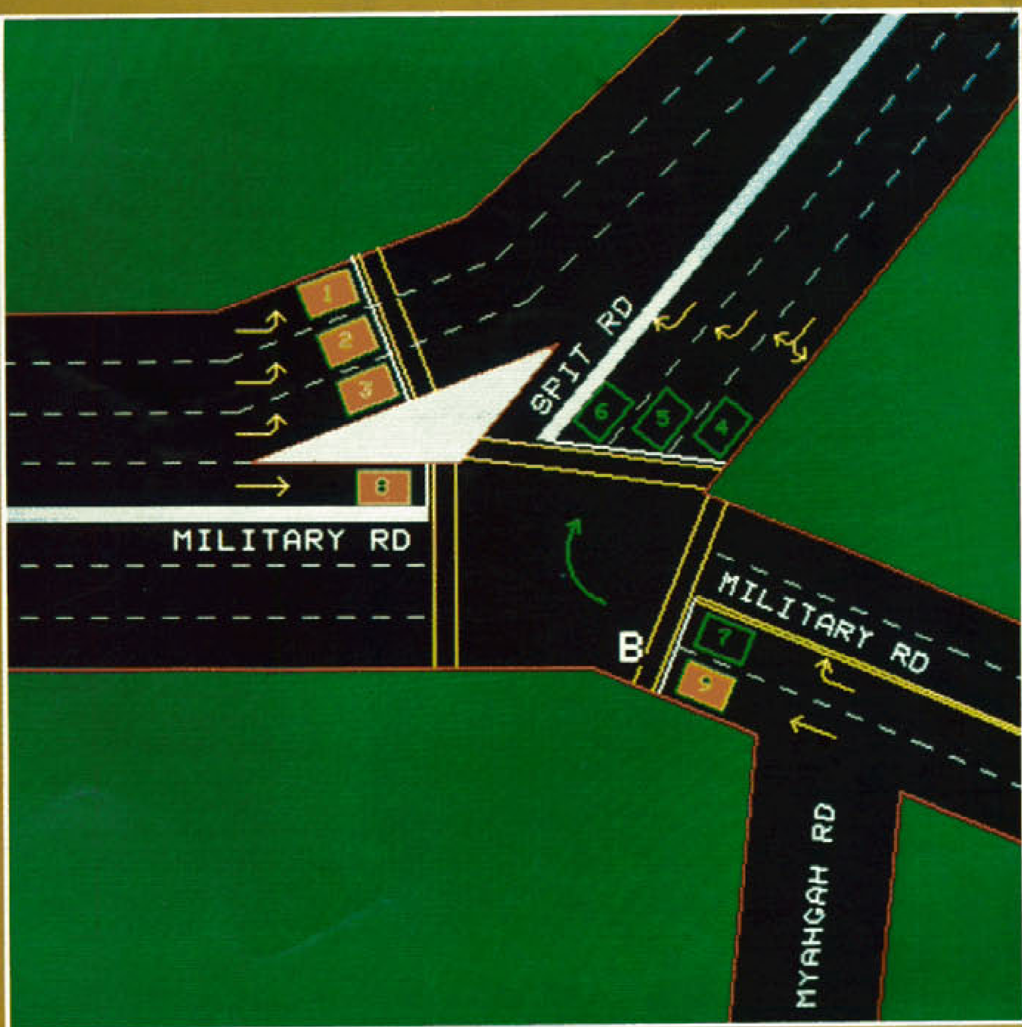
main roads

SEPTEMBER 1983



main roads

JOURNAL OF THE DEPARTMENT OF MAIN ROADS, NEW SOUTH WALES

SEPTEMBER 1983, VOLUME 48 NO. 3
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CONTENTS

Front cover: a computer-operated colour graphics display of traffic operation at Spit Junction, Mosman.
Back cover: the old bridge over Fish River at O'Connell on Main Road 253.

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CLAY TABLETS TO COMPUTERS

We are inclined to think that traffic problems are unique to the 20th century, yet methods of traffic control date back to ancient civilisations.

In the Mesopotamian city of Nineveh, for example, there were traffic signs in the form of clay tablets bearing hieroglyphics. These were placed on both sides of the paved procession streets which led to places of worship, to warn anyone who dared leave a vehicle there that they would be liable to pay the death penalty. Fortunately, parking penalties today are no longer as severe as this.

Our transit lane regulations are designed to assist the movement of selected categories of vehicles, such as public operators and motor cars with three or more occupants, during peak periods. This form of control to relieve traffic congestion was actually foreshadowed in ancient Rome: only gentlemen employed in public service, priests, priestesses and visitors from other towns were allowed to drive wheeled vehicles through the city streets from the sixth to the sixteenth hour of the day. Ladies of the upper class shared this privilege on festive occasions.

Traffic control is as old as traffic itself, but in New South Wales there are some historic milestones that warrant special mention.

On 13 October 1933, Australia's first vehicle-actuated traffic lights were switched on in Sydney. To celebrate the 50th anniversary, this issue features articles on the history of traffic signals and on recent developments such as portable signals, the Sydney Co-ordinated Adaptive Traffic System and computer graphics.

ABRD FUNDS FOR NATIONAL HIGHWAY PROJECTS

In our last issue (June 1983), we looked at the funds that the Commonwealth Government is making available under the Australian Bicentennial Road Development Program for urban arterial, rural arterial and local roads.

Approval has also been given for ABRD funding of 18 National Highway projects in New South Wales (see table below). These projects alone have an authorised total cost of $128 million. An allocation of over $22 million has already been made for work undertaken in 1982/83.

In keeping with the National Roads Grants Act of September 1981, State and local government authorities must call public tenders for ABRD funded projects. The authority itself may also bid for the work.

Regardless of the final apportionment of construction work, the ABRD program will mean a welcome boost to employment and to the standard of road travel in our State.

Roadworks at Kyeamba on Hume Highway.

The Department has commenced construction of two lane dual carriageways over the Kyeamba Range on the Hume Highway between 31.0 km and 37.9 km south of Tarcutta. This section of road traverses a series of hills and contains a number of steep grades on a winding alignment. The new work will provide easier grades and curves which will mean safer, smoother travel for road users.

Since the new alignment crosses the existing road on different levels at several locations, the overall project will be constructed in stages by individual contracts to provide an uninterrupted flow of traffic.

The total cost of the upgrading and associated works, which are being funded by the Commonwealth Government under the ABRD Program and the Roads Grants Act will be almost $9 million.

National Highways

Road	Location	Description	Estimated Cost $000 (1982)
Hume Highway	Cherry Tree Hill to Black Bobs Creek.	Construct northbound carriageway, rehabilitate existing carriageway, construct bridge over Black Bobs Creek.	6,300
"	Kyeamba Gap.	Construct dual carriageways.	7,340
"	Two Mile Creek to Dunderallego.	Construct northbound pavement.	1,200
"	Tumblong Deviation.	Construct Section 2 including grade separation at Snowy Mountains Highway.	10,600
Pacific Highway	Wyong	Construct dual carriageways from F3 Motorway connection to Doyalson.	1,000
"	Lake Munmorah	Construct second carriageway Elizabeth Bay Road to Kanangra Drive.	1,030
F3 — Sydney-Newcastle Freeway	Calga	Calga to Mooney Mooney Creek. Earthworks and drainage.	3,400
"	Calga	Mooney Mooney Creek Bridge.	16,500
"	Kariong	Deviation of Pacific Highway. Pavement and finishing works.	1,700
"	Kariong	Mooney Mooney Creek to Kariong.	19,200
"	Somersby	Kariong to Somersby.	15,250
"	Wyong	Concrete pavement from Wyong River to Wallarah Creek.	6,800
"	Wyee	Wallarah Creek to MR.217 (Wyee) including pavement, finishing works and bridges.	10,760
"	Morisset	Wyee Creek to Morisset earthworks and drainage (109.1 km - 114.2 km).	4,400
New England Highway	Scone	Concrete pavement Kelly Street.	1,400
"	Bendemeer	Bridges at Bendemeer and Perrys Ponds.	1,960
"	Singleton	Dunnolly Bridge.	4,200
"	Maitland	Inner City Bypass.	15,700

A contract for the first stage of this project was let in March this year to Thiess Contractors Pty. Ltd. for $942,336. It involves formation and drainage construction of the section between 34.7 km and 36.6 km. On the completion of this contract in November 1983, further earthwork and pavement construction will be let, with overall completion anticipated by late 1985 ●

Earthworks and drainage underway on the Hume Highway at Kyeamba Gap.

DEVIATION AT DEVILS PINCH

A four and a half kilometre deviation of the New England Highway at Devils Pinch, 20 km north of Armidale, is now completed.

The first 1.5 km section was opened to traffic in December 1982. Heavy falls of rain delayed completion of the second section, but the 3 km continuation was finally opened to traffic on Friday, 13 May 1983.

About 3,000 vehicles per day use the New England Highway for both local travel and travel between Sydney and Brisbane. Previously, the route was narrow and winding, and icing over in winter made driving conditions hazardous.

The deviation has considerably upgraded the standard of this route. It has been constructed on an improved alignment, and provides a two lane carriageway with overtaking lanes for northbound vehicles at two locations.

The new work will provide more comfortable and more economical motoring conditions and will reduce traffic accidents in the area.

This roadwork was undertaken as a National Roads project at an overall cost of $4 million ●

Part of the Devils Pinch Deviation, a concrete bridge 14 km south of Guyra.

NEW BRIDGE OVER FISH RIVER AT O'CONNELL

A new prestressed concrete bridge is being built to carry Main Road No. 253 over Fish River at O'Connell, north of Oberon. The new structure will be 94 m long and 8 m wide, and is being constructed by Norwest Holst Australia Pty. Ltd. of Toongabbie, at a contract price of $476,620.

An old timber truss bridge at the same site is to be replaced by the new structure. The timber bridge, designed and built by the Public Works Department, was first in use in 1879 at the decline of New South Wales' gold rush era. It is 56 m long and 4.4 m wide. The central pier of the truss bridge is sinking, causing the whole structure to deteriorate.

The new bridge is expected to be completed early in 1984.

Gold changes hands

The great gold rush began in May 1851 in the gullies around Orange and Bathurst. But the years which followed were a mixed blessing for most as travellers on the dirt highways became easy prey for robbers. Both ticket-of-leave and escaped convicts were attracted to the goldfields in such numbers that most murders and highway robberies were attributed to them.

Within this environment Frank Gardiner, Ben Hall and John Gilbert formed a new school of bushranging which was drawn largely from the sons of poor settlers. They were romantically referred to as the 'wild colonial boys'; young men with a strong taste for adventure and the desire to share in the miner's easily-won wealth. Hall was perhaps the most competent of all bushranger leaders. His men were well-armed and rode fine mounts, often stolen racehorses.

At one stage Hall's gang held up a general store not far from O'Connell, only to be thwarted by a quick-thinking storekeeper who hid the gold in a barrel of flour. In early days both police and bushrangers blazed away without much harm to either party. At one particular confrontation, three of the gang and two policemen exchanged 40 shots, and between them hit only a hat and a barroom.

The long immunity of Hall's gang led the New South Wales Government to pass a Felons' Apprehension Act on 12 April 1865. Under this Act bushrangers could be shot on sight and those who harboured them might be proclaimed outlaws.

Hall was less callous than most of his associates. As far as is known, he killed no one, and he appears to have been one of the few bushrangers driven to a life of crime as a result of unfortunate circumstances. In May 1865, Hall was surrounded in the bush near Forbes, and shot ●

(Below left) The original bridge, built in 1879, shows signs of deterioration. (Below right) Work is well in hand on the replacement structure.

FIFTY YEARS OF TRAFFIC SIGNAL SERVICE

MAKING LIGHT OF TRAFFIC

Gas prototype

On 10 December 1868 the first lit traffic signals in the world went into action. Comprising a semaphore arm with red and green gas lamps, the signals were installed in Bridge Street opposite Parliament House in London. By pulling a lever at the foot of the pole, policemen were able to change the light from red to green, and this moved the semaphore arms at the same time. A police announcement relating to the signals said:

"The 'proceed with care' signal warns every vehicle driver or horse rider to cross the crossing carefully and to pay attention to the safety of the pedestrians. The 'stop' signal is only used when it is necessary to completely stop the traffic of both vehicles and horses on both sides of the crossing in order to enable pedestrians to cross over. In this way every driver of vehicles or horses is warned that he has to keep the crossing free."

Early reports state that not long after the device's installation the signals exploded, putting an abrupt end to the experiment.

A highly ornamental traffic tower at Detroit's Woodward and Boulevard intersection in the 1920s. The police officer on duty would change the signals when required.

In 1918 the first three-coloured light signals were installed at several intersections in New York. These were manually operated by police officers at each intersection. Two years later similar signals were installed in England.

Signals were soon operated by an electromechanically fixed time controller, a mechanism which measured off an arbitrarily determined period of green time. Yet these were still inefficient as far as traffic management was concerned and often caused unnecessary delays. Following Adler's introduction of the horn-actuated detector in the U.S.A. in 1928, vehicle-actuated signals were developed. These are characterised by two main features:

(a) a demand detector to enable vehicles in side streets to call the signal away from the main road, and

(b) automatic extension of green timing to enable vehicles to maintain right-of-way (up to a preset time limit) in the presence of demands from conflicting traffic.

Sydney switched on

On 13 October 1933 the then Minister for Transport, Colonel Michael F. Bruxner, switched on New South Wales' first set of traffic signals at the intersection of Market and Kent Streets, Sydney. The equipment was vehicle-actuated, and was imported from England at a cost of 390 pounds. It was installed by the Electricity Department of Sydney City Council at a cost of 183 pounds, six shillings and fourpence, under the supervision and subsequent maintenance of the then Department of Road Transport and Tramways.

The proposal to install electrically-operated traffic control devices met with little enthusiasm from the then Police Commissioner Mackay, who was understandably against the idea of having his point-duty men replaced by machines.

Opponents of the electric signals scheme were quick to point out the inflexibility and inefficiency of Melbourne's fixed-time

A pedestrian-actuated traffic signal installed in Baltimore, February 1929.

signals, which were based on the American system. However, electrically-operated traffic signals in the United Kingdom had followed a different pattern of development. Traffic conditions in England had fostered the introduction of vehicle-actuated equipment, such as manufactured by the Automatic Telephone Manufacturing (A.T.M.) Co. of Liverpool. This firm was represented in Sydney by Automatic Electric Telephones (A.E.T.) Pty. Ltd.

One of this firm's eager young salesmen, A.R. (Bob) Filmer, made a determined effort to convince the New South Wales Government that traffic-actuated signal equipment in general, and ATM equipment in particular, possessed none of the shortcomings of the much-maligned fixed-time equipment. He pointed out that it had been established in the United Kingdom as an efficient and economical alternative to police control of traffic at street intersections. To lend weight to his convictions, Bob Filmer offered to import one set of equipment without obligation to

The horn-actuated traffic signal developed by Adler in the U.S.A. in 1928.

the Government, and supply it at no charge for a trial period. He undertook to have it removed at no cost to the New South Wales taxpayer if, at the end of the trial period, the installation was not considered to be satisfactory.

Despite continued opposition from the Police Commissioner, the Government finally accepted the offer from A.E.T.

A difficult test

But the Government imposed some additional conditions on the trial installation. The most stringent of these was that the location of the first signal installation was to be selected by the Police Commissioner. He nominated the intersection of Kent and Market Streets, a busy intersection at which many a police officer had gained valuable point-duty experience and one which offered particular problems for horse-drawn carts from the Pyrmont and Darling Harbour wharves. Market Street was paved with woodblocks, a slippery surface to horses' hooves pulling heavily laden carts uphill.

It was recognised that poor traffic control at this intersection could wreak havoc with the horse-drawn traffic ascending Market Street.

The equipment imported from England comprised the ATM two-phase type 33 cam-shaft controller, three-aspect signal lanterns with 200 mm lenses (the red inscribed 'STOP' and the green inscribed 'GO'), and massive contact-plate detectors. It was specially adapted for operation on Sydney's 240 volt D.C. network, with the low voltages for operating the detectors being derived from huge, power-dissipating resistors mounted in the top of the ornamental cast-iron cubicle. The final installation was painted with alternate bands of black and yellow

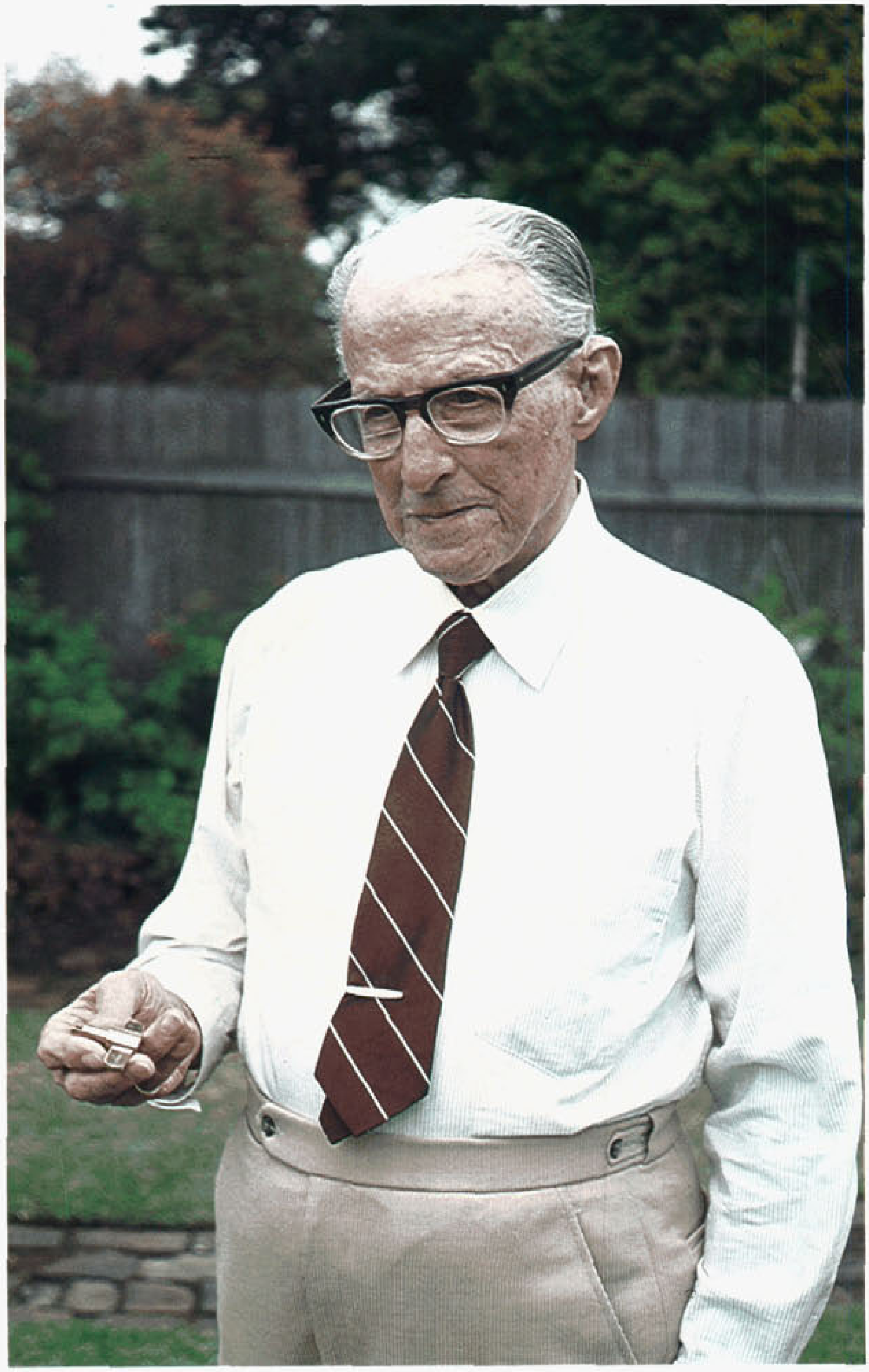
Sydney's first set of traffic signals, at the corner of Kent and Market Streets, began operating at 11.00 a.m. on 13 October 1933.

in accordance with contemporary English practice.

Although the commissioning was carried out with much fanfare and publicity, Bob Filmer knew that the battle was far from won, especially as the reliability of the cumbersome contact-plate detectors left much to be desired. During the three month trial period Bob was seen frequently on the site leaning against the controller cubicle, anxiously watching the operation of the signals. Many years later, it became known that Bob had become quite adept at changing the signals by means of a switch concealed in his coat pocket, so that any faults in the detectors would go unnoticed. His efforts were not in vain, as the Government decided to retain the device in service permanently.

Following the success of Sydney's first set of signals, tenders were invited in 1935 for similar sets at other locations. However, the tender prices were considered to be excessive and no further action was taken until 1937 when four sets of signals were installed at York and Margaret Streets, Sydney; Clarence and Erskine Streets, Sydney; Pyrmont Bridge Road and Booth Street, Camperdown; and Pyrmont Bridge Road, Wattle Crescent and Jones Street, Forest Lodge. After that time the number of installations increased rapidly. The 1,000th signal installation (at the intersection of Pittwater, Harbord and Warringah Roads, Dee Why) was ceremoniously placed in service by the New South Wales Premier on 8 April 1974.

Few people would deny that traffic light signals have pervaded the urban environment to an extent which could hardly have been envisaged in 1933. Although the priorities they impose may be disliked by some roadusers, there is a strong consensus that traffic signals are now an essential feature of the congested urban scene, and an effective method of traffic management ●



The original gold-plated key, used by Colonel Bruxner at the 'switching on' ceremony in October 1933, was given to Mr. Leo Grouse, then Secretary to the Ministry of Transport.

CHRONOLOGY OF EVENTS

Concerning traffic control signals in New South Wales

1933

Installation of first set of traffic control signals at the intersection of Kent and Market Streets, Sydney, under the auspices of the City Council. The controller was the Electromatic Type 33 operated from 240 volt D.C. with contact-plate detectors.

1937

Installation of first tram detectors on overhead trolley wires at Bridge and Glebe Point Roads, Forest Lodge.

1938

Introduction of the pneumatic vehicle detector, replacing the contact-plate detector. This was a detector comprising two sections for uni-directional detection.

1940

Installation of first four sets of signals in Newcastle. New South Wales traffic signal population: 30.

1941

First use of CROSS NOW (white) light signals for pedestrian traffic in Macquarie Street, Sydney.

1948

Introduction of the single-strip pneumatic detector.

First mid-block traffic signals for pedestrian traffic at Pacific Highway, Lindfield near the railway station. This used a two-phase controller with three aspect signals for pedestrians.

1950

Establishment of Burwood Traffic Signal Depot (with staff of 12) to replace cramped quarters at the old City Depot in Jamieson Street. New South Wales traffic signal population: 70.

1952

Installation of the 'blinking light' at the intersection of Warringah Road and Wakehurst Parkway, Frenchs Forest. (It was replaced by traffic control signals in 1966.)

1953

Introduction of the first pedestrian-actuated signal controller. This was designed and built in Sydney for school crossings and comprised part-time signals which only operated during school hours.

1955

Installation of the first lane control signals on the old Spit Bridge. (The system was removed in 1958 with the opening of the new bridge.)

Installation of the first set of signals in Wollongong, at Crown and Keira Sreets.

1957

Installation of first co-ordinated pedestrian crossing signals at Princes Highway, Kogarah.

Installation of 'Belisha Beacon' flashing signals in Canterbury Road at Canterbury Hospital. This was the forerunner to a number of experimental crossing warning signals (all ultimately superseded by the overhead internally illuminated pedestrian symbol sign).

1959

Removal of the last contact-plate detector from service.

Installation of first co-ordinated vehicle-actuated traffic signals in Parramatta Road at Crystal and Norton Streets, Leichhardt.

First use of two-aspect WALK/DON'T WALK signals for pedestrian traffic in Pacific Highway at St. Leonards railway station.

1960

Installation of the first internally illuminated overhead pedestrian crossing symbol sign at Pyrmont Bridge Road outside the Camperdown Children's Hospital.

Introduction of first commercially produced pedestrian-actuated signal controller. New South Wales traffic signal population: 222.

1961

Electric trams used traffic signals for the last time (25th February).

Installation of the first co-ordinated arterial system of signal sites in Church Street, Parramatta. The system was supplied by Siemens (U.K.) and used cable linking.

School signals were switched to full-time operation.

Introduction of flashing DON'T WALK signals to identify pedestrian clearance period.

1963

Commissioning of the inner-city pilot scheme comprising eight sets of signals in Pitt and Castlereagh Streets. The signals were commissioned with a temporary master controller produced by I.B.M. (Aust.) and located in the basement of the Department of Main Roads' building.

1964

Commissioning of the first stage of the Inner-city Signal System using the Traffic Control Centre at Brisbane Street. The master control equipment was supplied by I.B.M. (AUST.) and the closed circuit television system by Philips. The intersection controllers were designed and built by the Department of Motor Transport.

1965

First use of red and yellow 'arrow' signals. Up to this time only green 'arrow' signals had been used.

Introduction of the passage-type inductive loop detector to supersede the pneumatic detector.

1966

Installation of the first sets of signals located outside the Sydney-Newcastle-Wollongong area. In this year a set of pedestrian-actuated signals was installed in Lochinvar, and a set of intersection signals at Tamworth.

1967

Introduction of CALL RECORDED facilities on pedestrian push-button detectors at Princes Highway and Mitchell Street, St. Peters.

1968

First use of semi-presence vehicle detectors for traffic signal control. These were of the inductive loop type.

Installation of first arterial co-ordinated signal system outside the Sydney Metropolitan Area in High Street, Maitland. Installation of 500th set of signals at Dean and Olive Streets, Albury.

1971

First use of a commercial type computer for co-ordination of traffic signal installations. Previous master equipment was custom-built by Departmental staff.

1974

Installation of the 1000th set of traffic control signals at Pittwater and Warringah Roads, Dee Why.

Introduction of signal controller using LSI micrologic to supersede electro-mechanical type equipment. The new equipment was designed and built by Philips Systems Engineering Centre using the INTEL 8008 microcomputer system.

1975

Commencement of SCATS (Sydney Co-ordinated Adaptive Traffic System) to incorporate various scattered signal systems into the Central Business District system, using Telecom lines.

1978

Publication of the first of a series of Australian National Standards for traffic signal equipment.

1979

Official opening of the Traffic Control and Emergency Centre at Oxford Street, Sydney.

Departmental helicopter adapted to computer control of traffic signal operation.

1981

Introduction of an installation programme for audio-tactile traffic signals for visually-handicapped pedestrians as part of the DMR contribution to the International Year of Disabled Persons. First usage of microwave vehicle detectors. New South Wales traffic signal population: 1735.

1982

Introduction of an expanded central monitoring computer system and colour-graphics system at the Traffic Control and Emergency Centre. Introduction of new pedestrian push-button design without illuminated demand indicator ●

*(See previous articles on traffic signals in Main Roads Journal:
Vol. 23, No. 2, December '57, p. 46.
Vol. 42, No. 4, June '77, p. 102).*

COUNTRY CENTRES GETTING THE GREEN LIGHT

In 1966 the first set of signals to be installed outside the Sydney-Newcastle-Wollongong metropolitan areas went into service, with pedestrian-actuated signals being installed in Lochinvar and intersection signals at Tamworth. By 30 June 1983, New South Wales' signal population had grown to 1,874, of which 300 were located in non-metropolitan areas.

As traffic volumes increase in country areas, the need for efficient traffic management techniques becomes more acute. Often the problem is the conflict between local and through traffic. Such situations are most easily remedied by the installation of traffic signals.

Two current examples are at Mittagong and Moree. The first set of traffic control signals on the New South Wales southern highlands was installed at the intersection of Bowral Road and the Hume Highway, Mittagong. The signals were officially put into service on 14 April this year by Mr. Ralph Brading, Member for the State electorate of Camden. It was soon evident that the signals were coping well with both pedestrian and vehicular traffic, and were providing valuable service to the local community.

A set of intersection signals are currently being installed at Balo and Heber Streets, Moree. Traffic volumes in the town have increased significantly over recent years. The average daily traffic figures show that the number of vehicles using the Mehi bridge increased from 13,740 in 1976 to 15,890 in 1980. Heber Street figures increased from 6,600 a day in 1976 to 8,220 a day in 1980. This particular installation comprising 12 sets of lights will cost around $136,000 and is expected to be in use by late 1983 ●

PORTABLE TRAFFIC SIGNALS

(Based on the paper "Shuttle Control of Traffic at Road Works" presented by Mr. F.R. Hulscher, Departmental Supervising Engineer, Traffic Section, at the 10th ARRB Conference, 1980.)

As long as there have been roads, there has been the need to maintain them in a good state of repair, to improve them and to provide access below them for services. Frequently this can be carried out with little disruption to traffic and workmen alike, by use of detours and by-passes, or because the carriageway is sufficiently wide to permit one or more lanes to be blocked off without major problems. However, where there is more direct conflict between the maintenance activity and the traffic, positive traffic control is needed.

As with other types of traffic control, the need for positive measures is related to both safety and delay. In the most common situation, traffic from opposite directions is constrained to share a single 'shuttle lane'.

While permanent traffic control schemes have advanced hard on the heels of developments in supporting technology, the temporary arrangements in most cases still rely on manual control. But the situation is changing due to the disproportionate increase in labour costs, which are forcing construction authorities around Australia to deploy labour more efficiently and examine automatic equipment more seriously.

Over the past 20 years, much development has taken place in Europe with the introduction of portable traffic light systems for shuttle control of traffic. In the U.S.A. on the other hand, the extensive system of wide, high-speed expressways has fostered the development of highly conspicuous, dynamic displays for guidance of traffic into other lanes, and shuttle control has remained relatively unsophisticated. Because British traffic patterns and road systems are more like conditions in Australia than those in the other countries, the development of portable traffic light signals in Britain has been studied at some length.

The early forms of portable three-colour signals were intended for operation in either the fixed-time or manual control mode, although for extended construction projects the British Government encouraged use of vehicle detectors to make the equipment demand-responsive. Until 1979 British specifications for portable traffic light signals were oriented towards cable-connected equipment, energised from either mobile diesel-powered generators or the electricity mains.

In 1972 a special research group set up by the Organisation for Economic Co-operation and Development (OECD) completed its survey of the then current practices concerning traffic management at road obstructions. The OECD Study found that practices between member countries varied significantly, but that there was an increasing emphasis on improved traffic management at roadworks.

The study also included a survey of different methods of timing of traffic signals, which indicated the range of methods used for determining signal timing without yielding consistent results. In most countries provision was made for shuttle lanes of considerable length e.g., up to 3.4 km in Germany, 1.4 km in The Netherlands, and 700 m in France. Such nominal distances were associated with recommended timings as high as 177 seconds for all-red, 235 seconds for green, and cycles up to 480 seconds. Motorists tended to disregard long red times at unattended sites under light traffic conditions. This led to the recommendation of an absolute limit of 250 m between signals for automatic working.

Where conditions were suitable, and motorists could be made aware that the signals were under manual control, longer all-red periods could be tolerated and the maximum distance between signals could be increased to 500 m.

With the development of suitable microwave (radar) vehicle detectors, vehicle-actuation could be extended to short-term applications. Because the detectors rely on the Doppler Effect, they are effectively movement detectors and their sensitivity drops off rapidly at the low speed end of the range. Under conditions where vehicles fail to move off promptly during a green interval, detection may be temporarily lost and the control equipment would then omit to extend or return the green signal for delayed traffic. The adverse effects of this feature are minimised by the simple expedient of generating a periodic artificial demand.

In practice, microwave detectors are mounted above the signal lanterns, so that correct aiming of the signal towards approaching traffic provides the proper orientation of the detector.

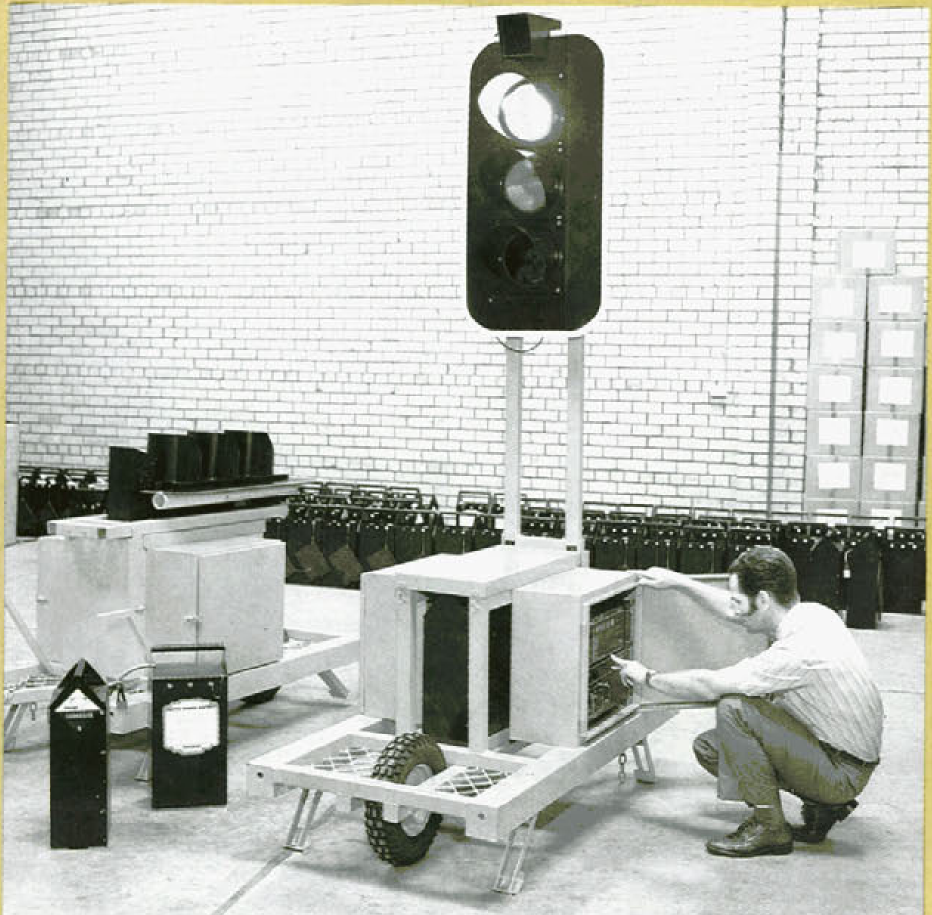
As previously mentioned, the connection between the various components of the portable signal system under British practice has been by trailing cables.

Improvements in radio transmission techniques and components, as well as improved miniaturisation and reliability of solid-state electronics, have fostered the development of sophisticated traffic control systems without interconnecting cables. The radio-controlled temporary signals comprise an integrated 'master' unit and a 'slave' unit for shuttle control.

The main technological problem facing radio-controlled systems has been the interlocking between the opposing signals and protection against interference from either man-made radio transmissions or nature's 'static'. The design of modern radio-controlled signal equipment ensures that the probability of dangerous signals being displayed is extremely low, although the system may stall in a fail-safe mode (all-red or flashing yellow) when the radio link between 'master' and 'slave' units is interrupted or corrupted.

The radio system provides an extremely mobile system, comprising only two items of equipment.

Such signals are able to operate in a completely unattended mode, offering the potential for saving on costly and time-consuming temporary road restoration to provide safe conditions overnight and on weekends ●



Mr. Frank Hulscher, Departmental Supervising Engineer in Traffic Section, inspecting portable traffic signal equipment.

SCATS: SYDNEY CO-ORDINATED ADAPTIVE TRAFFIC SYSTEM

As drivers, passengers or pedestrians, most of us have become accustomed to the sight of traffic signals at intersections throughout our suburban road network. These signals help to bring order to the otherwise chaotic conflict of intersecting traffic movements.

But, many people in our community may not be aware that these seemingly simple devices are part of one of the most advanced urban traffic control systems in the world. In its continuing improvements to the system, the Department of Main Roads is keeping in the forefront of the latest technological developments.

The Sydney Co-ordinated Adaptive Traffic System, or SCATS as it is more widely known, is currently being extended throughout the Sydney Metropolitan Area. It will ultimately control more than 1200 sets of traffic signals, including over 150 in the Sydney Central Business District (CBD). Similar systems are now also being developed by the Department in Newcastle and Wollongong.

Using the experience and expertise of Departmental officers, co-ordinated and adaptive systems, based on SCATS, have been introduced into major cities in other States (such as SCRAM in Melbourne and PACTS in Perth) as well as overseas (such as in Kuala Lumpur, capital of Malaysia).

Sydney Central Business District

SCATS was introduced into the Sydney Central Business District in 1964 and was computerised in 1972. The heart of the System is located at the Department's Traffic Control and Emergency Centre in Oxford Street near the southern end of Hyde Park. It has its own master minicomputer and a duplicate unit is kept constantly on stand-by at the Police Headquarters in nearby College Street.

Present Problems from the Past

Any traffic control system is bound not only by the constraints of imperfect driving behaviour but also by geography and history.

Very few of Sydney's early roads were built to form a regular grid system. Land and water shapes, the hilly topography around waterways, as well as human needs and habits, have all combined over the years to produce irregularities in Sydney's main traffic routes.

Consequently, urban traffic in many areas must still travel on comparatively tortuous roads with sharp curves, steep hills and complex intersections . As in many other urban regions, road planning and development in Sydney are restricted by features which are valuable and necessary in their own right. Such varied features range from railway marshalling yards to the parks, squares and plazas which give city workers welcome open spaces in an increasingly crowded and towering cityscape.

Making the Best of It

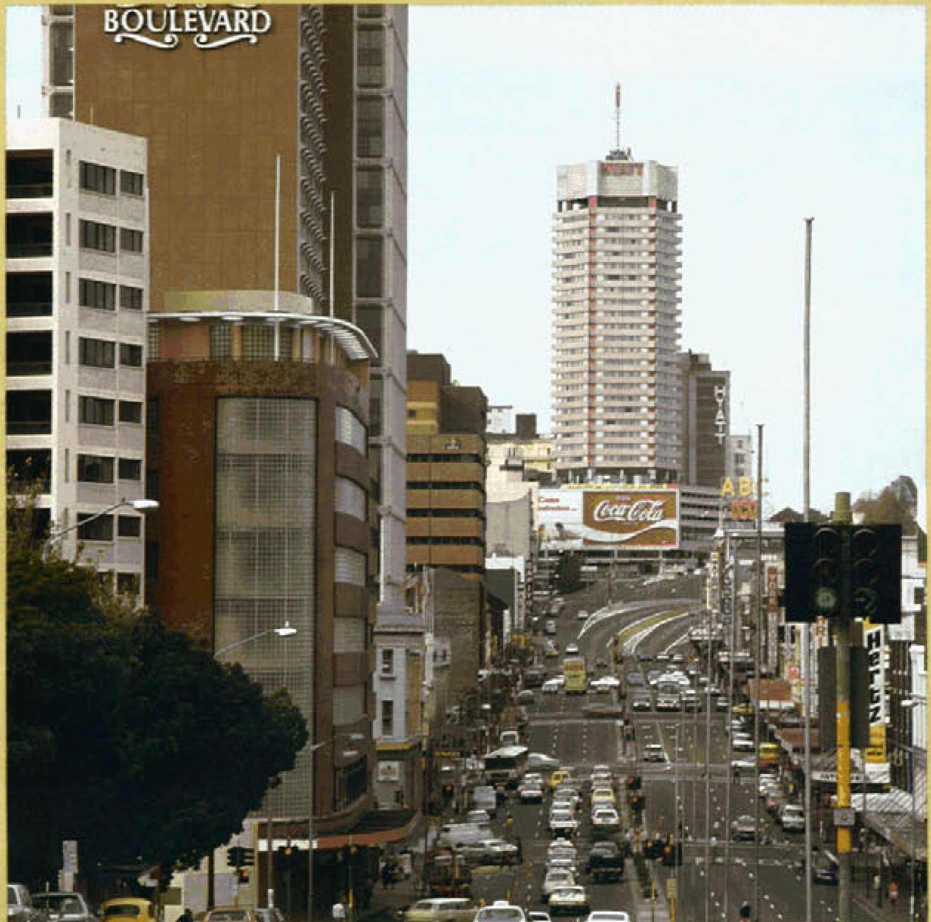
With limited funds available and environmental considerations affecting new major urban roadworks, it is not only desirable but imperative that we make the best use of our existing roads and streets. Other traffic improvement activities, such as channelising intersections, improving alignments, widening carriageways, closing medians, and introducing clearways and transit lanes, all contribute to better traffic flow. But SCATS incorporates the more active control measures which are needed to react swiftly and intelligently to fluctuating traffic demands and to keep vehicles on the move.

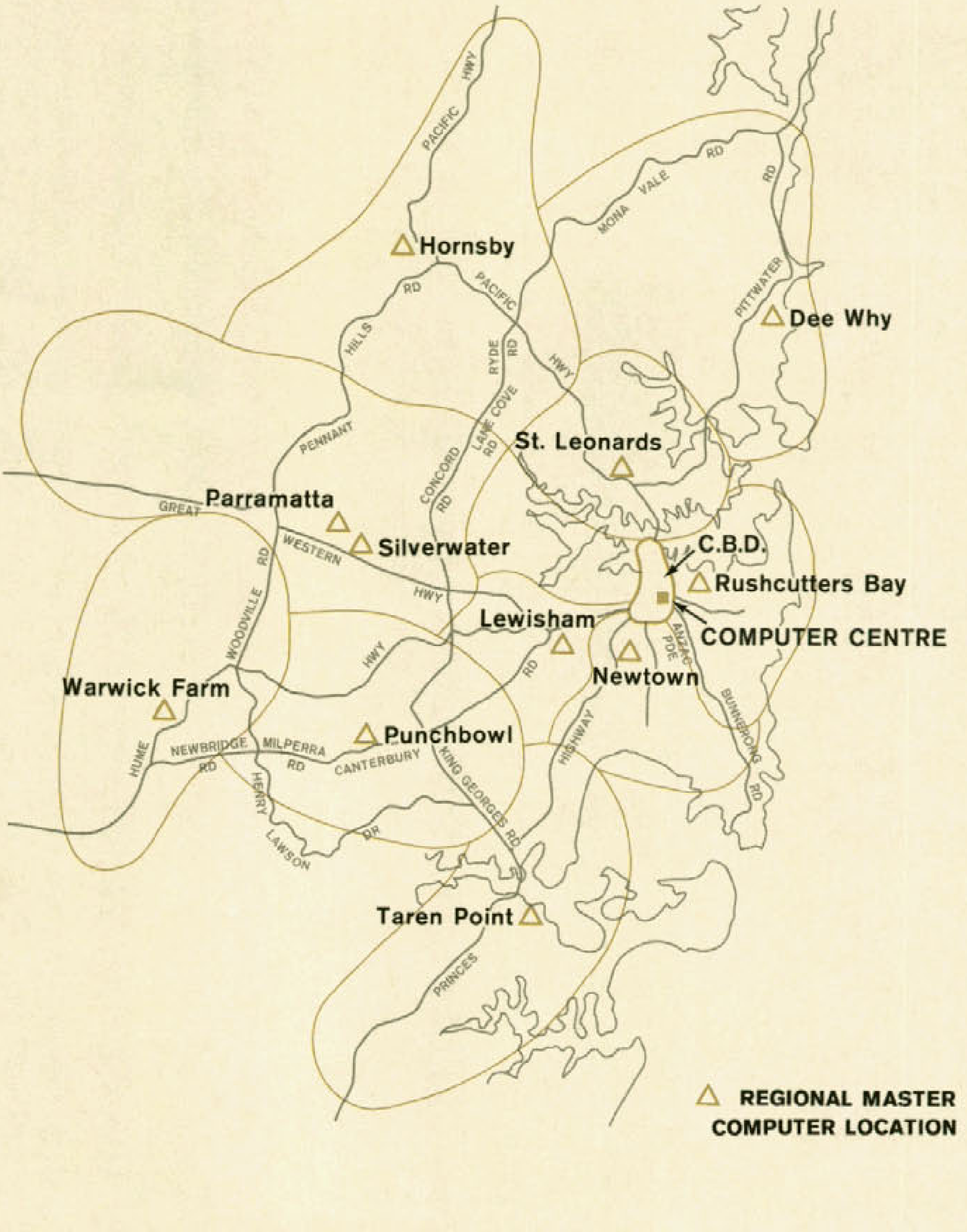
The challenge of the increasing traffic movements in Sydney's Central Business District is being met by using the power and speed of modern computer technology. Without the co-ordinated and adaptive system now in use, the city would probably eventually 'drown' in a flood of traffic.

Computers to the Rescue

The traffic signals in the Sydney CBD operate directly under computer control.

Looking east from Hyde Park along William Street at some of the 150 signal sites in Sydney's Central Business District.




Hornsby
Dee Why
St. Leonards
Parramatta
Silverwater
C.B.D.
Rushcutters Bay
COMPUTER CENTRE
Lewisham
Newtown
Warwick Farm
Punchbowl
Taren Point
PACIFIC HWY
MONA VALE RD
PITTWATER RD
PACIFIC HWY
HILLS RD
RYDE RD
LANE COVE RD
PENNANT
CONCORD RD
GREAT WESTERN HWY
WOODVILLE RD
HUME HWY
NEWBRIDGE RD
MILPERRA RD
CANTERBURY RD
HENRY LAWSON DR
KING GEORGES RD
PRINCES HIGHWAY
ANZAC PDE
BUNNERONG RD
REGIONAL MASTER
COMPUTER LOCATION

There is a constant two-way flow of information and instructions between the master minicomputer at the Control Centre and more than 150 signal sites throughout the District. Units called 'site controllers' are housed in the familiar grey boxes located adjacent to the footpaths where signal lights are installed.

The traffic information gathered by the site controller and relayed by it to the master minicomputer is in the form of a stream of electrical impulses. These are produced by vehicles passing over electromagnetic detectors buried in the road pavement, as well as by pedestrian pushbuttons which are usually mounted on the signal support posts.

From this data, the master minicomputer is able to co-ordinate sets of adjacent or closely related signals and smooth out the flow of traffic, from one set of signals to the next.

In brief, the general principle is to group vehicles into 'platoons', which can then pass as spaced units through intersections with as little mutual interference as possible. This reduces stops and delays, thus reducing journey times and saving precious fuel.

If all streets formed a regular grid and all vehicles moved at uniform speed, a simple timing system would do the job quite well. But streets are not regular and neatly parallel, and different vehicles travel at different speeds. Furthermore, at various times during the day, the number of vehicles demanding road space changes. They are parked and 'unparked', and make other unpredictable manoeuvres.

So, an efficient traffic control system must not only co-ordinate signals but also be quickly adaptable to changing circumstances. One of SCATS major advantages is its ability to do this.

Extending the Principle

Based on the experience gained by the initial SCATS operations in the Sydney CBD, it was decided to use the same general principles throughout the metropolitan areas of the State's three largest cities.

The development of microcomputers and their use in on-street traffic controllers has helped to make this a practical and economical proposition. These can process the raw data from vehicle detector loops and pedestrian pushbuttons, and can send simpler 'predigested' information to the regional minicomputers.

Site controllers are located wherever signal lights are erected to relay traffic information to the regional master minicomputer.

Within the Sydney Metropolitan Area but outside the CBD, there are eleven regions, each under the control of a minicomputer and each handling up to as many as 120 sets of traffic signals. These are located at Punchbowl, Newtown, St. Leonards, Rushcutters Bay, Lewisham, Dee Why, Silverwater, Hornsby, Taren Point, Warwick Farm and Parramatta.

The microcomputers at the signal sites are linked to their regional minicomputers by ordinary telephone lines leased from Telecom. The cost of installing 'dedicated' (i.e. Department owned) land lines was considered far too expensive over the distances involved. The regional minicomputers are connected by data line to the Traffic Control and Emergency Centre in Oxford Street.

Finding Faults

Besides traffic information, the microcomputers also supply their master units with reports on the faults status of the signal equipment. These include checks of the in-road detectors and advice of malfunctions of signals caused by accidents or equipment failures. A 'blacked out' signalised intersection is immediately detected by the regional computer and relayed to the management computer at the Traffic Control and Emergency Centre, where it is brought to the attention of an officer on duty. The nearest signal repair team is then directed to the site and the signals are put back into working order as soon as possible.

Since a regional minicomputer is fed information from and sends instructions to its related signal site microcomputers, any loss of communication between them will affect the co-ordination of signals in that region. An alternative means of operation (the fallback mode) is provided, but it does not entail the complete duplication of components as this would not be economical.

The Fallback Backstop

This alternative is referred to as a 'cableless link'. All microcomputers in a region revert to it within seconds of any loss of contact with the regional minicomputer.

This link is 'fixed time', the time determined by a clock circuit built into each microcomputer. It is accurate within a few milliseconds (a millisecond is 1/1000th of a second) and is regularly checked and kept synchronised.

In this mode, traffic signals in the affected region run on a time of day co-ordination

The regional master minicomputer at Silverwater, which is one of the eleven regional masters outside the Central Business District.

plan, based on regularly measured traffic trends in that area. Although not as efficient as a fully adaptive mode, which responds to transient and random demands, it does ensure smoother flow than completely unco-ordinated operation, since all signals can be kept in step with one another.

Adaptability and Flexibility

The 'adaptive' aspect of SCATS can be said to have two meanings. Firstly, the system automatically adapts itself to the moment-to-moment demands of road traffic within its area of influence. For instance, outside peak hours, it can clear sudden unpredictable loads (e.g. sports spectators and concert audiences) more efficiently than any simple time-based system could.

Secondly, it tracks the gradual daytime changes due to the onset and finish of peak periods, and continuously adjusts the system to optimise traffic flow.

The "hardware" (i.e. computers, terminals, data storage, etc.) is fixed and unlikely to change much in the near future, although additions may be made if SCATS is extended further afield. But changes are relatively easy and economical in the "software" (i.e. programmes, schedules, plans, recorded data and instructions) which tells the equipment what to do.

Fingertip Control

As mentioned earlier, the nerve centre of SCATS is the Traffic Control and Emergency Centre. Here, in the control room, is a bank of over 32 television screens which display the view from a series of TV cameras installed at strategic vantage points high on city buildings throughout the CBD, on Sydney Harbour Bridge and at several critical locations in the suburbs.

Facing the television screens is a curved row of seven complex control consoles (and the room often gives visitors the impression of being part of a space vehicle launch facility). Each console has an impressive array of informational and control equipment within easy reach of its operator. Functional considerations were well to the forefront when the console layout was planned.

Slightly to the right of each operator is a TV screen, on which he or she can call up

The control room inside the Traffic Control and Emergency Centre at Oxford Street, where traffic is monitored by D.M.R. staff and members of the N.S.W. Police Force. D.M.R. staff also operate the colour graphics display sets which are suspended from the ceiling.

the same image which appears on any of the main TV monitors, for a detailed view. A 'joy-stick' lets the operator move the position of the exterior camera, if necessary, to obtain a different view and to zoom in for a close-up picture, when appropriate.

On the left of each operator is a visual display unit on which they can see a read-out of the complete status of any signal set within the total SCATS control area. Individual keyboards allow the operators to ask specific questions of the management computer at the Centre and, through it, of any regional minicomputer or any associated microcomputer.

The consoles also provide telephone facilities as well as a police radio communications link-up, which ensures the immediate clearance of unexpected traffic queues due to accidents or other emergencies.

Traffic flow is monitored at the Centre by both Departmental personnel and officers of the NSW Police Department.

Round-the-Clock Help

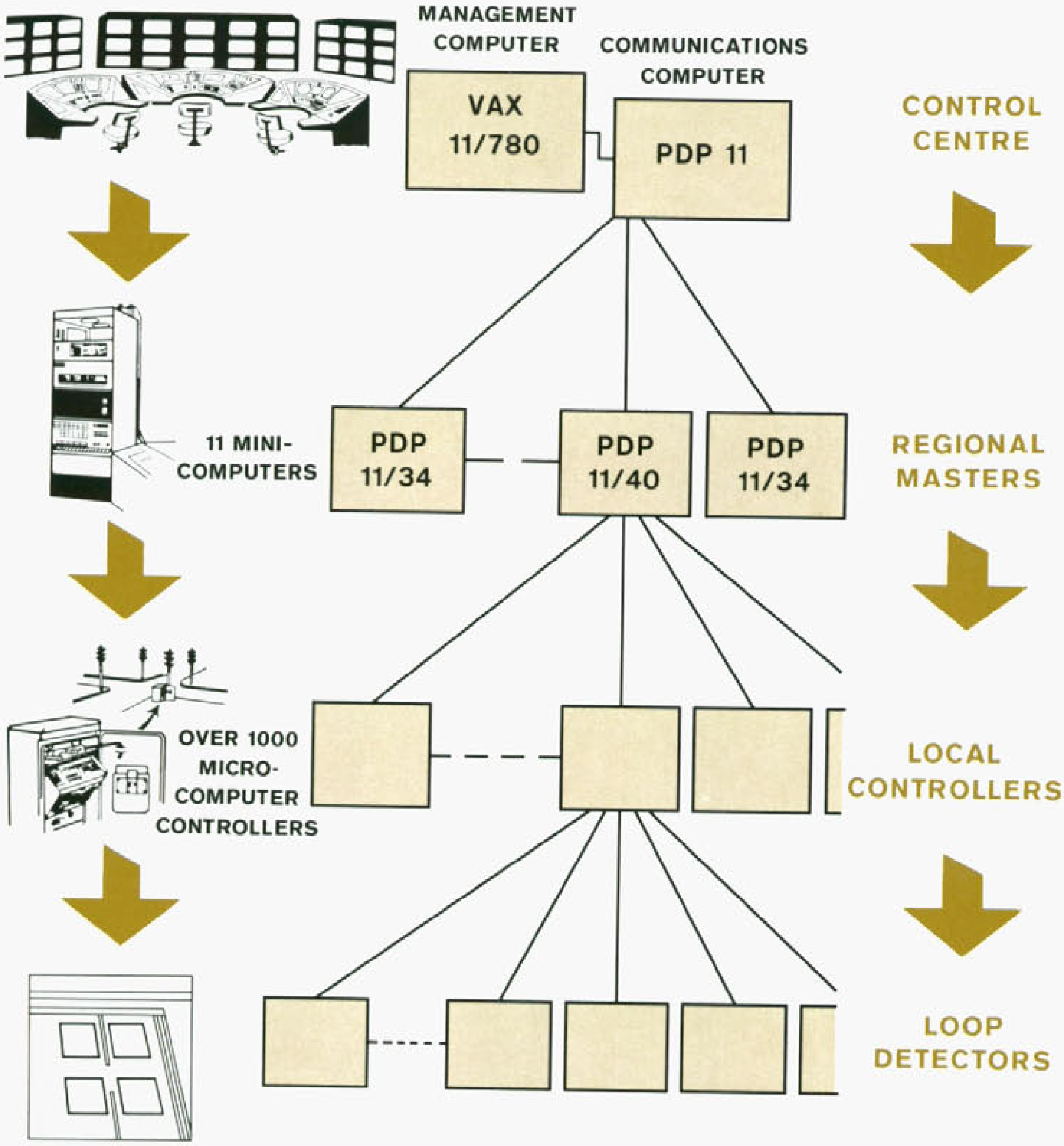
An essential role of the Control Centre is the management of all the Department of Main Roads' mobile radio traffic in the Sydney region, and the answering of emergency calls on freeway roadside telephones. All emergency calls associated with roads and breakdowns are handled by an efficient team of Departmental operators working at four radio consoles adjacent to the traffic control room.

Without the quick clearing of road obstructions and breakdowns expedited by the communications officers, who provide a 24-hour-a-day service at the Centre, the best automatic traffic control system would be ineffective.

Images of Reality

Suspended from the ceiling of the control room are a number of computer-operated colour graphics display sets. An operator selecting one of these graphics terminals can view the traffic operation of whole regions down to individual intersections in an easy to comprehend, diagrammatic way. Changes occurring in traffic patterns and intersection operations are immediately displayed on the graphics screen, giving the operator a remarkably clear, current and informative image of traffic flow throughout the metropolitan area.

A computer graphics display wherein the principal arterial roads are colour-coded to indicate changes in current traffic densities.



S.C.A.T. COMPUTER HIERARCHY

Departmental engineers in the management computer room at Oxford Street.

On these screens, the principal arterial roads are colour-coded to indicate current traffic signal cycle times which are adjusted by the system in response to changes in traffic densities. The colour codes are updated at 30-second intervals with information from the microcomputers at key intersections. A flashing area of colour indicates a change in the level of traffic density, prior to the automatic adjustment of relevant signal cycles to cope with the situation.

These graphics screens are augmented by large display maps installed strategically within the bank of television monitors. The maps serve as a quick indication to operators of key traffic parameters in the system.

Eye in the Sky

The Department's helicopter has been adapted so that it can carry a computer terminal with a radio link to the management computer. Through this link, an airborne operator can contact any regional minicomputer and any single microcomputer traffic controller at a set of signals.

From the air, an operator can sometimes see traffic patterns developing which are not detectable at ground level. He can then 'trim' or 'fine-tune' the microcomputer or the regional minicomputer to provide more effective traffic signal operation.

Keeping up a Good Record

Although nominally at the top of the SCATS hierarchy of computers, the management computer at the Traffic Control and Emergency Centre is not primarily a traffic decision-maker. Rather, it is a data storage and off-line device.

As its name implies, the management computer oversees operations. It reports traffic and equipment operation so that faults can be noted and rectified. It collects specific traffic data for short-term or long-term storage. This can be of great assistance when testing plans (actual signal timing programmes) and their effectiveness in field conditions.

The management computer also holds records of each regional minicomputer's overall plans and can 'reload' the minicomputer if necessary, for instance after a failure.

Quite a Quiet Achiever

SCATS is a computer-based traffic control system, which is immediately sensitive and totally adaptive to traffic

The Department's Traffic Systems Manager keying traffic information into the computer terminal on board the Department's helicopter. (Courtesy of Philips Industries Holdings Limited.)

demands. Its communication network provides extremely powerful yet flexible management of the system.

It offers a substantial improvement to traffic flow on arterial roads at low cost, and enables the community to get the best use out of the existing road network.

Studies on a typical urban arterial road have shown that, in comparison with unco-ordinated operation, SCATS produced the following benefits.

- Travel time was reduced by 23%,
- Vehicle stops were reduced by 46%,
- Accidents were reduced by 20%, and
- Fuel use was reduced by 12%, which represents a saving of 60 000 litres per year per set of signals.

In summary, the benefits of SCATS include not only reduced delays for road-users, improved traffic flow and decreased congestion, but also fewer tragic accidents, less use of costly and valuable petroleum resources, decreased air pollution and better conditions for residents living along arterial routes where the system is installed.

Make a Note of our Number

The Traffic Control and Emergency Centre is administered for the Department of Main Roads NSW by an Engineer-Manager. It is located in the heart of Sydney's Central Business District . . .

on the 1st Floor,
of the State Bank Building
at 1 Oxford Street,
Sydney NSW 2000.
Telephone: (02) 267 6483.

Visitors are welcome to inspect the control room on weekdays. All you need to do is to contact the Centre beforehand.

Emergency Calls

The Radio Room at the Centre is on a 24-hour stand-by for emergency calls. To contact it about traffic signal failures or faults, as well as to report any emergencies associated with roads and vehicle breakdowns, please ring (02) 211 3000.

Department of Main Roads, NSW ●

A TV camera overlooking the Cahill Expressway. These cameras are strategically located around the Sydney area so that operators at the Traffic Control and Emergency Centre can instantly monitor the traffic at any major intersection.

NEW EQUIPMENT

Department develops electronic odometer.

A need of the Department's field organisations is to measure distances for route lengths, kilometre post-marking and other aspects.

The standard Bowden Cable odometer on most cars provides neither the accuracy nor the resolution needed. Commercially available odometers which were previously used, were found unsuitable in the modern electronically instrumented vehicles, such as the Ford Falcon.

A fully electronic unit was therefore developed in the Electronics Workshop of the Department's Mechanical Section.

The new electronic odometer connects to the vehicle's dashboard across the wiring from the pulse unit on the gearbox. The unit counts the metres travelled and displays the value on a six digit Liquid Crystal display. It has a range of 1,000 kilometres and reads to one metre. Absolute accuracy depends on calibration over one kilometre when the meter is set to ± 50 cm (0.05%). Test runs have indicated repeatability of measurement to better than 0.2%.

Features of the unit include:

- a reset control to clear the display;
- a preset control which enables the operator to enter a preset value on the counters and the display;
- a latch control to freeze the display but not the counter;
- a count up/down control for decrementing the display instead of incrementing it (used in measuring lengths of side routes);
- CMOS integrated circuits which draw negligible power;
- easy installation into most vehicles.

Special features such as audible cues can be included ●

The Department's electronic odometer: an important piece of equipment which has been well-received throughout the State.

JOB CREATION PROGRAMMES

In response to new initiatives for boosting employment announced by the State Government earlier this year, the Department has been participating in several job creation programmes.

The State Youth Corps Scheme, which ran from January to May 1983, enabled the Department to employ 291 people over the 13 week period. Young men and women were engaged on a one day per week basis at various Works Offices throughout the Metropolitan and country areas. Duties ranged from clerical assistance to general labouring and survey field hand work. Each participant received a certificate and reference to verify the practical work experience gained.

Under the State Government Youth Training Programme, six people were employed with the Department in country areas. The participants were involved in both clerical and field work for 17 weeks on a full-time basis.

Funding was also provided by the Commonwealth Government for a Wage Pause Programme to assist the long term unemployed and others disadvantaged in gaining employment. Fifteen projects were selected by the Department as making a special contribution to the community. Recruitment was then carried out through the Commonwealth Employment Service in the local areas where those projects were being undertaken. The Commonwealth allocation of $5.1 million has allowed for the employment of 67 people since the programme commenced on 7 March 1983.

Under the National Employment Strategy for Aborigines, conducted in co-operation with the Department of Employment and Youth Affairs, two Aboriginal trainees were employed by Bega Works Office. They gained practical experience in the areas of road construction and maintenance works.

Providing work for our unemployed is a vital initiative. It encourages individual endeavour and, in the long run, will promote sustained economic recovery. The Department is proud to participate in such a worthwhile goal ●

Wendy Thiele. ● State Youth Corps Scheme participant, assisting Ted Bevan from Windsor Works Office with button laying.

ROAD PAVEMENT FIELD TRIAL AT ROOTY HILL

Rooty Hill Road is a main arterial road in Sydney's western suburbs. Carrying about 8,000 vehicles a day, it links the Richmond-Blacktown Road with the Great Western Highway, Wallgrove Road, and the F4-Western Freeway.

In 1981, a 1.12 km length of Rooty Hill Road north of Woodstock Avenue at Plumpton was reconstructed as a full-scale field trial to study the behaviour and performance of asphaltic concrete and fine crushed rock pavement layers.

Six different pavement designs were adopted. Each was extensively sampled and tested during construction, and subsequently observed and monitored. Instrumentation was installed in the pavements to measure strains, deflections and temperatures. Testing and analysis of results are being carried out by the Parramatta Divisional Laboratory, and the Materials and Research Laboratory in conjunction with the Materials Engineering Section and the Australian Road Research Board (ARRB).

Details of the six pavements appear in Table 1. The subgrade material varied along the length of the trial, with California Bearing Ratio (CBR) valves ranging between 2% and 35%. It was decided to import a more uniform subgrade material from Dharruk pit. This imported subgrade was nominally 200 mm thick with a final range of CBRs between 2% and 5%. Both lanes of the project were identical, but only the southbound lane was intensively tested and instrumented.

Construction by Windsor Works Office commenced in February 1981 and was completed in December of the same year at a cost of around $965,000.

Since the number of vehicles using the road each day averages between 7,500 and 8,200, it was necessary to keep both lanes open to traffic during construction by providing sidetracks capable of carrying the fairly heavy traffic volumes for a period of up to four months. A construction zone speed limit of 40 kph was implemented for the safety of motorists and workers. In order to minimise disruption to traffic while still providing a safe working area, the work was subdivided into 12 areas, each consisting of one pavement lane and an adjoining shoulder.

Excavation to a depth of 400 mm was carried out using a track-type loader fitted with rear rippers. The clay subgrade was then compacted using a self-propelled tamping foot roller, trimmed by a grader and further compacted using a vibratory-smooth drummed roller.

Culverts were upgraded and replaced. Imported subgrade material was then brought in and the compaction, sampling, trimming and levelling sequence was repeated. Target compaction was achieved after 16 to 20 passes by the roller. Setting out and levelling the cross-sections was carried out at 10 m intervals along the length of each section.

Instrumentation provided for strain gauges in both wheel paths and thermocouples in the outer wheel paths of the asphaltic concrete (AC) sections. Cables enclosed in heavy-duty PVC ducts linked the gauges to access terminals in galvanised steel boxes set in the nature strip.

The AC base courses for sections 1 and 2 were laid in four stages as follows:-

70 mm AC 20 — section 1
100 mm AC 20 — section 2
70 mm AC 20 — section 2
30 mm AC 10 — both sections

TABLE 1.

Section 1 — 100 mm asphaltic concrete
Section 2 — 200 mm asphaltic concrete
Section 3 — 300 mm asphaltic concrete
Section 4 — 450 mm unbound crushed rock (Class DGB 20)
Section 5 — 250 mm unbound crushed rock (Class DGB 20)
Section 6 — 100 mm unbound crushed rock (Class DGB 20)

The temperature of the asphaltic concrete was carefully monitored throughout the paving operation. Rolling patterns were observed and documented to ensure strict control over compaction. After each layer was paved, cross-sections were set out and levelled and instrumention was monitored.

Once the base was completed, 200 mm thick shoulders were placed then sealed with a 10 mm chip primer seal. Constant rain during June frustrated all efforts to proceed with the construction of section 3. It was then decided to excavate sections 4, 5 and 6. By the time construction of these crushed rock pavements was completed, the section 3 subgrade had dried sufficiently for its construction to commence.

The road which formed the field trial was straight and flat, with a gradual rise of 8 metres over its 1.12 km length. Existing drainage was poor and was aggravated by runoff and, in some cases sullage overflow from the adjoining semi-rural properties on the eastern side. Waterlogged subgrade material was a common problem.

The in situ material was a heavy clay, typical of Sydney's western suburbs. Excavation revealed areas under the table drains which were saturated with moisture from sullage overflow. The Dharruk material was more granular and when compacted at field moisture content yielded quite high CBR values, but after rainfall turned into a 200 mm thick quagmire. The effect of water on both subgrade materials was aggravated by ponding due to inadequate drainage.

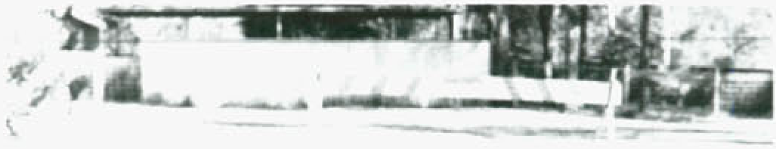
Since the experiment required a uniform, weak subgrade, it was not possible to improve the subgrade as a construction expedient by stabilisation with lime, cement or other means. Neither was it an option to provide a bitumen seal to the surface of the subgrade. The only means of 'drying' the materials was to allow air drying until plant could rip, recompact and trim the water affected area. Wet weather problems increased the time required for construction by an estimated three and a half months.

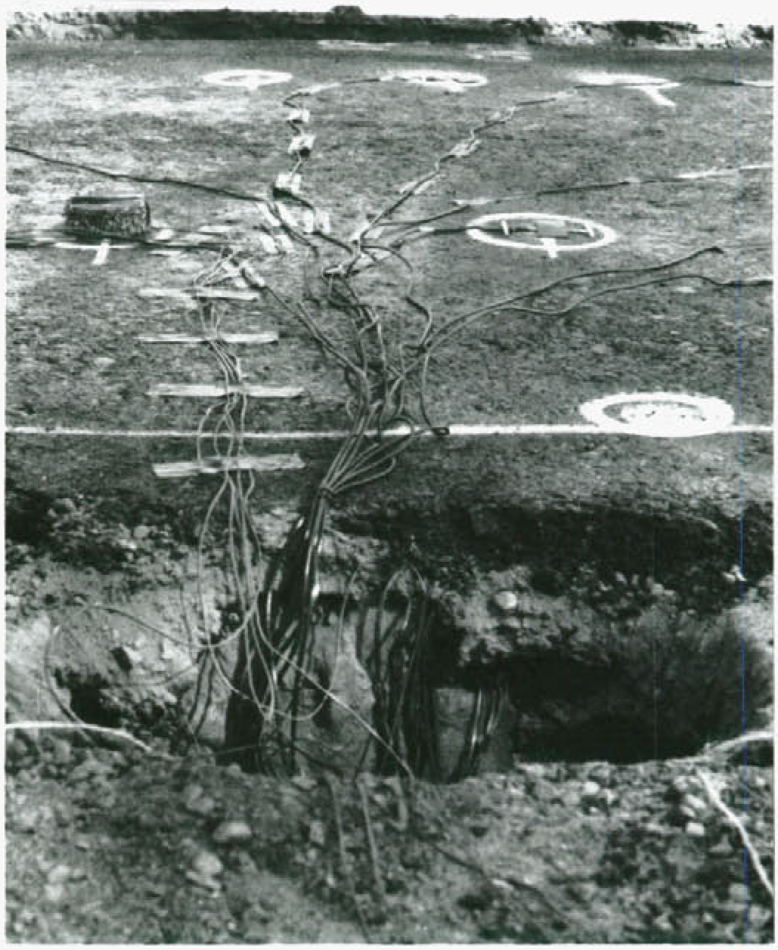
One of the main difficulties was co-ordinating the activities of the four crew involved in:

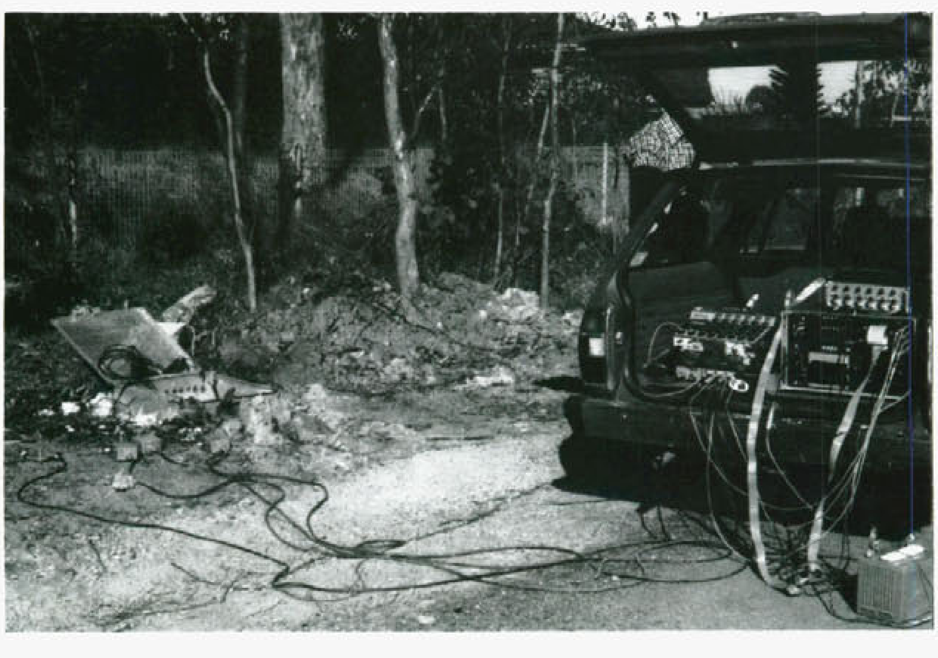
- Survey — setting out, levelling and locating instrument position;
- Testing — DMR testing laboratory operators; sampling and testing of subgrade and pavement materials;
- Testing (Special) — ARRB instrumentation, DMR nuclear density meter, and
- Construction — day labour construction crew and asphalt crew for AC pavements.

Co-ordination was effected by an engineer and scientific officer who were on site for all construction and testing of the southbound lanes. Each layer had to have cross-sections, wheel paths, instrumentation and testing sites set-out and levelled prior to cone-penetrometer, in situ CBR and deflection testing. Subject to test results being satisfactory construction of the next pavement layer could then occur. Although the construction sequence was staggered to keep all crews sequence was staggered to keep all crpling of materials for laboratory testing was usually carried out during construction.

The information obtained from the field trial will further improve the Department's pavement design procedures. As knowledge of material properties and performance increases, pavements can be designed more rationally with more appropriate selection of materials for each particular situation, and more cost effective service. Information obtained from the Rooty Hill field trial has already led to some modifications, and further improvements to design procedures are expected as analysis and monitoring continue ●







(Above) H-bar strain gauges and thermocouples are implanted below the pavement surface and connected to the Pavement Response Data Acquisition System (at right) for information recording.

SYDNEY OPERA HOUSE TURNS TEN

For many years, the Sydney Harbour Bridge stood alone as the proud symbol of our city. When the Sydney Opera House was completed in 1973, the Bridge handed over half of this honour to its young, flamboyant neighbour.

In October this year, the Opera House will celebrate its tenth anniversary. Because of the special link that exists between these dual symbols of Sydney, it is fitting for the Department to pay a birthday tribute.

Taking shape

In the 1950s, the New South Wales Government set up a committee to organise an international competition for the design of a Sydney Opera House. The winner was Jorn Utzon, a Danish architect.

To raise funds for building the complex the then Premier, J.J. Cahill, launched the Sydney Opera House Appeal Fund in 1957, which raised about $900,000. However, most of the $102 million needed for construction came from the Opera House Lottery series introduced by J.J. Cahill in 1958. (The Cahill Expressway, which carries traffic between the Bridge and Woolloomooloo, was named in his honour.)

The Opera House took 19 years to plan, build, equip and furnish. Actual construction began in March 1959.

The complex has concrete foundations and the structure is reinforced concrete. More than 1,056,000 Swedish-made ceramic tiles were used to cover the unusual conglomeration of roofs.

About 2,000 panes of French glass, totalling over 6,200 square metres, were placed in two layers to finish the vertical facing of the shell-shaped peaks.

(Right)
Festivities at the opening of the Sydney Opera House on 20 October 1973 were spectacular by day . . . and by night.
(Far Right)
The Opera House and the Harbour Bridge — dual symbols of Sydney that are recognised the world over.

Pink aggregate granite, quarried in the New South Wales town of Tarana, was used to face the exterior and interior walls, stairs and floors. New South Wales brush box and white birch plywood were used to decorate the interiors.

There are more than 900 rooms in the complex, including four main theatres, a recording hall, an exhibition hall, a

reception hall, rehearsal studios, restaurants, theatre bars, dressing rooms and a library.

Meeting the public

Prokofiev's 'War and Peace' was the first public performance to be given at the Opera House. A production of The Australian Opera, it was held in the Opera Theatre on 28 September 1973.

Three weeks later, on 20 October 1973, Her Majesty Queen Elizabeth II officially opened the Sydney Opera House. Colourful streamers played from the roof peaks of the structure and thousands of balloons were released from the grounds. A miriad of small craft gathered on the harbour to watch the spectacle. At night, the Opera House was illuminated by a massive fireworks display.

Another anniversary

The scene that day was almost a foreshadowing of events that took place on 19, 20 and 21 March 1982, when the Bridge had its fiftieth anniversary. A similar gala atmosphere and visual spectacle attended these celebrations.

With sisterly spirit, the Opera House played a significant role in the festivities. It presented a magnificent display of Departmental memorabilia entitled 'Reflections — a nostalgic look at our Bridge', in the Exhibition Hall. It offered a unique vantage point for people who took part in the many activities arranged by the Department, and provided a stunning backdrop for the Laser Light Show.

Sydney will certainly throw more parties in the future, and the chances are high that the Bridge and the Opera House will continue to feature as dual focal points for community participation and enjoyment.

Tenth year

Since its opening, approximately 30,000 performances by international and Australian artists have been presented within the walls of the Opera House, attended by more than 12,500,000 people. Presenting as many as 10 attractions each day, it has achieved a reputation as one of the world's major performing arts centres.

Throughout 1983, the Sydney Opera House has arranged a whole series of special performances in honour of its anniversary. Children will be able to join in the fun during their September holidays by taking part in a mural painting for senior schools, a poster competition for junior schools, a costume competition and fancy dress parades.

The official anniversary poster designed by Martin Sharp features the shell-shaped peaks of the Opera House surrounded by seagulls and sailing boats. A superimposed southern cross reminds us of the national identity of the structure. In the background, supporting a giant number '10', are the familiar lines of our own Sydney Harbour Bridge ●

BRIDGE WIDENING ON THE MITCHELL AND NEWELL HIGHWAYS

The Economical Alternative

Upgrading of the main roads system is constantly in progress. As part of this process, the Mitchell Highway at Rocks Hill, west of Bathurst, and the Newell Highway between Parkes and Dubbo have undergone significant improvements in recent years.

At Rocks Hill, 6.9 km of climbing lane has been constructed, one of the longest continuous sections of climbing lane in the State. The Newell Highway has been provided with a 6.8 m wide sealed pavement and an additonal one metre of sealed shoulder along much of its length.

Both these sections of highway contained a number of narrow bridges which were built in the 1930s. These varied in length from 8.6 m to 24.4 m, and all were about 6.1 m wide between kerbs. Such proportions were quite adequate for traffic conditions at that time but, fifty years later, with increased traffic volumes and travel speeds, these narrow bridges on otherwise good standard highway have become potential safety hazards to road users.

Ordinarily, new structures would have been built as funds became available but, to avoid high costs and delays, bridge widening was seen as the better alternative.

A bridge must satisfy two basic conditions to be suitable for widening: it must be structurally adequate for current design loadings, and the existing approach alignment must be of a sufficient standard to preclude the need for major realignment in the near future.

Bridge widening presents some unique construction problems mostly related to connecting the old and the new structures. Control of traffic at this stage of the work is a critical procedure that is always carried out by the Department, even on contract works.

The extent of traffic control works varies. In some cases it is a simple matter of removing the existing kerb and rail and patching the deck, activities that can be completed in one day. However, arrangements can be quite elaborate, such as requiring 24 hour flagging under floodlights while work is carried out.

An example of the work involved can be seen in this extract from the construction sequence for bridge widening at Rocks Creek No. 1 on the Mitchell Highway:

STAGE 1.

1. Support the upstream road embankments.
2. Demolish existing upstream wingwalls.
3. Construct abutments and piers.
4. Construct new wingwalls.
5. Drill holes at upstream face of deck and fix in dowels. Remove existing kerb, posts and railing upstream (cut posts flush with existing deck vertical face and seal exposed reinforcement with epoxy resin). The Department to erect a temporary barrier after removal of the kerb. Construct spans 1 and 2 excluding dowel recesses. Erect traffic barrier railing on kerb of new deck.
6. Construct column supporting existing pier headstock.
7. Contractor to allow four working weeks for the Department to construct road approaches to the new work and to remove temporary embankment support erected by Contractor in (1).

STAGE 2.

8. The Department to erect a second temporary barrier and control the traffic flow, closing the upstream lane on existing bridge and directing traffic on to new widening.
9. The Department to remove the first temporary barrier. The Contractor to scabble deck, place fabric, fix DC2 dowels and place full concrete overlay to required level and crossfall on upstream lane of existing deck. The Department to resecure the above barrier to the deck. Work to be completed within one working day.

STAGE 3.

10. Fill dowel recesses with high early strength cement concrete between 8 a.m. and 12 noon on selected day. The Department to close the traffic on new widening for 24 hours, diverting this traffic onto the downstream lane of existing bridge. Floodlighting of the bridge to be furnished by the Department during partial closure of the bridge in Stage 3.

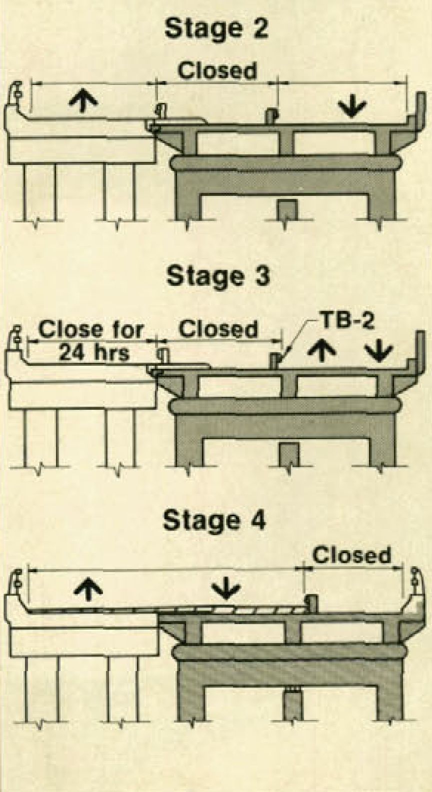
STAGE 4.

11. Effectively prop existing pier headstock on each side of new column. Place high early strength cement mortar between column and underside of existing pier headstock. Propping to be removed 24 hours after placing mortar.
12. Contractor to allow three working days for the Department to remove the first temporary barrier and place asphaltic concrete on the widening and existing deck to the second temporary barrier. The Department to control traffic during this period.
13. Demolish existing downstream kerb, post and railing on downstream side. Construct new kerb and erect traffic barrier railing. Completion of Contract.

STAGE 5.

14. Work by Department. Remove the second temporary barrier, place asphaltic concrete on remainder of deck and open the bridge to traffic.

Bridge widening at Rocks Creek No. 1.



To date, eight narrow bridges in the Central Western Division have been widened:

On the Mitchell Highway —

— Rocks Creek No. 1, 12.5 km west of Bathurst, was widened to 9.2 m between kerbs. The existing pier required strengthening and an additional pier column was constructed. The work was carried out by G. & E.M. Tincknell at a cost of $82,105.

— Rocks Creek No. 2, 13.5 km west of Bathurst, was widened to 9.2 m between kerbs by Gordon Ryan & Sons Pty. Ltd. at a cost of $126,000.

— Rocks Creek No. 3, 18.1 km west of Bathurst, was widened to 13.75 m between kerbs to incorporate a climbing lane. Traffic diversion resulted in the use of one lane in each of the new and existing decks. A median was required so that workmen could complete connection of the two decks. To provide safe conditions for both motorists and workmen a complex system was employed, combining, linemarking and guardrails with impact absorbers at either end. Work was commenced by Dalland Civil Engineering Pty. Ltd. and completed by direct control at a cost of $151,000.

On the Newell Highway —

— Fiddlers Creek, 77.6 km north of Parkes, was widened to 11.85 m between kerbs by Dallas Civil and Building Pty. Ltd. at a cost of $55,950.

— Bundara Creek, 84.8 km north of Parkes, was widened to 11.85 m between kerbs by G. & E.M. Tincknell at a cost of $54,698.

— Ugumjil Creek, 87.1 km north of Parkes, was widened to 11.85 m between kerbs. Minor realignment was carried out by designing the widened deck on a skew relative to the existing bridge. This required constructing a new kerb on the existing bridge at an angle to the original centreline. Work was carried out by G. & E.M. Tincknell at a cost of $55,445.

— Rays Creek, 87.9 km north of Parkes, was widened to 11.85 m between kerbs by G. & E.M. Tincknell at a cost of $62,825.

— Mountain Creek, 94.8 km north of Parkes was also widened to 11.85 m between kerbs by G. & E.M. Tincknell at a cost of $48,819.

The effectiveness of the bridge widening programme can be assessed by comparing the improvement to the main road system with the level of expenditure. By retaining an existing asset, the greatest advantage can be obtained for each dollar spent, which means a very economical increase in the level of service ●

(Above)
The need for widening is evident at Rocks Creek No. 2: approaching traffic must stop to allow for heavy vehicles crossing the centreline.

(Centre)
Mountain Creek during construction.

(Left)
Traffic control at Rocks Creek No. 3 during connection of the new deck to the existing deck.

(Top Right)
The improvements are apparent at Ugumjil Creek after the completion of bridge widening.

DIARY OF A FLAGMAN

The Image and the Reality

With the demise of the 'point-duty' policeman, flagmen are generally now the only human traffic controllers which most drivers see. Traffic directions are now mainly perceived from static signs or changing signals.

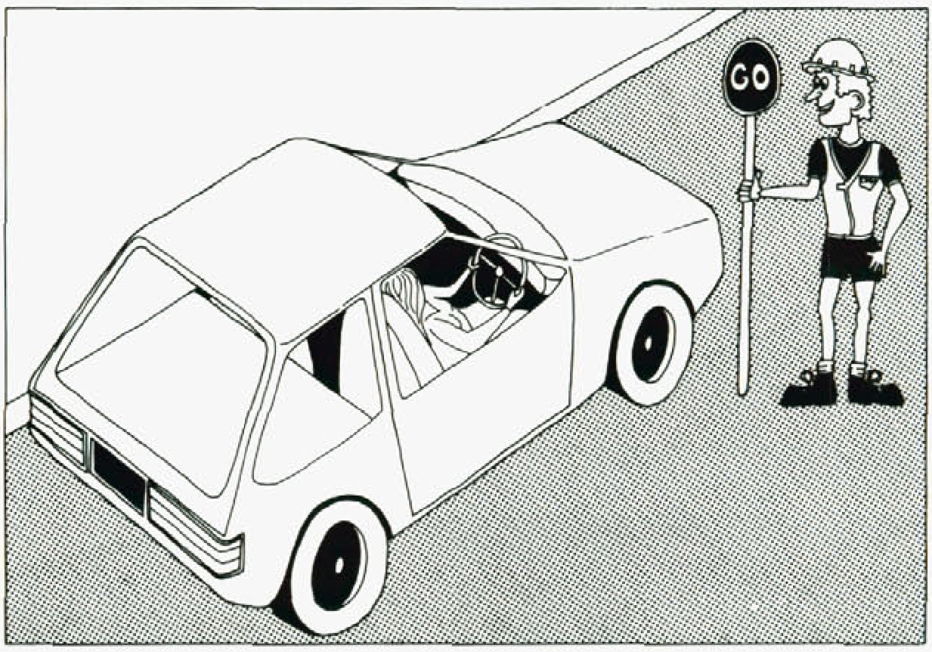
Flagmen at works in progress perform a vital traffic control function but they are often the focus of unwarranted criticism and sometimes abuse. For some (and fortunately they are a minority) passing motorists see flagmen as an obstruction to their presumed right to go wherever they want to 'without let or hindrance'.

Flagmen have considerable responsibilities in maintaining safe traffic flow past road and bridge works. In wearing a DMR armband, or other clearly visible Departmental insignia, they are authorised by their Works Engineer to control traffic on behalf of the Commissioner for Main Roads, under Clause 4 of Ordinance 30, made under the Local Government Act, 1919.

The all-too-frequent public image of a flagman is someone leaning on his baton for support, then rather sluggishly and reluctantly allowing drivers to move on.

Recently, Gus Frantz of the Department's Bega Division wrote of his own experiences with the Department. Here, in his own words, is what he sees as the other side of the picture - the reality behind the image:

"Over 20 years ago, I used to think: 'What an easy life! to be a man with a stop-go baton . . . looking about lazily.' Then, when I started with the DMR, I was



soon given a stop-go baton myself and I couldn't help thinking how good the boys were to give me such an easy job.

Well, it was okay for the first few minutes . . . but I quickly learnt I had to be alert, to keep an eye on the traffic coming and to watch for the heavy machines moving backwards and forwards on the job. I discovered that one had to hope for extra luck, too.

Anxious moments started to pop up during the day and in the evening I was even more tired than when I was fencing or on the shovel. But one just had to stay there . . . no matter if the wind was blowing the machines' dust on you or if your chest was vibrating from the noise of the heavy equipment.

I found I had to study every driver on the machines and their way of driving, to find out if they were careful ones or if they had 'blind spots' from their drivers' seats.

One also had to keep a sharp eye open at the oncoming traffic drivers. One had to try to see, in a fraction of a second, what type of driver it was. Was he going to be fast, careful or that 'king-of-the-road' type?

I saw many drivers with strained and tired faces, in cars with lots of children and often closed in with walls of glass. No wonder there are accidents with such poor ventilation, I thought. So I tried a bit of talk just to relax the drivers and, also, to answer the questions they put to me. At Brown Mountain, I couldn't help telling them . . . 'just open the windows and breathe in a bit of fresh air'.

One could not help but notice the looks on the faces of the public . . . and hear their comments. I soon learnt that a flagman is generally only thought of as a nuisance — just the chap who stops the traffic. But he is important, as he stands between the people who want to rush past and the DMR and contract drivers who have a job to do and have to concentrate to do it well.

If the new work was rough, I tried to warn drivers by waving my hand. The drivers usually smiled but hurried on. Yet as soon as they sped onto the new work, they sure got the message and slowed down!

Some years later, a flagman I knew was hit by a car at Merimbula and, after being in hospital, he still needed a walking stick for a long time. The driver who hit him had a car with faulty brakes. Today, we have plenty of better signs and flagmen have bright jackets so as to be seen quicker. But I could not help wondering how many times I could have been hit, just like he was.

Many times, I have had to get out of the way quickly when a driver in a hurry has rushed past like an offended god. As a flagman, it often seemed that I was just a pest, or less to them.

So, please when you're a driver, try to have a bit of understanding and patience, for a flagman could save you a lot of time . . . in court or in hospital or in your life, too. Don't forget, he gets all your car's fumes, all the dust, all the burning sun, all the wetting rain, all the cold, merciless wind . . . and all the danger. Please don't add your abuse of nasty words.

Try to remember the good new road being built as something that he and his mates did for you. For they are just like ghosts who vanish the moment the roadwork is finished . . . and you and your family arrive at your home door safe."

Augustus Tarcisius Frantz ●

Tenders accepted by the Department of Main Roads

The following tenders (in excess of $20,000) for road and bridge works were accepted for the three months ended 30 June 1983.

Road No.	Work or Service	Name of Successful Tenderer	Amount
Freeway No. 3	Raising and replacing guardrail on southbound carriageway between Berowra and Hawkesbury River on Freeway No. 3 — Sydney to Newcastle Tollway.	J. Corlis	$21,504.00
Freeway No. 3	Municipality of Lake Macquarie. Construction of twin bridges over Wyee Creek at 105.4 km north of Sydney.	AAMM Construction Pty. Ltd.	$299,579.50
Freeway No. 5	Supply and erection of fencing.	Boral Cyclore	$72,613.50
Freeway No. 5	City of Liverpool. Construction of earthworks and drainage from the Hume Highway to the bridge over the Georges River at Casula.	Walker Earthmoving Pty. Ltd.	Schedule of Rates
Freeway No. 6	City of Wollongong. Construction of new bridge on northbound carriageway over Byamee Street at Dapto, 94 km south of Sydney.	ADUA Contracting Pty. Ltd.	$208,891.00
State Highway No. 1	Princes Highway. Shire of Eurobodalla. Construction of bridge over Coila Creek at 12.26 km south of Moruya.	Nelmac Pty. Ltd.	$228,598.80
State Highway No. 1	Princes Highway. Shire of Eurobodalla. Repainting of bridge over Moruya River at Moruya.	K.G.B. Contractors	$98,727.00
State Highway No. 2	Hume Highway. Shire of Mulwaree. Construction of section 13.48 km to 20.30 km south of Goulburn, between Yarra and Breadalbane Hill.	Davis Contractors — A Division of Woodhall Limited	Schedule of Rates
State Highway No. 2	Hume Highway. Shire of Yass. Construction of earthworks, drainage and pavement. Two Mile Creek to Dunderalligo Creek 16.18 km to 19.95 km south of Yass.	Thiess Contractors Pty. Ltd.	Schedule of Rates
State Highway No. 2	Hume Highway. City of Wagga Wagga. Construction of dual carriageways 31.00 km to 37.70 km south of Tarcutta. Contract No. 1. Earthworks and drainage section 34.75 km to 36.60 km.	Thiess Contractors Pty. Ltd.	$942,336.00
State Highway No. 9	New England Highway. Supply and lay up to 3,500 tonnes of 10 mm dense graded asphaltic concrete and up to 4,500 tonnes of 20 mm dense graded asphaltic concrete to construction work at Bournans Creek, 13.0 km to 16.5 km west of Singleton.	Bitupave Ltd.	$569,425.00
State Highway No. 9	New England Highway. Supply, installation and commissioning of a weighing system for the Department's Kankool Weighbridge in accordance with Specification P.2430.	Avery Australia Ltd.	$21,000.00
State Highways No. 9 and 10	New England and Pacific Highways. Supply and load up to 400 tonnes of 10 mm bituminous cold mix into the Department's contract trucks to State Highways No. 9 and 10 for maintenance during 1983/84.	Boral Road Surfaces	$20,120.00
State Highway No. 10	Pacific Highway. Supply and lay up to 4,000 tonnes of 20 mm asphaltic concrete and up to 4,000 tonnes of 10 mm asphaltic concrete to reconstruction work at Cams Wharf Turnoff, 134 km north of Sydney.	Bitupave Ltd.	$565,000.00
State Highway No. 10	Pacific Highway. Shire of Tweed. Construction of bridge over Terranora Creek (Boyds Bay Bridge) at 1.8 km south of Tweed Heads.	Jennings Construction Ltd.	$3,498,524.00

Tenders accepted by the Department of Main Roads

The following tenders (in excess of $20,000) for road and bridge works were accepted for the three months ended 30 June 1983.

Road No.	Work or Service	Name of Successful Tenderer	Amount
State Highway No. 10	Pacific Highway. City of Newcastle. Construction of embankment in the southern approach to the new bridge over the Hunter River at Hexham.	Robson Excavations	Schedule of Rates
State Highway No. 10	Pacific Highway. Manufacture and delivery to site of 32 precast, pretensioned concrete girders for the widening of the bridge over Allgomera Creek, 15 km south of Macksville.	Structural Concrete Industries Pty. Ltd.	$26,160.00
State Highway No. 10	Pacific Highway. Manufacture and delivery to site of 32 precast, pretensioned concrete planks for the new bridge over Green Wattle Creek at 3.96 km south of Kempsey.	Humes Ltd.	$30,880.00
State Highway No. 10	Pacific Highway. Shires of Maclean and Richmond River. Supply and delivery of pretensioned concrete planks for bridges over Tabbimoble Creek and Tabbimoble Overflow 67.1 km and 68.4 km north of Grafton.	Humes Ltd.	$213,400.00
State Highway No. 10	Pacific Highway. Shire of Tweed. Supply and delivery of up to 2,500 cubic metres of 7MPa ready mixed concrete between 103.74 km and 106.74 km north of Ballina.	B.M.G. Resources Ltd.	$136,188.40
State Highway No. 10	Pacific Highway. Driving of 90 precast concrete piles for new bridges over Tabbimoble Creek and Tabbimoble Overflow 67.1 km and 68.4 km north of Grafton.	E.K. Sanderson	$31,025.32
State Highways No. 10 and 26	Supply and load up to 600 tonnes of 10 mm bituminous cold mix into the Department's contract trucks to State Highways No. 10 and 26 at Calga-Ourimbah Road for maintenance 1983/84.	Bitupave Ltd.	$33,600.00
State Highway No. 19	Monaro Highway. Shire of Yarrowlumla. Reconstruction of earthworks and drainage, 34.7 km to 40.4 km south of Canberra.	M.P. Constructions Pty. Ltd.	Schedule of Rates
Trunk Road No. 63	Shire of Bingara. Construction of bridge over Myall Creek at 8.0 km north of Bingara.	Roberts Construction Ltd.	$766,826.00
Trunk Road No.77	Shire of Gilgandra and Coolah. Construction of bridge over Castlereagh River at Boyben.	Ermani Constructions Pty. Ltd.	$522,797.00
Main Road No. 503	Supply and spray up to 210,000 litres of Class 170 bitumen to resealing work on Main Road No. 503, between 27 km and 85 km south of Singleton.	Boral Road Surfaces	$142,548.00
Main Road No. 503	Removal of chainwire and erection of guardrail on Main Road No. 503, between 30 km and 80 km south of Singleton.	C.P.K. Fencing Contractors	$26,620.00
Unclassified	Repainting of steelwork on the bridge over Paterson River at Dourebang.	Kayda (Aust) Pty. Ltd.	$31,698.00
Unclassified	Shire of Hume. Construction of bridge over Murray River at 'Heywoods' below Hume Dam near Abburg.	Eric Saunders and Son	$586,324.59
Various	Supply and load up to 5,000 cubic metres of natural gravel base.	Sheeky Brothers. Pty. Ltd.	$40,000.00
Various	Linemarking in Central Northern Division.	Western Roadmarking	$91,367.80
Various	Supply and laying of Calcined Bauxite Epoxy Seals.	Suregrip Surfacing Pty. Ltd.	$110,376.00
Various	Supply and application of thermoplastic transverse road marking material.	Spraypave Pty. Ltd.	$22,100.00

Tenders accepted by Council

The following tenders (in excess of $20,000) for road and bridge works were accepted for the three months ended 30 June 1983.

Council	Road No.	Work or Service	Successful Tenderer	Amount
Bombala	State Highway No. 19	Construction of bridge over Outskirts Creek.	Claremont Construction Joint Venture Pty Ltd.	$279,251.72
Cobar	Trunk Road No. 68	Construction of new bridge over Nelyambo Creek 92.81 km north of Wilcannia.	William Minterton Constructions Pty. Ltd.	$166,700.00
Coonamble	Various	Bitumen sealing under 1983/84 Trunk, Tourist and Ordinary Main Roads Maintenance and Improvement Programme and Rural Local Roads Programme.	Spraypave Pty. Ltd.	$203,488.00
Gosford	Main Roads No. 336 and 504	Supply and lay up to 4,500 tonnes of 20 mm asphaltic concrete to construction work on Main Road No. 336 from Punt Bridge to Main Road No. 504 — duplication of carriageway.	Bitupave Ltd.	$478,130.00
Junee	Various	Bitumen sealing 1982/83 Trunk and Ordinary Main Roads Maintenance and Improvement Programme.	Emoleum Aust Ltd.	$146,906.40
Port Macquarie	Rural Local Road	Demolition and removal of existing timber bridge over Cattai Creek.	Geoffrey Stewart Constructions	$21,321.00
Shoalhaven	Main Road No. 312	Construction of bridge over unnamed creek (Colognes Bridge) at 6.0 km west of Huskisson. Manufacture and delivery of bridge planks.	Rescrete Industries Pty. Ltd.	$29,400.00
Strathfield	County Road No. 5010	Hudson Park Deviation — Stage 3. Supply and delivery of 2200 tonnes of lime treated fine crushed rock.	Readymix Farley Group	$36,300.00
Walgett	Trunk Road No. 68	Reconstruction and bitumen surfacing 13.51 km to 19.10 km west of Walgett — National Developmental Roads Programme.	Cartwright Nominees Pty. Ltd.	$448,001.60
Warren	Main Road No. 333	Bitumen seal and reseal under 1982/83 Trunk, Tourist and Ordinary Main Roads Maintenance and Improvement Programme.	Spraypave Pty. Ltd.	$63,350.00
Wollondilly	Various	Supply and lay asphaltic concrete. 1982/83 Country, Trunk, Main and Tourist Roads Maintenance and Improvement Programme.	Allen Bros. Asphalt Ltd.	$89,838.00
Wollondilly	Main Road No. 177	Supply and lay asphaltic concrete — 1982/83 County of Cumberland Main Roads Maintenance and Improvement Programme.	Allen Bros. Asphalt Ltd.	$29,946.00
Wollondilly	Main Road No. 177	Supply and lay asphaltic concrete at King Falls Bridge approaches and the junction of Wedderburn and Appin Roads.	Bitupave Ltd.	$20,787.00