the northern end there are two cylinders, 3 feet 6 inches in diameter, with stone abutments. In consequence of a failure in the strata of the rock one of the piers sank considerably but now all are said to be bedded on firm foundations. The superstructure is of American design and workmanship, and is the first of its kind erected in the colony. It comprises a principle known as the "whipple truss", and many persons will no doubt remember that a section of it was exhibited in the grounds of the Garden Palace in 1879. It is intended to be used at present for ordinary traffic, but may ultimately be appropriated for the purposes of railway traffic also. Connected with it is a bridge over the Bomaderry Creek, handsome in appearance, constructed of wood and resting on stone piers. This structure has been strongly designed in order that it also may sustain railway traffic, and has one 90 feet span and two spans of 30 feet each. It is connected with a bridge of two 30-feet spans on an embankment forming the approaches to the creek. The cost of the three structures will be about £42,000. Clearing only is completed on the new lines of approach, but the bridges will be available for use immediately. The approaches and the embankments will be composed of stone. Mr J. E. Williamson was resident engineer in charge of the works on behalf of the Government but for several months, during which the subsidence of the pier occurred, Mr F. Wells, Assistant Engineer of Roads and Bridges was in attendance."

⁂

A later description of the bridge, in the "Australian Graphic" of 25th May, 1889, included:

"The eight long spans are of American manufacture, being supplied by the Edgemoor Iron Company, Delaware, U.S.A. The 50-feet span is of Sydney manufacture. The bridge is carried on nine piers and a stone abutment; each pier consists of two columns of cast-iron cylinders braced together with wrought-iron bracing, the cylinders being sunk to a firm bed and filled with concrete. The cylinders are colonial work, having been cast at the Atlas Foundry, Sydney, and are quite equal to any received from foreign countries. The time occupied in building the bridge was about 20 months, it having been commenced on July 5th, 1879, and completed on November 2nd, 1880."

⁂

The "Illustrated Sydney News" of 4th September, 1880, reported that:

"The first span of the superstructure . . . has just been swung into position. This span weighs over 70 tons of iron, and is 124½ feet long, 22 feet 6 inches wide, and 28 feet high from the top of the piers to the top of the truss. It was put together and swung into position by fifteen men in six days."

⁂

In the "Reports of Judges and Awards" section of the official catalogue of the International Exhibition held in Sydney during 1879, there are some interesting comments on the merits of this type of bridge in general and on the span exhibited in particular.

"EDGEMOOR IRON COMPANY.—Wilmington, Delaware.—The American Pin Truss Non-continuous Girder Bridge for the Shoalhaven River, at Nowra, designed in Sydney. First degree of Merit Special.

Report—This bridge was ordered by the New South Wales Government, on the suggestion of the Commissioners of the Philadelphia Exhibition, with a view to determine the relative merits of this type of bridge and those generally adopted in the Colony previously, and was designed in Sydney by Mr Onward Bates, C.E., the Agent in New South Wales for the Company, under the general direction of Mr W. C. Bennett, Engineer-in-Chief for Roads and Bridges. The workmanship of the bridge exhibited in the grounds of the Garden Palace is excellent, and the design is a good example of a system of construction adopted by many engineers and manufacturing bridge companies in the United States, and extensively used in that country and in South America, both for railways and public roads. A diagram sheet showing the strains to which the various parts of the bridge would be subjected from its own weight, and also from the moving loads of a public road, as well as that due to the running of a heavy locomotive, has been submitted to the Board, and checked by one of its members, and found to be correct. The dimensions of the respective members of the bridge appear to the Board to have been carefully considered and adjusted to their loads, with an ample allowance for safety in all parts. In the comparison drawn by the Judges between this and the bridge exhibited by Messrs Appleby Bros, East Greenwich, London, as to their relative adaptability for the uses of the Colony, the following remarks were made: That much as this type of bridge is admired, it is not to be forgotten that every part has to be very carefully made by experienced workmen in a factory possessing special facilities and appliances for this particular description of work. The iron is also of a superior description prepared for the purpose, and is more costly than the ordinary plate and bar-iron used in English bridges. Although this description of bridge can be readily transported to a site for erection, and be put together with great rapidity and certainty, yet from its construction it requires staging of a more extensive character than that necessary for lattice or plate girder bridges, thereby forming a serious item in the expenditure of the work, especially in this Colony, where the rivers are subjected to great floods. This bridge shows a less quantity of iron in its construction than the lattice type; but on the other hand, the first cost both of material and labour is much greater, which would probably be found to bridge the cost up to the same amount in both descriptions of bridge. Great care has been taken in the quality of workmanship of the girders, which may be considered excellent. Taking all the different points into consideration the Judges arrived at this conclusion: 'That, unless under *peculiar* circumstances, the lattice type of bridge is preferable for both railways and roads in this Colony'."

# THE ARTIST

*SAMUEL ELYARD* was born on the Isle of Wight in 1817. His father Dr William Elyard, R.N., was appointed as surgeon on the convict vessel "John Bull" and brought his wife and family with him, evidently intending to settle here. They arrived in Sydney during December, 1821. The eldest son William was, at once, appointed a clerk in the Colonial Secretary's Office, and gradually rose to the position of Under Secretary.

Samuel Elyard entered the Colonial Secretary's Office on 16th April, 1837, and after serving more than 31 years he retired on 18th August, 1868. Following his retirement, Elyard rented a small farm near Nowra for a number of years, before moving into Nowra where he built "Merindah" in Osborne Street. Here he lived until his death on 23rd October, 1910.

The following extract is from the introduction to a book of his drawings entitled "Scenery of Shoalhaven" (1892).

"Since he left the Civil Service, Mr S. Elyard has followed the profession of a Landscape Painter; and the following are the particulars of this career as such:

About the year 1826 he was placed at the School kept by Mr Gilchrist, tutor to Sir Francis Forbes' family; and was there taught drawing by Mr Edgar, an engraver by profession, who was an assistant in that School. . . .

Afterwards, when a schoolboy at the Australian College, Mr Elyard studied miniature and oil painting under Mr East, who . . . painted a picture of the then well known 'Billy Blue' in oil colours, which attracted great attention.

Whilst at this School Mr Elyard painted some portraits in Water Colour, which were thought very highly of, and brought him several commissions.

After leaving School he became acquainted with Mr Conrad Martens, the distinguished landscape painter, and was delighted with his drawings, which were highly poetical. He painted a miniature of Mr Martens which pleased him so much that he obtained several commissions for him, and advised Mr Elyard never to charge less than four guineas for one of his portraits. . . . Soon after Mr William Nicholas, the Engraver and Miniature Painter, arrived from England, and obtained immediate patronage. Mr Elyard became acquainted with, and studied under him during the time he remained in Sydney; but after much reflection he determined to give up portrait painting as a profession, and in 1837 he entered the Public Service, and gradually became a clerk of the first-class, in which position he remained until 1868.

Afterwards he determined to devote any leisure time he might possess to landscape painting; and whenever he met with persons capable of teaching it, he always took lessons from them; and for a considerable time he studied under Mr John Skinner Prout, an eminent Landscape Painter, who came to New South Wales about the year 1841 . . . (but) did not remain long in Sydney. . . .

Mr Elyard came to settle in Shoalhaven in March, 1869, the scenery in the district having attracted his notice by its beauty. Since then he has worked almost incessantly for five days of each week in endeavouring to delineate the exquisite views which abound in various parts of Shoalhaven. By Mr Prout's advice he always painted his studies directly from nature in colour, and of a large size."

Elyard exhibited with the Society for Promotion of Fine Arts, Sydney, in 1847 and 1857, and sent five views to the New South Wales section of the Paris Exhibition of 1867. Some of his watercolours, illustrating Sydney in the mid-1800's, are now held in the Dixson Gallery of the Public Library of New South Wales.

His pictures of the Nowra district were local news. The Shoalhaven Telegraph in December, 1880, noted that he had completed "another of his beautiful landscape paintings" and remarked on the "delicacy of touch and exquisite harmony of colour . . .". In 1890, he was presented with the Shoalhaven Agricultural Society's Medal, in recognition of his services to the fine arts section of the show. A Nowra newspaper recently claimed "It is a fairly safe speculation that no other town in Australia, apart from the capital cities, can boast so complete a set of illustrations of its history".

*In acquiring, restoring and exhibiting a large number of his works, the Shoalhaven Shire Council has preserved not only examples of the skill of the artist but also valuable historical records of the district in which he lived.*

# AERIAL PHOTOGRAPHY FOR ROAD LOCATION AND DESIGN

*This article is the first in a series of three which will appear in "Main Roads" on aerial photography and photogrammetry for road and bridge location and design.*

It describes the use of aerial photographs as a means of recording information which cannot be readily obtained from maps or plans. The types of aerial cameras and film are mentioned as well as the various purposes for which aerial photography is used. The limitations on the use of air photographs are discussed, with reference to the geometry of the photograph itself and the obstacles which prevent a clear picture of the terrain being obtained.

The processing of films and the different photographic products, such as mosaics and rectified photographs, are described. The comparative costs of positioning the aircraft, and processing and printing the film are assessed. A check list for the annotation of photographs and mosaics is included.

Subsequent articles will deal with the use of photogrammetry for road engineering purposes. The separate requirements for investigation, location and design surveys will be described and the differences shown between conventional mapping and project photogrammetry. The articles will cover such aspects as:

- the need for ground control, with possible field survey;
- the formation of a "stereomodel";
- the various photogrammetric instruments used;
- conventional stereoplotting of various scales; and
- methods of automating photogrammetry.

These articles have been edited from a paper prepared by the Department's Senior Photogrammetrist, Mr P. G. Sandwith and presented to a seminar for senior Asian and African engineers, held in Sydney during August, 1971.

## THE AERIAL PHOTOGRAPH

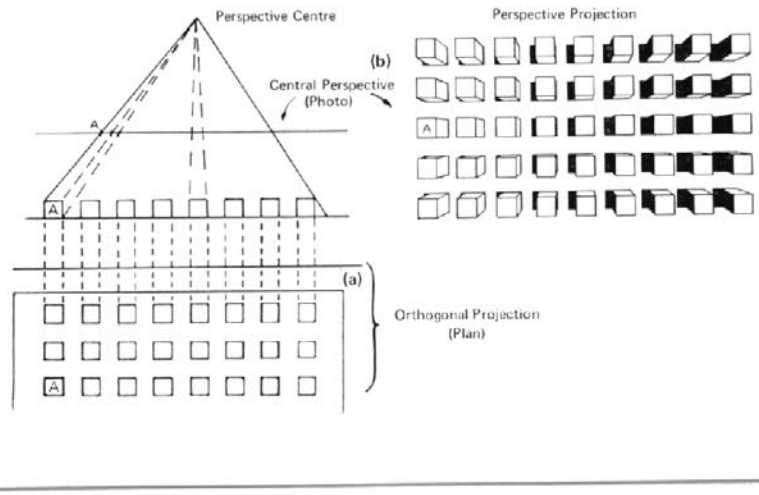
The uses of photography for engineering purposes are numerous and varied. This article will be, therefore, generally confined to the use of vertical aerial photography, since the science of photogrammetry is mainly connected with photographs that most nearly approach the characteristics of maps.

The chief characteristic of a topographical map is that it is an orthogonal projection. Each point on the ground is depicted on the map as it appears to an observer situated vertically above that point (fig. 1). The scale of a map is therefore constant over its whole extent, irrespective of the amount of relief on the ground. Other types of maps based on different projections exist (such as Mercator's projection, where the scale of the map is variable over its surface), but the engineer is primarily concerned with topographical maps.

If an aerial photograph were taken with a camera held exactly vertical over exactly flat terrain, the photograph would have the same characteristics as a map. However, the image of a point on the ground is fixed on the photograph by a central or perspective projection through the lens of the camera. If the camera is tilted from the vertical, or if the terrain is not flat, the scale will vary over the photograph and accurate measurements (such as are made on maps and plans drawn to a set scale) will no longer be possible (fig. 2). The amount of scale variation on a photograph will depend on the height differences between objects on the ground and the amount of camera tilt. The primary objective of aerial photography is to produce photographs with a camera tilted as little as possible and at such a height above the ground that the differences in scale caused by variations in relief are small.

The scale of an aerial photograph is a function of the focal length of the camera and the flying height of the aircraft. If an aircraft were flown 1,000 metres above terrain using a camera whose focal length

FIGURE 1.



was 0·1 metres, the scale of the photograph would be 1 : 10,000 (fig. 3).

This scale means that 1 metre on the photograph or plan represents 10,000 metres on the ground. The metric system has been adopted throughout this article for convenience: one English foot is approximately 0·3 metres.

The advantage of an aerial photograph over a conventional map is the wealth of detail recorded on the photograph that cannot be depicted on the map. In addition to the obvious details (such as buildings, rivers, and roads), soil types and vegetation types, seasonal crops and areas subject to flooding can all be identified by the engineer trained in interpretation. Maps always require some generalisation which distorts the true shape of buildings and the true widths of roads, and maps cannot depict seasonal variations, nor can they be quickly revised when out of date.

## AERIAL CAMERAS

There are many types of aerial cameras, ranging from those used in space vehicles to photograph the earth whilst in orbit, to the comparatively cheap and simple reconnaissance camera which can be used to photograph busy intersections for traffic counting. The aerial survey camera was designed principally for mapping but has also become a very useful tool to the engineer.

Conventional survey cameras fitted to take vertical aerial photographs normally use roll film or glass plates with an 18 cm x 18 cm (7 in x 7 in) format or 23 cm x 23 cm (9 in x 9 in) format. Glass plates are cumbersome and are easily damaged, but are more stable than film.

Various focal lengths are available for survey camera lenses, but the commonest types are narrow angle, normal angle, wide angle, and super wide angle. The nominal focal lengths for these lenses, when a 23 cm x 23 cm format is used, are 600 mm, 300 mm, 150 mm and 88 mm respectively (fig. 4). In practice, the focal length of a survey camera is calibrated in a laboratory to the nearest hundredth of a millimetre to obtain the distance of the lens from the film surface as accurately as possible. The optical axis should intersect the exact centre of a photograph at a point known as the "principal point". This point can be located on any photograph from register marks at the sides or corners of photographs, known as "fiducial marks" (fig. 5). In theory, aerial camera film should be kept exactly flat at the instant of exposure either by a register glass or a vacuum, but in practice there are always areas of "unflatness" which cause film distortion.

No camera lens is perfect and there is always a slight bending of rays projected through a lens, known as lens distortion. Both film and lens distortion affect the quality of the image on a photograph and the accuracy of measurement. Even with these distortions it is possible to measure distances on an aerial photograph in a photogrammetric instrument to an accuracy of 0·02 mm, which would represent 0·2 metre on the ground, at a scale of 1 : 10,000.

## AERIAL FILMS

The different types of film used in aerial survey cameras include panchromatic, infra-red black and white, infra-red colour, "true" colour and "false" colour. Lengths of films that can be mounted in one magazine range from 200 to 400 frames of panchromatic film to 120 frames of colour film. Panchromatic film usually provides the greatest contrast between light and dark tones on photographs and is the type of film most used for mapping. However, colour film is being used increasingly for engineering projects in Australia, as it affords greater ease of interpretation for particular purposes. In Australia, the tops of trees and the ground often appear indistinguishable on panchromatic photographs as a uniform shade of grey, whereas colour photography shows a predominance of green on the tree tops and brown on the ground beneath. The cost of an aerial colour film is approximately twice that of panchromatic film.

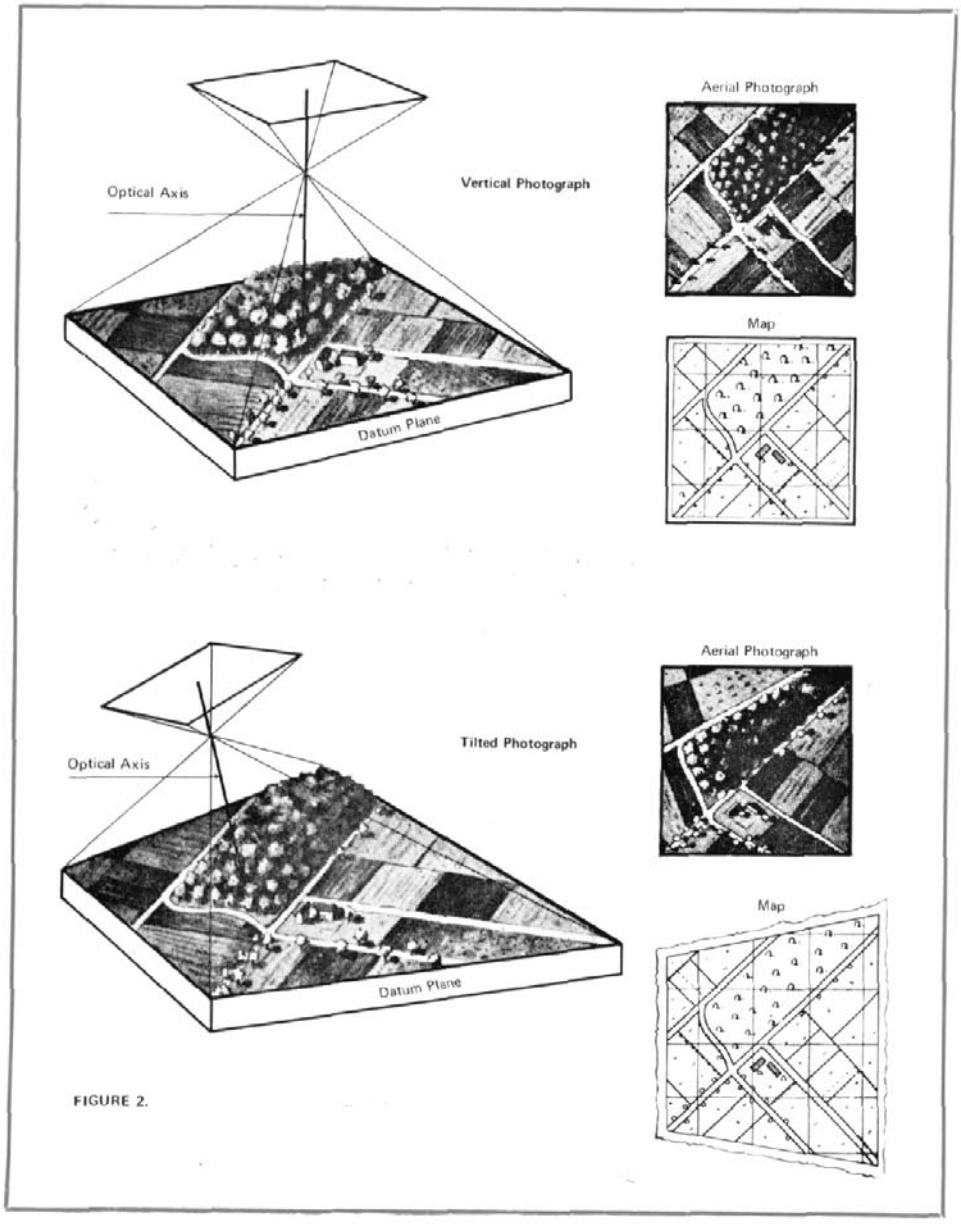
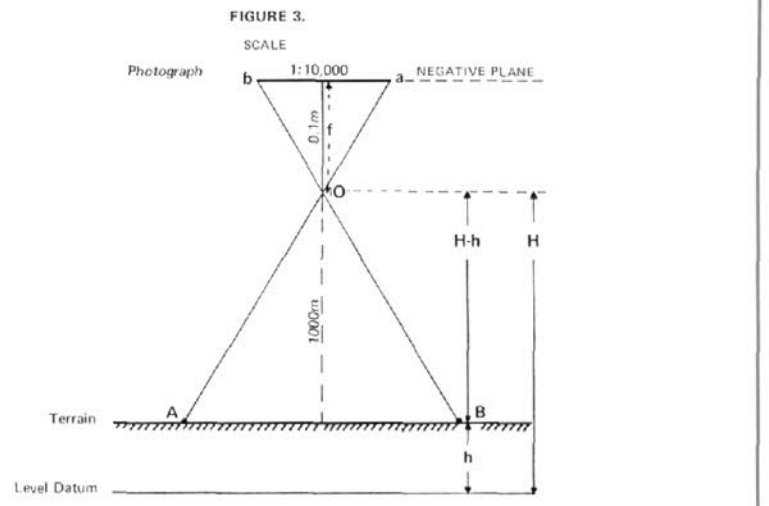



FIGURE 2.

FIGURE 3.




Infra-red colour photography is used for specialised purposes, for instance in detection of diseased trees in forests. For example, infra-red film is more sensitive to moisture content in the sub-soil than other films. It has, therefore, been used to good effect when it is required to know what areas have a high water table and hence will give drainage problems. "False" colour film is now widely used by geologists in Australia as it apparently gives easier interpretation of different rock formations.

## FLYING OF AERIAL PHOTOGRAPHY

Mapping of a country is planned so that the area to be mapped is divided into a number of map sheets at a selected scale with sheets of approximately equal size. These sheets are either bounded by meridians of longitude and parallels of latitude or by grid lines calculated on a chosen projection. Aerial photography for mapping is planned so that a suitable number of map sheets are covered by photography in one flying season. A large number of aerial photographs may be required to cover one map sheet. Strips of photography are flown parallel to one another, with ground detail on the edge of a strip being also covered by photographs of the next strip to ensure that there are no gaps in the total coverage of photography (fig. 6). Similarly, an overlap between successive photographs in a strip must be provided, but as mapping is nearly always performed from pairs of photographs this overlap must be large enough to ensure that one pair of photographs overlaps the next pair. This means that there must be more than 50 per cent overlap on each photograph to ensure a continuous run of pairs (fig. 7). In fact, an overlap of 60 per cent is normally adopted, with a 15 per cent to 30 per cent side lap between strips of photography.

The extent of aerial photography for engineering purposes will usually be limited by the area on the ground to be included in a particular project. It is practically certain that the area will not be as conveniently rectangular as the area to be covered by a map sheet. The planning of aerial photography for road engineering projects, in order to cover a strip of land which may be affected by a road deviation or bridge approaches, is therefore more complicated than aerial photography for mapping, although the area to be covered on the ground may be smaller. Mapping photography is a continuous, progressive process, year after year, requiring constant revision, whereas photography for road engineering purposes must be planned differently for each project. One project may require only a series of narrow strips of photography many kilometres long to cover the site of a proposed highway. Another project may require photography at different altitudes to cover the same area. The higher altitude photography will give a general picture of the terrain whilst the lower altitude photography will show the terrain at a larger scale and therefore in more detail. The latter, however, requires more photographs to cover the same area that was covered by the high level photography.

The all-important variable factor in planning aerial photography is the scale at which the photographs are to be presented. Small scale photographs can be enlarged photographically, but the size of the enlargement can become unwieldy for storage and the clarity of detail can be lost. Furthermore, most plotting instruments cannot accommodate enlarged photographs. The accuracy of measurements from aerial photographs is also dependent on the scale. If too small a scale is chosen the details that the engineer wishes to examine on the photograph may appear too small to distinguish. If too large a scale is chosen, details may be seen very clearly but the overall picture is lost. The limiting factor at either end of the scale is the height at which a survey aircraft can fly.

Most light planes have a ceiling of about 7,000 metres. Above an altitude of about 6,000 metres, oxygen must be used in the plane and, at higher altitudes, larger and more expensive aircraft must be used. The lowest altitude an aircraft may fly is usually governed by law.

However, the limiting factor in survey photography is that image movement on photographs will be caused at low altitudes, due to the forward movement of the aircraft whilst the camera shutter is open. For instance, an aircraft flying 152 metres above ground with a camera whose focal length is 0·152 metres takes photography whose scale is 1: 1,000. If the aircraft flies at 75 metres per second and the camera shutter is open for 1/250th of a second the aircraft has travelled 0·3 metres during exposure. At the scale of 1: 1,000 the image movement on the photograph due to the aircraft's speed is 0·3 mm, an amount which would cause visible blurring of the photograph. Accurate mapping could not be attempted from such photography.

## PROJECT AERIAL PHOTOGRAPHY

Scales of photography that have been found useful for various Departmental tasks are:

1: 40,000–1: 20,000 . . . for preliminary investigation of highway relocation.

1: 20,000–1: 6,000 . . . for highway location particularly through or near towns.

1: 6,000–1: 4,000 . . . for detailed road and bridge design.

FIGURE 4.

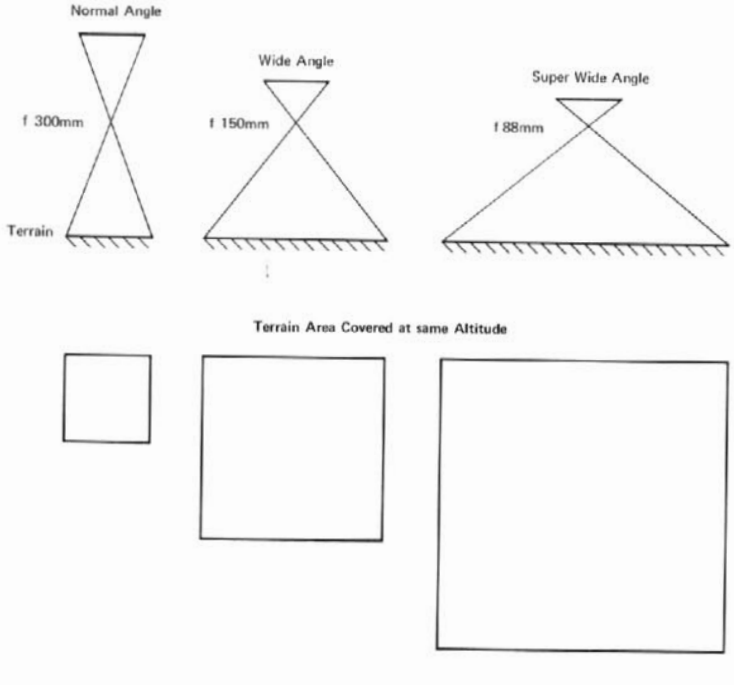
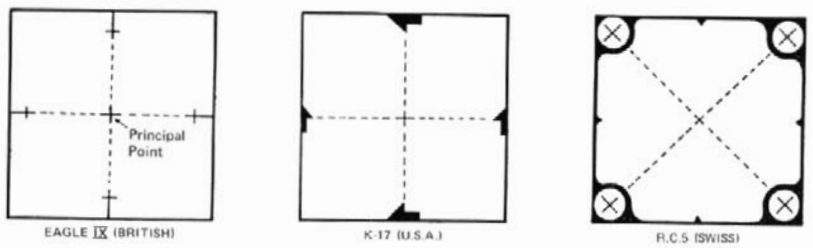



FIGURE 5.




The type of lens to be used on a particular project is determined by the nature of the ground to be photographed. On a detailed survey over a town or city, a narrow or normal angle lens would be used to minimise "dead" ground behind buildings On suburban or rural surveys a wide angle lens would be used and on investigation surveys a super wide angle lens would be used to obtain the maximum amount of coverage (fig. 4). In general, an aerial camera with a wide angle lens will supply the needs of most engineering surveys.

Several government departments and private organisations in Australia have the facilities for processing and printing panchromatic aerial films, but only a few have the full facilities for processing and printing colour, or infra-red aerial films. Their equipment includes:

- baths for processing and fixing negative film;
- contact printing frames or boxes;
- special printing machines known as "Log-Etronic" printers for obtaining prints of even contrast by the use of electronic scanning; and
- enlarging cameras for producing negatives and positives at different scales from the aerial film.

There are various products that can be obtained from the film negative. The most common requirement is the contact print, but a transparent diapositive on stable film base or on glass is used for photogrammetric work. A series of prints taken from a continuous strip of photographs can be joined together to form a strip "mosaic". The mosaic is very useful for viewing the project as a whole and, after assembly, can be re-photographed and reproduced in multiple copies. Mosaics can be annotated with proposed location routes, property boundaries, place names, and important physical features.

Colour film can be processed to negative colour for printing of colour diapositives or colour prints, or it can be processed to positive colour as a transparency for use in a projector or in a photogrammetric instrument. The cost of printing and processing colour film is at least twice that of panchromatic film and the laboratory temperatures and procedures are much more critical when working with colour film. As yet, there are only a few organisations in Australia which are proficient in the handling and processing of colour aerial film.

FIGURE 6.

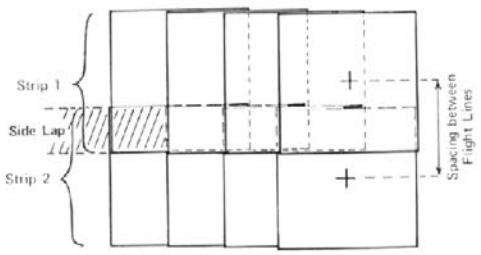
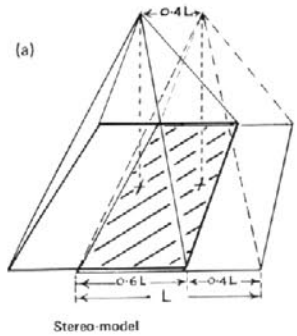
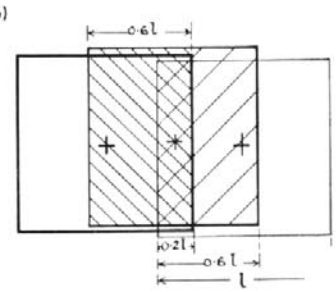



FIGURE 7.




## LIMITATIONS ON AERIAL PHOTOGRAPHY

There are few parts of the world which can claim to have good flying conditions for aerial photography for more than three months in a year. In the temperate zones with deciduous forests, the photographic season is in spring and autumn (at a time when little or no snow lies on the ground but the trees are bare), whereas, in tropical countries with wet and dry seasons, the best time for photography is just after the rains when the air is still clear. At the end of a dry season, bush fires and dust storms reduce visibility and will seriously affect photography. In areas with a combination of high mountain ridges, dense forest and heavy rainfall, aerial photography is hazardous and is only possible on a very limited number of days in a year.

The sun's altitude at the time of photography will affect the results. If the photography is taken early in the morning or late in the evening, long shadows will obscure much of the detail in timber areas. If some cloud is present above the aircraft, shadows from the clouds will be cast on the ground and will make printing of photographs with even contrast very difficult. Photography can be flown under a blanket of high stratus or stratocumulus cloud with no sun at all, but some contrast will be lost. The lack of contrast in this case is offset by the absence of shadow on the photography. Recent experiments have shown that there may be a distinct advantage in flying low-level colour photography under high cloud to avoid shadows in forest country.

Turbulence at low altitudes will affect the stability of the aircraft during flight, and may result in photographs with large tilts, scale differences and insufficient overlaps. The aircraft may also be driven off its correct flight path, with the result that some photographs will not show the full extent of the required coverage.

If aerial photography is exposed over water, care must be taken to see that the sun's altitude is not so high that its reflection on the water appears on the photographs.

## COST OF AERIAL PHOTOGRAPHY

By far the greatest proportion of the cost of aerial photography is the positioning of the aircraft. Actual time spent on photography may be only a few minutes, but many hours may be spent in ferrying from the base airfield to the site and back. A small aircraft is more economical to operate than a large one, but it may take longer to reach the required altitude for the photography. Time must be allowed for turning the aircraft at the end of one strip before commencing the next. In New South Wales, separate charges are made at rates per hour for time spent in ferrying and time spent on photography. In addition stand-by time may be charged when the aircraft, pilot and crew have to be on call for more than a day, when the weather is not suitable for photography at the specified time. If photography of a large area is to be flown or a series of strips are to be photographed as a single project, charges may be made at rates per square kilometre or per kilometre flown.

It has become evident that it is much more economical to repeat any doubtful photography during the initial flying programme rather than to re-photograph at a later date. For photography where correct overlap becomes critical, exposing more photographs per run using an 80 per cent or even 90 per cent overlap will be useful. The additional cost of photographs at approximately $1.00 each is usually much less than the minimum cost of re-flying unsuitable photography, which would be about $400.

## NOTATION ON PHOTOGRAPHS AND MOSAICS

The following information appears on most aerial photographs during exposure:

- Camera serial number.
- Nominal focal length.
- Altimeter reading.
- Time of photography.
- Exposure number.

The following additional information should be recorded:

- Film number.
- Strip number.
- Title referring to the project.
- Calibrated focal length.
- Estimated flying height above sea level. (N.B.—This may not be the same as the altimeter reading.)
- Direction of north.
- Name of the organisation providing the photography.

Other information which should be added to mosaics produced later, includes:

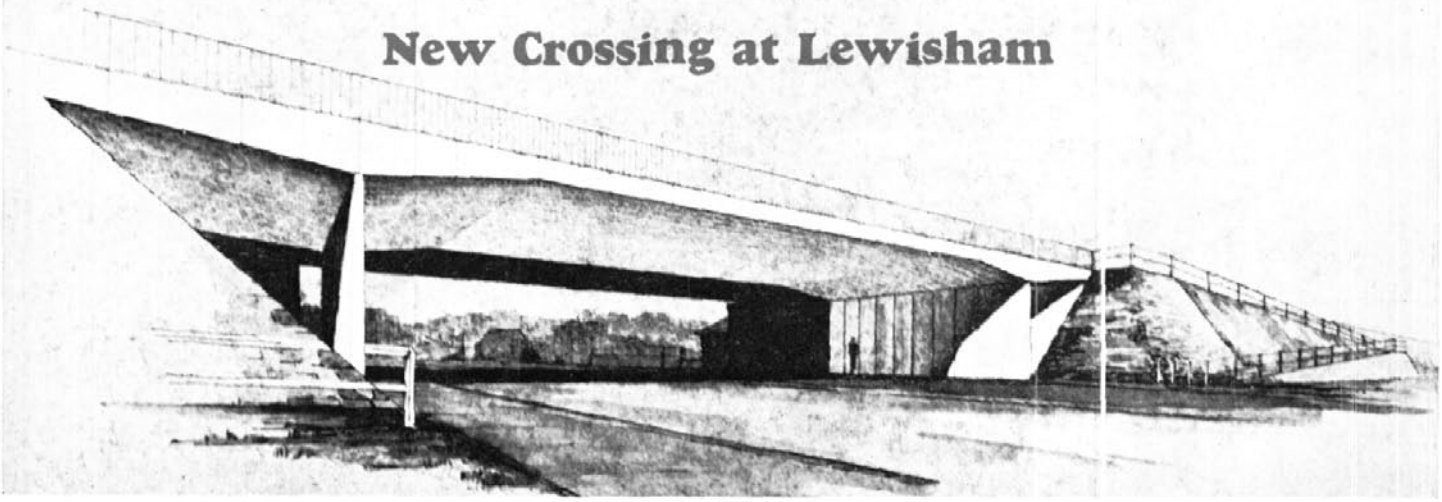
- Approximate scale.
- Direction of north.
- Description of the area covered.
- Name of the authority producing the mosaic.
- Names of towns, rivers, etc.

*The following articles have appeared in earlier issues of "Main Roads":*

- *Aerial Survey as an Aid to Road Location—May*, 1940, *pp.* 73–79.
- *Aerial Photography—Twelve Years Use in Road Location—December*, 1949, *pp.* 33–40.
- *Developments in the Use of Aerial Photography for Road Location in New South Wales—December*, 1957, *pp.* 57–63.

# FIRST ROAD BRIDGE OVER PARRAMATTA ROAD

## New Crossing at Lewisham



Linking the early colonial settlements at Sydney Cove and Rose Hill, Parramatta Road was one of Australia's first major roads. The rural atmosphere of 1802, when it was described as "an immense avenue of foliage and verdure" where "a charming freshness and an agreeable shade always pervades" (Peron), has long since disappeared. It has, in fact, developed into one of the State's busiest thoroughfares, carrying some of the highest volumes of traffic of any road in New South Wales.

Parramatta Road is crossed by rail and pedestrian overbridges at a number of locations, but in all its long history it has not, until now, been crossed by a road bridge.

On 26th August, 1971, just over 160 years after Parramatta Road was reconstructed and opened to traffic on 10th April, 1811, the Department completed and opened a road crossing near Old Canterbury Road, Lewisham.

The prestressed concrete bridge, 129 feet long, was built for the Department by Arthur Boyd Constructions Pty Ltd at a cost of $110,130.00. The structure has three spans, the central one being 85 feet long with a 22 feet span on each side. A minimum vertical clearance of 16 feet 4 inches has been provided under the bridge for traffic proceeding along Parramatta Road. The bridge has a carriageway width of 24 feet, with two traffic lanes, and a footway on each side. Mild steel balustrades have been installed and the sides of the bridge have been attractively "dressed" with panels of exposed aggregate. The approach embankments have been faced with handplaced sandstone.

As the photograph (below right) shows, the bridge is situated adjacent to and east of the steel truss railway bridge which carries goods traffic on the Rozelle-Wardell branch line running parallel to Hawthorne Canal. The new bridge provides a safer and quicker passage for traffic which previously crossed Parramatta Road diagonally through traffic lights at Old Canterbury Road (on the south side) and Tebbutt Street (on the north). This cross route has become a popular one for traffic passing between the Canterbury and Leichhardt districts. Prior to the opening of the bridge, an average of over 15,500 vehicles per week-day entered, left or crossed Parramatta Road at Old Canterbury Road while a week-day average of 47,700 vehicles used Parramatta Road in both directions, according to records made by an automatic counter located just west of this junction.

Traffic on the south side at present travels between the bridge and Old Canterbury Road via Barker or St John Streets, then Brown Street (northbound) and via Brown and Cook Streets (southbound). On the north side, traffic travels between the bridge and Tebbutt Street via Hathern Street. More direct road approaches to the bridge will be provided at a later date. A continuous median strip has been constructed along Parramatta Road at this location in order to prevent vehicles from crossing and thereby in errupting the traffic flow along such an important city artery ●

*Aerial view looking south during construction of the new bridge and its approaches. Tebbutt Street is on the lower left while Old Canterbury Road is on the upper left where, at the top of the photograph, it runs under the main western railway lines. The branch railway line and Hawthorne Canal are adjacent to the bridge on the right. The cross streets are, from bottom to top, Hathern Street, Parramatta Road, Cook Street, St John Street and Barker Street. Brown Street runs directly south from the bridge.*

# Swan Lake

## Peak Performance by 108 Plant Squadron (Heavy).

In 1871, Peter Ilyitch Tchaikovsky composed a miniature ballet for the amusement of his sister's children and gave it the title "Swan Lake". Several years later, working on a commission from the Bolshoi Theatre, he included this music along with part of his opera "Undine" and from this commission came the score of the beautiful ballet "Swan Lake".

However, the Swan Lake to which this article refers is a lake with no Odette and no von Rothbart. It is situated securely in the "real" world rather than the dream world of Tchaikovsky's enchanting ballet.

Swan Lake, sometimes known as Cudmirrah Lake, is a large body of water with an outlet into the Pacific Ocean at the village of Cudmirrah, approximately 30 miles south of Nowra. It was here around the broad expanse of Swan Lake that the various elements of 21 Construction Regiment undertook many of their exercises during their individual annual fortnightly camps between 20th February and 2nd April, 1971.

The camp for 108 Plant Squadron (Heavy), which is sponsored by the Department of Main Roads, was located between Swan Lake and the southern headland of Sussex Inlet and was visited on a typical training day. The day commenced with reveille at 0600 hours (6.00 a.m.) and, following roll call, a hearty breakfast was provided.

An administration and training parade was called for 0800 hours and during the parade it was noticeable that this specialist unit, which has a peace-time establishment of over 180 men, was well below strength. The Squadron Commander explained that he is in urgent need of recruits who are qualified plant operators, fitters and truck drivers. A number of vacancies also exist for men willing to be trained as field engineers and truck drivers. As members of the Squadron are recruited from the Department, most of them hold civil engineering or trade qualifications and require only basic army training to fit them for carrying out large military engineering works.

The camp involved training in the various activities which such a Plant Squadron would be expected to undertake during war. A number of sections moved down to Swan Lake to practice the assembly and operation of a light tactical raft able to ferry a number of men, together with their transport, over water. While this training was proceeding, other groups were obtaining experience in the handling and operation of assault boats. At the same time, appropriate personnel were working on small construction tasks such as camp perimeter roads, drainage systems and a heli-pad which on completion will improve the facilities and efficiency of the camp site. Other similar jobs included the establishment of a water purification and reticulation system and a fuel-operated generating unit which supplied electricity (power and light) to all parts of the camp (including every tent) 24 hours a day.

One day was not sufficient to appreciate the whole of the field activities of 108 Plant Squadron (Heavy) while on its two weeks camp. As well as working with engineering equipment, the squadron trained in infantry minor tactics. There were also periods of helicopter familiarisation with Navy and R.A.A.F. aircraft. This training included aerial reconnaissance and winching in and out of helicopters.

A large number and wide variety of mechanical equipment was being operated and its size, versatility and excellent condition were impressive. Without detailing the whole of the equipment strength of the Squadron, the items used included a three cubic yard front-end loader, small bulldozers which are capable of being carried comfortably by air transport, some six-wheel drive trucks which can traverse any type of bush country without the assistance of a constructed road, and a number of truck-mounted cranes (10,000 lb at 20 feet), heavy graders and water tankers.

Back at headquarters, the vitally important administrative duties were being undertaken by an efficient and active team. The functions of the Quartermaster were inspected and it became immediately noticeable that an immense amount of detailed preparation was needed in order to have all provisions readily available whenever required. The supply of meals for the troops is only one of these tasks but a very necessary one. At this camp, the problem of supply was compounded by the isolation from a main army supply centre. Meals for two weeks had to be planned beforehand, ordered in quantity, delivered on time, stored either dry or frozen, issued to the cooks day by day and served up to satisfy the keen appetites of men engaged in hard physical work.

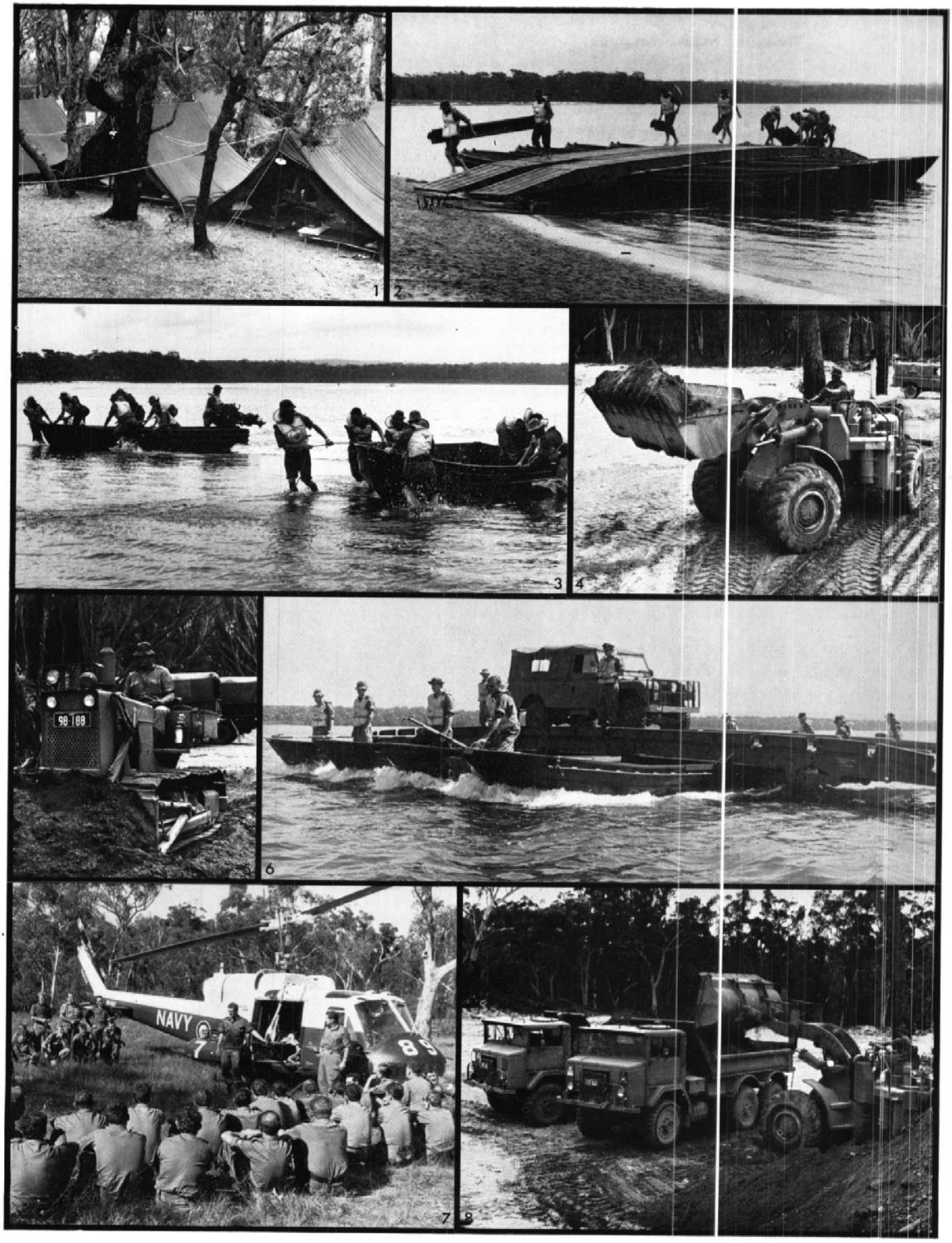
In addition to food, the Quartermaster must also have on hand, for immediate issue, all the items necessary for the efficient functioning of any army camp. These include petrol, oil, greases, ammunition, tents and bedding.

Camped so close to the shores of the blue Pacific Ocean, full advantage was taken by the unit of the rolling surf with a voluntary swim parade each evening to Cudmirrah Beach. Those sappers not inclined to surfing, took the opportunity to shower, do a little washing, or enjoy a beer and talk together at the wet canteen until the meal parade at 1800 hours. After dinner, for those who could be spared, there were leave passes to Sussex Inlet, where entertainment was available at the R.S.L. Club.

These comforts were, of course, not always available, especially during a three-day continuous field exercise away from the base camp, on "hard" rations and under "battle" conditions. This exercise entailed the use of water-crossing equipment, and involved such activities as casualty evacuation, re-supply from the air and aerial observation of ground troops.

The attractive scenery and ideal weather conditions at Swan Lake made one wonder why the Army was not charging its troops to come here, rather than paying for the privilege of participating in a camp which incorporated such pleasant fringe benefits. However, the true appeal and value of such camps is in the opportunity they provide to every member of the unit to be introduced and trained in the interesting and challenging engineering tasks which come within the duties of the 108 Plant Squadron (Heavy).

*An article entitled "Royal Australian Engineer Supplementary Reserve Army Units" appeared in the December, 1970, issue of "Main Roads".*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# 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, 1971.

| Council | Road No. | Work or Service | Name of Successful Tenderer | Amount |
|---|---|---|---|---|
| | | | | $ |
| Barraba | M.R. 360 | Construction of 5-span steel and reinforced concrete bridge over Noogera Creek at Boomi Crossing, 19·32 miles from Cobbadah. | A. Goor Pty Ltd | 66,438.58 |
| Baulkham Hills | M.R. 160 | Supply of ¾-inch crushed dolerite pavement material for use on reconstruction from Rogan's Hill to Crego Road. | Blue Metal and Gravel Pty Ltd | 18,370.00 |
| Boorowa | M.R. 380 | Construction of 3-cell 9 ft x 9 ft reinforced concrete box culvert and approaches over Corcoran's Creek, 3 miles west of Trunk Road No. 56. | Nello Pizzolitto | 11,950.00 |
| Colo | M.R. 181 | Operation of Webb's Creek Ferry | W. E. White | 41,382.24 (3-year contract) |
| Cudgegong | T.R. 55, M.R. 216, 233, & 598 | Supply, heat and spray R.90 bitumen at various locations. | Shorncliffe Pty Ltd | 20,459.92 |
| Cudgegong | T.R. 55, M.R. 216, 233, & 598 | Supply and delivery of ½-inch and 3/16-inch aggregate to stockpiles at various locations. | T. and F. Concrete and Gravel | 14,631.75 |
| Dumaresq | T.R. 74 | Construction of 3-span, 164 feet 5 inches long, steel and concrete bridge over Oakey Creek, 41 miles east of Armidale. | Enpro Constructions Pty Ltd | 56,418.80 |
| Goulburn | S.H. 2 | Supply and lay ¾-inch and ⅜-inch asphaltic concrete for reconstruction and channelisation of Clinton Street, Goulburn between Auburn and Cowper Streets. | Allen Bros | 20,174.50 |
| Lane Cove and North Sydney | S.R. 2070 | Widening and reconstruction of River Road from Canberra Avenue to Boronia Street. | Roadworks and Buildings Pty Ltd | 48,257.60 |
| Liverpool Plains | D.R. 1277 | Manufacture, delivery and erection of 56 prestressed concrete bridge units to site of new low level bridge at Cox's Creek. | A. Goor Pty Ltd | 11,392.00 |
| Monaro | D.R. 1268 | Construction of 5-span, 250 feet long, 28 feet 10 inches wide, steel and reinforced concrete bridge over Big Badja River, 24 miles east of Cooma. | N. D. McIntosh | 98,318.00 |
| Port Macquarie | Tourist Road 4030 | Construction of 183-feet long concrete bridge over Lake Cathie, 11·3 miles south of Port Macquarie | M. R. and E. M. Firth | 96,069.00 |
| Rylstone | T.R. 54 & M.R. 215 | Bituminous surfacing and resurfacing at various locations. | Emoleum (Aust.) Ltd | 15,357.25 |
| Walgett | S.H. 12 & M.R. 127 | Resealing 5·35 miles to 11·0 miles east of Collarenebri on Gwydir Highway. Reconstruction and bituminous surfacing 0·5 miles to 3·5 miles west of Walgett on Main Road No. 127. | Shorncliffe Pty Ltd | 23,215.41 |
| Wyong | M.R. 335 | Supply and lay asphaltic concrete surface between Toowoon Bay Road and Campbell Avenue and at approaches to the Entrance Bridge. | Bituminous Pavements Pty Ltd | 28,054.00 |

1. *Typical tent lines at camp site near Sussex Inlet*
2. *Dismantling a light tactical raft. When assembled, this raft is capable of transporting one fully-laden truck and trailer, together with a complete plant troop of approximately* 40 *men and their equipment*
3. *Beaching Mark* 4 *assault boats during an exercise on Swan Lake*
4. *Three-cubic yard front-end loader in operation.*
5. *Class O air-transportable bulldozer constructing a "hard-standing" area for vehicles*
6. *A light bridging raft being tested on Swan Lake*

*—Photograph by courtesy of Department of Army*

7. *Members of the Squadron receiving briefings on helicopter techniques by both Army and Navy personnel*

*—Photograph by courtesy of Department of Army.*

8. *Loading gravel into Mark* 5 *five-cubic yard capacity, six-wheel drive dump trucks, during construction assignment*

# 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, 1971.

| Road | Work or Service | Name of Successful Tenderer | Amount |
|---|---|---|---|
| | | | $ |
| Western Expressway (X4) | Municipality of Auburn. Construction of 3-span cast-in-place concrete and prestressed concrete bridge, 171 feet long. | Pearson Bridge (N.S.W.) Pty Ltd | 284,000.00 |
| Western Expressway (X4) | City of Penrith. Construction and erection of concrete precast pretensioned bridge girders for Roper Street Overbridge at St Marys. | E.P.M. Concrete Pty Ltd | 90,941.00 |
| Western Expressway (X4) | City of Penrith. Construction of 4-span, 260 feet long concrete bridge over Western Expressway at Bennett Road, St Marys. | Central Constructions Pty Ltd | 201,802.16 |
| South Western Expressway (X5) and Main Road No. 177 | City of Campbelltown. Construction of cast-in-place reinforced concrete piles for three bridges over Bunbury Curran Creek. | Concrete Industries (Monier) Ltd | 22,333.80 |
| State Highway No. 4 | Snowy Mountains Highway. Shire of Tumut. Construction of 3-span, 110 feet long composite steel girder and reinforced concrete deck bridge near Log Creek, 8 miles south of Tumut. | Central Constructions Pty Ltd | 27,113.80 |
| State Highway No. 7 | Mitchell Highway. Shire of Molong. Construction of 3-span, 172 feet long steel girder and reinforced concrete deck bridge over Bell River at Claremont. | Ermani Constructions Pty Ltd | 116,347.20 |
| State Highway No. 9 | New England Highway. City of Newcastle. Supply and delivery of up to 1,400 tons of $\frac{3}{8}$-inch gauge asphaltic concrete to Beresfield Deviation. | Bituminous Pavements Pty Ltd | 17,668.00 |
| State Highway No. 11 | Oxley Highway. Shire of Walcha. Construction of 165 feet long concrete bridge over Tia River at 22·2 miles east of Walcha. | M.R. and E.M. Firth | 84,082.00 |
| State Highway No. 11 | Oxley Highway. Shire of Warren. Construction of 17-span, 595 feet long prestressed concrete bridge, and removal of existing bridge, 5 miles south of Warren. | Peter Verheul Pty Ltd | 203,145.50 |
| State Highway No 17 | Newell Highway. Shire of Boolooroo. Supply and spray up to 18,800 gallons of R.90 bitumen and 3,760 gallons of cutter oil between 47 miles and 53·5 miles north of Moree. | Shorncliffe Pty Ltd | 11,167.20 |
| State Highway No. 17 | Newell Highway. Shire of Boolooroo. Supply and spray up to 27,000 gallons of R.90 bitumen and 1,960 gallons of cutter oil between 61 miles and 72 miles north of Moree. | Shorncliffe Pty Ltd | 12,681.00 |
| Main Road No. 108 | City of Newcastle. Supply and delivery of up to 3,700 tons of lower course asphaltic concrete to eastern approaches of Stockton Bridge. | Boral Road Services Pty Ltd | 45,732.00 |
| Main Road No. 108 | City of Newcastle. Supply and delivery of up to 1,000 cubic yards of ready mixed concrete to eastern approaches of Stockton Bridge. | Newcastle Lime and Cement Co. Pty Ltd | 16,229.00 |
| Main Road No. 108 | City of Newcastle. Haulage of up to 42,000 tons of slag products from B.H.P. stockpile to eastern approaches of Stockton Bridge. | W. D. Smith (Construction) Pty Ltd | 67,200.00 |
| Main Road No. 173 | City of Sydney. Construction of 2-span concrete bridge 90 feet long over eastern end of Kings Cross Tunnel at Craigend Place. | R. M. and B. Cocrancig | 79,994.00 |
| Main Road No. 217 | Shire of Lake Macquarie. Construction of two 8-span pretensioned concrete bridges, each 576 feet long over the North and South Arms of Cockle Creek. | Central Constructions Pty Ltd | 692,511.00 |

# NOWRA – THEN & NOW