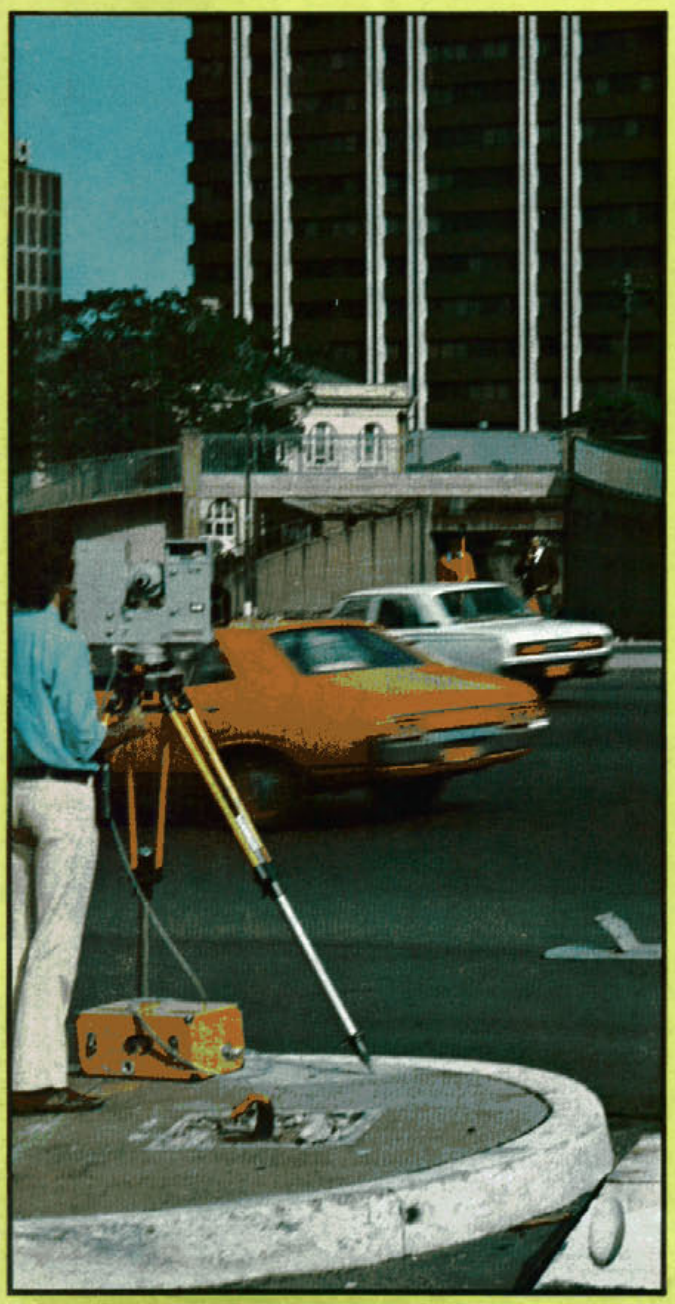
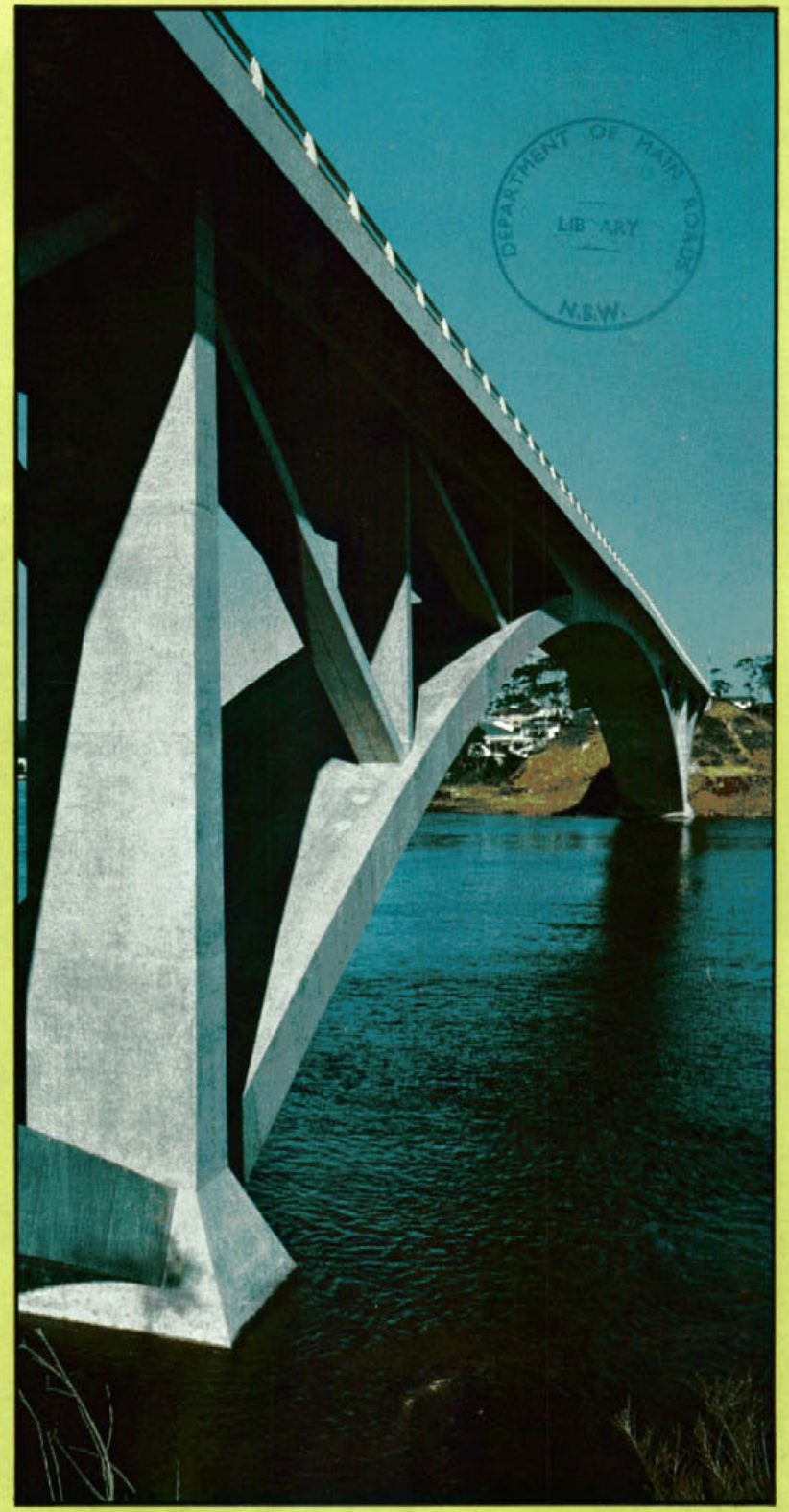
MAIN ROADS





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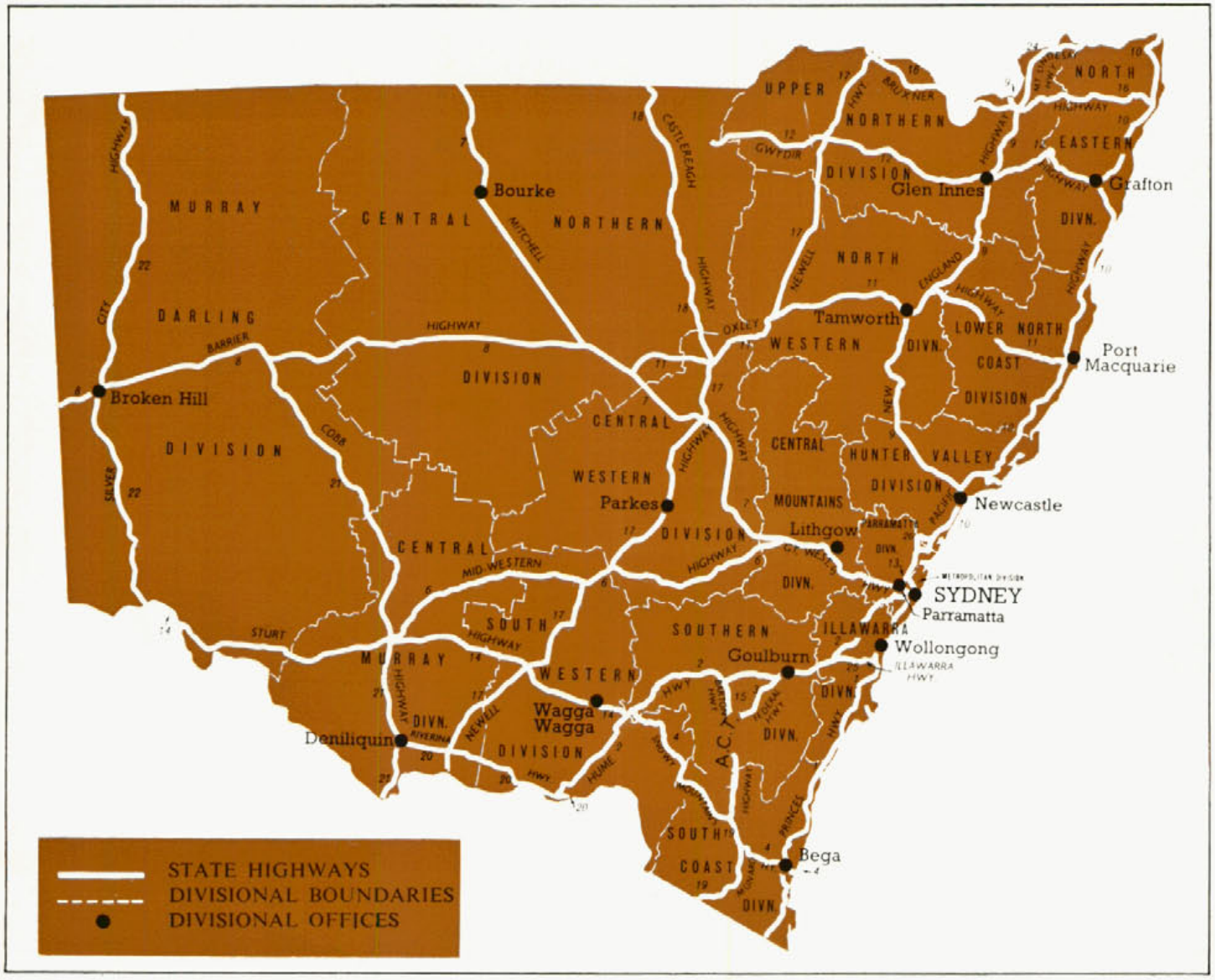

New South Wales

Area—801 431 km² *(309,433 sq miles)*

Population as at 31st March, 1973—4,715,100 (estimated)

Length of Public Roads—208 890 km (129,745 miles)

Number of Motor Vehicles registered as at 30th June, 1973—2,328,037

ROAD CLASSIFICATIONS AND LENGTHS IN NEW SOUTH WALES

Lengths of Main, Tourist and Developmental Roads, as at 30th June, 1973. (Mileage equivalent shown in brackets.)

Freeways	63	(39)
State Highways	10 509	(6,527)
Trunk Roads	7 042	(4,374)
Ordinary Main Roads ..	18 470	(11,472)
Secondary Roads	290	(180)
Tourist Roads	396	(246)
Developmental Roads ..	3 896	(2,420)
Unclassified Roads	2 476	(1,538)
TOTAL	43 142 km	(26,796 miles)

MAIN ROADS

JOURNAL OF THE DEPARTMENT OF MAIN ROADS, NEW SOUTH WALES

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Front Cover

Left: Automated electronic surveying equipment in use at the Bradfield Highway, see article on pages 30 *and* 31.

Right: Recently opened bridge over Brisbane Water at The Rip, see article on pages 2-4

HIDDEN EFFORT

In 1814 William Cox was commissioned to build a cart road through the Blue Mountains and he completed the construction of the "Mountain Road" in the very short time of six months. This was a real achievement, even for building the narrow unpaved tracks of that day, particularly as the road was literally cut through unexplored bush and over rough and unknown terrain.

Although present day surveying and road *building equipment* is far more highly developed and effective than Cox's, it would take a great deal longer to build a road through native land across the Blue Mountains now.

Roadbuilding to meet the exacting traffic demands of 1974 requires expert planning and stringent attention to the details of construction. The days have been long gone when the decision to build or reconstruct a road could be made in a few days and men put out on the job in an equally short time.

The effort behind modern roadmaking, particularly those works of major dimensions, sometimes involves months, but more frequently years, of researching, reviewing, planning, designing, acquiring land and adjusting public utilities. An outline of the procedure involved is given in the article "Reviewing the Country Main Roads System" on page 7. Accurate data, on which these decisions are based, are vital to the policy maker, but more important still is the initial selection of categories of information to be gathered for assessment. Altering established roads involves the interests of so many individuals and public authorities that the final decision made must be definitive.

The roadbuilders had an advantage in Cox's day because of the lack of man-made, individually owned obstacles to overcome before setting out to provide a track suitable for conveying man and his goods from one point to another. Their obvious disadvantages included little overland exploration and sketchy, possibly unreliable, maps which could lead the unwary roadbuilder on a journey to nowhere. At least our modern roadbuilders know the route to follow, but what beautiful, effective roads would be the result if the untrodden conditions of our early history could have been combined with modern miracles of surveying and road engineering.●

Bridge over Brisbane Water at The Rip

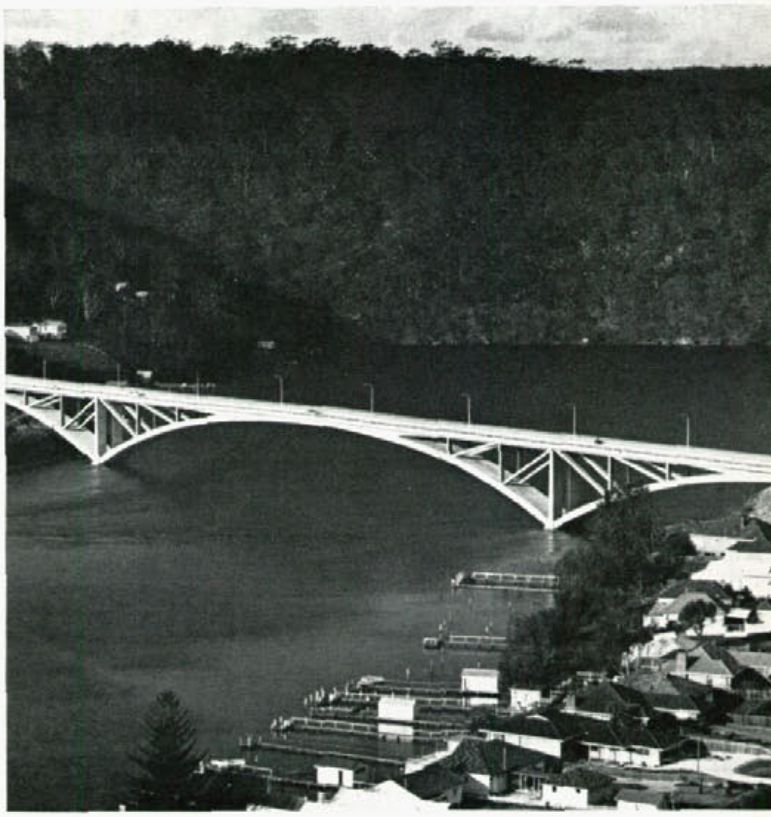
POPULAR AREA

Stretching gracefully between Orange Grove and Daleys Point, on the Central Coast, a striking looking new bridge now carries traffic across the entrance to Brisbane Water at The Rip. The high, clean sweep of the arch-like structure is beautifully balanced to the surrounding countryside, which is a popular and scenic residential and tourist area.

The bridge, which connects the Woy Woy—Patonga Road (Main Road No. 349) on the south side by deviation and to Empire Bay Road and eventually the Scenic Drive, Kilcare, on the northern shore, is a link between the Woy Woy District and the section of the Central Coast to the east of Gosford. This entire area is a particularly fast developing and expanding region of the coast. The population emphasis there has been changing in recent years from retirement and recreation to permanent residence for workers in decentralized industry. Many residents also commute daily to various centres within the Sydney and Newcastle Metropolitan Areas.

By linking Woy Woy and the eastern side of Brisbane Water, the bridge will shorten the distance to the nearest railway station and thus benefit many train commuters who until now have travelled to Gosford. The new bridge will also accelerate the development of the area from Davistown to Avoca and provide a more direct access to Central Coast beaches for residents and tourists.

This bridge was opened to traffic on 14th June, 1974, by the Hon. Sir Charles Cutler, Deputy Premier, Minister for Highways and Minister for Local Government.



From any aspect, the new bridge crossing The Rip is pleasing to the eye

CROSSING THE RIP

Obviously named for its fast tidal currents, The Rip is a narrow channel, about 183 m wide and with a maximum depth of 6 m, which separates two sections of Brisbane Water.

When site investigation data was being gathered, use was made of a model of Brisbane Water which had been constructed by the Department of Public Works at its Manly Vale Hydraulics and Soils Laboratory. A relatively shallow ridge of bedrock, swept clear of overlaying material, runs between the two headlands at The Rip. On either side are extremely deep "holes". Strong tidal currents run over the ridge and these produce noticeable surface turbulence and eddy currents. Such conditions would have made construction of piers in the water extremely difficult.

For this reason, the bridge was designed as a single span structure. The absence of piers in the water also eliminates hazards to small craft. The new bridge is an arch-shaped prestressed concrete cantilever structure which crosses the channel by means of a single, 183 m long span. During the preliminary stages of the design of this bridge, the existing rock foundation appeared to favour the construction of a long span arch which would have blended well with the surroundings. However, as only a relatively low structure would have been required to provide the necessary navigational clearance, the foundations of such an arch would have been subjected to extremely severe thrusts and stresses. A cantilever structure of a similar arch shape was, therefore, selected for this site to overcome the structural problems.

UNIQUE DESIGN

With an overall length of 330 m, The Rip Bridge is the longest prestressed, concrete cantilever span in New South Wales and is the first design of its type in Australia. The solid walls of a conventional concrete girder cantilever have been replaced by open concrete trussing, thereby creating an appearance even lighter than that of an arch.

The unique design of this bridge called for new methods of construction. The cantilever was erected over the channel by joining precast concrete units without the use of falsework.

The 11·25 m wide deck of the bridge consists of two traffic lanes each 4·3 m wide and a footway 1·5 m wide on the southern side of the bridge. The maximum height of the deck above mean sea level is 19·5 m. A maximum vertical navigation clearance of 17 m allows the passage of yachts and other craft through The Rip.

The design of the bridge was prepared by staff of the Department of Main Roads with architectural advice given by a consultant, D. C. B. Maclurcan.

The bridge was constructed under contract by John Holland (Construction) Pty Ltd the contract price being $2,173,640. The contract was supervised by the Department of Main Roads. The cost of construction of the bridge, including the immediate approaches, was shared between the Department and the Gosford Shire Council—three quarters of the cost being met by the Department.

Roadworks associated with the bridge were carried out by Gosford Shire Council with the cost being apportioned between the Department and the Council in a ratio of $\frac{2}{3}$ and $\frac{1}{3}$ respectively.

CONSTRUCTION

Reinforced concrete piers which rest on rock shelves at both sides of The Rip channel, form the foundations of this bridge. Reinforced concrete piles were sunk through soft layers of clay and rock overlaying the sandstone bedrock.

The superstructure of the bridge consists of two 73 m long cantilever truss spans which extend out over the channel from each shore where they are connected to and balanced by an anchor truss span. The two cantilevers support a central suspended or "drop in" slab span, 37 m in length (see diagram on page 4).

The upper and lower chords of the truss sections are hollow, concrete slabs constructed by joining five 1·5 m wide precast concrete box sections for the upper chord and "I" beam sections for the lower chord. Concrete "I" beam sections were also used to form the hollow slabs that make up the slender tips of the cantilever and anchor spans and for the suspended or "drop-in" span.

Careful consideration was given to the shape of the lower chords of the trusses during design of the bridge in order to minimize forces in the vertical and diagonal truss web members. An arched-shape design was selected as this placed much of the structural load upon the lower chord, by compression, as in a true arch. Reduction of the forces in the web members permitted, in turn, that they be of a very slender design, not more than 0·6 m thick, yet strong enough to reduce bending and buckling movements in the lower chords of the trusses.

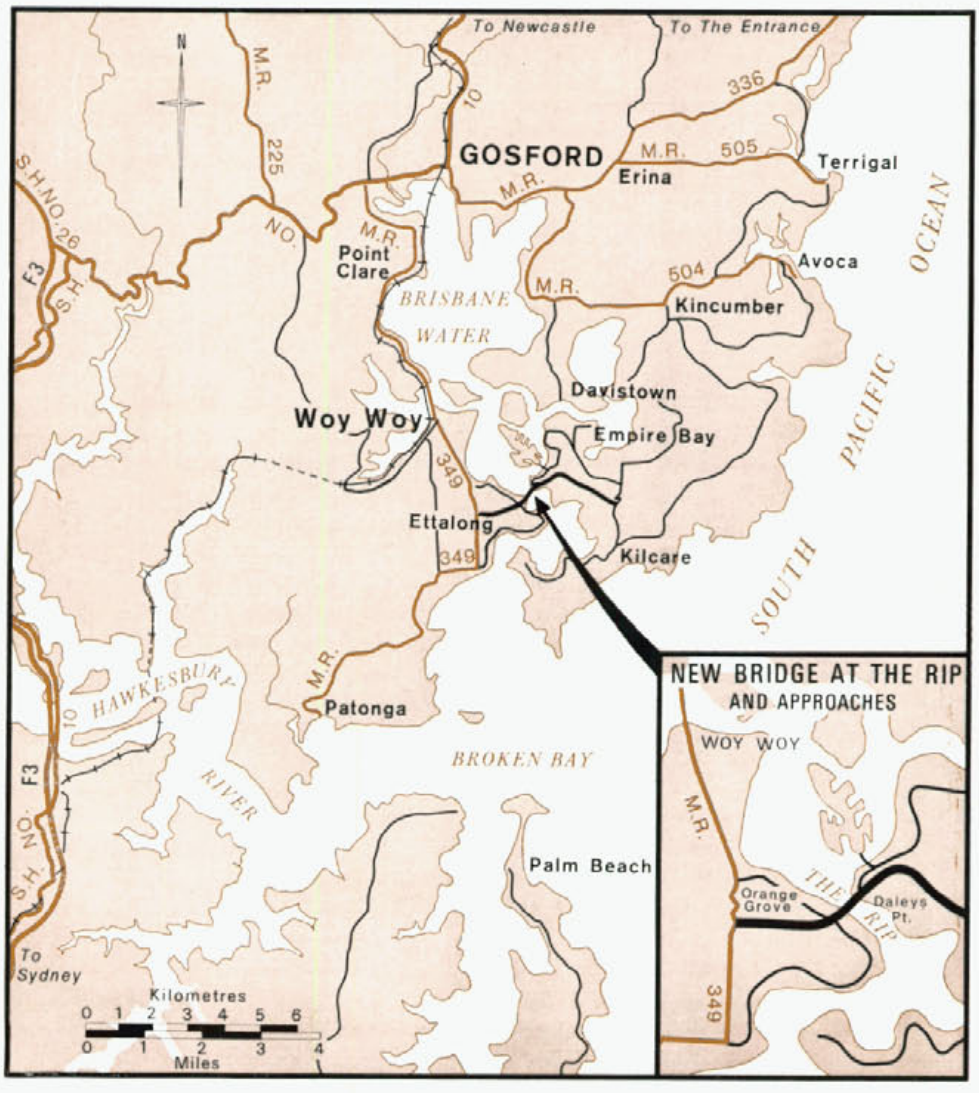
The upper chords of the trusses support the deck of the bridge (see diagram). In order to accommodate the roadway and footway, the width of the upper chord was increased by attaching precast L-shaped cantilever units along each side. The roadway on the deck comprises a 65 mm thick asphalt running surface.

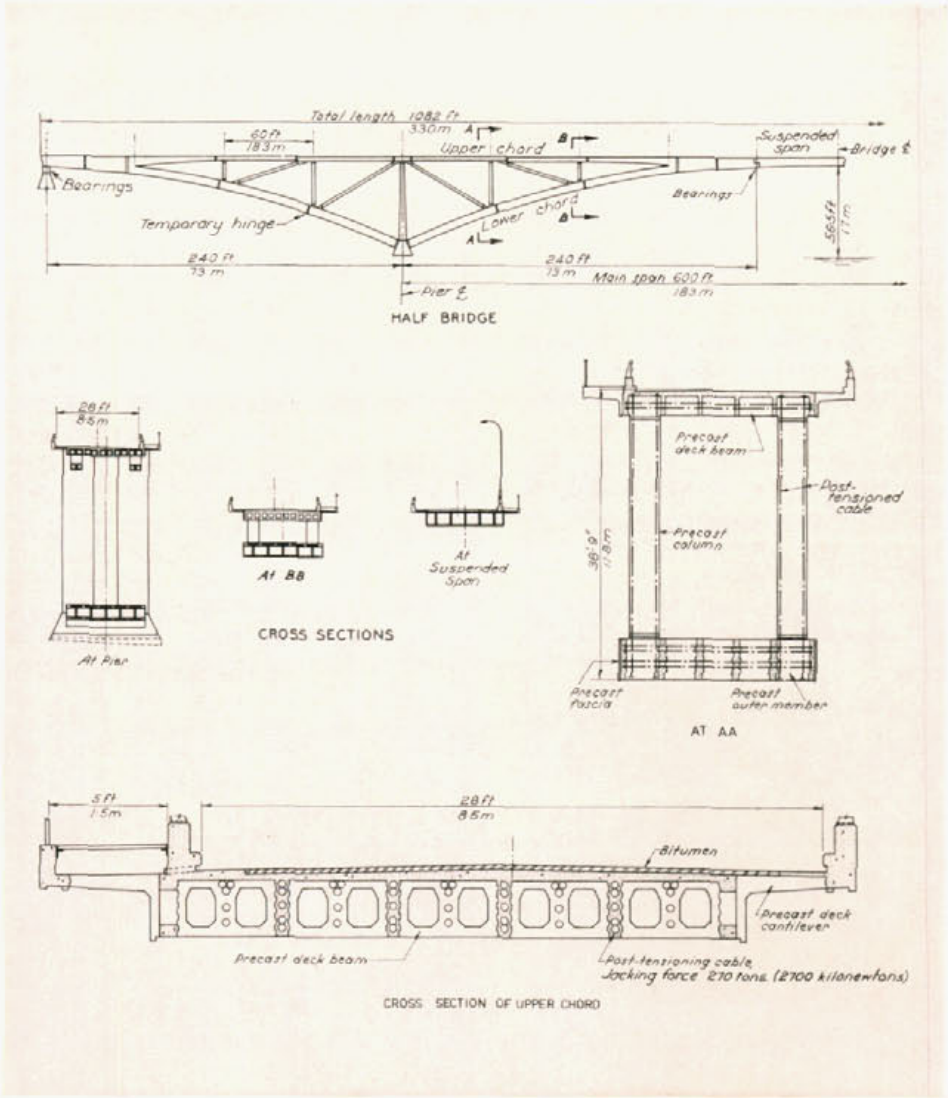
The method of construction involved some noteworthy features. The joints within the truss were designed to remain "pin-jointed" until the erection of the entire truss was near completion. Steel bearing plates were cast into the ends of each member of the trusses where it framed into a hinge.

Because of the temporary hinge action at the joints it was possible to adjust the camber of the structure to compensate for discrepancies between actual and theoretical deflections. In order to carry out this camber adjustment as well as to provide for joint rotations during erection, the bridge was constructed with a battery of twenty 460 mm diameter flat jacks in each arch joint. Until these joints were finally concreted, each battery of flat jacks transmitted the full thrust in the arch. At some of the joints the jacks were expanded by up to 20 mm during jacking movements, thereby lifting the tip of the cantilever by as much as 75 mm.

While conventional falsework supports were used for the construction of the land based anchor spans, the entire 183 m clear span between piers was constructed without falsework, in 18·3 m long sections, each section being anchored to the end of the previously erected sections. The individual members of the sections which comprised arch ribs, deck beams, columns and diagonals, weighed up to 50 t each and measured up to 20 m in length. The problems of lifting, positioning and temporarily securing such long, heavy members constituted an unusual construction challenge.

The design of this bridge required that it be constructed in a predesignated sequence. The order of erection was subdivided into seven major stages, each stage concluding with the installation





and stressing of a number of 2 000 kN capacity high tensile steel cables running through the completed section of the deck. Each such stage of prestress rendered the existing structure safe enough to support the next erection stage.

Most major elements of the bridge were precast, although, the main piers, the tips of the cantilevers, the longitudinal and transverse deck joints and deck topping and kerbs were cast-in-situ. The precast members were erected by means of a 49 m long steel truss which lifted each member from the ground, moved it forward and lowered it into position. Railway tracks were set up on the deck to enable the truss to be winched along to each new erection position.

When the two cantilever structures were completed, including attachment of the deck cantilevers and topping, a gap of 37 m remained between them. The erection truss was cantilevered out until it straddled the gap and was then used as a launching gantry for the placing of the prestressed lightweight concrete girders of the suspended span.

Stainless steel roller bearings and galvanized steel finger plates, to allow movement and expansion within the bridge, have been installed at expansion joints, at the abutments and at one end of the suspended span.

There is a permanent uplifting force at the shore end of the cantilevers which is resisted by placing the roller bearings above the cantilever ends.

The quantities of the principal materials used during construction were:

Concrete	5 050 m^3
High Tensile Steel	265 t
Reinforcing Steel	710 t

An average of 30 men was employed at all times on construction of the bridge which took 32 months.

A LITTLE LOCAL HISTORY

Brisbane Water

Brisbane Water was named in honour of Major-General Sir Thomas Brisbane, Governor of New South Wales, 1821–1825.

The north east arm of Broken Bay (as Brisbane Water was originally known) was discovered by Governor Phillip in 1788. The name was changed to Brisbane Water in 1825 when, as a result of numerous applications for land surrounding the north east arm, a surveyor was sent to the area to "mark out farms . . . and to survey the Arm and other inlets".

Daleys Point

In 1825 William Fitzgerald received a grant of 100 acres in the area now referred to as Daleys Point. In 1829 it is recorded that Fitzgerald had 25 acres under cultivation in oranges and passion-fruit and was running sixty head of cattle on his property.

Fitzgerald's property was later purchased by William Daley, a stevedore and M.L.A. (1901–7) and in whose honour the Point was named.

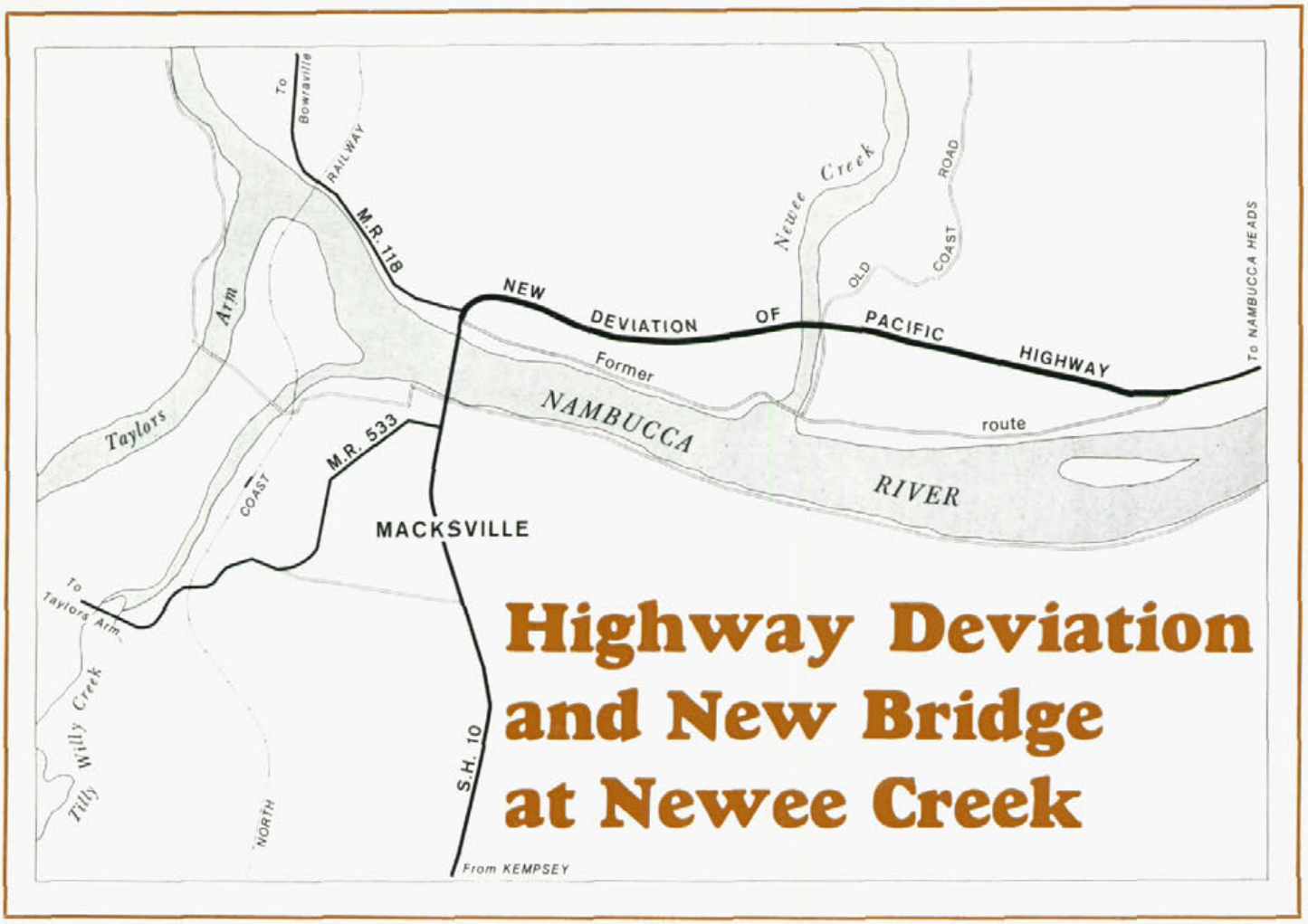
The Rip

The Rip was originally known as Webb's Reef after James Webb, a boatbuilder, who owned land on the western side of The Rip.

Webb, who arrived in New South Wales in 1790, first settled on the Hawkesbury River. In 1823 he applied for a grant of 300 acres on the "East Side of the North East Arm of Broken Bay". In October 1823 Webb occupied this grant, which was known as Mulbong Farm or Current Point Farm and which was located in the vicinity of present day Orange Grove. In 1843, Webb purchased a further 150 acres including the township of Woy Woy. Four years later he added another 50 acres to his holdings in the area. By the time of his death in June 1848 the whole area on the western shore of The Rip was known as Webb's Flat.

Woy Woy

The township of Woy Woy derives its name from the aboriginal words Woy Woy which mean "deep water" or "a lagoon".●



Highway Deviation and New Bridge at Newee Creek

The new bridge over Newee Creek forms part of a 3·2 km deviation of the Pacific Highway commencing immediately north of Macksville.

Newee Creek had previously been bridged by a structure built in 1911. This was a six span timber bridge, 53 m long and located at the junction with the Nambucca River. A deck only 4·5 m wide on the old bridge carried a single lane of traffic and was a hazard to the increasing number of vehicles using the Pacific Highway at this location. It had been proposed on a number of occasions to dam Newee Creek and relocate the Highway on the top of the dam wall.

BRIDGE LOCATION

Initial location work for the new bridge some years ago indicated a position away from the existing structure when the implications of future dual carriageway construction of the Highway were considered.

The problems for road planning in the area centred around the development of Macksville and the ribbon-type development along the Pacific Highway immediately north of the town.

It seemed likely that any future crossing of the Nambucca River would be about midway between the present Macksville Bridge and Newee Creek, allowing the southern approach to skirt the town development.

With such a crossing in mind, the location of Newee Creek bridge was moved upstream about 300 m on a deviation of the Pacific Highway aligned to serve likely future plans. This deviation was re-routed north of the previous location avoiding the ribbon development. To prevent this type of development from re-occurring the new route was proclaimed a motorway.

THE NEW DEVIATION

First stage construction of the project has provided for two lanes of traffic on a carriageway paved 7·3 m wide and with 3 m wide shoulders throughout the length. Sufficient land has been acquired to accommodate a second carriageway. Suitable accesses have been provided to the old route of the highway and other existing roads and limited access has been allowed to fronting properties which do not have suitable alternative access.

STRUCTURE OF NEW BRIDGE

The 118 m long bridge over Newee Creek is a 5 span, prestressed concrete continuous structure on wall type piers supported on driven, tubular piles. There are two 21 m spans and three 28 m spans and the width between kerbs is 8·5 m.

Right: A section of the new deviation of the Pacific Highway at Newee Creek

Far right: The old, single lane bridge, crossing Newee Creek about 300m downstream from the new structure

The site at Newee Creek is tidal, being close to the junction with Nambucca River. The creek bed consists of marine mud overlying firm clay and decomposed serpentine rock at depths of 9 m to 21 m.

The height of the embankment in the approaches which can be supported safely by the material in the flood plain was limited to about 3·5 m on the Macksville approach and slightly more on the Nambucca Heads approach.

An initial investigation of the foundation material was done by consulting engineers and a full investigation was subsequently undertaken from the Divisional Office at Port Macquarie and the Materials and Research Laboratory. The depths to firm material were determined with a hand-driven Dutch cone and a probe driven by a petrol jackhammer and in-situ shear strengths of the mud were found by means of a Swedish vane borer. Laboratory tests on the samples determined triaxial shear strength and consolidation characteristics.

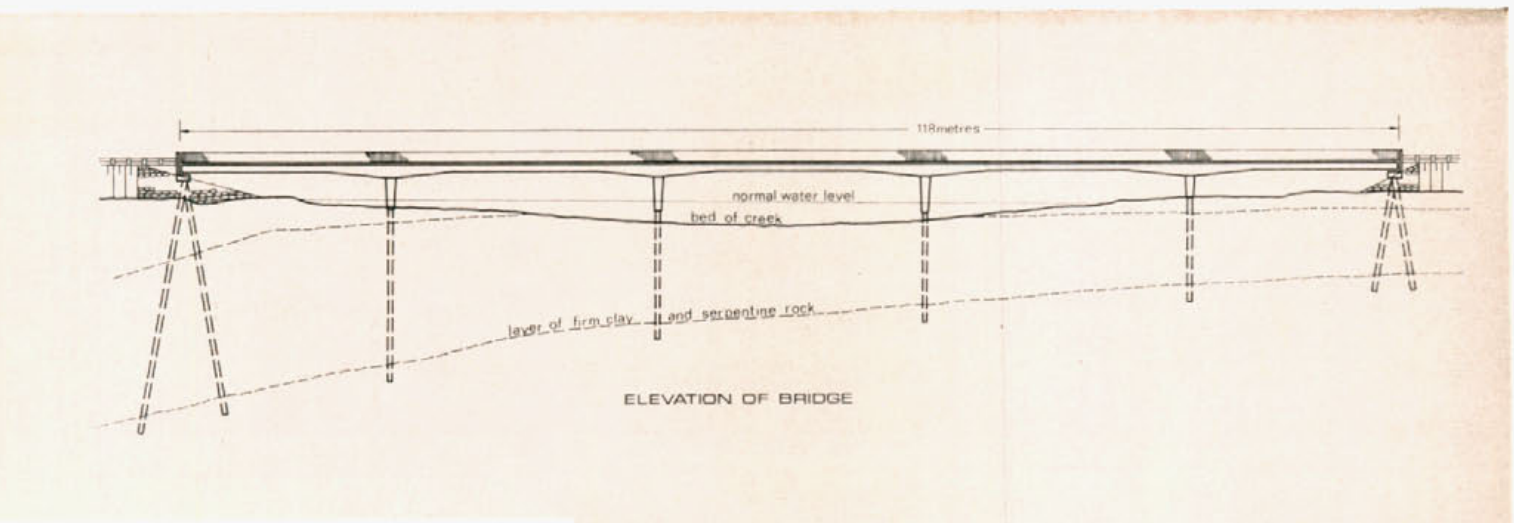
Velocities due to a flood in the creek alone and to the subsidence of back water from the river are low and the location of the abutments was largely controlled by the maximum safe height of fill. The approach filling has been allowed to spill through the abutments to help stabilize the ends of the embankments.

A superstructure of shallow depth was desirable in order to give adequate clearance above back water from the river within the limited height possible for the embankments.

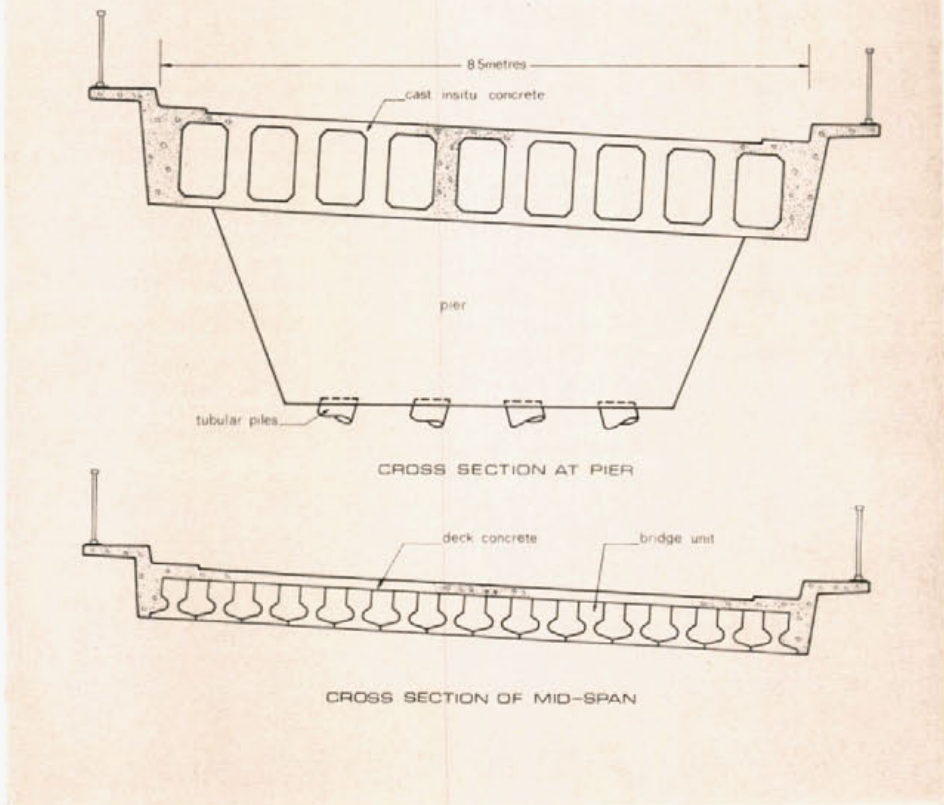
The solution adopted is based on using 535 mm deep, precast, pretensioned, "Inverted Tee" bridge units 14 m long formed into a continuous superstructure by 12 m long, hollow box, cast in-situ reinforced concrete sections framed with the piers. The variable depth of the in-situ section has resulted in a pleasing appearance for the bridge. Wall type piers were adopted to match the slab type superstructure.

The piles are 460 mm diameter mild steel casings closed at the toe and driven to the required resistance. These piles have a greater capacity than standard reinforced concrete driven piles. The top sections of the piles were reinforced and the piles filled with concrete. Capacity of the piles is 112 tonnes. The filling at the abutments was placed and allowed to consolidate before driving the abutment piles through the fillings.

The Department commissioned a firm of Consulting Engineers, Hughes, Trueman and Ludlow, to design the bridge. Pearson Bridge (N.S.W.) Pty Ltd constructed the bridge at a tender price of $220,952.●



ELEVATION OF BRIDGE



CROSS SECTION AT PIER

CROSS SECTION OF MID-SPAN

OPENING CEREMONY

The opening ceremony at this bridge site was performed on Tuesday 25th June, 1974 by the Chief Engineer (Bridges) Mr F. C. Cook, on the eve of his retirement from the Department of Main Roads.

In almost forty years of service, Mr Cook has seen the construction of many such bridges as Newee Creek and the opening ceremony was a tribute to his dedication to the Department's work.

Also present on the official dais were the Commissioner for Main Roads, Mr R. J. S. Thomas, Mr J. H. Brown, M.L.A. and Councillor B. Laverty, President of Nambucca Shire Council.

The opening of this bridge and deviation was welcomed by local residents as it eliminates a length of road with a very high accident rate.

Reviewing the Country Main Roads System

The Department of Main Roads is currently undertaking a comprehensive review of the layout and classification of the Main Roads System throughout the country areas of New South Wales. This area encompasses the whole of the State except the County of Cumberland, the City of Wollongong, the Municipality of Shellharbour, the City of Newcastle and urban Newcastle within the Lake Macquarie Shire.

This article has been divided into two sections. The first describes generally the background to reviewing the Country Main Roads System and the investigating procedure. To show this in operation, the second part uses the example of the Department's study on an improved road connection between Goulburn and Bathurst and the resulting implications for the Main Roads System in the area.

THE GENERAL REVIEW

Basis of Main Roads System

The responsibility for the construction and maintenance of public roads in New South Wales is shared generally between the State Road Authority (Department of Main Roads) and Local Government Authorities, which are constituted as shire and municipal councils. The division of responsibility between the Department and Local Authorities is based on a functional classification of roads in accordance with the statutory requirements of the Main Roads Act, 1924.

The general principle is that the State should assume some responsibility for arterial roads and special purpose roads, whereas Local Government Authorities should retain responsibility for roads that are primarily for the use of local traffic.

On 30th June, 1973, 36 084 km out of a total of about 209 000 km of public roads in New South Wales, were classified as Main Roads. The Country Main Roads (34 460 km) comprise only 18 per cent of the total length of all rural roads in the State, but carry about 80 per cent of the total traffic on rural roads.

The Main Roads System in New South Wales is basically a three tier hierarchy of roads classified as State Highways (10 509 km), Trunk Roads (7 042 km) and Ordinary Main Roads (18 470 km). At the upper end of the hierarchy are the beginnings of a Freeway system (63 km) while at the other end are added separate classifications for special purpose roads, i.e. Tourist Roads (396 km) and Developmental Roads (3 896 km). Other roads for which the Department has some responsibility are Secondary Roads in the County of Cumberland (290 km) and certain unclassified roads (2 476 km), mainly in the unincorporated area of the Western Division of the State.

This article is concerned specifically with State Highways, Trunk Roads, and Ordinary Main Roads in the country areas of New South Wales. These classifications are defined as follows:

State Highway—*Any Main Road being a principal avenue of road communication between the coast and the interior or throughout the State and connecting with such avenues in other States, and proclaimed a State Highway under the Main Roads Act.*

State Highways are under the control of the Commissioner for Main Roads and the Department bears the full cost of construction and maintenance thereon.

Trunk Road—*Any Main Road being a secondary avenue of road communication forming with the State Highways and other Trunk Roads a framework of a general system of intercommunication throughout the State and proclaimed a Trunk Road under the Main Roads Act.*

Together, State Highways and Trunk Roads make up the basic framework of roads of Statewide or inter-regional significance. Trunk Roads are under the care and control of Local Government Authorities, which carry out the works required thereon under Department of Main Roads supervision and at the cost of the Department.

Ordinary Main Road—*Any Main Road providing for inter-town or inter-district communication by road, connecting towns and important centres of population with the State Highways, Trunk Roads, and other ordinary Main Roads, and proclaimed a Main Road under the Main Roads Act.*

As with Trunk Roads, most of the Ordinary Main Roads in the State are under the care and control of Local Government Authorities, which carry out the works required thereon at full cost to the Department of Main Roads.

Over the past 50 years, the network of roads comprising the Main Roads System has in part evolved and in part been developed by conscious planning in response to the changing requirements of transport and communications.

Motor vehicle registrations in New South Wales have risen by 550 per cent from 358,450 in June, 1947 to 2,328,037 in June, 1973.[1] In the same period the State's population increased by 57 per cent from 2,984,838 to 4,702,500.[2]

Population is distributed unevenly, there being large and rapidly growing concentrations in the seaboard cities of Sydney (population 2,874,380), Newcastle (357,770) and Wollongong (205,780)[3] and relatively sparse settlement in the wheat growing and grazing areas of the drier interior. The State's rural economy is geared to extensive forms of land use, notably wool and wheat production, with a low labour requirement, high production per head and substantial dependence on overseas markets.

The rural areas of the State are characterized by a scattering of towns and provincial cities with populations ranging generally between 2,000 and 30,000. Rural population density is low, generally less than 4 persons per square kilometre except in a few intensively farmed areas such as the Murrumbidgee Irrigation Area and some localized coastal dairy farming districts. The population density gradient falls steeply from the coast to the sparsely settled Great Dividing Range, then rises in the mixed farming and wheat-sheep areas of the western slopes and falls further west to very low levels in the drier interior of the State.

1. Annual Reports of the Department of Motor Transport, New South Wales.
2. and 3. Estimates as at 30th June, 1973, supplied by the Commonwealth Bureau of Census and Statistics. Populations of cities relate to "Statistical Districts" and not to Local Government Areas.

Country Main Roads System continued

It is not surprising then, that the major road arteries have developed in a somewhat fan-shaped pattern extending from the main overseas ports (particularly Sydney) into the interior of the State.

The State's secondary industries are mainly concentrated in Sydney, Newcastle and Wollongong—Port Kembla and the growth of commercial traffic between these cities has been a feature of recent years. Another important development has been the rapid increase in heavy haulage over the main inter-capital highways, particularly between Sydney and Melbourne, the two largest cities in Australia.

The pattern of primary routes developed to service Sydney's economic region and intercommunication between Sydney and other capital cities is overlain by a series of coast to interior connections and by inland routes between Melbourne and Brisbane and between Adelaide and Brisbane.

The coastal strip about 50 kilometres wide, centred on Sydney and extending for about 400 kilometres from Port Stephens in the north to Jervis Bay in the south, is an area with strong propensity for growth in population, and within this area plans must be made for considerable changes in the road network in the coming decades. Topographic constraints suggest the development of a linear pattern of arterial routes, but eventually the disposition and spread of urban areas may give rise to a grid pattern of primary intra-regional routes connecting the main inter-regional axes of communication.

Outside this principal growth area, population growth in New South Wales is expected to be slow, apart from planned growth centres at Albury and Bathurst-Orange, a few of the larger provincial cities, areas within the influence of Canberra and certain coastal tourist resorts. The current trend for the larger centres to increase in population while the smaller centres and rural areas decline is expected to continue, and as a result, the proportion of the vehicle distance travelled is likely to increase on the principal arteries and connections between main towns, and decrease on the minor inter-town routes.

The future network pattern over much of rural New South Wales should retain its present basic form, but with modification to emphasize the more important arterials and inter-city connections.

NEED FOR COMPREHENSIVE REVIEW OF MAIN ROADS SYSTEM

The classification of Main Roads provides, together with needs surveys, the basis of Main Roads planning. It is the framework around which responsibilities can be established, works programmes formulated, a sound financial plan devised and organization and management requirements defined.

The layout and classification of Main Roads are being constantly examined by the Department to take into account the changing patterns of population, land use, resource distribution and travel desire lines. Because of the dynamic nature of road requirements in New South Wales, the classification of the Main Roads System should take into account the potential future functions of routes as well as existing functions, but the extent to which future needs are catered for in the network is limited by available finance.

However, it is over 20 years since the last comprehensive review was carried out, as distinct from consideration of changes in the system on a special basis.

The advantages of a comprehensive review are twofold. Firstly, it enables proposals to be considered in their overall context and while still considering the individual merits of each proposal, it enables a proposal to be examined in the light of other similar proposals throughout the State. Secondly, it enables the financial implications of a proposal to be examined in the context of overall financial commitments and the available funds.

The principal objectives of the current comprehensive review are:

- To bring the general layout and classification of the Country Main Roads System into line with modern thinking on the functional classification of roads, in accordance with the Main Roads Act.
- To lead to a more rational apportionment of funds for road and bridge works between routes of National, State, and local importance.

THE SELECTION OF MAIN ROADS

The factors which the Department takes into account in considering whether to recommend the proclamation of a Main Road come under three main headings:

Local Government views—representations made by local authorities through whose area the road passes or will pass or whose areas the road serves or will serve.

Available funds—for construction and regular maintenance of Main Roads.

Importance of a route—for intercommunication between centres of population, producing districts and capital cities.

Local Government views are important because they are the means by which the people residing along and near the road or roads in question can put forward their views and also because local authorities themselves are vitally concerned in the execution of works on Trunk and Ordinary Main Roads. It is usual for local authorities to resolve any local differences of opinion before submitting a proposal to the Department. Nevertheless, in some cases the Department is asked to provide technical assistance and advice when the claims of two or more competing routes involve complex problems of road location, or when an economic evaluation is required to determine the issue. In such cases the Department carries out studies of engineering feasibility and benefit/cost analysis.

The funds available in relation to the estimated requirements for the construction, maintenance and improvement of Main Roads have an important bearing on the extent to which the Department is able to increase its liabilities by proclaiming new Main Roads. The aim is to achieve the optimum use of funds consistent with demands of road and bridge improvement works, new construction and maintenance.

The question of road functions and particularly the extent to which a road is used by through traffic, is fundamental in considering Main Road classifications. All public roads are characterized to a greater or lesser extent by local traffic movements, and in some cases these represent an important component of the total traffic pattern, but to qualify for proclamation as a Main Road it is necessary that a road should function as an arterial route for intercommunication. Thus, it is found that some roads carrying heavy volumes of local traffic in densely settled areas may not qualify for proclamation as Main Roads. On the

other hand, a road carrying only light traffic volumes in a sparsely settled area may be proclaimed a Main Road because of its strategic location in relation to the long distance movement of goods and people.

PROCEDURE USED IN INVESTIGATIONS

The following method of approach was adopted by the Department for its comprehensive review.

Preliminary Investigations

Roads are for people, and therefore population distribution, trends and forecasts are of fundamental importance to the road planner.

Each town, district, and region competes with other towns, districts, and regions for population, which is a limited resource at any one point of time. The approach to population predictions must then be from the whole to the part, by a process of successive reduction. Any population estimate based solely on local trends and local resources is suspect. So, starting from Australia's population, its age and sex distribution, birth rates, death rates and estimates of net migration, a forecast for Australia as a whole is obtained. Then from estimates of differential growth potential between States, a proportion (or proportions at different times) is allocated to New South Wales. This is then broken down by a tentative allocation of population between major towns and regions (for example, on a Divisional basis). These allocations are then checked against current trends and modified as necessary having regard to town functions, economic base, land suitability and availability, resources and their potential and location factors (for example, as a transport node or port). Generally, forecasts of natural increase or decrease can be fairly accurate, given the right data, but estimation of net migration poses difficult problems.

Figure 1 shows the distribution of population in south eastern Australia at 30th June, 1971, with an estimate of population growth by the year 2000. The map illustrates the dominance of capital cities and the importance to New South Wales of two growth sectors, Newcastle-Sydney-Wollongong and Sydney-Canberra-Albury-Melbourne.

Roads are the routeways for movement of goods and people and planning of a road system, therefore, involves a consideration of physical, economic, and human resource patterns and the ways in which they are linked.

Studies are made of the land use pattern including the disposition and intensity of rural and urban land uses, the location of productive zones, trends in productivity and potential for growth in primary, secondary and tertiary industries (including tourism). Investigations include the effect of town and regional planning schemes and major developmental projects upon land use and the transportation network. Existing transportation networks are themselves a resource and are considered as an integral part of the whole environment.

These studies are carried out to a fair degree of generalization at the State level, including consideration of relevant developments outside the State's borders, examples being the growth of Melbourne, Brisbane, Adelaide and Canberra. Again the procedure is to work from the *whole* to the *part* with broad area investigations followed up by much more detailed studies using Divisions as units. The spheres of influence of towns and their degrees of interdependence one with another are evaluated. All these investigations require a substantial amount of office and field work, and include examination of aerial photographs and photomaps.

Traffic volumes, composition and growth rates, are important considerations when it comes to comparing route A with route B in a similar geographic context.

Traffic volumes, however, cannot be the sole criterion for selection of Main Roads or unbalanced systems would result. The State's responsibility under the Main Roads Act is such that it requires the development of a balanced Main Roads network, which includes Main Roads in the sparsely settled west of the State, where roads only carry low traffic volumes.

Studies are made of trends in traffic volumes and composition, separating through from local traffic where possible by origin and destination surveys or number plate surveys. In cases where direct information about through traffic volumes is unavailable, the approximate through traffic component may be deduced from an analysis of the traffic flow pattern for sections of road where local traffic is at a minimum.

Network Analysis

Against the background of the population, land use and traffic studies, the Main Road System is analysed to identify apparent inadequacies, redundancies and anomalies in the network pattern and classifications.

The network of State Highways is studied first on a Statewide and interstate basis, followed by an examination of Trunk Roads separately and in combination with the State Highways. Further analysis is made of the system as a whole, including Ordinary Main Roads and the basic units for this study are the Department's Divisions.

The study points up those specific routes which require further investigation and those areas where new Main Roads may be needed. Roads which are considered to be classified correctly are set to one side at this point and the next stage in the study relates to specific roads and areas.

Up to now, the investigations have been directed at those factors which throw light on traffic generation, possibilities for growth of through traffic and travel desire lines.

What follows is an examination of factors which tell us about the physical conditions along a road route, and whether a road can be improved at reasonable cost to enable it to fulfil its intended functions.

Specific Route Studies

These studies include a field examination of the following:

- The *physical condition* of the road in question including existing construction, obstacles to throngh traffic, pavement and bridge widths, and maintenance problems.
- *Standards of grading and alignment*—existing and potential.
- *Topography and drainage* including underlying rock strata, any major stream crossings, susceptibility to flooding (if so, its incidence and duration); susceptibility to landslides; and soil types.
- *Other factors* such as restricted speed zones, traffic congestion, railway level crossings, road reserve widths, land values, nature of tenure and improvements, whether the route is amenable to widening, and whether controlled frontage access, and limited entry and egress points are feasible.
- *Cost* of meeting present and likely future requirements for construction, improvement and maintenance, in relation to the overall funds position.

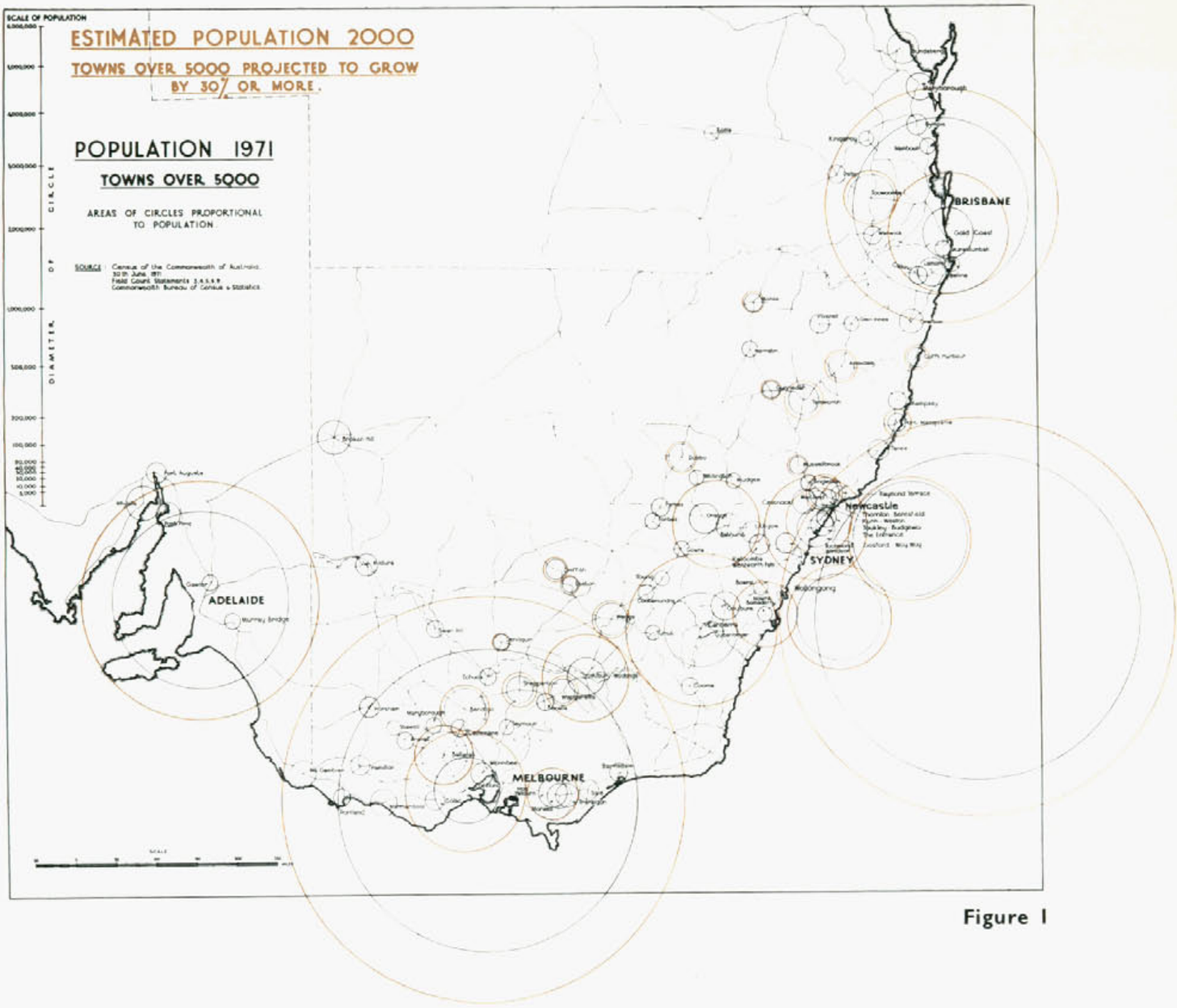


Figure 1

The Final Analysis

The significant data are analysed and summarized. The proposed additions, deletions and changes of classification are arranged in priority groupings together with a listing of the financial implications. The data are also displayed in map form.

The planning period is 30 years ahead and broken down into 10 year periods. After an analysis of the financial implications, recommendations for changes in the Main Roads System are made and these may take the form of:

- Proposals for immediate change and
- Proposals for consideration at some future date.

Flexibility of the *Master Plan* should become possible by the constant review of the relevant data and the introduction of further changes to the system as the need arises.

Consultation with Local Government Authorities

Proposals for changes in the Main Roads System will be discussed with the Local Government Authorities concerned and the Councils' concurrence sought prior to implementation of the proposals. It is intended that meetings be held at which proposals for whole or part of a Departmental Division will be put forward for the consideration of a group of Local Government Councils. In all probability these meetings will take place during 1975.

FUTURE PROSPECTS

The general review has revealed that the principal arterial roads and the more important inter-regional and inter-city routes are carrying an increasing proportion of the vehicle distance travelled. The State's needs for improvement of these more important routes are therefore increasing very rapidly relative to the needs of less important feeder and inter-district roads.

The funds available to the Department are never likely to match needs. To achieve maximum use and value from these funds, they should, in the State's interest, be concentrated on the more important routes rather than diffused over a large number of Main Roads.

Country Main Roads System continued

It seems logical to propose that the Main Roads System be pruned of some of its minor branches by deproclamation of those Main Roads which are no longer significant for through traffic. This should not imply a reduction of grants to Councils, but rather a greater concentration of the funds available on fewer routes.

At the same time, there are likely to be some unclassified roads which, because of their importance for inter-communication, will warrant inclusion in the Main Roads System as new Main Roads.

The Department's financial capacity in relation to works needed on the Main Roads System will depend very much on the provisions of the National Roads Act, 1974 and the Roads Grants Act, 1974 (which were assented to on 20th September, 1974. Accordingly, the implications of these Acts will have to be examined before finality is reached in the comprehensive review of the Country Main Roads System.

ROUTES BETWEEN GOULBURN AND BATHURST

Over a number of years there have been representations to the Department for an improved north-south road between Goulburn and Bathurst. The various councils concerned all agreed on the need for an arterial north-south road to connect Canberra in the south with Tamworth in the north and to pass through Goulburn. They did not agree on the precise route to be followed. Bathurst, Oberon and Mulwaree Councils favoured Main Road Nos. 256 and 253 from Goulburn via Taralga and Oberon to Bathurst (193 km) while Abercrombie, Lyndhurst and Crookwell Councils favoured a route generally following Trunk Road No. 54 (189 km).

From time to time Crookwell and Mulwaree Councils had proposed various routes for Trunk Road No. 54 between Mount Wayo and Tuena. The suggested variations were:

- via Main Road Nos. 376 and 249 from Mount Wayo via Crookwell to Laggan.
- via Main Road No. 376, Mount Wayo to Crookwell, Main Road Nos. 291 and 201 from Crookwell through Binda and thence via Junction Point Road to Tuena.

A comprehensive technical and economic appraisal of the alternative routes was carried out by the Department between 1970 and 1973. The study covered an area of 9 000 square kilometres between Goulburn in the south and the Great Western and Mid Western Highways between Lithgow and Blayney in the north. It also took into account the possible long range effect of the proposed Orange-Bathurst Growth Centre and the significance and location of connecting roads to Canberra and Orange.

The following aspects were covered:

- Land use in areas served by the road network, population distribution and the potential growth of major centres, the spheres of influence of towns, traffic and travel desire lines, tourist attractions, estimated travel times and market outlets, existing and potential.
- An engineering and cost appraisal of the alternative routes.
- The implications for classification of roads, particularly the changes of classification needed in Crookwell and Mulwaree Shires.

The routes considered and the proposed layout of the Main Roads System are shown in Figure 2 on page 15.

ECONOMIC EVALUATION

The economic evaluation of the area revealed that there is very little *community of interest* between Goulburn and centres of population such as Lithgow, Bathurst, Orange, and Blayney, located on or near the Great Western or Mid Western Highways. Through traffic in 1972 averaged no more than 70 vehicles per day on Trunk Road No. 54 and 60 vehicles per day on Main Road No. 256.

The Abercrombie River is the approximate boundary between the spheres of influence of Goulburn-Crookwell in the south and Bathurst-Oberon in the north. The cities at present exerting the greatest influence on the area under consideration are Goulburn (population 22,000) and Bathurst (population 18,000). The Lithgow-Wallerawang area has virtually no *community of interest* with the Goulburn district.

About 13,000 people live between Goulburn and Bathurst, 7,000 of these being served by Trunk Road No. 54 and about 6,000 by Main Road Nos. 256 and 253 through Oberon.

Rural population has declined over the past 20 years, but levels of primary production have increased and there is scope for further increases in productivity over wide areas. The opportunities for increased pastoral production appear to be greater in the area traversed by Trunk Road No. 54 than in the area served by Main Road No. 256. On the other hand, there is scope for further development of timber production in the State Forests adjoining Main Road No. 256 to the south of Oberon.

The improvement of a direct road between Goulburn and Bathurst would lead to a wider choice of market outlets for primary products from the intervening area. The growth of Canberra could create a market for stock and agricultural crops produced in Crookwell and Mulwaree Shires. An improved route could also extend the scope for movement of stock and agricultural products to selling centres at Goulburn, Bathurst, Orange and Blayney and could extend the catchment area for consignment of wool through the Goulburn wool sales centre.

The implementation of the State Government's proposal for a major growth centre in the Orange-Bathurst area could eventually create a strong market for primary products from the surrounding shires.

At the present time, the movement of manufactured goods on any route between Goulburn and Bathurst is almost negligible, because the functions of these two cities are similar and most firms are concerned with supplying markets in Sydney.

The existing road conditions do not favour goods haulage between Goulburn and Bathurst. Trunk Road No. 54 is used to a very limited extent for this purpose, but the steep and winding approach to the Abercrombie River on Main Road No. 256 acts as a complete deterrent to the use of the latter road as a through route by trucks and semi-trailers.

Eventually, an interchange of manufactured goods could develop between Canberra and the proposed growth centre in the Orange-Bathurst area. The most direct route will probably be via Main Road No. 249 from Sutton to Crookwell via Gunning, Main Road Nos. 291 and 201 through Binda, thence the Junction Point Road to Tuena and Trunk Road No. 54 northerly through Trunkey.

However, until this direct route is improved to a much higher standard and sealed throughout, the preferred route would be via the Barton Highway (State Highway No. 15) to Yass, Trunk Road No. 56 from Yass to Cowra and the Mid Western Highway (State Highway No. 6) from Cowra through Blayney.

This latter route, although about 40 km longer in a distance of 250 km, traverses easier country and is at present much more highly improved.

Routes between Goulburn and Bathurst are not frequented by many tourists, but tourist activity could increase with road improvement. Local tourist attractions include the Fish River Dam near Oberon, Ben Chifley Dam off Trunk Road No. 54, the Abercrombie River Valley for camping and fishing, the Abercrombie Caves off Trunk Road No. 54 (10,000 visitors per year) Wombeyan Caves (36,000 visitors per year) and old mining villages such as Tuena.

The improvement of a direct route between Bathurst and Goulburn could attract those tourists who are looking for shorter ways of reaching their destination, particularly those travelling to (or from) South Coast beaches (i.e. driving to the coast through Goulburn and thence via Trunk Road Nos. 79 and 51).

An improved road between Goulburn and the Great Western Highway is likely to function as an inter-regional route, rather than as part of a long distance north-south artery throughout the State. In general, long distance north-south traffic is catered for by the Hume and Federal Highways (State Highway Nos. 2 and 3) to the east of the area under consideration and by Trunk Road No. 56 and the Barton Highway (State Highway No. 15) to the west.

The principal requirement is for an improved direct road between Goulburn and Bathurst to function as an inter-regional link between the two areas and a feeder road servicing the hinterlands of Goulburn and Bathurst.

The route selected would be appropriately classified as a Trunk Road.

Additional important considerations in selecting the route are the capability of combining the route with suitable connecting roads to Canberra and Orange and the capability of adapting the route as part of a north-south arterial road between Canberra and the proposed Orange-Bathurst growth centre.

In the long term, the Orange-Bathurst growth centre could require a direct road connection with Canberra and such a route could emerge as the principal north-south inter-regional link.

ENGINEERING FACTORS

The engineering investigations involved an assessment of the physical condition of existing routes, an evaluation of their service to traffic and their capability of improvement to a suitable standard for through traffic. Location studies were made covering wide areas in the first place, but later polarizing on critical aspects, such as the crossing of the Abercrombie River Gorge.

A series of alternative routes was compared and the least favourable eliminated by a process of successive reduction until the best general route emerged, and the process was then repeated in more detail for variations of the best general route to arrive at a proposed road location.

Route 1 from Goulburn via Taralga and Oberon to Bathurst was found to be constructed to a satisfactory standard and sealed generally 5·5 metres wide over 120 km or 62 per cent of the total through distance of 193 km. A further 24 km had been constructed to gravel stage to 64 km/hr standard, but the remaining 49 km included substantial lengths of very low standard road unsuitable for use by commercial vehicles.

The critical section of this whole route is the crossing of the Abercrombie River Gorge between 70·8 km and 76·6 km from Goulburn Post Office. From the south the existing Main Road No. 256 makes a descent of 229 metres in 3·06 km through very steep country to the Abercrombie River, which is crossed on a low-level timber bridge 39 metres long and 5 metres wide. The ascent out of the gorge within Oberon Shire involves a climb of 244 metres in 2·7 km through mountainous terrain with grades up to 17 per cent and 30 metre radius curves. The road is signposted as being unsuitable for caravans.

The reconstruction of about 5·7 km of road and replacement of the low level bridge could cost roughly $900,000 and bring only minor improvement to these standards. Further it would not be practicable to provide a crossing of the Abercrombie River Gorge in this general locality to standards acceptable for a through route between Goulburn and Bathurst.

So, Route 1 was ruled out as a possible inter-regional link and the variations of this route (i.e., from Oberon via Tarana to the Great Western Highway and from Oberon via Hampton to Lithgow) could not form part of a satisfactory through road between Goulburn and the Great Western Highway.

The Abercrombie River Gorge between the crossings of Main Road No. 256 and Trunk Road No. 54 was examined on topographic maps, aerial photographs and by helicopter to check whether there might be a feasible alternative crossing of the gorge which could be linked either with Trunk Road No. 54, with Main Road No. 252 (Perthville-Burraga) or with Main Road No. 256.

The only locality which offered any prospect was between the Fullerton Road near Hadley, and Arkstone. A route in this area would involve extensive construction over plateau country as well as about 10 km of very heavy construction across the gorge on steep grades with side slopes to 30° to obtain even a low standard road. Therefore, an intermediate route was considered to be an uneconomic proposition.

Route 2 following the location of Trunk Road No. 54 at the time of the study from Goulburn via Mount Wayo, Laggan, Tuena, Trunkey and Perthville to Bathurst, was found to be sealed generally 5·5 to 6 metres wide over 82 km or 43 per cent of the total length of 189 km. About 142 km have been constructed to 64 km/hr or better standards, but the remaining 47 km, principally the section between Peelwood and Trunkey, are constructed generally to 48 km/hr standard, reducing to about 32 km/hr on the steep and winding approaches to the Abercrombie River.

The steep approaches to the Abercrombie River between 107 km and 114 km from Goulburn are characterized by grades of 8 per cent to 10 per cent and 60 to 90 metre radius curves. Although the terrain is difficult, investigations showed that the only feasible location for a crossing of the Abercrombie River Gorge to provide standards acceptable for a through road is in the general vicinity of the present route of Trunk Road No. 54. An eventual new crossing of the Abercrombie River would probably be downstream of the confluence of Tuena Creek and would replace two existing bridges, one over the Abercrombie River and one over Tuena Creek.

Right: The steep approaches to the Abercrombie River made the planning of an improved crossing a major problem to overcome. This is the existing bridge on Trunk Road No. 54

Far Right: Floodway at Binda, on Main Road No. 201

Further investigations were centred around the various alternative routes between Mount Wayo and Tuena in the general direction of Trunk Road No. 54. These alternatives are shown on Figure 2 and are compared in the table below.

Comparing Routes 2 and 2 (b) it will be seen that they are similar in through distance, but in all other respects Route 2 (b) is superior to Route 2. The standards obtainable on Route 2 (b), through Crookwell and Binda are higher than those for Route 2, the cost of construction would be less and the service to traffic and population en route would be better.

Route 2 (a) and Route 2 (b) involve similar costs but Route 2 (b) has the advantage of being 6·5 km shorter in through distance, serving a slightly larger population along the route and being better located for a direct connection to Canberra via Main Road No. 249 (now Trunk Road No. 52).

It was concluded then that Route 2 (b) via Crookwell, Binda, and Junction Point to Tuena had significant advantages over other possible routes and should be adopted as the route of the Trunk Road.

The total estimated cost of works required to provide a sealed road suitable for through traffic between Goulburn and Bathurst via Route 2 (b) through Crookwell, Binda, Junction Point, Tuena, Trunkey, and Perthville is in the order of $5 million. Having regard to the extensive works and high cost involved and the Department's heavy commitments for many other works of higher priority throughout the State, it is evident that the works on the route between Goulburn and Bathurst will have to be spread over a long period of time. However, it will be possible to bring the route to a standard acceptable for the traffic demands in the foreseeable future by minor reconstruction and bitumen surfacing generally along the existing alignment.

COMPARISON OF ALTERNATIVE ROUTES BETWEEN MOUNT WAYO AND TUENA

See map on page 15	*Route 2*	*Route 2 (a)*	*Route 2 (b)*
Through distance—			
Existing	86 km	91 km	86 km
With improvements	84 km	90 km	83·5 km
Length sealed	17·5 km	47 km	47 km
Length unsealed	68·5 km	44 km	39 km
Railway level crossings	3	..	..
Standards obtainable—			
100 km/hr	58·5 km	64 km	70 km
80 km/hr	25·5 km	26 km	13·5 km
Estimated construction cost	$2·8 m.	$2·2 m.	$2·2 m.
Population served 1971	1,300	3,400	3,700
Order of suitability for connection to Canberra via Main Road No. 249	2	2	1

IMPLICATIONS FOR CLASSIFICATION OF ROADS

A decision on the route of the Trunk Road is the first consideration before the appropriate classifications of other Main Roads in Crookwell and Mulwaree Shires can be determined.

The adoption of Route 2 (b) from Goulburn via Crookwell, Binda, Tuena, Trunkey, and Perthville to Bathurst as the inter-regional link between Goulburn and the Great Western Highway has direct and indirect consequences for the layout and classification of the Main Roads System.

The direct consequences are the need to proclaim the roads forming the route as part of Trunk Road No. 54 and to alter the classifications of the superseded Trunk Road route between Mount Wayo and Tuena and of other classified roads affected, that is, Main Road Nos 376, 291 and 201.

The indirect consequences arise out of the likely future functions of the new Trunk Road and its effect on the functions of classified roads in the area generally, all considered in the context of the general review of the classified road system.

The proposed changes in Main Road classifications were discussed with the interested Shire and Municipal Councils at a meeting in Sydney on 29th June, 1973, when the following specific proposals were put forward.

Trunk Road No. 54 between Mount Wayo and Laggan

This length of 28·9 km (8·5 km in Mulwaree Shire, 20·4 km in Crookwell Shire) does not carry much through traffic and would carry even less following the improvement of the road through Junction Point to Tuena.

Most of the traffic between Goulburn and the small village of Laggan travels via the all sealed route through Crookwell. When the proposed Trunk Road route through Crookwell, Binda and Junction Point is improved, virtually all the long distance traffic will use this latter route and the function of the former Trunk Road No. 54 between Mount Wayo and Laggan will be confined to local access.

It was concluded that this section of Trunk Road No. 54 should be deproclaimed.

* * * * *

Trunk Road No. 54 between Laggan and the Junction Point Road, 1·8 km south of Tuena

This length of 53 km (which is all in Crookwell Shire), will continue to function as a route used by through traffic, until such time as the proposed Trunk Road route through Junction Point to Tuena is improved.

At present, through traffic is split between both routes, but as the Junction Point route is improved and becomes better known to long distance travellers, the old Trunk Road will function principally as a feeder road to the Fullerton and Peelwood districts.

It was concluded that this section of Trunk Road No. 54 should be reclassified as an Ordinary Main Road in the first instance, on the understanding that Departmental assistance for this road would be limited to grants for maintenance and minor improvements only.

When the new Trunk Road route between Binda and Tuena is improved to the stage where it carries most of the through traffic, then action would be taken to repeal the proclamation of the Laggan-Tuena Road.

* * * * *

Main Road No. 201 from the Junction Point-Tuena Road turnoff to the northern boundary of Crookwell Shire at the backwaters of Wyangala Dam

This length of 53·3 km (which is also all in Crookwell Shire), is a spine road through the northern part of the Shire serving the small village of Bigga and giving access to the backwaters of Wyangala Dam. It does not function as a through route and is too remote from important tourist routes and frequented tourist areas to warrant proclamation as a Tourist Road under the present circumstances.

It was concluded that this section of Main Road No. 201 should be deproclaimed following the completion of certain desirable construction works. Following subsequent discussions with Crookwell Shire Council, the Department offered a fixed grant for construction and reconstruction on Main Road No. 201 between the Junction Point Road and the Reids Flat Road. When this grant has been expended, action will then be taken to repeal the proclamation of Main Road No. 201 north of the Junction Point Road.

Crookwell Shire Council referred to the proposal by the Department of Lands to establish a State Recreation Area on the foreshores of Wyangala Dam and intimated that Council would apply for the proclamation of the road as a Tourist Road in due course.

* * * * *

Main Road No. 248 between Goulburn and Main Road No. 291 at Winduella

This length of 60·3 km (2·35 km in Goulburn City, 33·8 km in Mulwaree Shire and 24·15 km in Crookwell Shire) has been sealed for 18 km north of Goulburn and for a short length at Grabben Gullen. The road serves well settled country and carries a fair volume of local traffic, but closely parallels the proposed Trunk Road route between Goulburn and Crookwell.

It was concluded that Main Road No. 248 between Goulburn and Winduella has very limited present and potential significance for through traffic and does not warrant retention in the Main Roads System.

* * * * *

Main Road No. 249. Crookwell via Gunning to the Federal Highway (State Highway No. 3) near Sutton

This length of 92 km will require considerable expenditure in the order of $2 million to bring the route to a standard attractive to long distance through traffic.

With the rapid growth of Canberra's population, there will be pressure for the improvement of this route as an arterial road connecting with the Goulburn-Bathurst Trunk Road.

It was concluded that Main Road No. 249 between Crookwell and the Federal Highway warrants reclassification as an extension of Trunk Road No. 52 (Sutton-Queanbeyan).

* * * * *

Yarraman Road from the Bigga-Greenmantle Road to Tuena. Application for proclamation as a Developmental Road

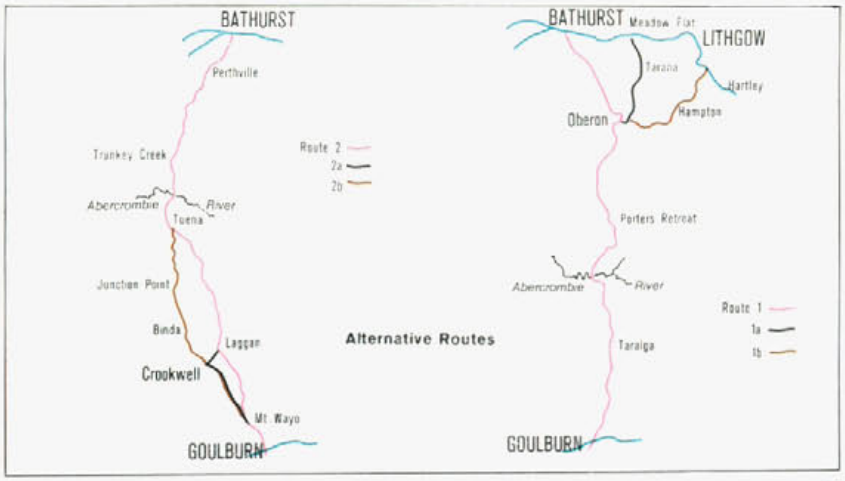
Some years ago, Crookwell Shire Council requested the proclamation of a Developmental Road from Main Road No. 201 near Bigga north easterly and easterly to Trunk Road No. 54 near Tuena, a length of 30·6 km.

The proposal has been examined in the field and later considered as part of the general review of the classified road system in the area.

It has been concluded that the first 5·3 km forming part of the Bigga-Greenmantle Road is already constructed to a reasonable standard and does not qualify for proclamation as a Developmental Road and that the remaining length of about 25·3 km from the Bigga-Greenmantle Road to Trunk Road No. 54 near Tuena warrants proclamation as a Developmental Road, the purposes of which would be to provide improved access to 10 000 hectares of underdeveloped grazing country held in eleven properties and to provide a reasonably direct road connection between the Bigga and Tuena districts.

The interested Shire and Municipal Councils agreed to the proposals on the understanding that the reduction in the length of proclaimed road would not result in a reduction of grants to Councils. Rather it would lead to a greater concentration of the available funds on roads of significance for through traffic.

The first stage of the proposed proclamations has been put into effect including the reproclamation of Trunk Road No. 54 to follow the route via Crookwell, Binda and Junction Point to Tuena.●



Improved Routes – Goulburn/Bathurst Area

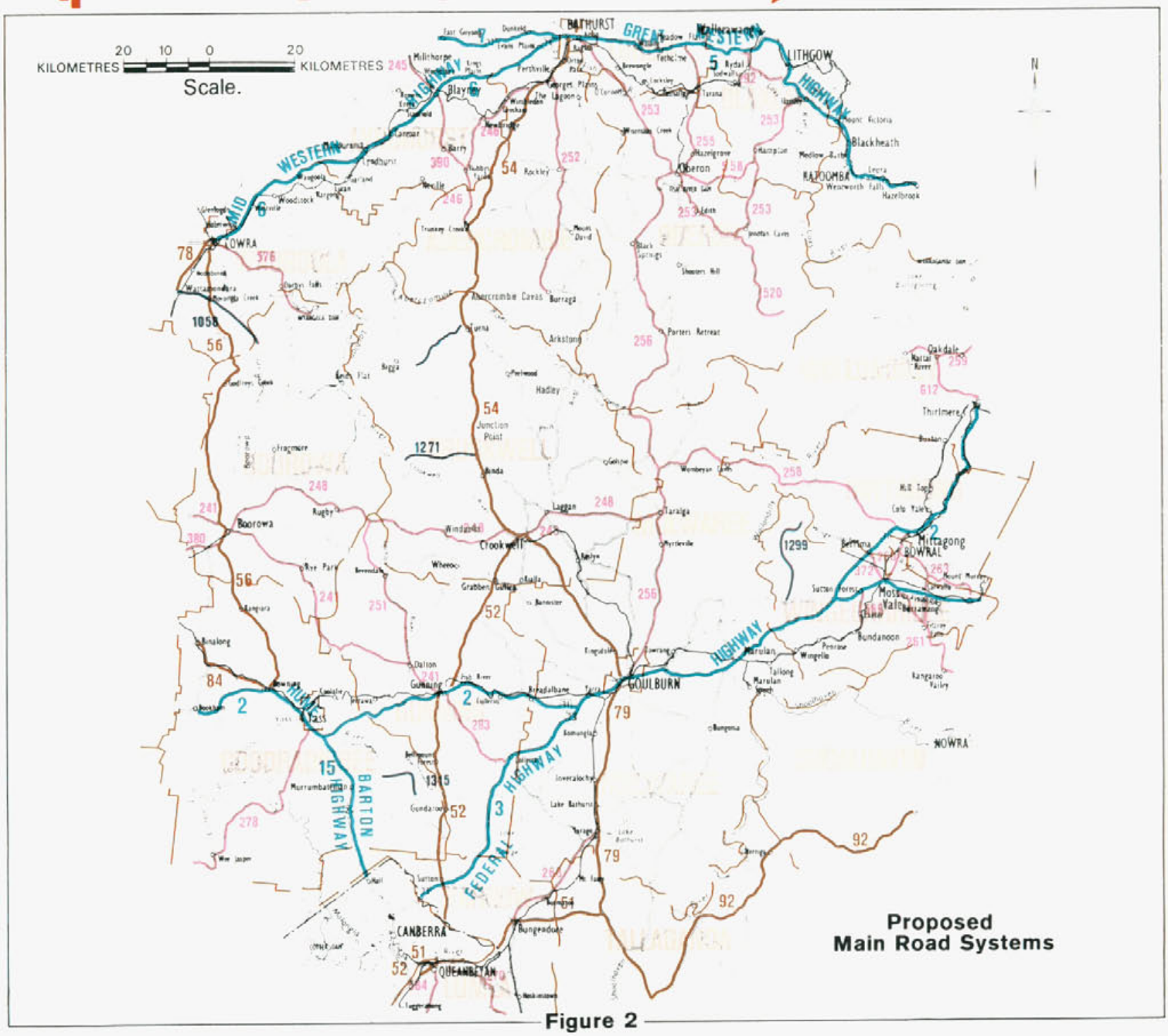


Figure 2

Building a Mountain Road

The original of this map is held by the Mitchell Library, N.S.W., with whose kind permission it has been traced and reproduced here. On the back of the original, the following note appears: "This Plan is a copy of part of G.W. Evans' original plan of his survey of the road (1813–14) from Emu Ferry to Bathurst, prepared by Governor Macquarie's direction for the guidance of William Cox, in construction of the said road in 1815. Mr Cox's notes in his own handwriting appear towards the left hand margin of plan". On this map, Cox's notes have been printed in colour.

From Mr Blaxland's to the end of the Ridge Mr Evans took lines not to be followed in account of the Hills, Valleys and Bluff Rocks: the wheel was made to shut pond occasions 16½ miles and has Eight Bridges built on it

Bridge here ____
Miles

16½ Miles ____

Two Bridges 11½ Miles ____

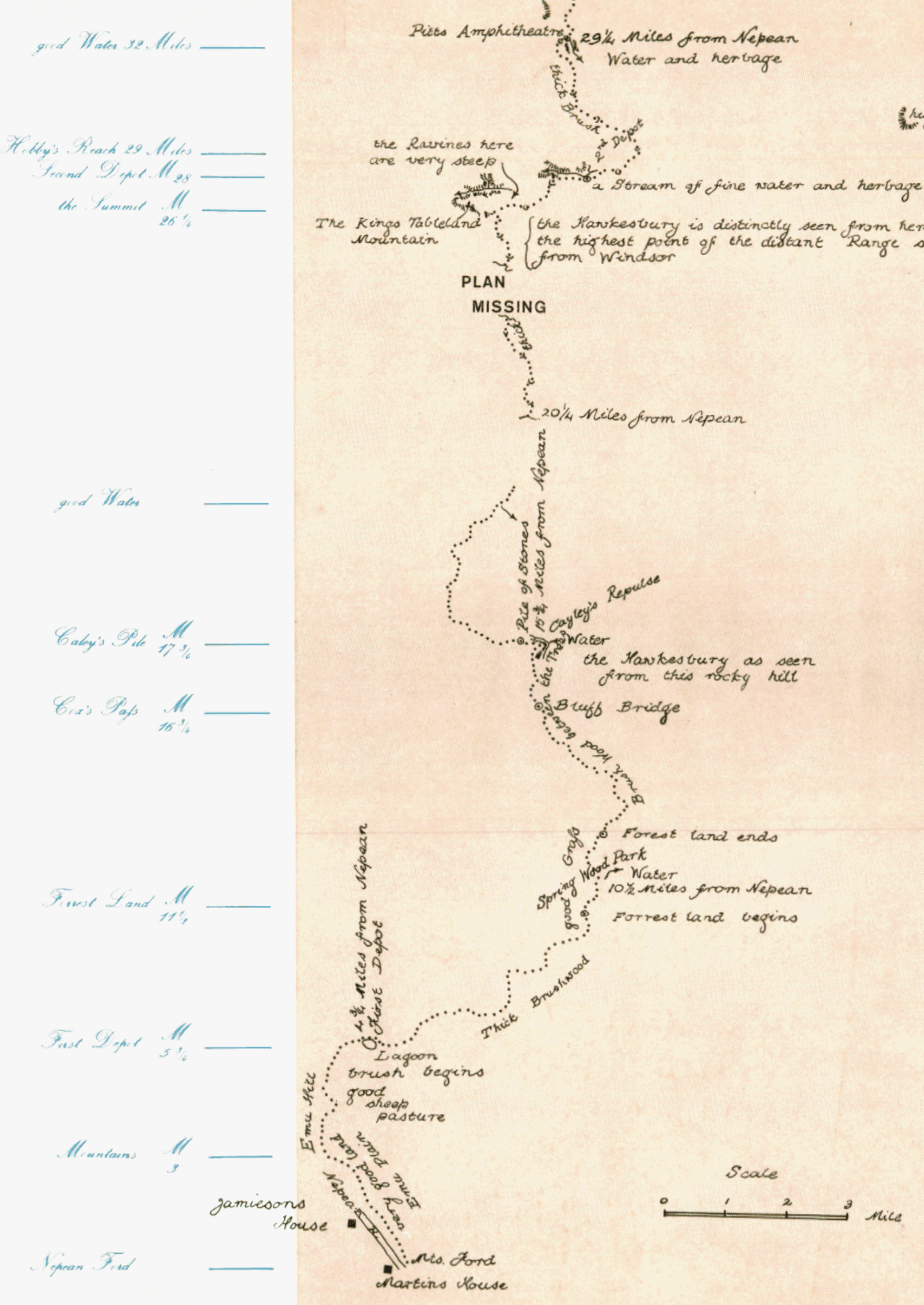
Blaxlands Mount Miles ____

In the West Country 5 Miles ____
here are 2 Bridges as Marked *

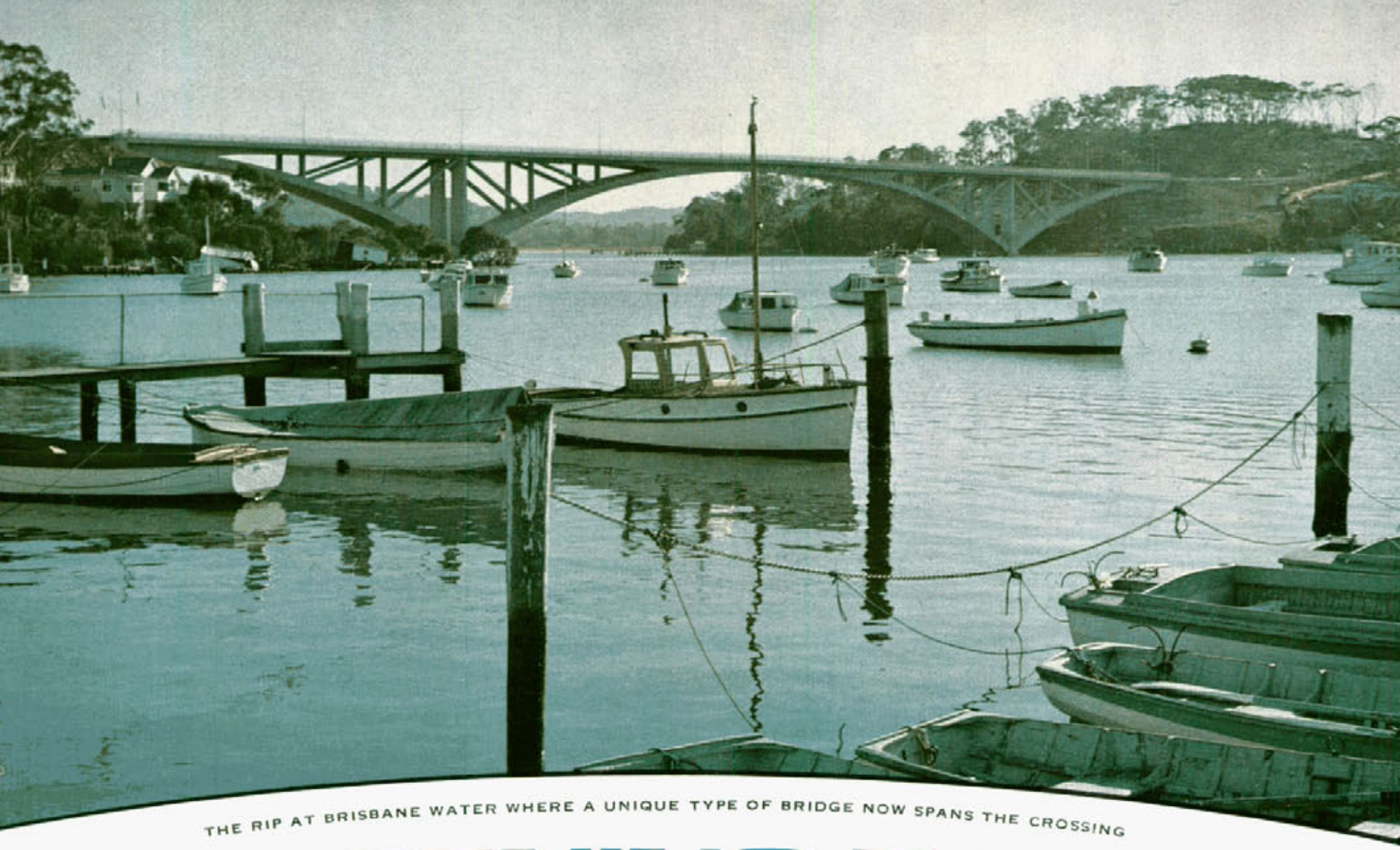
End of the Mountains 50 Miles ____

Water fed Miles ____
Lear's Watering place M 40½ ____
good Water M 37¾ ____
Hollow Rock M 35¾ ____

Coloured illustrations are reproductions of watercolours painted by John William Lewin during his 1815 journey over Cox's newly-made road with Governor Macquarie's party. (Top): "Cox's Pass"; (Below): "Campbell River" (both paintings).



Colour illustrations reproduced by courtesy of the Mitchell Library.



THE RIP AT BRISBANE WATER WHERE A UNIQUE TYPE OF BRIDGE NOW SPANS THE CROSSING

OPENING DAY

OF MAJOR NEW WORKS

THE NEW DEVIATION OF THE PACIFIC HIGHWAY JUST NORTH OF MACKSVILLE INCLUDES A FINE NEW BRIDGE

INTO THE EARTH

A summary of the use of Benoto Boring Machines by the Department of Main Roads

The Department has been using the Benoto EDF type of pile boring machine for almost 15 years. Two models of this machine have been in service during that time, proving reliable and successful machines for the type of work undertaken.

Regardless of the type of subsurface material through which bridge piles are first driven, all piles have a common element—the need to be taken to a depth where they can be founded on rock or other sound foundation material. Constructing concrete bridge piles in place is often a difficult, dirty job, the final results of which are normally not seen. It is important, therefore, for the task to be completed as quickly and efficiently as possible, and this is made practical by the use of the Benoto EDF pile boring machine.

By late 1968, it became obvious that the first boring machine had aged to the point where its replacement would soon be necessary. It was a 1955 model EDF and had been superseded by a slightly larger capacity model shortly after its purchase. Although the machine was in good operating condition following a recent overhaul, it was obvious that future reconditioning costs would be unduly high, and this, combined with its obsolescence and the availability of more modern machines, made the early replacement of the machine an attractive and economic proposition.

In September 1971 the Department purchased a new Benoto Super EDF Boring Machine to replace the earlier model which had been in service since 1961. One of the prime considerations for replacement related to the future use of this type of machine on proposed major construction projects.

During its operating life, the original EDF Benoto Machine was used at a number of difficult construction sites, including work on foundations for the bridge over the North Arm of the Hunter River at Stockton, where it was necessary to bore to a depth of 46 m in a salt water environment. The machine's best performance was in non-cohesive soils and soft rock, but it had limitations when boring through cohesive material such as heavy clay or in drilling holes in hard rock where rotary boring equipment would have been more suitable. Plans were therefore made to retire the old machine by mid-1971, after the delivery of a more modern, versatile and robust replacement some months earlier.

Tenders Called

Tenders for a new pile boring machine were called in December 1969 and $200,000 was allocated for its purchase during the financial year ending 30th June, 1971. The specifications were for a multi-purpose pile boring machine capable of the following functions:

- Drilling or excavating a hole of not greater than 1·37 m diameter to a depth of 76 m either vertically or *raked* up to one-in-five.
- Excavating the hole by grab or suitable alternative technique.
- Handling drilling tube or steel casing of up to 1·3 m diameter and aligning the tube or casing for jointing.
- Driving and extracting the casing to full depth, preferably assisted by an oscillating rotary device on the machine.
- Drilling a hole of up to 1·37 m diameter by rotary methods and extracting the spoil either by direct or reverse circulation methods.

The machine also had to be self-propelled and self-levelling on the construction site.

Specifications and other details were forwarded to the Agent General for New South Wales and embassies, consulates, and trade commissions representing Japan, United Kingdom, France, U.S.S.R., Italy, Switzerland, Canada, Czechoslovakia, Netherlands, Austria, U.S.A., and the Federal Republic of Germany.

Tenders closed in March 1970 and 14 quotations were received from 9 firms. The successful tender for the Benoto Super E.D.F. Pile Boring Machine with accessories, was for a total of $135,000. When the tender was accepted, a further recommendation was made to obtain quotations for a truck-mounted rotary drill of the Calweld type. This equipment could be used in conjunction with the Benoto machine for drilling pile sockets into rock when required and could be utilized otherwise on many jobs for the rotary drilling for piles which do not require casing. Being truck-mounted and therefore very mobile, this unit could be employed on many smaller jobs which would not warrant the transfer of the Benoto machine.

The New Benoto Machine

Although the diameter and depth capabilities of the new Benoto machine were below the figures in the tender specification, they were considerably above those of the former model and it had a more powerful motor. Additional advantages of the new machine were that:

- Departmental operating and repair personnel were already familiar with Benoto equipment.
- Many of the attachments for the Department's original Benoto machine could be used on the new unit, such as transport bogies, hammer grabs, and rock splitting chisel bits.
- Spare parts for the original machine were already held by the Department and were suitable for use on the new model.

The larger capacity of the new machine is shown by the following table:

	Old machine	New machine
	Benoto type E.D.F.	Benoto Super E.D.F.
Engine kilowatts	74·5 kW	134 kW
Maximum diameter of tube or casing	0·96 m	1·17 m
Maximum depth of operation (average conditions)	36·6 m	54·9 m
Extraction force	40·6 tonnes	61 tonnes
Oscillating torque	400 kNm	723 kNm

The new machine weighs approximately 36·5 t and collapses to 13·3 m long by 3·7 m wide by 3·5 m high for transportation on a special low loader.

It arrived in September, 1971 and the machine has since worked on the North Western Freeway and the new bridge over the Murrumbidgee River at Gundagai.

Left: The boring rig *showing the two rear lateral pads (just raised off ground). With the two front pads, these devices form the patented "Otarie" system which enables the machine to move into position (it appears to "walk") and level itself*

Centre: The boring tube *is lifted into position*

Above: Cutting edge *of boring tube has teeth which "bite" into the earth as tube begins to sink. This cutting edge is also designed to prepare hard earth strata for the hammer-grab*

WORK ON THE NORTH WESTERN FREEWAY

The structure on which the new Benoto machine was first employed in December, 1971 was a 21·3 m high viaduct crossing of the Darling Harbour Railway Goods Yard which will form the first part of the City to Glebe section of the North Western Freeway. An account of these operations appeared in "Main Roads", June 1973, Vol. 38, No. 4, pp. 101–5

DRILLING OF PILES FOR THE NEW BRIDGE AT GUNDAGAI

A new bridge on the Hume Highway over the Murrumbidgee River at Gundagai is being constructed one mile downstream from the narrow wrought-iron Prince Alfred Bridge which was built in 1866.

The Benoto machine was despatched to Gundagai in September, 1972 where it was engaged until December, 1973 in the construction of 106 x 0·98 m diameter cast-in-situ piles. The expected average depth of the piles as indicated by the test bores was 21·5 m.

The piles were drilled using drilling tubes, reinforcing was placed for the full depth of the drilled hole, the pile concrete placed and then the drilling tubes were extracted.

Pile Construction Cycle

Two operation cycles were tried, and are as follows:

2-*pile Cycle:* One pile is drilled to the full depth and drilling is commenced on the second pile. The reinforcing steel and tremie pipes for concreting are then commenced on the first pile and, on the completion of drilling of the second pile, placement of the reinforcing steel for it follows.

The first pile is then concreted and the drilling tubes are extracted. When the placing of the reinforcing steel and the tremie pipes for the second pile is completed, the concrete is poured and the drilling tubes extracted. The cycle is then repeated.

1-*pile Cycle:* In this operation one pile is drilled to its full depth and then drilling is commenced immediately on the second pile. While drilling is in progress on the second pile, the reinforcing steel and tremie pipes are placed in the first. The first pile is poured, the drilling tubes are extracted and drilling is recommenced on the second pile. The cycle is then repeated.

The 1-pile cycle is the better as it produces the least "down time" of the machine and allows some flexibility in concrete pouring times, if there are sufficient drilling tubes for 2 piles, while the cycle is essential where there are insufficient drilling tubes to complete two piles.

TREMIE PIPES

These are pipes for placing concrete down the pile holes, and had an internal diameter of 0·25 m with quick-acting male and female socket joints. Lengths of 3·0 m, 1·8 m and 1·2 m are available.

To ensure the joints are waterproofed, sealing tape is wrapped around them. At the start of concrete pouring, the concrete is sealed from the water in the pile hole by using an ordinary standard size basketball or a steel plate fixed to the bottom. The ball method is preferable as this allows placement of the tremie pipes well in advance of pouring the concrete. It is also quicker and less sensitive to leaks or problems associated with leaks.

DRILLING OF PILES

Drilling is carried out by pushing the tubes down, using an oscillating motion and hydraulic rams for downward force of up to 71·5 tonnes. Mucking out of the material inside the tube is effected with a special hammer-grab with clam-shell jaws.

Drilling times are dependent on size of the pile, depth and material. Typical rates achieved at Gundagai were:

24·4 m long pile—
depth 0–18·3 m 3·0–3·5 m per/hr.
18·3–24·4 m 1·5–2·1 m per/hr.
Drilling in sound shale 0·3–1·0 m per/hr.
Average time for pile—10 hours
28·9 m long pile—
0–18·3 m 3·0–3·5 m per/hr.
18·3–28·9 m 1·5–2·1 m per/hr.
Drilling weathered shale 0·6–1·2 m per/hr.
Average time for pile—12 hours

The above rates include pitching and bolting of drilling tubes, minor repairs of half an hour or less and general operating efficiency.

Above: A semi-rotary alternate movement *drives the tube downwards. The interlocking tubes come in lengths of 6 m but their width varies*

Centre: The hammer-grab mechanism (*shown open*) *drops and penetrates into the soil, and picks up the earth material and brings it to the surface where it is directed into a cylindrical, hydraulically tilting spout and emptied into a vehicle* (*here, a front-end loader*)

Right: A Calweld drilling rig *is used in conjunction with the Benoto machine, its purpose being to drill socket holes into rock at the base of the pile bores.*

The Benoto machine "walks" from one position to another at approximately 185 m/hour and requires 15-20 minutes to position itself at a new pile location. Setting up on an existing drilling tube, already partially drilled, requires 5 minutes. With a distance of 40 m between piers, the average time required to shift from one pile to another and commence or recommence drilling was 30 minutes.

REINFORCING STEEL

The reinforcing steel for each pile consisted of two cages—the top cage 11·6 m long of either 24, 18 or 12 bars with spiral at 0·1 m pitch, and the bottom cage of variable length of 6 bars with spiral at 0·3 m pitch. The top cage provides the required structural strength for the pile, while the bottom cage was mainly to support the top cage. To facilitate transport, the bottom cages were of a slightly smaller diameter and fitted inside the top cages.

The required reinforcing length for each pile was obtained by adding to or cutting away the bottom cage on the site of operations. In practice, where piles were known to exceed 24·4 m, the bottom cage was extended by up to the desired length when required.

Welding of the two cages was carried out at the pile location with a 0·6 m splice on the main bars and, if required, spiral reinforcement was added. The average time required for the placing and joining of the reinforcement was 2½ to 3 hours.

Concrete

Concrete having a specified strength of 20·7 MPa and a slump of 150 mm to 200 mm was used. The concrete was placed directly from agitator trucks into the tremie pipes. The concrete overflows from the top of the Benoto tubes to ensure the removal of laitance and water affected concrete. Tremie pouring aids the displacement of silt and other fines not removed by the hammer-grab from the base of the pile and has a minimal disturbing effect on the shale socket.

EXTRACTION OF DRILLING TUBES

Extraction of the drilling tubes is performed by the use of a reverse drilling action. The oscillating action of the tubes during extraction and high slump of the concrete which contains a concrete setting retardant ensures the flowing of the concrete to fill the space previously occupied by the drilling tubes and, hence, the development of skin friction on the pile. The time to extract the tubes was from 2 to 2½ hours.

The extraction of approximately 6 m of drilling tube produced a 0·9 m to 1·5 m drop in the concrete level under normal conditions. However on a number of piles the concrete drop during extraction of the last or second last drilling tubes was greatly in excess of that normally expected—3·7 m to 4·3 m as against the normal 0·9 m to 1·5 m. This indicated that the pile surrounds were caving-in approximately 4·5 m to 6 m below ground level and the concrete was flowing into the hole thus produced. These cave-ins have required up to 4 cubic metres of concrete to be completely filled but were generally only of the order of 2 cubic metres.

TYPICAL PILE CYCLE

	Operation time in hours	
	24·4 m pile	28·9 m pile
Setting up	¼	¼
Drilling	10	12
Travelling between piles	½	½
Placing steel	2¼	3
Concreting	1½	2
Extracting tubes	2	2½
Cleaning and servicing	¾	¾
Total	17½	21

Based on a 6-day, 55-hour working week, it is possible to complete 3 to 3½ piles, 24·4 m long in a week.

Forty-five of the 106 piles were constructed by the end of March, 1973, a further 27 were constructed by the end of June and the remainder were completed by December, 1973. The Benoto machine was then withdrawn and, following an overhaul, it was returned to operations on the North Western Freeway. The cost of the finished piles was approximately $1872/metre, including on-cost.

E.D.F.

As recognition of a grant made by the electricity authority of Paris—Electricite de France—the initials E.D.F. have been included in the names of the Benoto Drilling Machines.●

F6

NEW BRIDGES FOR SOUTHERN FREEWAY NEAR WOLLONGONG

Construction of two bridges to provide access to the Freeway from Gladstone Avenue, Fig Tree, is now under way. The contract for the bridges, which were designed by officers of the Department, was awarded in May to McConnell Dowell Constructors Ltd for a tender price of $256,499. The bridges will be of prestressed and reinforced concrete and each will be approximately 30·5 m long.

FREEWAY EMERGENCY

An unusual sight on a freeway. This light plane is pictured beside the F4 Western Freeway near the overbridge at Roper Street on 16th June, 1974. Sudden poor visibility after take-off forced the pilot to seek a landing on the Freeway. A 9·5 km section of road was closed by police prior to the landing and about three hours later closed again to permit take-off.

Photograph by courtesy "Sydney Morning Herald"

IN GENERAL · IN GENERAL · IN GENERAL · IN GENERAL

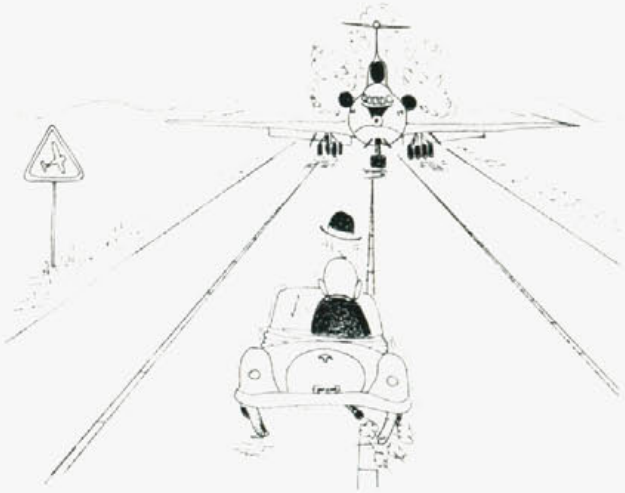
KINGS CROSS ROAD TUNNEL PROJECT

The route of this tunnel through Kings Cross extends from William Street near Dowling Street to join Bayswater Road east of Nield Avenue. The 275 m tunnel has been designed with two cells, each carrying two lanes and a breakdown lane. Each cell will be 11·54 m wide with a height of 4·9 m between the roadway pavement and the ceiling line.

The construction of this tunnel is proceeding well and in May a contract was awarded to GEC-AEI (Australia) Pty Ltd for tunnel lighting lanterns and lamps. The tender price was $179,466.

Each tunnel cell will be illuminated by four rows of lanterns, while a total of 34 incandescent emergency guidance lights will also be provided. Operating from a battery supply these would switch on automatically in case of a power failure.

A special safety feature incorporated into the design of the lighting system will be the co-ordinating of the levels of illumination in the interior and at the entrances to the tunnels to counteract glare from the rising and setting sun.



F4
OPENING OF NEW SECTION OF WESTERN FREEWAY

A new $2 million section of the F4 Western Freeway opened on 23rd April, 1974 has further reduced travelling times for through traffic between the western suburbs and the Blue Mountains.

The Western Freeway is now directly linked to the Great Western Highway at Prospect where traffic lights have been installed to control the flow of traffic. The new section of Freeway then stretches 4 km to Wallgrove Road, the previous limit of the Freeway, where a connection has been provided to Wallgrove Road through a grade-separated intersection.

The addition of this 4 km length brings the total number of continuous kilometres of Western Freeway to 24. The four traffic lanes of this first class road are divided by a wide grassed median except for about 1·6 km at the western end where traffic uses a single carriageway across the Nepean River at Regentville.

HOMEBUSH TO CLYDE

Work is progressing on the 6·5 km length of Western Freeway between Homebush and Clyde. Its completion will separate through traffic from the heavy industrial traffic using Parramatta Road.●

The Mountain Road

One of the most amazing feats of early colonial times was the construction of the first road over the Blue Mountains of New South Wales. Difficult though it was to force a path through the rugged terrain, the 160 km road was built in an incredibly short six months.

The man responsible for supervising this task was William Cox, a Justice of the Peace and landowner from Windsor, who had formerly been a Captain in the New South Wales Corps.

To commemorate the 160th anniversary of the construction of the famous road, this issue of "Main Roads" reprints a section of the diary kept by William Cox during the event. The diary will be concluded in the December issue.

One hundred and sixty years of roadbuilding have produced vast changes in the process but many who have toiled at the practical side will appreciate that poor weather conditions, which were one of Cox's major problems, still frustrate to-day's roadmakers. Modern roadbuilders, fortunately, are no longer plagued by some of Cox's other irritations—such as straying stock, loack of medical treatment for the men or obtaining their supply of food.

It is also interesting to see the character of William Cox gradually revealed in his writing. Working as he was in an unexplored land, surrounded by unknown and potentially hostile elements, Cox emerged as a practical, industrious supervisor with a genuine concern for the welfare of his men.

BACKGROUND AND BEGINNINGS

The story of over 20 years of difficulties encountered by early explorers seeking to cross the Blue Mountains barrier was climaxed by the journey of Gregory Blaxland, William Lawson and William Charles Wentworth, who in 1813 succeeded in finding a practical route across the first range. Assistant Surveyor-General G. W. Evans was immediately sent by Governor Macquarie to confirm the discovery, which he did, continuing over the main range and down the far side of the mountains to examine the fertile country beyond.

Because of the urgent need for settlers on the coastal plain to gain permanent access to these newly discovered grazing lands, Macquarie acted quickly and consulted William Cox about the building of a road. After discussion with Macquarie, Cox volunteered to supervise the task and was given fairly liberal control within a series of guidelines later conveyed to Cox by letter.

Macquarie wanted to build a road on which four wheeled vehicles could travel safely. He expected it to be at least 3·5 m wide in a clearing of about 6 m, with bridges complying to the 3·5 m width. As a workforce for this project he made 30 convicts and eight guards available who would be "supplied with a plentiful and adequate ration of provisions whilst employed upon it."

The route of the road must follow the track surveyed by Evans, diverging in places where Cox judged a better way to be possible.

Journal kept by Mr. W. Cox in making a road across the Blue Mountains from Emu Plains to a new Country discovered by Mr. Evans to the westward.

Reproduced by courtesy of the Mitchell Library, Sydney from "Memoirs of William Cox, J. P.", published in 1901 by William Brooks and Co., Sydney and Brisbane.

1814—

July 7—After holding conversation with his Excellency the Governor at Sydney relative to the expedition, I took leave of him this day.

July 11—Began converting a cart into a caravan, to sleep in, as well as to take my own personal luggage, which was completed on the 16th.

July 17—Left Clarendon at 9 a.m.; arrived at Captain Woodruff's farm at noon. The carts from Richmond arrived at 2 p.m., and at 4 the two carts and waggon arrived from Sydney with provisions, slops, tools, etc. Mustered the people, and issued bread to them.

July 18—At daylight gave out the tools to handle and put in order. Issued half a week's provisions to the whole party. Began work at 10 a.m. to make a pass across the Nepean River; the banks very steep on the east side. In the afternoon issued to the workmen a suit of slops, and a blanket to each man (thirty in number). In examining the slops, two pairs shoes and three pairs trousers were deficient. Gorman, who had charge, states the case had been broken open when he took it out of the Parramatta store. Wrote to his Excellency the Governor for additional bullocks and some small articles of tools. Weather fine, clear, and frosty.

July 19—Tuesday. Finished the road down the right bank of the river. The swamp oak on Emu side very hard to cut and root. In the afternoon began our operations on Emu Plains. A complaint being made of the pork, which was issued at 6 lb pieces, were very deficient. I examined the Commissary's return, which stated there were 53 6 lb pieces in each cask. Counted the remaining, and found 51 left. Examined the mess book, and found 18 pieces had been issued, making 69 in all, instead of 53. Weighed the 51 pieces, and they weighed 24 lb over 4 lb pieces quite, with brine and salt. Ordered Gorman to issue the remainder as 4 lb pieces until further orders.

July 20—Sent the smith to Field's to make four new axes and steel two of the English ones. Gave him 20 lb of iron and 4 lb of steel. Fine, dry weather.

July 21—The smith completed laying the axes, and steeled five others. Much trouble today with the axes; the timber being hard, they all turned. Kept the grindstone constantly going. Made good progress on Emu Plains; the men worked very well. Weather clear and frosty.

July 22—The smith steeled two more axes, and made nails of one. The working gangs removed two miles to the south-west on Emu Plains. Wind very high in the afternoon. One of the fellers, W. Lonain, received a hurt in the face and shoulder through the limb of a tree falling on him. Hard frost and clear.

July 23—Hard frost and clear weather. Sent all provisions, tools, etc., to a hut on the left bank of the river, which hut is fitted up to receive our provisions as they arrive from Sydney. Gave the blacksmith the tools, iron, steel, etc. Lonain, who was hurt yesterday, much better. I wrote to the Governor for two men's pit-saws, iron, and steel. Examined the ground leading from Emu Plains, and fixed on the spot to cross the creek at, as well as one to begin ascending the mountain. The soldiers with Gorman and Kelly all went for Emu Plains to-day.

July 24—Examined the ground and marked the road from the creek to the first depôt (with Lewis). Gave a pound of tobacco to Field for a lot of cabbage, which I gave to the workmen. Purchased 4 cwt. 1 qr. of bran for myself, which I forwarded to the depôt

at 10s per cwt., delivered at Martin's. The workmen exerted themselves during the week, much to my satisfaction.

July 25—Finished a crossing-place over the creek, and worked from the creek to the crossing-place where you ascend the mountain. Sent the two carpenters to the depôt to build a tent-hut, and put in order the depôt fit for the receipt of the provisions, etc. Cloudy weather, but dry.

July 26—Made a complete crossing-place from the end of Emu Plains to the foot of the mountains, and began to work up them. The ascent is steep; the soil very rough and stony; the timber chiefly iron-bark. Sent the stonemason to the depôt to build or line the chimney, as also the smith to put up his forge. Sent the superintendent with a man to mark the road from the depôt through the bush to the next forest ground, a distance of about five miles. Ordered the corporal and soldiers to prepare to remove in the morning from the bank of the river to the depôt, with a cartload of provisions, and there to remain until further orders.

July 27—Removed the soldiers and provisions from the river to the depôt. Worked up the mountain; measured the ground from the ford in the river to the creek leading from Emu Plains to the mountain, three miles; marked the trees at the end of each mile, at the left side of the road. Removed my caravan from the river to the depôt on the mountain, a distance of five and three-quarter miles and slept there the first night.

July 28—Went to Clarendon, and left R. Lewis in charge.

August 1—Left Clarendon at 10 a.m., and arrived at the depôt at 2 p.m. Found the road completed to the said depôt, much to my satisfaction.

August 2—The workmen go on with much cheerfulness, and do their work well. Gave them a quantity of cabbage as a present. After dinner I gave directions to Lewis to inform Burne he was to take the three forward fellers to fire-making. Soon after he came to me and said he would not receive any orders from Lewis, but would obey any I gave him, on which I told him I should send any orders I had to give to him by whom I pleased. He went away, but soon returned again, and said he would leave, on which I ordered the constable to receive his gun and ammunition, and he went away. Ordered him to be struck off the stores, and informed the party he was discharged from being a superintendent under me, and had nothing more to do with me or them.

August 3—Sent the two working gangs, with their bedding, etc., two miles ahead. Heard the report of a gun, and soon after heard the chattering of natives, on which they returned and reported the same. Gave notice to the sergeant to provide a corporal and three men to go forward and take up their quarters with the working men. The second pork cask being issued, I found it to contain 74 pieces, on which I had the third cask opened, and the pieces counted by the sergeant and Gorman in my presence. It also contained 74 pieces. Brought the remaining provisions from Emu Plains, and had the store completed, with a lock on the door, etc. The weather fine. Cleared the roads to the entrance to a thick brush two and a-half miles ahead.

August 4—Removed the depôt to seven and a-half miles forward, as also the corporal and three privates. Lewis got leave to go to Richmond and return again on Sunday next. The men at work in a very thick troublesome brush. A fine day, but close. The wind in the evening got round to the south.

August 5—Timber both thick and heavy, with a thick, strong brush, the roots of which are very hard to grub up, making it altogether extremely hard work.

August 6—Timber and scrub brush the same as yesterday, but got through it this evening, and measured the new road and found we had completed nine miles. Marked the trees at the end of each mile. Went forward, and found a good-sized piece of forest land, with good water, to the right of an intended road about one and a-quarter mile ahead. The men all healthy and cheerful. Mr Hobby joined me last evening. The people all moved forward to the end of nine miles.

August 7—Removed to the nine miles on the road. I sent a man from last camp to the depôt to draw their rations. Wrote to his Excellency the Governor.

August 8—Timber and brush very heavy and thick from the ninth to tenth mile. Thos. Kendall ill, unable to work. Mr Hobby, with R. Lewis, went forward with John Tye about four miles, and marked the trees. Two natives from Richmond joined us; one shot a kangaroo.

August 9—Fine weather continues. Good water at seven and a-half miles to the right of the road; about eight and a-half to the left of the road; ditto at four and a-half to left. Good forest ground down in the valley at four and a-half miles to the right. Mr Evans came to us just before sunset.

August 10—Mr Evans left us for Sydney at 2 p.m. Removed forward to four and a-half miles. The workmen remain a little behind us. Kendall somewhat better, and undertook the cooking for his mess.

August 11—Clear weather. The wind very strong from the west, made it dangerous in falling the timber, which is both heavy and thick. Workmen removed 10½ miles. Water to the right of road. The smith set up his forge; employed in repairing tools. Mr Hobby, with Lewis and Tye, went forward six miles and marked the road for the fellers. Gave the people a quantity of cabbage.

August 12—Mr Hobby went to Castlereagh. Fine weather, with cold wind. Gorman reported there was not any meat or sugar, and that he had only 14 4 lb. pieces left in store, and no sugar.

August 13—At daylight sent Lewis to the depôt with a letter to Mrs Cox to send me out immediately 300 lb. of beef to serve to the people in lieu of salt pork. Gave orders to the corporal to send Private Ashford to the depôt, and for Sergeant Bounds to send me Carrol in lieu of him. The former being ill and unfit for the advance party, he has not done any duty this week past. Measured 11 miles this morning, and this evening got through the brush ground, which has given us very hard work since leaving the depôt, the timber being heavy and the brush strong. Gave orders to all hands to remove forward to-morrow morning to the forest ground, about half-a-mile ahead of our work.

August 14—Removed to the forest ground. Sent Lewis with a letter for the Governor, informing him we were without meat or sugar.

August 15—Fine morning, and, being out of the brush, had six fellers at work. At 9 a.m. arrived a cart from Clarendon with a side of beef 386 lb., 60 cabbages, two bags of corn, etc., for the men.

August 16—Fire-making on the 12 mile ridge. Timber very heavy, thick, and long; extremely troublesome to get rid of. Having no sugar, borrowed 40 lb. from Mr Hobby, and I gave 1 lb. to each man.

August 17—Removed forward to a hill ahead of the workmen. Water at 11½ miles to the left; ditto 12 to the right; ditto 12½ to the left; ditto 13½ to the right. At the three first places in very small quantities; at the latter plenty, with a place fit to drive stock to water. The timber on the forest from 11½ miles to 13 very tall and thick. Measured a dead tree which we felled that was 81 ft. to the first branch, and a blood tree 15 ft. 6 in. in circumference. There is some good stringy bark timber in this forest ground.

August 18—Wind very high the last two nights, and this evening stormy, but the wind blew off the rain. Measured the 13th mile this evening, and just entered a scrub with stunted timber. Mr. Hobby returned this day. Got 2 lb. of shoemakers' thread from Clarendon, and put Headman, one of our men, to repair shoes during the week. The smith employed this week in making and repairing tools and nails for the men's shoes. The stonemason went forward to examine a rocky ridge about three miles ahead, and on Monday next he will go there to work to level them.

August 19—At 7 a.m. left the party for Clarendon. Mr. Hobby and Lewis left in charge. Stephen Parker ran a splinter in joint under his ankle; unable to work.

Portrait of William Cox,
from the Mitchell Library, Sydney.

August 26—At 10 a.m. arrived at Martin's, where I found the sergeant of the party, he having died the day before. Sent to Windsor to the sergeant commanding there for a coffin and party to bury him at Castlereagh, but Sergeant Ray sent for the corpse to bring it to Windsor. Wrote to the Governor for another sergeant, and sent back Corporal Harris to the depôt, there to remain until relieved. Called at the first depôt at 12; ordered a cask of pork to be opened; counted the pieces in the presence of Gorman, my son Henry, and a soldier; it contained 75 pieces. Arrived at the working party at 2 p.m. Found Mr. Hobby well. The road finished during my absence. Done well. Lewis left the party on Monday last, very ill of a sore throat.

August 27—Measured to the 16th mile, immediately after which the ground got very rocky, and in half-a-mile we came to a high mountain, which will cost much labour to make a road over. Got two natives, who promise to continue with us—Joe from Mulgoa and Coley from Richmond.

August 28—Removed, with all the people, to a little forward of the 16th Mile. (Lewis returned).

August 29—Commenced operations on the mountain, with all the men. Continued the same on Tuesday, except with the fellers, who went forward on the next ridge. Had to remove an immense quantity of rock, both in going up the mountain and on the pass leading to the bluff on the west of it. Examined the high rocks well, and fixed on making a road off it from the bluff instead of winding round it. Began cutting timber and splitting staff to frame the road on the rock to the ridge below it, about 20 ft. in depth. The men worked extremely hard and smart to-day.

Sick list, Monday

Sam. Davis, splinter in his hand.
Thos. Kendall, ill from bad cold.
Step. Parker, from sick list to work again.

August 31—All hands employed at the bridge.

September 1—Retained eight men to work at the bridge. Sent the rest forward road-making. Sent back to Walters' bullocks to *Emu, and received* Myers' team.

September 3—Augmented the men at work on the pass at the bridge to 10, both yesterday and to-day. The road finished to Calev's heap of stones, 17¾ miles.

September 4 *(Sunday)*—Removed forward to the bridge the working road gang. Removed forward to Caley's pile. No water we get is near a mile distant, and that in a tremendous gully to the right. Went forward to Caley's pile, and from thence up the rock to Evans' cave you get a view of the country from north-west round to south-west as far as the eye can carry you. From hence the land to the west is still higher. The country to the northwards appears extremely hilly, with *nothing but timber and rocks.* To the east there appears much level country. Windsor and various parts of cleared land is seen from this.

September 5—Davis returned to labour; *Kendall to cooking.* Appledon ill; splinter in the foot. Set the following persons to the pass and bridge:— Two carpenters, two sawyers, two quarrymen, two cutting timber, and two labourers. Smith employed mending tools and making shoe-nails. Shoemaker mending and nailing shoes. The remainder of the men employed in road-making forward, under the direction of Mr. Hobby and R. Lewis. J. Tye got a week's leave on Friday last to go to Windsor. Sent a soldier on Thursday last to the Governor for blocks, augurs, and irons, etc.

September 6—All hands employed as before. One extra man brought back to assist at the bridge and pass. Soldier returned from *Sydney.*

September 8—Men at work as yesterday. The wind has been very high and cold from the west since Sunday last, and last night it blew a perfect hurricane. Saw a few flying showers yesterday, but we got scarcely any rain, and it appears the wind will carry it away. The country about here very barren. No kangaroos to be seen. Shot one pheasant, with tail complete; shot two others without tail. It appears to be too early in the season for them, as *their tails are just shooting, and* others not at full length. Scarcely any small birds to be seen.

September 9 and 10—Workmen employed as before. The bridge rises very fast, and the *quarrymen well on with the stonework.*

September 11 (Sunday)—Went three miles forward to examine the road with Mr. Hobby and Lewis. From the bridge it continues rocky over two or three small passes to Caley's pile; from thence, at least two miles further, the mountain is nearly a solid rock. At places high broken rocks; at others, very hanging or shelving, which makes it impossible to make a level, good road. The more the road is used the better it will be.

September 12—No person on sick list. Continued with 10 men to get on at the *bridge and pass until Thursday, when it* was completed all but the hand-rails and battening the planks. Gave orders for six men to pack up and go forward in the morning, leaving to complete the bridge two sawyers and two carpenters, which they expect they will complete in three or four days. Sent forward part of our heavy luggage, and intend removing myself to-morrow. Issued a pair of strong shoes to each man. The bridge we have completed is 80 ft. long, 15 ft. wide *at one end and 12 ft. at the other;* 35 ft. *of it* is planked, the remainder filled up with stones. The face from the bluff end of the rock was about 20 ft. before we began to work. At the left there is a side wall cut from the solid rock. At the right, where the ground is lower, we have put up a rough stone wall about 100 ft. long, which makes the pass to the bridge quite a lane. It is steep from the top of the mountain quite to the lower end of the bridge, a distance altogether of about 400 ft. The bridge and pass have cost me the labour of 12 men for three weeks, which time they worked very hard and cheerful. It is now complete—a strong, *solid bridge,* and will, I have no doubt, be reckoned a good-looking one by travellers that pass through the mountain.

September 13—Removed forward; found the road *completed to 21 miles. At the latter end* of this the ground was completely covered with gum roots. Was obliged to turn all hands to grubbing and finishing the road, and with very hard labour nearly completed the 22nd mile by Saturday night.

September 15 (Sunday)—Went forward to examine the road about three miles ahead. Got on very high ground. The greater part of the scrub burnt here last summer, and the trees also much burnt.

September 16—Moved forward, ahead of the cleared road. Went as far as the fire-makers had finished. Shot several small new birds the last week, and also a young cockatoo, quite mottled or cuckoo colour.[1] There was one old one and *three young ones in*

Above: "Passage de Cox, dans les Montagnes—Bleues", lithograph from a sketch by A. Pellion in 1819, *published in Volume I of L. C. D. De Freycinet's "Voyage Autour Du Monde". Reproduced by courtesy of the Mitchell Library, Sydney.*

At right: This monument at Mt York is close to the point where Cox's Road descended the mountain. The monument was erected to commemorate the crossing of the mountains by Blaxland, Lawson, and Wentworth and the building of the first road

[1] A small cockatoo called Gang-gang; the head of male bird pink.

company, which are the only ones we have seen of the sort. Ordered Angus to bring forward a load of provisions on Wednesday next. Kept a strong party at the grub hoe.

September 17 to 24—Kept all hands at road-making, and they did a very good week's work, having completed four miles of good road this week. Removed on Saturday to the 26 mile, being just at the foot of a steep mountain. Examined it well, and found it too steep to ascend in a straight direction.

September 25 (Sunday)—Went up the mountain; examined it, and fixed on the way to make a winding road up. This is the highest mountain on the whole range we cross. From it Windsor houses, etc., are distinctly visible, as are the wheatfields, farmhouses, etc. There is a river running to the east about a mile south of this, the banks of which are so high and steep it is not possible to get down. This river empties itself into the Nepean about four miles higher up than Emu Plains. Went forward to fix on a site for a second depôt.[2] Chose one about two miles ahead, close to a stream of excellent water. We have found much greater quantities of water these last six miles than we did before, and all very good.

September 26—Sent forward two sawyers and two other men to procure the necessary timber, etc., for the second depôt. Set 10 men to work making the road up the mountain. The remainder at work as usual road-making. Sent T. Randall to the Windsor Hospital, sick. P. Handrigan ill with a bad sprained ankle.

September 27—Finished the road up the mountain this evening. Made a very good job of it (cost 10 men two days). The ground extremely rough and rocky for about a mile between the high mountain and second depôt.

September 28—Worked at the road forward to the second depôt, where we removed on Thursday morning. The rocky ground we had to pass over was very troublesome, being obliged to turn out of the road a very large quantity of stone, it being too hard to break with sledge-hammers.

October 1—Began on Friday to put up the building for the second depôt. The situation is very pleasant, being on a ridge high enough in the front (which is due east) to overlook the standing timber altogether, and at the back there is a considerable quantity of ground without a tree, and a rivulet of fine spring water running through it. On this ground there is the grass tree and other coarse food, which the bullocks eat and fill themselves pretty well. The building for the store is 17 x 12, with 3 ft. sides, gable-ended, all weatherboards, and a door on the east end. Got well on with it this evening; finished on the 8th inst. Cost me eight men, six days. It is just 28 miles from Emu ford.[3]

October 3—Sick list. Handrigan, Lowe, sprained ankle. Several men have bad colds, but none laid up. Sawyers, carpenters, and smith are at work at the depôt. The remainder gone forward, road-making. Went forward to see the workmen. At the 29th mile is a very handsome long reach, quite straight, which I call, from the layer of it out, "Hobby's Reach". Finished the road this evening to the 30th mile. The carpenters getting well on with the depôt. Nothing left to be done but weather-boarding part of the roof. Sent workers to the first depôt to bring forward the sergeant and Gorman to the second depot. Gave charge of all the bullocks to Walters, and ordered Cryer to labour for his bad management and inattention to the bullocks. There are many large emmets, or ant-hills, in this part of the mountain. I measured one at the 26 miles, of a sugarloaf shape; it was 6 ft. high, and 20 ft. round at the bottom. S. Parker laid up with a cold today. The blacksmith employed in steeling axes and grub hoes, and repairing tools; at other times making nails for the second depôt. At 5 p.m., my servant arrived with horses from Clarendon, and to-morrow morning at 7 o'clock intend returning there, leaving the party under the direction of Mr. Hobby and R. Lewis. Wrote to the Governor to inform him of my going, stating to him my arrangements, etc., I had made.

October 22—Having made my arrangements, etc., at Clarendon and Mulgoa with respect to my sheep and ensuing harvest, and attended his Excellency the Governor at the muster, I left Clarendon on Saturday afternoon in a single horse chaise, and slept at Castlereagh.

October 23 (Sunday)—At half-past 5 this morning left Rev. Mr. Fulton's. Remained two hours at the first and second depôts to examine the stores, and make arrangements for forwarding the provisions, etc., for the people; and at 6 p.m. came up with the working party at the 39th mile, to which place the road was completed, having finished, during my absence of two weeks and four days, nine miles. Found Mr. Hobby and all the party in good health. On Monday morning Mr. H. returned in my chaise to the Nepean for a week or 10 days, and for want of grass I also sent back my saddle-horse to Clarendon. On Sunday evening R. Lewis returned from the end of the mountain, about 10 miles forward, having been with three men to examine the mountain that leads down to the forest ground. His report is that the descent is near half-a-mile down, and extremely sharp; that it is scarcely possible to make a road down; and that we cannot get off the mountain to the north to make a road; that it appears to him much more difficult, now he has examined the hill, to get down than he was before aware of.

October 24—Set all hands to work road-making including blacksmith, carpenter, stonemasons, etc., being extremely anxious to get forward and ascertain if we can descend the mountain to the south before we get to the end of the ridge.

Tuesday and Wednesday the men continued the same work, and getting on extremely well. Wrote to the Governor for a further supply of gunpowder, to enable us to blow up the rocks in our way; as also rope and blocks, to expedite us in building bridge and getting off the mountain.

Monday and Tuesday, wind at east, with cold showers.

Wednesday, at west, blowing very high and cold.

October 27—Wind at east; very cold, with rain. All hands working only half a day.

October 28—Removed forward to 42nd mile. Wind south, with constant rain. No work done, except the cobbler mending shoes. Sent the cart back to the second depôt for rations. Two other horse carts employed in bringing forward provisions from first and second depôts, which they appear to do very slowly. Heard nothing of the bullock cart belonging to Walters.

October 30 (Sunday)—Rain until about 5 o'clock in the evening. Wind at south-west. Blankets belonging to the men very wet and uncomfortable.

October 31—The weather appears to have broken up. All hands went to work at half-past 5 a.m. The men removed to the 44th mile this day. The high, short ridge of mountains seen from Windsor was this day observed at 43¼ miles, bearing north, 60 deg. east, distant about eight miles. A table rock seen by us from the rocks near Coley's pile to our right, and from all high lands since, was observed to-day, bearing east-north-east, distant about two miles. Two parties of natives are seen on the low lands to the west. One within two miles of us; the other about six miles.

November 1—Fair weather. Three persons sent to examine the mountain to the left, to find a place to make a road down to the forest ground. Returned unsuccessful.

November 2—Fine morning. Thunder, with light showers. Sent three men again to examine the descent of the mountain, and ascertained that there is no other way but from the bluff originally marked. To-morrow I intend going to survey it, as a road must be made to get off the mountain.

November 3—At 6 this morning went forward with Lewis, Tye, and a soldier to examine the mountain at the end of the ridge—four miles. Found it much worse than I expected. It commences with going down steep between immense large boulders, when it opens with a very steep gully in front, and towards the left it falls off so steep that it is with much difficulty a person can get down at all. The whole front of the mountain is covered with loose rock, at least two-thirds of the way down; and on the right and left it is bounded both by steep gullies and rocks, so that we cannot, by winding short to the left, get half length sufficient to gain ground to get down without a number of circular turns both to right and left, and in that case the hill is so very steep about half-a-mile down that it is not possible to make a good road to go down and up again without going to a very great expense. I have, therefore, made up my mind to make such a road as a cart can go down empty or with a very light load without a possibility of its being able to return with any sort of load whatever; and such a road will also answer to drive stock down to the forest ground. After getting down this said mountain, we got into very pretty forest ground, and went as far as Blaxland's rivulet, about two miles. The grass on it is generally of a good quality—some silky; some hard, intermingled with rib grass, buttercup and thistle. Timber thin, and kangaroos—plenty. In returning back, we had to clamber up the mountain, and it completely knocked me up. It is a very great drawback to the new country, as no produce can be brought from thence to headquarters, except fat bullocks or sheep. The sheep also will be able to bring their fleeces up, and be shorn on the mountains, or driven to the second depôt for the purpose. In either case, waggons can fetch the wool. Gorman came forward with a cartload of provisions. From him I learnt that Walters had got some fresh Government bullocks at the first depôt, but that he could not harness them—they were so wild. Sent another man down to assist him. Also sent a man to bring up the remainder of the bullocks that are unable to work from lameness or poverty, to get them down the mountain, where there is good feed. The Government bullocks have not carried a single load of anything for me since Sunday week last. Made an agreement with Sergeant Minehan and another man for their horse and cart to remain with us until we have performed the whole of our work, and the sergeant went to the

[2] Cox's River, emptying into the Wollondilly, about 20 miles above Emu Plains.

[3] The site of the old Weatherboard Inn, now Wentworth Falls.

Hawkesbury for them. T. Tindall received a hurt in his arm from the fall of a tree. Removed all hands this morning to 45½ miles. Put up the forge for the blacksmith to repair all tools for the Herculean mountain. Issued to all hands a gill of spirits.

November 4—Sent three men to examine all the ridges and gullies to the north, offering a reward if they found a better way down. All returned unsuccessful. Removed to 47 miles.

November 5—Wind to the east; rain and cold. All hands employed on the road. The blacksmith made eight pikes for self-defence against the natives. Lewis and a party took the dogs to the forest ground. Killed a fine kangaroo; weighs about 120 lb. Examined the big mountain, and fixed on the spot where to begin on Monday, having given up all thoughts of attempting it elsewhere. J. Manning sprained his ankle in bringing up a keg of water from the rocks below. T. Raddock ill; believe it arises from the wet weather. There is timber here, which appears to bear all the property of the ash in its young state. It is easily transplanted, as the sprouts are like the white thorn. It grows quickly, tall and straight, bends to anything. When large it splits well, and will, I have no doubt, make very good hoops. In its appearance it is like the black butt, but the leaves are unlike. The bark ties much better than stringy bark. In falling the timber trees it cut remarkably free, and in order to try it I cut a small one down, and quartered it, which I mean to send to Clarendon and try them for light cart or chaise shafts.

November 6—Rain in morning; began to clear up about noon. Received a letter from the Government, dated 2nd. Sent S. Davis to Sydney with a letter to the Governor at 2 p.m. to bring up powder and spirits.

November 7—Mr. Hobby joined me this morning. At 6 a.m. went forward with 10 men to commence operations for a road down the mount. Light rain and heavy fogs.

November 8—Employed the same hands in the same manner. Light rain as before. The men very wet and uncomfortable, their clothes and bedding being also wet.

November 9—Removed to the extreme end of the mountain with the whole of the party. The rocks here are so lofty and undermined that the men will be able to sleep dry, and keep their little clothing dry also, which is what they have been unable to do this last fortnight. Left 12 men to finish up the road; the rest employed with myself. Cold rain set in about noon. Wind S.W.

November 10—Raining; cleared up at 9 o'clock. Got a good day's work done. Evening fine and starlight.

November 11—Rain commenced before daylight, and continued the whole day. Wind S. and very cold. Sent T. Raddock to Windsor, being very ill. S. Freeman, the carpenter, laid up with a cold and swollen face. Jas. Dwyer ill; pain in side and breast. Sent two carts to the second depôt for provisions. Sent three men with the dogs to catch kangaroos three times this week. Brought one home every day. The bullock driver, with 11 bullocks joined me yesterday. All they have done this last fortnight has been to bring in one bag of biscuits from the first depôt to this place (43 miles). Ordered the bullocks down the mountain to the forest ground, where I intend letting them remain to recover themselves until we remove forward towards the Fish River. One of them is quite blind. He got into the gully going down, but we got him out to-day safe.

November 12—Very fine day. Wind east and cold. Completed the road to the beginning of the large mountain, which we have to descend to the forest ground. Measured it up; it is 28 miles 50 chains. Continued to clear away the timber and rubbish through the large rocks, and to the beginning of the bluff end of the mountain. Two men on the sick list.

November 13—Went down to the forest ground; from thence on to the rivulet, and traced it to the river, about five miles down. Went one mile down the river and came back on the high lands, exploring the best ground for a road. The grass on the greater part of the land we went over to-day is good. The timber thin. The ground is hilly, but sound; some parts near the rivulet and river is rocky, but no iron stone, it being rather of a sandy soil, and very good pasture for sheep. The ground on the other side of the rivulet appears also to be equally good for feed, thinly timbered, and very hilly, with good grass clear up to the hut. The river runs nearly east, and must, from its course, empty itself into the Nepean River. The horse carts arrived to-day from the second depôt. They brought very small loads indeed. Ordered two of the carts to go to-morrow to the first depôt, and to return here again on Sunday next loaded. Saw the working bullocks this morning. They are improving quite fast. Mustered the whole of the tools, harness, etc; found nearly all right. Ground the axes and put the grub hoes and picks in order to begin to-morrow. Ordered Gorman to issue 4 lbs. biscuits and 3 lbs. flour for each mess, instead of 6 lbs. each, the biscuits running short, and being also too bulky to bring so far, being 90 miles from head-quarters.

November 14—Sick list: F. Dwyer, cold, pains in limbs; S. Freeman, cold and swelled face; S. Crook, cold, bad eyes; V. Hanragan, cold, pains in limbs; S. Walters, hurt by bullock. The extreme wet weather we had for a fortnight before we arrived here has given most of the men colds, but as they are now dry lodged, and, in addition to their large ration, have fresh kangaroo at least three times a week, it is to be hoped they will soon recover. So many men sick, and chiefly very useful ones, breaks in on our working party much, and the continuous rain also prevents so much work being done as I could wish. Fine morning; at noon thunder, with rain and hail. Wind east; very cold. Steady rain all the evening. Got on erecting the bridge at the beginning of the descent off the mountain, and blowing up the rocks that are in the line of our intended road down to the forest. Find is difficult work, and it will cost us much labour.

November 15—Five men sick. Sent Mr. Hobby, with Lewis and Tye, to trace a ridge that leads to the river a little below Blaxland's rivulet, it being my wish to cross the river in preference to crossing the rivulet twice. The report was favourable, but the water being too high they could not cross. I intend going myself the first fine day I can leave the work. Got on well with our work on the mountain. Fixed two large trees as side pieces—one 45, the other 50 ft. long. Fine weather; wind east, thunder, no rain.

(to be continued.)

RETIREMENT OF COMMISSIONER

R. J. S. THOMAS, A.S.T.C., F.I.E. AUST., F.C.I.T.

Mr Thomas, who had held the office of Commissioner for Main Roads since 26th August, 1967, retired from duty on 25th August, 1974.

Mr Thomas, had a total length of service exceeding 48 years, commencing when he joined the Main Roads Board in May, 1926, as a Junior Draftsman. He completed a Civil Engineering course at Sydney Technical College and was appointed an Assistant Engineer, then serving in several locations. His war service commenced in the 2nd A.I.F. during July, 1940 and after serving in the Middle East and through the Islands, Mr Thomas retired with the rank of Major in the Royal Australian Engineers at the completion of hostilities.

Returning to service with the Department of Main Roads, Mr Thomas became Supervising Engineer in the South Coast Division and for part of this time was in charge of road-works carried out by the Department in connection with the Snowy Mountains Hydro-Electric Authority's projects. In 1955, Mr Thomas was appointed Divisional Engineer at Broken Hill to initiate the Murray Darling Division and in 1957 became Divisional Engineer of the North Eastern Division at Grafton.

Following his transfer to Head Office in 1961, Mr Thomas was appointed Assistant Highways Engineer and Executive Engineer before being appointed Assistant Commissioner in 1962.

Mr Thomas has made several overseas visits to attend conferences and study road construction practices. In 1961 he attended a traffic engineering conference in Washington D.C. and continued through the U.S.A. studying various aspects of road construction then visiting Great Britain and Europe for the same purpose. He again visited these areas in 1966 to attend a conference of the International Road Federation in London and study developments in practice since his earlier visit.

APPOINTMENT OF SUCCESSOR

A. F. SCHMIDT, B.E., F.I.E. AUST., F.C.I.T.

Mr Schmidt, who assumed the office of Commissioner for Main Roads on 26th August, 1974, was educated at Fort Street Boys' High School and the University of Sydney from which he graduated a Bachelor of Engineering (Mechanical and Electrical) in 1935.

On joining the staff of the Department of Main Roads in 1939 he was appointed to the Bridge Design Section.

During the war Mr Schmidt enlisted in the 2nd A.I.F. and served in the Corps of Electrical and Mechanical Engineers where he rose to the rank of Captain.

In 1946, Mr Schmidt returned to the Department's Bridge Design Section. He was transferred to the Bega Divisional Office in 1948 and he served there until 1953 when he became Officer-in-Charge at Windsor.

As Supervising Engineer, Mr Schmidt was appointed Senior Assistant to the Divisional Engineer at Goulburn in 1955 and in 1960 he became Divisional Engineer at Wagga.

He returned to Sydney as Assistant Metropolitan Engineer in 1962 and in this capacity his duties were principally related to the administration and supervision of major bridge construction in the Metropolitan Division. This work included the Gladesville, Captain Cook, and Roseville Bridges.

Mr Schmidt was appointed Metropolitan Engineer in February, 1967 and Assistant Commissioner for Main Roads in August, 1967.

In 1969, Mr Schmidt visited the United Kingdom, Europe, and North America to observe trends in the operation and administration of overseas highways' departments. While in the United States of America, he attended a Highway Safety Conference sponsored by the Highway Research Board of the U.S.A. at Salt Lake City, Utah.

Mr Schmidt also visited Japan and Hong Kong in 1973 to inspect and observe methods of construction of freeways and structures.

Mr Schmidt is a Fellow of the Institution of Engineers, Australia and a Fellow of the Chartered Institute of Transport. He is also a member of the Campbelltown Development Committee of the State Planning Authority and a member of the Council of the Post Graduate Civil Engineering Foundation of the University of Sydney.

NEW ASSISTANT COMMISSIONER

B. J. SEXTON, B.E., F.I.E. AUST., F.C.I.T.

On 26th August, 1974, Mr Sexton was appointed Assistant Commissioner for Main Roads.

Mr Sexton, a graduate in Civil Engineering from the University of Sydney, commenced his service with the Department in December, 1942, working on the Sturt Highway from Darwin to Mataranka, in the Northern Territory.

During his nearly thirty-two year's service, Mr Sexton has been employed by the Department in many capacities. His most recent positions were Divisional Engineer at Broken Hill from 1961 to late 1963, Engineer for Field Organization and Methods, 1964 to 1967 and Metropolitan Engineer from 1967 to 1972. Since then, Mr Sexton has been Acting Advance Planning Engineer and Acting Highways Engineer and just prior to his new appointment was Engineer for Programmes and Budgets.

In October, 1973, Mr Sexton attended the Seventh International Road Federation World Meeting in Munich where he delivered his paper "Low Cost Road Design and Construction in Sparsely Settled Areas of New South Wales, Australia". Discussions at this Meeting centred on the political, economic, and social aspects of road matters, progress on road construction, road safety, traffic in cities and densely populated areas and traffic management techniques.

Mr Sexton has been actively associated with the Sydney Division of the Institution of Engineers, Australia, having held the position of Chairman of the Civil Engineering Branch and is currently a member of the Sydney Division Committee. In 1972, Mr Sexton attended the Australian Administrative Staff College at Mr Eliza, Victoria.

Mr Sexton has also been deeply involved with the Main Roads Social and Recreation Club, in particular the interstate cricket series with the Queensland Main Roads Department, which later expanded to the present Sports Carnival, and the Main Roads Bowling Club.

New Zealand in connection with the widening of the Auckland bridge and the application this could have to bridgeworks in New South Wales. A year later, a second visit to New Zealand was made to attend a meeting of the Australian Road Research Board in Wellington.

In December, 1969, Mr Thomas travelled to Japan to examine arrangements adopted by the Japanese Government for financing roads, highways, and freeways. The Sixth World Congress of the International Road Federation was held in Montreal, Canada, in October, 1970 and Mr Thomas attended to take part in discussions on urban mobility, roads and the environment, traffic and safety. On this visit he also undertook a number of official calls, interviews and inspections in the United Kingdom, Europe, and U.S.A.

A third visit to New Zealand took place in August, 1971 for the purpose of attending the New Zealand Roading Symposium conducted by the New Zealand National Roads Board in Wellington. Mr Thomas' most recent official visit was to South Africa in early 1974 to study road design and construction in that country.

In May 1968, Mr Thomas travelled to

Mr Thomas has been a very active worker for Legacy and during 1966–67 was the President of the Legacy Club of Sydney. He is a Fellow of the Institution of Engineers, Australia, a Fellow of the Chartered Institute of Transport and a member of the Royal Australian Historical Society.

Official duties of Mr Thomas as Commissioner for Main Roads have involved him in membership of a number of bodies, including the State Planning Authority, the Urban Regional Transport Advisory Committee, the Commonwealth-State Airport Committee and the Traffic Advisory Committee. This year he has been the Chairman of the National Association of Australian State Road Authorities and is a past Chairman of the Australian Road Research Board.

automated electronic surveying

ZEISS REG. ELTA 14

A section of a plan of an area surveyed using the Reg. Elta 14. *All symbols and most annotation were drawn by automated equipment operating in accordance with codes set on the Reg. Elta* 14

The Department of Main Roads has a continuing requirement for large numbers of plans on which to base road construction proposals and designs. The surveys to obtain data from which the base plans can be compiled have, until recently, been made by the "centreline and offset" method. This method, involving marking of the proposed nominal centreline of the road and location of all relevant data relative to the centreline, has proved suitable for use in design of basic two-lane road formations. However, for use with respect to complex urban roadways, multi-carriageway formations and structures, the method is inefficient for both field survey and office plan compilation.

The advent of electronic tacheometers and availability of electronic calculators and computers to process the observations, has brought automation to the survey and plan compilation process. To investigate the suitability of automated electronic surveying equipment to its surveying requirements, the Department has acquired an electronic recording tacheometer.

The instrument which the Department has acquired is a Reg. Elta 14, manufactured by Carl Zeiss Pty Limited at Oberkochen in West Germany. The name of the instrument is made up from a contraction of the descriptive name, *REGistering ELectronic TAcheometer*. The Department's instrument is the only one of its make in practical operation in this country. Only one other similar type of instrument is known to be available, but neither this nor the Reg. Elta 14 is known to be operated and the results processed in the same manner as that in which this Department's instrument is employed.

The Instrument

The instrument is an integrated theodolite and electronic distance measuring device, able to record automatically on paper tape, together with identifying codes, horizontal directions, angles of slope and distance. The punched paper tape of observation records can be submitted directly to a computer for processing.

The rangefinder operates on the principle of phase measurement, in which the phase of wave fronts is compared between emitted light from a Gallium Arsenide (GaAs) diode and the light at the receiver after transmission and reflection from the target prism. The diode emits light when stimulated by electric current generated by an oscillator which can produce two measuring frequencies. Switch over of frequencies is automatically controlled so that each complete measurement is a combination of the mean of 100 measurements on the higher (fine) frequency and 1 000 measurements at the lower (coarse) frequency. The emitted and reflected light waves are transmitted through the same objective lens used for the theodolite, thus ensuring a coaxial observation of direction and distance.

The circuitry of the rangefinder has been designed so that interruptions to the measuring beam do not necessitate recommencing the sequence, as was the case with earlier types of electronic rangefinders. A switch is provided which can be set to values in accordance with a displayed scale to correct the measurements for variations in atmospheric conditions, as determined from barometer and thermometer readings.

Angular measurements are obtained by a combination of mechanical gearing and electro-optical interpolation to provide an electrical coding of the value. The vertical circle index is set automatically by connection of the compensator to the vertical circle interpolation wedge. Both horizontal and vertical circles are graduated in grades (400 grades = 360 degrees).

Twelve code switches, each of which can be set to ten positions, are provided on the instrument. The switches may be used to convey data describing measurements made, or to control computer processing of the measurements. The values set on the switches are punched on to the paper tape, followed by the horizontal direction, vertical angle and measured distance, for each observation recorded using the automatic registration system. Alternatively to registering the data, a multiposition switch may be used to select display, by the nixie tube array, of measured distance or angles, so that if required, manual recording of results may be made.

Use of Codes to Identify Observations and Control Processing

It was determined that as the Department already provided a comprehensive set of survey computation programmes, translation of the punched paper tape should be programmed to provide the data in a format compatible with the existing programmes.

A system was developed whereby the first code switch becomes a "function indicator". Depending on the code set on that switch, differing interpretations are made of the other switches so that all data necessary for complete processing of each observation is recorded with the measured values on the tape. This coded information includes such items as the number of the occupied station, the height of instrument, the height of reflector, the code describing the observed point and the code to control automated plotting of the observation.

While most of the foregoing data is inherently of a numerical character and thus directly compatible with the code switch configuration, nothing similar existed to describe the nature of points of detail to which observations would be made. However, a schedule was developed in which a given numerical code, when read from the punched paper tape, would cause the computer to extract from a file the corresponding alphabetical abbreviation to permit recognition of the observed feature.

Survey Observations Using the Reg. Elta 14

The instrument is operated in a similar manner to a conventional theodolite, being set over traverse stations with an optical plummet and levelled with foot-screws by reference to a plate bubble, and with a telescope reticule for sighting to targets.

On commencing operations, a known survey line must be sighted and recorded, with appropriate code settings, so that all following observations from that instrument position can be adjusted to the survey azimuth. After this initial recording, observations may be made to all required points within the field of view of the observing station up to a range of 2 000 metres.

Assistants, carrying prism rods, portable radio transceivers and code schedules move to required points as directed by the surveyor. At each point, the rod is held in a vertical position with the prism facing the Reg. Elta 14. The code describing the point is determined from the schedule and together with the reflector height above the point, is transmitted by radio to the Reg. Elta 14 operator. The operator sets the appropriate codes, sights the telescope to the centre of the prism and initiates the rangefinder operation during which he must regulate the reflected single strength. The distance is measured and recorded, together with codes and angles, without further action by the operator. Observations can be completed at the rate of two per minute, with a nominal distance accuracy of plus or minus one centimetre.

Processing of Observations

The punched paper tape is processed by a paper tape reader attached to an I.B.M. 1130 Computer, to provide a deck of computer cards in the format used by the Department's survey calculation programme. The translation includes the conversion of angle records from grades to degrees, and the substitution of the corresponding alphabetical point description in place of the numerical Reg. Elta 14 Code.

The card deck is then processed by the computer to reduce the tacheometric observations to obtain horizontal co-ordinates and reduced levels for the observed points. A printout of these values is obtained to provide a digital record of the observations.

From inspection of these digital values, specifications are prepared to control the computer as it operates in conjunction with a Gerber 522 flat bed plotting table. The computer co-ordinates of the points are plotted and marked with a symbol and abbreviated description of the point as provided originally in the code schedule. Similarly, the calculated levels of required points are also annotated on the plot.

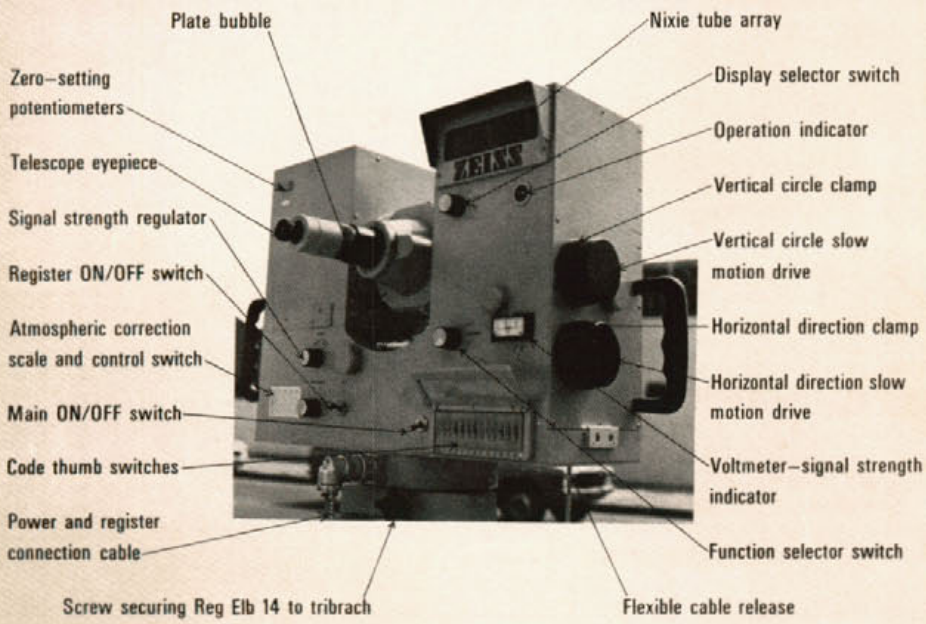
The linework necessary to complete the plan by joining the observed points is done manually, usually at the same time as the final field inspection necessary to record descriptions of structures, house names and numbers, etc.

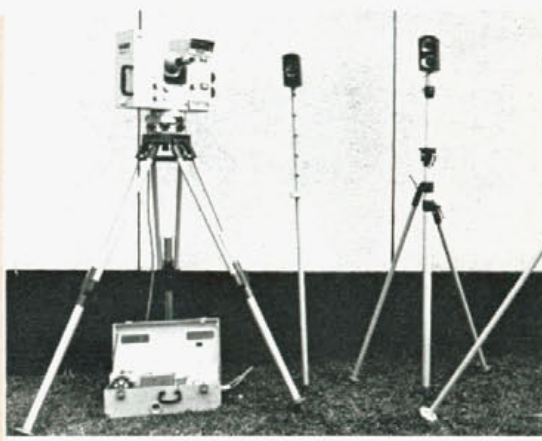
Summary

The Reg. Elta 14, being an instrument designed especially for tacheometric operations requiring automated processing, has proved suitable in application to the Department's detail survey operations. On resolving initial difficulties associated with the implementation of the new system, further development is envisaged to increase the automation of the processing procedure. Application of the Reg. Elta 14 system in other aspects of the Department's surveying activities appears feasible.

Top right: Reg. Elta 14 *and associated equipment. Tacheometer on tripod connected by cable to battery and paper tape punch in box. Single prism for ranges to* 500 *m. Double prism for ranges to* 700 *m. Seven prisms for ranges to* 1 200 *m. Nineteen prisms (not shown) to* 2 *km. Strutted rods are used to stabilize prisms for more reliable positioning than is possible with simple rod. All rods are telescopic.*

Bottom right: Reg. Elta 14 *operating through traffic to locate pavement detail and levels.*





TENDERS ACCEPTED BY THE DEPARTMENT OF MAIN ROADS

The following tenders (in excess of $20,000) for road and bridge works were accepted by the Department for three months ended 30th June, 1974.

Road No.	Work or Service	Name of Successful Tenderer	Amount
			$
Warringah Freeway	Municipality of North Sydney. Construction of 2-span prestressed and reinforced concrete bridge 57·7 m long over West Street, Cammeray.	Central Constructions Pty Ltd	350,597.00
North Western Freeway	City of Sydney. Prestressing of Pier Head stocks in Darling Harbour Railway Goods Yard.	B.B.R. Australia Pty Ltd	39,635.00
Southern Freeway	City of Wollongong. Construction of twin 3-span prestressed concrete bridges 30·5 m long to provide access from Gladstone Avenue to Figtree.	McConnell Dowell Constructors Ltd	256,499.00
State Highway No. 1	Princes Highway. Shire of Shoalhaven. Construction of 4-span prestressed concrete bridge 42·6 m long over Jaspers Creek, 159·1 km south of Sydney.	The Hornibrook Group (Southern Division)	91,577.00
State Highway No. 2	Hume Highway. Shire of Gundagai. Construction of 27-span composite steel and concrete structure 1 143 m long over Murrumbidgee River at Gundagai.	Transbridge Pty Ltd	3,296,272.74
State Highway No. 10	Pacific Highway. The supply, heating, haulage, and spraying of up to 88 160 litres and 123 000 litres of R90 bitumen south and north of Ballina respectively.	Boral Road Services Pty Ltd	26,597.92
State Highway No. 17	Newell Highway. Shire of Berrigan. Construction of 6-span 33·5 m long prestressed concrete and reinforced concrete deck bridge over Mulwala Canal 1·2 km north of Finley.	Allan Tessier Pty Ltd	65,000.00
Trunk Road No. 95	Shire of Wollondilly. Construction of approaches to new bridge over Allans Creek 0·8 km east of Wilton.	Ray De Silva Haulage & Earth-moving Pty Ltd	182,472.57
Main Road No. 184	Municipality of Windsor. Construction of 3-span prestressed concrete bridge 32 m long over Rickabys Creek 2·4 km west of Windsor.	McConnell Dowell Constructors Ltd	74,498.00
Main Road No. 503	Shire of Colo. Construction of 3-span prestressed concrete bridge 41 m long over Roberts Creek 17·7 km from Windsor.	McConnell Dowell Constructors Ltd	83,650.00

TENDERS ACCEPTED BY COUNCILS

The following tenders (in excess of $20,000) for road and bridge works were accepted by Councils for three months ended 30th June, 1974.

Council	Road No.	Work or Service	Name of Successful Tenderer	Amount
				$
Blacktown	S.R. 2084	Construction of 4 cell 2·7 m x 1·8 m reinforced concrete box culvert over Blacktown Creek at Blacktown.	Central Constructions Pty Ltd	197,800.00
Colo	M.R. 181	Operation of Webb's Creek Ferry	W. E. White	84,637.11 (three year contract)
Colo	M.R. 182	Operation of Sackville Ferry	J. L. O'Toole	62,673.81 (three year contract)
Colo	M.R. 225	Operation of Wiseman's Ferry	H. Merilaid	87,594.00 (three year contract)
Holroyd	S.R. 2071	Betts Road. Widening of pavement and installation of drainage between Merrylands Road and Bruce Street, Merrylands.	J. R. Burton	36,316.60
Imlay	T.R. 91	Construction of 3-span 64 m long steel girder and concrete deck bridge over Honeysuckle Creek 25·4 km west of Pambula.	Nelmac Pty Ltd	137,687.20
Lake Macquarie	M.R. 217	Supply and delivery of 20 000 cubic metres of fill material and 5 000 cubic metres of surface course gravel to deviation from Cockle Creek Railway Overbridge to Second Street, Boolaroo.	G. Hawkins and Sons Pty Ltd	31,800.00
Ryde	S.R. 2052	Construction of a single span prestressed concrete girder bridge 14·3 m long over Kittys Creek, East Ryde.	Arthur Boyd Constructions Pty Ltd	58,420.00

MAIN ROADS STANDARD SPECIFICATIONS

Note: Imperial drawings are prefixed by letter A, metric drawings by letters SD; instructions are so described; all other items are specifications or forms

ROAD SURVEY AND DESIGN

	Form No.
Design of two-lane rural roads (Instruction) (1964)	355
Data for design of two lane rural roads (1973)	892 (Metric)
Flat country cross sections—bitumen sealed pavement (Instruction) (1972)	A6132
Standard grading at drainage structures in flat country (Instruction) (1972)	A6161
Standard grading at approaches to culverts (Instruction) (1972)	A6162
Design of urban roads (Instruction)	369
Design of subsoil and subgrade drainage (Instruction) (1973)	513 (Metric)
Standard cross sections for bitumen surfaced two-lane rural roads (1974)	SD 6056

STREET DRAINAGE

Concrete converter	A 1418
Concrete works other than bridges (1974)	738 (Metric)
Gully grating (1969)	A 190
Gully pit with grating	A 1042
with kerb inlet only	A 1043
with grating and extended kerb inlet	A 1352
with extended kerb inlet only	A 1353
with grating for mountable kerb	A 4832
Perambulator ramp	A 3491
Vehicle dish crossing	A 134A
Waterway calculations for urban drainage (Instruction) (1963)	371B

CULVERTS

(a) Cast in place reinforced concrete box culverts—	
Single cell, height of opening 2 ft (A 5791); 3 ft (A 5792); 4 ft to 12 ft	A 1014–20B
Two cell, height of opening 2 ft (A 5793); 3 ft (A 5794); 4 ft to 12 ft (1958)	A 1023–30A
Three cell, height of opening 2 ft (A 5795); 3 ft (A 5796); 4 ft to 7 ft (A 1033–36); 8 ft (A 1038); 9 ft (A 1040); 10 ft to 12 ft	A 4843–45
Four cell, height of opening 2 ft (A 5797); 3 ft (A 5798); 4 ft to 12 ft	A 4846–54
Reinforced concrete box culverts with concrete wearing surface and concrete handrailing, heights of opening 3 ft to 12 ft, 1, 2, 3 and 4 cells (1963)	A 4994–97
Posts and handrails for culverts	A 3732
(b) Precast reinforced concrete box culverts—	
Supply of precast concrete box culverts up to 10 ft high and 10 ft span	138A
(c) Pipe culverts—	
Construction concrete pipe culverts (1974)	25 (Metric)
Design concrete pipe culverts (1974)	25A (Metric)
Supply and laying of asbestos cement drainage pipes (1972)	861
Headwall drawings are available for the following pipe culverts—	
(a) Single row—15 in to 6 ft dia.	
(b) Double row—15 in to 6 ft dia.	
(c) Triple row—15 in to 3 ft dia.	

BRIDGES

Concrete work for bridges (1967)	350
Concrete end posts for concrete bridges	A 279
Concrete handrail for concrete girder bridges	A 279A
Concrete end post and handrailing for prestressed concrete bridge units (1959)	A 4932–33
Data for bridge design (1973)	18 (Metric)
Erection of precast, prestressed concrete bridge units (1971)	557
Erection of precast, prestressed concrete piles (1966)	558
Erection of precast, prestressed concrete bridge girders (1974)	561 (Metric)
Extermination of termites ni bridges (Instruction) (1958)	326
Excavation for bridges (1968)	563
Supply of high strength steel bolts	261
Erection of steelwork using high strength steel bolts	262
General notes on Assembly of bridge construction specifications (Instruction) (1962)	599
Manufacture of precast or cast-in-place, prestressed concrete bridge members (1970)	556
Manufacture of elastomeric bearings for bridge units and girders (1964)	562
Proforma specification for bridge construction (Instruction) (1962)	599A
Protection of steelwork by metal coating in shop (1961)	579
Protective treatment (Field) of steelwork—metal spraying and painting (1961)	584
Protection angles for bridges or culverts with concrete wearing surfaces (1960)	A 1272
Prestressed concrete bridge drawings—	
(a) Bridge units for square and skew crossings, 25 ft to 35 ft spans (1963)	A 4910–12
(b) Bridge girders pretensioned or post-tensioned, 40 ft to 70 ft spans (1964)	A 5540–49
(c) Reinforced concrete deck for pre-cast, prestressed concrete bridge girders 24 ft and 28 ft between kerbs 40 ft to 70 ft spans (1963)	A 5550–59
(d) Formwork slabs for prestressed concrete bridge girders	A 5560
(e) Details of cast-in-place deck for prestressed concrete bridge units 25 ft to 35 ft spans (1967)	A 4931
(f) Prestressed concrete piles—12 in x 12 in—35 tons (A 4764); 14 in octagonal—45 tons (A 4943); 16 in octagonal—50 tons (1963)	A 4944
(g) Test load diagrams for prestressed concrete piles—12 in x 12 in (A 5601); 14 in and 16 in octagonal piles	A 5828
(h) Test loads for prestressed concrete bridge units (1964)	A 5514
(i) Flexural tension test loads for pre-cast, prestressed concrete bridge girders (1964)	A 5538
(j) Principal tension test loads for pre-cast, prestressed concrete bridge girders (1964)	A 5539
Reinforced concrete bridge drawings—	
(a) Flat slab bridges, 24 ft and 28 ft between kerbs; 20 ft to 30 ft spans (1958)	A 4862–71
(b) Piers with spread footings for flat slab bridges, 20 ft to 30 ft spans (1959)	A 4967–75
(c) Reinforced concrete piles, 35 and 45 tons (1963)	A 1207–8
Reinforced concrete piles for bridge foundations (precast)	564
Reinforced concrete cylinders for bridge foundations	565
Standard bridge loading (Instruction) (1957)	A 4
Substructure for bridges (567); Superstructure	568
Timber for bridges (1966)	140
Timber bridge drawings—	
(a) Timber beam bridge, 24 ft between kerbs (1961)	A 5593
(b) Timber beam bridge, details of construction (1961)	A 5594
(c) Low level timber beam bridge, 12 ft between kerbs	A 3470
(d) Running planks	A 1216
(e) Longitudinal deck sheeting (1961)	A 5576
Waterway diagram (0 to 200 acres)	A 26

BITUMINOUS SURFACES

Bituminous emulsion (cationic) (1973)	304 (Metric)
Bituminous emulsion (anionic) (1973)	305 (Metric)
Residual bitumen (1974)	337 (Metric)
Supply of prepared cutback bitumen for sealing purposes	740
Tar	296
Supply and spraying bitumen (1973)	898 (Metric)
Sealing and resealing with bitumen (1974)	93 (Metric)
Cut-back chart for bitumen seal coats (1973)	466 (Metric)
Cutting back bitumen—proportioning chart (1966)	466A
Bitumen sealing field book	400
Standard performance requirements for mechanical sprayers for bituminous materials (1973)	272 (Metric)
Supply and delivery of cover aggregate for bitumen seal coats (1973)	351 (Metric)
Supply and laying of asphaltic concrete paving mixtures	612
Supply and delivery of asphaltic concrete (1974)	953 (Metric)

FENCING

Chain wire protection fencing (1970)	144, A 149
Corrugated guard rail (1971)	A 5595
Protection fencing using corrugated steel guardrail (1973)	A 5829
Warrants for use of guard fences (Instruction) (1973)	246 (Metric)
Erection of guardrail protection fencing (1971)	680
Ordnance Fencing	143, A 7
Post and wire fencing (1974)	141 (Metric)
Drawings: Sheep — A 494 (1966); Rabbit-proof—A 498 (1966); Cattle A 1705 (1966); Flood gate A 316.	
Removal and re-erection of fencing (1974)	224 (Metric)

FORMATION, INCLUDING EARTHWORKS AND RURAL DRAINAGE

Earthworks and formation (1973)	70 (Metric)
Shoulders and table drains (1973)	827 (Metric)
Standard rubble retaining wall	A 114
Standard mass concrete retaining wall (1959)	A 4934
Standard cantilever retaining wall (1959)	A 4935
Subsoil drains (1973)	528 (Metric)
Corrugated PVC subsoil drainage pipe (1972)	907 (Metric)

PAVEMENTS

Cement concrete pavement	A 1147
Preformed expansion joint fillers (1962)	610
Supply and delivery of ready mixed concrete (1973)	609 (Metric)
Design of non-rigid pavements	76
Construction of natural gravel or crushed rock road pavement (bitumen surfaced)	743
Supply of natural gravel or crushed rock for road pavements (bitumen surfaced)	744
Construction or resheeting of natural gravel or crushed rock road pavement (not to be bitumen surfaced)	800
Supply of natural gravel or crushed rock for road pavements (not to be bitumen surfaced)	801

ROADSIDE

Roadside fireplace	A 4671
Roadside litter bin	A 5841

TRAFFIC PROVISION AND PROTECTION

Floodway information sign (1966)	A 5752
Manufacture of warning signs (1968)	682
Motor grid 12 ft (A 5769); 24 ft (1964)	A 5770
Provision for traffic (1966)	121
Drawings: General arrangement (A 1323) (1967); details of temporary signs (A 1325) (1966).	
Guide posts—supply (1973)	252 (Metric)
Guide posts—erection (1973)	253 (Metric)
White paint for guide posts (1963)	618
Roadmarking paint (1966)	671

CONTRACTS

Bulk sum tender form, Council contract (1966)	39
Bulk sum contract form, Council contract	38
Cover sheet for specifications, Council contract (1964)	342
Caretaking and operating ferry	498
General conditions of contract, Council contract (1966)	24B
Schedule of quantities form (1966)	64

MANUALS

Manuals, No. 1—Plant*; No. 3—Materials*; No. 4—Roadside Trees*; No. 5—Explosives*; No. 6—Bridge Maintenance*; No. 7—Road Maintenance*.

BOOKLETS

Guide to Main Roads Administration.
General Conditions of Assistance to Councils.
Miscellaneous Activities on Main Roads.
Schedule of Descriptions of Classified Roads and Works.
Duties and Responsibilities of a Superintending Officer.

N.A.A.S.R.A.

Guide to Publications and Policies of NAASRA.
Policy for Geometric Design of Rural Roads*.
Highway Bridge Design Specification*.
Highway Bridge Construction*.
Full list of publications and prices.

All standards may be purchased from the Plan Room at the Department's Head Office, 309 Castlereagh Street, Sydney. Single copies are free to Councils except those marked *. A charge will be made for a set of standards.

G 74574 D. West, Government Printer, New South Wales—1974

A new road COMING

This section of Shire Council Road 47 (Junction Point Road) in the Compass Range (photograph right), will be improved to form part of a higher grade road connecting Goulburn and Bathurst. The new road will also give better access to an important tourist site featuring the Abercrombie Caves (below) and Grove Creek Falls (below right).

An old road FADING

William Cox's famous road constructed across the Blue Mountains in 1814, can now only be seen at a few locations, two of these being – near Woodford Trig. Station (below left) and descending Mount York (below right).