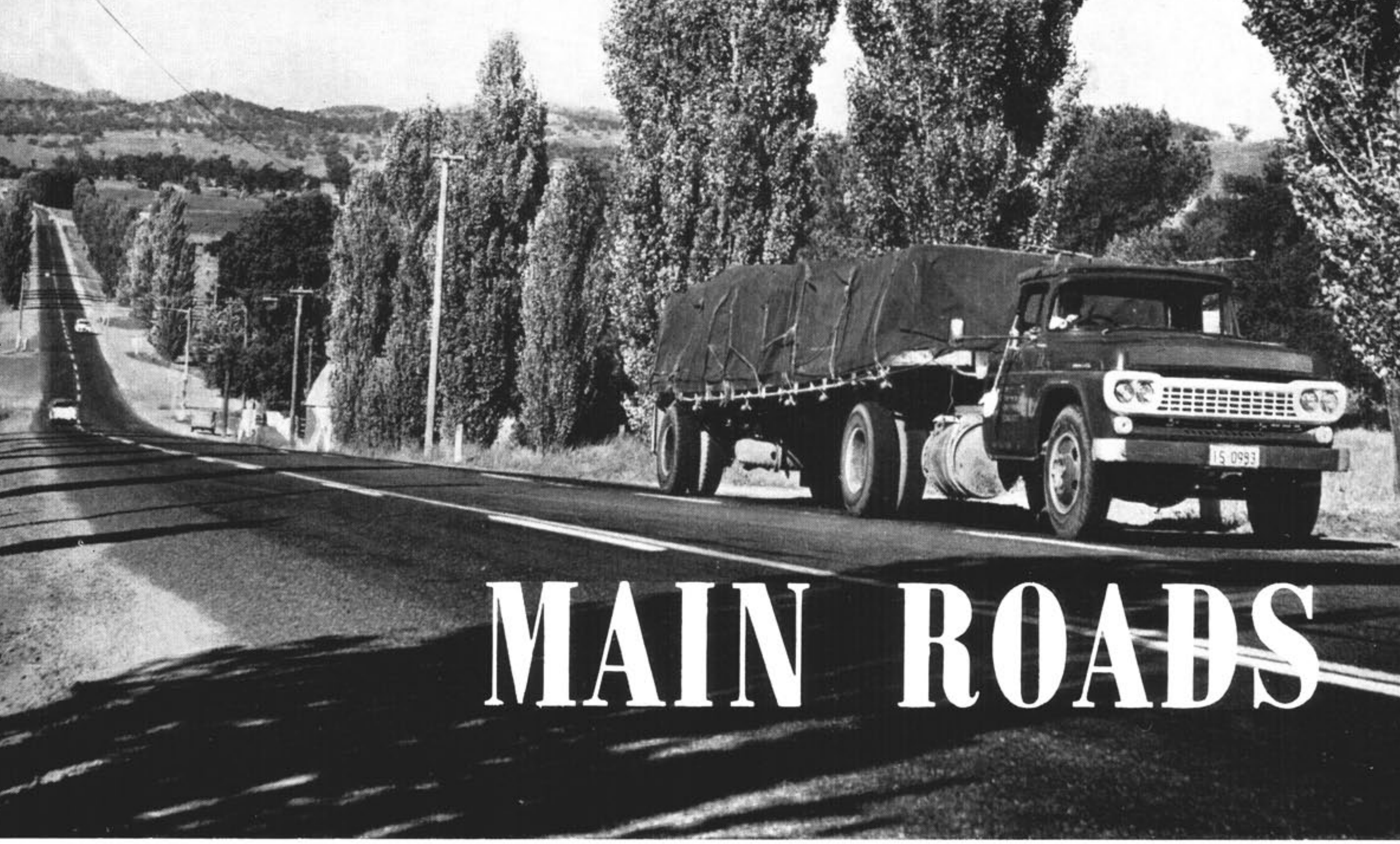
MAIN ROADS

JOURNAL OF THE
DEPARTMENT OF
MAIN ROADS
NEW SOUTH WALES
JUNE, 1961



MAIN ROADS

JUNE, 1961 Volume 26 Number 4

CONTENTS

COVER SHEET

Wollongong seen from the Prince's Highway

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DEPARTMENT OF MAIN ROADS
NEW SOUTH WALES

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Proclamation of Tourist Roads

THE Main Roads Act was amended recently to make provision for the proclamation of roads as Tourist Roads and to provide for the granting of assistance to Councils (and in the case of National Reserves to the Trustees of such reserves) towards the construction and maintenance of such roads from Main Roads Funds. The Councils throughout New South Wales have been informed that they may now apply for a road to be proclaimed as a Tourist Road.

In considering applications from Councils and Trustees of National Reserves, the Department of Main Roads will take into account the following:—

(1) Whether the road is a principal road of access to an important tourist area.

(2) Whether the road, although not serving an important tourist area, nevertheless will serve tourists by providing access to an isolated natural feature of special tourist interest.

(3) Whether the use of the road is or is likely to be confined mainly to tourists and to traffic arising from the tourist industry.

(4) The extent to which the road needs construction or reconstruction or maintenance of a nature which is, or is likely to be, beyond the reasonable capacity of the Council or of the Trustees to provide.

The Department does not propose to consider recommending for proclamation any road which is situated in a built-up area, or any road which is required principally for the use of local residents, or any road which is already adequately constructed.

Assistance to Councils towards construction and maintenance of Tourist Roads will generally be 50 per cent. of the cost involved.

It is proposed that where a Tourist Road will be required to carry considerable traffic, the standard of construction aimed at should be as for a Main Road, but for relatively low volumes of traffic, Developmental Road standards would be suitable.

The Road Needs of New South Wales

A TEN YEAR SURVEY (1960-1970)

DURING 1959/60 the Department of Main Roads, New South Wales, undertook a survey of the Main Roads system to determine what works of construction and maintenance would be required to meet properly the needs of traffic for the ten-year period from the 1st July, 1960 to the 30th June, 1970.

The survey was co-ordinated with similar surveys in other States by the National Association of Australian State Road Authorities.

The survey revealed that works estimated to cost approximately £515 million would be required to meet the reasonable needs of traffic on the New South Wales Main Roads system during the ten-year period. This is approximately £200 million in excess of the funds that are likely to be available from current sources of revenue.

In order to consider methods by which additional funds could be raised, the Minister for Local Government and Highways arranged for a conference with representatives of road user organisations and local government bodies. The conference was unanimous in its support for an expanded programme of works and recommended to the Minister means by which it considered an additional £155 million revenue might be obtained.

The following article gives a brief account of how the survey in New South Wales was made and what the needs were found to be, expressed in terms of road-work and also in terms of money.

The total length of public roads in New South Wales is approximately 127,000 miles. The classified Main Roads system comprises 22,498 miles, made up as follows:—

Classification	In County of Cumberland (Sydney Metrop. Area and immediate rural environs)	In Country Areas
	miles	miles
State Highways	194	6,309
Trunk Roads..	....	4,181
Ordinary Main Roads ..	650	11,077
Secondary Roads	87	......
Totals	931	21,567

Although the Main Roads represent only about 17½ per cent. of the total length of all the roads in the State, it is known that the Main Roads in the country carry at least 75 per cent. of all country traffic.

For many years there has been a steady increase in the number of motor vehicles registered in New South Wales and a corresponding increase in the volume of traffic on the Main Roads system. Because of limited finance, roadworks have not kept pace with the needs of traffic. Consequently many roads are inadequate in one way or another for the traffic they are required to carry. For example, in country areas there are many miles of dusty gravel or soil roads which need to be reconstructed and provided with bitumen surface; many miles of earth roads need gravelling to make them serviceable in wet weather; hundreds of new bridges are required at sites not previously bridged; hundreds of bridges already existing are too narrow or have badly aligned approaches; many roads require widening, realigning or regrading in order to provide safer travelling conditions and reduce transport costs; existing bitumen and concrete pavements need strengthening in order to carry the increasing volume of heavy loads; railway level crossings on heavily trafficked roads need to be eliminated. Similarly, in the Sydney metropolitan area many pavements need extending to the full width between kerbs, some roads need widening beyond their present boundaries, and expressways are required to carry the main streams of traffic.

To overcome deficiencies on so large a scale, improvement works must be planned over a period of years and must be based on a factual statement of their nature, cost and relative urgency. It was for this purpose that the Department decided to proceed with a Road Needs Survey along the lines of similar studies undertaken by several individual States in America over the last few years. These surveys entail extensive traffic counting and detailed field surveys of existing road conditions to determine the extent of needed road improvement.

PREVIOUS NEEDS STUDIES IN NEW SOUTH WALES

A limited Needs Survey had been made by the Department in 1950, but this related primarily to pavement condition and was confined to country State Highways. In 1955 an inventory and "sufficiency rating" survey was made in respect of the Main Roads system in the County of Cumberland. In that year also, an estimate of funds required for New South Wales roads for the ensuing ten years was prepared for a committee of the Australian Transport Advisory Council. This estimate was compiled without making a special field survey and together with estimates from other States was used in preparing a statement of road needs for the Commonwealth for the ten-year period commencing the 1st July, 1956.

AN AUSTRALIA WIDE SURVEY

In 1957 the National Association of Australian State Road Authorities agreed that the results of studies by individual States and the Commonwealth Department of Works would be used to prepare a Road Needs report for the whole of Australia. This survey did not call for as much detail as was proposed in the New South Wales survey, but, in addition, was to include unclassified roads except those situated in built-up areas.

The Association also set down the general standard of road required for various traffic intensities under average conditions.

METHOD FOR THE NEW SOUTH WALES SURVEY

The following general procedure was adopted. First of all, standards were laid down to indicate the class of road considered appropriate to various intensities of traffic (see Table 1*). Traffic counts were made to determine present traffic intensities and these were adjusted to allow for future growth. Existing road conditions were then studied to determine the extent and estimated cost of improvement works required to raise each road to the appropriate standard for the traffic it would be required to carry during the ten-year period. Provision was made for works of maintenance as well as construction.

In order to complete the survey in reasonable time, it was necessary to restrict detailed surveys to the more important roads. All State Highways throughout New South Wales (6,503 miles) and most Main Roads in the Metropolitan Division were surveyed in detail. The other roads (both classified and unclassified) were dealt with by a sampling method.

Selection of Sample Regions

As a basis for sampling, the Local Government Council areas of the State were divided into groups according to their general characteristics. Within each of these groups one Council area was selected as representative of the group, so that information obtained by detailed survey in the sample area could be extended to other members of the group, with a minimum of adjustments from shire to shire. The locations of the twenty-one sample areas are shown in Figure 1.

Traffic Counting in Sample Areas

For State Highways, traffic figures already available were sufficient to provide basic traffic data for a Needs Survey. For Trunk and Ordinary Main Roads and for unclassified roads in the sample areas, traffic counts had to be planned and made.

For each sample area a map was prepared, usually by the Council concerned, showing all roads which were known to carry, or which might possibly be carrying, 25 or more vehicles per day. From these maps, traffic counting programmes were designed and the counts were made by using fully-automatic counters, semi-automatic counters and manual classification counting. The counting for each area took about two weeks using about 30 counting machines. Counts were conducted concurrently in several areas. The resultant traffic figures were analysed and extended to produce flow maps of annual average daily traffic for each sample area. A typical map is shown in Figure 2.

Inventory and Estimates

The field inventory and estimates for the classified roads were recorded in full detail; unclassified roads were not detailed to the same extent. Figure 3 is a copy of a completed form showing the amount of detail recorded for rural classified roads. The form used for urban roads was similar, but included provision for such additional items as kerb and gutter, median strip and intersection treatment. Data for unclassified roads were recorded in summary form only for each road.

Explanatory notes were issued with the field sheets to avoid any ambiguity and to ensure uniformity in recording data on the standard forms. Each person engaged on the survey was supplied also with a schedule showing the appropriate standard of roads to be adopted for various intensities of traffic (see Table 1).

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* This table was designed to ensure uniformity with the standards adopted by the other State road authorities and varies in minor detail from some of the Department of Main Roads current standards. The standards used for the survey are considered to be the minimum required to meet the reasonable needs of traffic.

TABLE I

WIDTHS FOR CARRIAGEWAY, SHOULDER AND PAVEMENT, AND PAVEMENT TYPE

Traffic (24 hour A.D.T.)	Traffic Type a.	Design Speed m.p.h.	No. of carriageways	Carriageway width ft.	Shoulder width ft.	Pavement width ft.	Pavement Type
0– 100	P, M, T	30, 40, 50, 60	One	20*c*	4	12*c*	Unsealed *b*
100– 125	P, M, T	30, 40, 50, 60	One	20*c*, *d*	4	12*c*, *d*	Sealed
125– 300	P, M	30, 40, 50	One	26	4	18	Sealed
125– 300	P, M	60	One	28	4	20	Sealed
125– 300	T	30, 40, 50, 60	One	28	4	20	Sealed
300–1,000	P, M	30, 40	One	26	4	18	Sealed
300–1,000	P, M	50, 60	One	28	4	20	Sealed
300–1,000	T	30, 40, 50	One	28	4	20	Sealed
300–1,000	T	60*e*	One	30	4	22	Sealed
1,000–2,000	P, M	30, 40	One	28	4	20	Sealed
1,000–2,000	P, M	50, 60	One	30	4	22	Sealed
1,000–2,000	T	30	One	28	4	20	Sealed
1,000–2,000	T	40*e*, 50, 60	One	30	4	22	Sealed
2,000–6,000	P, M	30*e*, 40*e*, 50, 60	One	38	8	22	Sealed
2,000–6,000	T	30*e*, 40*e*,	One	38	8	22	Sealed
2,000–6,000	T	50*e*, 60*e*	One	40	8	24	Sealed
Over 6,000	P, M, T	30*e*, 40, 50, 60	Two	. .	8	2/24	Sealed

(*a*) *Traffic Type:*

P = Predominantly passenger cars.

M = Predominantly mixed passenger cars and trucks and/or buses.

T = Predominantly trucks and/or buses.

(*b*) *Early Sealing of Pavements:* In certain cases where, owing to shortage of materials, the maintenance of an unsealed road is very costly, or gravel is scarce, sealing of roads carrying less than 100 vehicles per 24 hour count may be considered. Also, where climatic conditions warrant it, sealing of roads carrying less than 100 vehicles per 24 hour count may be provided if such a course would effect financial savings.

(*c*) *Increased Pavement Width:* Where the sight distance, 4 feet to 4 feet, is less than twice the stopping distance, where the curvature is such that a greater width than 12 feet is required for manoeuvring, or where the shoulders are not capable of carrying traffic, the width for a pavement carrying up to 125 vehicles per day should be increased to a minimum of 16 feet, and carriageway width increased accordingly.

(*d*) *Increased Pavement Width:* Where the need for widening the sealed width can be foreseen, and where the shoulders of a 12 ft. pavement will not carry traffic satisfactorily or where the traffic volume is at the upper end of the range for which 12 ft. is considered adequate, the width of the pavement itself should normally be 18 feet, and the carriageway widened accordingly.

(*e*) *Decreased Pavement Width:* Where shoulders are firm and capable of supporting vehicles at all times, carriageway and pavement two feet less in width may be considered.

(*f*) *Measuring Carriageway and Shoulder Widths:* Carriageway widths and shoulder widths should be measured from the top of the batter in the case of embankments, and from the edge of the table drain nearer the pavement in the case of cuttings.

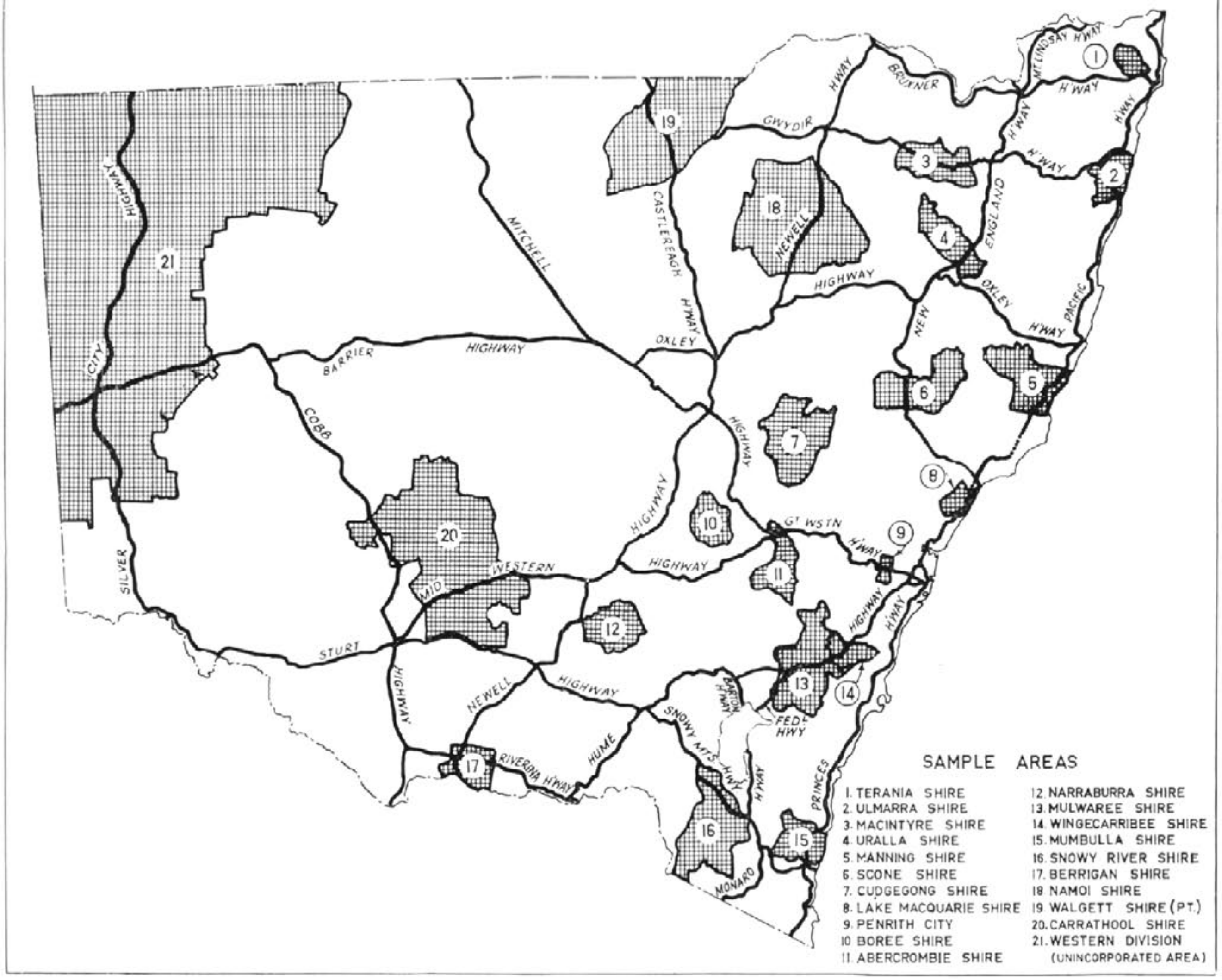
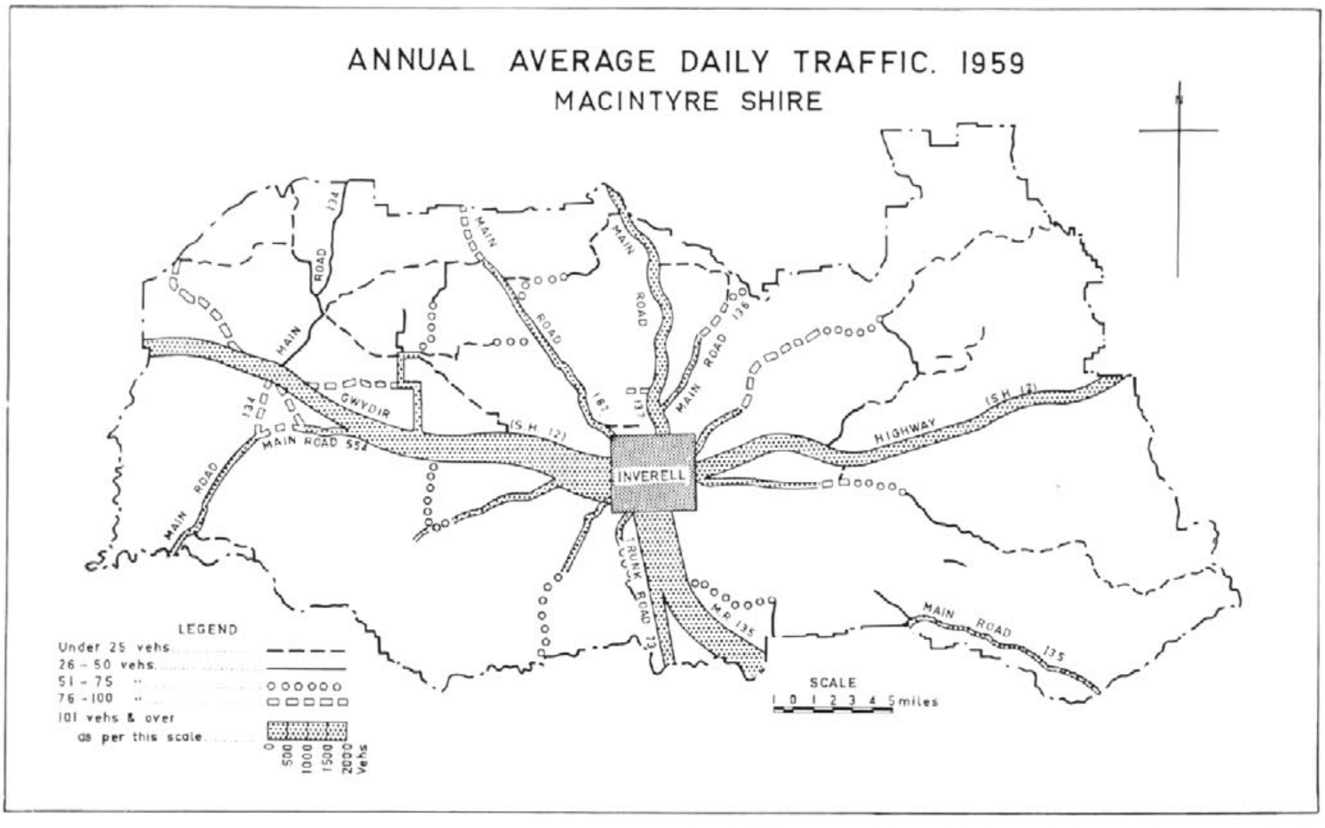


FIGURE 1

FIGURE 2



The Field Survey

Engineers from the Department's Divisional Offices carried out the field survey for State Highways, and jointly with Councils' engineers a field survey for Trunk Roads and Ordinary Main Roads in the sample areas. The rural unclassified roads in the sample areas were generally surveyed by Councils' engineers.

The Department received willing co-operation and assistance from the Councils concerned, both in the traffic survey and in the preparation of road inventories and estimates.

The field work of the Needs Survey, comprising inventories and estimates, was commenced in June, 1959, and completed in February, 1960. The traffic counting was done during the same period.

The procedure for the field inventories and estimates can be seen from an examination of the field form for rural classified roads (Figure 3). For ease in recording the data the roads being surveyed were divided into sections, so that each section had uniform characteristics throughout its length (see Items Nos. 1 to 13). programmes and these estimates were used. Maintenance estimates (Items Nos. 22 to 26) were prepared from detailed cost information relating to current maintenance operations.

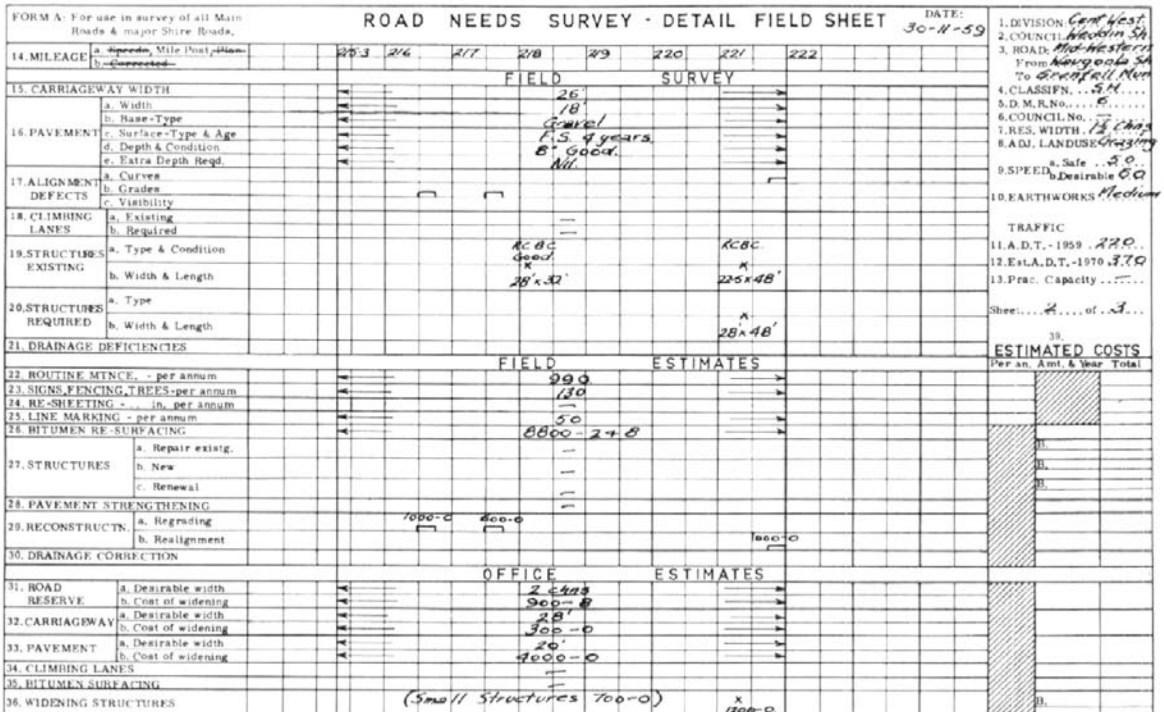
The field forms for urban classified roads and for rural unclassified roads were completed in a similar manner.

ANALYSIS OF THE SURVEY DATA

The layout of the field sheets was designed so that the survey data could be analysed either by manual methods or by data processing equipment.

Data Processing

As the field survey sheets were completed they were despatched to Head Office and prepared for punch-card tabulation. Considerable time and care was given to this phase of the work so that the cards could be stored as a future source of readily-available information as well as serving the immediate purposes of the Needs Survey. In all, some 12,000 eighty-column cards were used.



FORM A: For use in survey of all Main Roads & major Shire Roads.

ROAD NEEDS SURVEY - DETAIL FIELD SHEET DATE: 30-11-59

1. DIVISION: Cent West
2. COUNCIL: Weddin Sh.
3. ROAD: Mid-Western From Waugoola Sh. To Grenfell Mun.
4. CLASSIFN. S.H.
5. D.M.R. No. 6
6. COUNCIL No. —
7. RES. WIDTH 1½ Chs.
8. ADJ. LANDUSE Grazing
9. SPEED a. Safe 50 b. Desirable 60
10. EARTHWORKS Medium

TRAFFIC
11. A.D.T.-1959 220
12. Est.A.D.T.-1970 370
13. Prac. Capacity —

Sheet 2 of 3

14. MILEAGE a. ~~Speedo~~, Mile Post, ~~Plan~~ b. ~~Corrected~~ — 215.3, 216, 217, 218, 219, 220, 221, 222

FIELD SURVEY
15. CARRIAGEWAY WIDTH — 26'
16. PAVEMENT a. Width — 18'; b. Base-Type — Gravel; c. Surface-Type & Age — F.S. 4 years; d. Depth & Condition — 8" Good; e. Extra Depth Reqd. — Nil
17. ALIGNMENT DEFECTS a. Curves b. Grades c. Visibility
18. CLIMBING LANES a. Existing — b. Required —
19. STRUCTURES EXISTING a. Type & Condition — RCBC Good; RCBC b. Width & Length — 28'×32'; 22.5×48'
20. STRUCTURES REQUIRED a. Type b. Width & Length — 28'×48'
21. DRAINAGE DEFICIENCIES

FIELD ESTIMATES
22. ROUTINE MTNCE. - per annum — 990
23. SIGNS, FENCING, TREES - per annum — 130
24. RE-SHEETING - ... in. per annum — —
25. LINE MARKING - per annum — 50
26. BITUMEN RE-SURFACING — 8800 - 2+8
27. STRUCTURES a. Repair existg. — b. New — c. Renewal —
28. PAVEMENT STRENGTHENING —
29. RECONSTRUCTN. a. Regrading — 1000-0; 600-0 b. Realignment — 1800-0
30. DRAINAGE CORRECTION

OFFICE ESTIMATES
31. ROAD RESERVE a. Desirable width — 2 chns b. Cost of widening — 900-8
32. CARRIAGEWAY a. Desirable width — 28' b. Cost of widening — 300-0
33. PAVEMENT a. Desirable width — 20' b. Cost of widening — 4000-0
34. CLIMBING LANES —
35. BITUMEN SURFACING —
36. WIDENING STRUCTURES — (Small Structures 700-0) 1200-0
37. MISC. ITEMS —

38. ESTIMATED COSTS Per an. Amt. & Year Total

FIGURE 3

The nature and location of existing road features were then recorded (Items Nos. 14 to 21). The appropriate standard of road for the known traffic volume was then decided and compared with the existing road conditions to determine the extent of needed works and their estimated cost (Items Nos. 27 to 38). Estimates for improvement works were generally prepared on the site. In some cases, improvement proposals and estimates had already been prepared for ordinary works

The punch cards, after sorting and interpolating, were processed at a data-processing service bureau on a statistical machine, in accordance with the procedure prescribed by the Department.

The "print out" from the statistical machine thus provided the basic data required for determining the needs of all State Highways, classified and unclassified roads in the sample areas, and most of the classified roads in the Department's Metropolitan Division.

Extension of Data of Non-Sample Areas

In order to assess the needs of those roads not specifically included in the field survey, it was necessary to record information concerning the Council areas in which these roads are situated.

For this purpose statistical data was assembled for each of the remaining (non-sample) areas in the State containing rural roads. This data covered such items as population, area, land use and valuation, state of development, together with mileages of the various types of roads and their general standard.

Using the basic division of Local Government areas into groups as referred to previously, the non-sample areas were examined individually in their relation to the sample areas, and thereby figures were calculated for each non-sample area showing the likely nature and extent of improvements needed within the next ten years for each type of road. In like manner, maintenance estimates were derived for the non-sample areas.

At this stage, consideration was given to the likelihood of new roads being brought into use, both on the classified system or as unclassified rural roads.

Expressway needs in the Sydney area

Many of the arterial roads leading out of Sydney have become increasingly crowded over the last few years, and this traffic development can be expected to continue. A system of expressways has been planned to meet these conditions.

For the purpose of the survey provision was first made for the principal routes of the existing road system to be improved and widened to their ultimate planned condition. A study was then made to determine at what time these routes, so improved, would reach an unsatisfactory state of congestion and would need to be relieved by the construction of expressways. Provision was also made for the construction and improvement of feeder roads to be co-ordinated with the construction of the expressways.

RESULTS OF THE SURVEY OF CLASSIFIED ROADS

The study produced several hundred thousand figures as an answer, occupying some four volumes of "print out" from the statistical machine. All of the data relevant to the classified roads will be valuable to the Department for future planning studies and is being stored for that purpose.

Typical figures indicating the nature and extent of the work needed on the classified roads are set out hereunder.

(a) Main Roads in Country Areas

STATE HIGHWAYS

The total length of State Highways in Country areas (i.e. outside the County of Cumberland), at the time of the survey, was 6,309 miles. Some details of the work required are as follows:—

Pavement strengthening ..	3,200 miles
Regrading	390 miles
Realignment	1,050 miles
Pavement widening	3,500 miles
Bituminous surfacing ..	2,730 miles
Climbing lanes required ..	131 miles
Bituminous resurfacing ..	7,000 miles
New bridges	330
Replacement bridges	430

The cost of work required was estimated at approximately £127,000,000 comprising approximately £97,000,000 for improvements and £30,000,000 for maintenance.

TRUNK ROADS

The length of Trunk Roads in the country was recorded as 4,181 miles. Details of work required, being obtained by extension from sample areas, are not so specific. The more important items include 2,180 miles of pavement strengthening, 2,030 miles of bitumen surfacing and 3,320 miles of bitumen resurfacing.

The cost of work required was estimated at approximiately £45,000,000, comprising approximately £33,000,000 for improvements and £12,000,000 for maintenance.

ORDINARY MAIN ROADS

The length of Ordinary Main Roads in the country was recorded as 11,077 miles. Estimated needs determined by the sampling procedure include 4,690 miles of new bitumen surfacing and 6,130 miles of bitumen resurfacing. The total cost is estimated at approximately £122,000,000, comprising approximately £91,000,000 for improvements and £31,000,000 for maintenance.

(b) Main Roads in the County of Cumberland

STATE HIGHWAYS

For the recorded length of 194 miles, some details of the work required are as follows:—

Pavement strengthening ..	35 miles
Regrading	20 miles
Realignment	40 miles
Pavement widening	135 miles
Climbing lanes	5 miles
Bituminous resurfacing ..	110 miles

The cost of work was estimated at approximately £21,500,000 comprising approximately £18,200,000 for improvements and £3,300,000 for maintenance.

ORDINARY MAIN ROADS

The length of Ordinary Main Roads was recorded as 650 miles. Details of work were obtained principally by survey in the Department's Metropolitan Division, and by extension from sample areas elsewhere. The cost of work required was estimated at approximately £48,000,000, comprising approximately £39,000,000 for improvements and £9,000,000 for maintenance.

TABLE 2

EXPENDITURE NEEDS 1960/70 FOR CLASSIFIED ROADS

(in £'000s.)

(*a*) Country:—

Road Classification	Nature of Work	Needs 1960/70 Estimated Cost	Total
		£	£
State Highways	Road maintenance ..	29,100	
	Road improvement ..	70,100	
	Bridge maintenance ..	400	
	Bridge improvement ..	27,500	
			127,100
Trunk Roads	Road maintenance ..	12,200	
	Road improvement ..	25,400	
	Bridge maintenance ..	200	
	Bridge improvement ..	6,800	
			44,600
Main Roads	Road maintenance ..	29,700	
	Road improvement ..	67,700	
	Bridge maintenance ..	1,100	
	Bridge improvement ..	23,200	
			121,700
All Main Roads in Country		......	293.400

(*b*) County of Cumberland:—

Road Classification	Nature of Work	Needs 1960/70 Estimated Cost	Total
		£	£
State Highways	Road maintenance ..	3,300	
	Road improvement ..	15,890	
	Bridge maintenance ..	10	
	Bridge improvement ..	2,300	
			21,500
Main Roads	Road maintenance ..	8,900	
	Road improvement ..	31,700	
	Bridge maintenance ..	200	
	Bridge improvement ..	7,300	
			48,100
Proposed Main Roads	Road maintenance ..	410	
	Road improvement ..	3,980	
	Bridge maintenance ..	......	
	Bridge improvement ..	1,010	
			5,400
Declared Secondary Roads	Road maintenance ..	1,060	
	Road improvement ..	3,350	
	Bridge maintenance ..	40	
	Bridge improvement ..	1,350	
			5,800
Expressways	Road maintenance ..	......	54,000
	Road improvement ..	......	
	Bridge maintenance ..	......	
	Bridge improvement ..	......	
All Main Roads and declared Secondary Roads in County of Cumberland		......	134,800

Total all Main Roads in country and all Main Roads and declared Secondary Roads in County of Cumberland .. £428,200

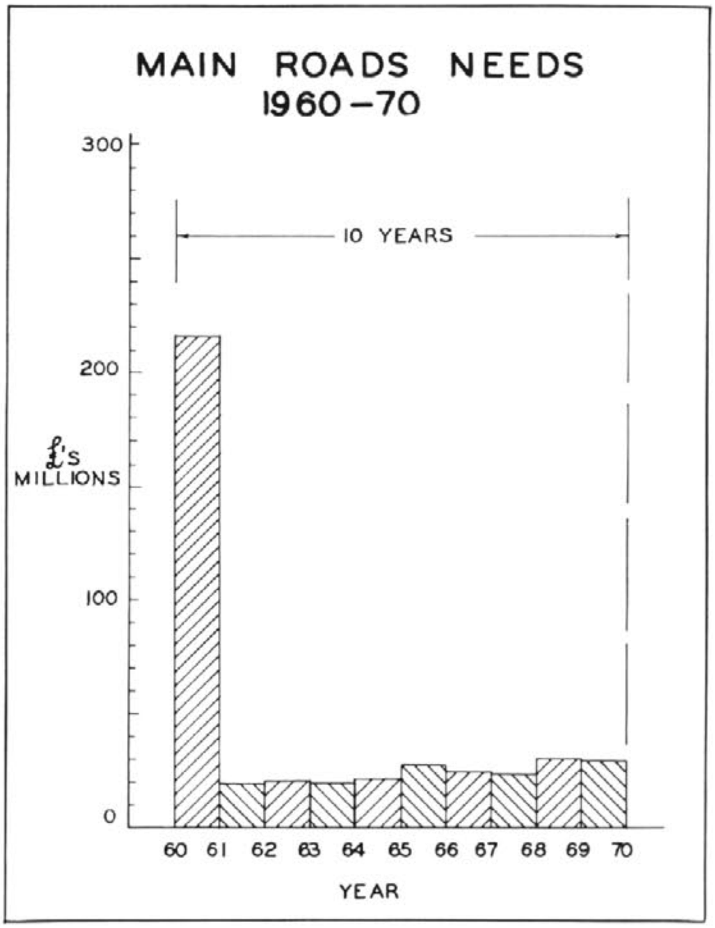


FIGURE 4

SECONDARY ROADS

Details of work for a recorded length of 87 miles were obtained in the same manner as for Main Roads. The cost of work required was estimated at approximately £5,800,000, comprising approximately £4,700,000 for improvements and £1,100,000 for maintenance.

EXPRESSWAYS

It was estimated that the expected growth in traffic over the ten-year period would make desirable the construction of about 82 miles of expressways estimated to cost £174,000,000. However, it was considered unrealistic to expect that, for such a mileage, all the land could be cleared of building, and plans and specifications prepared for construction, sufficiently quickly to enable the carrying out of all the programme judged to be needed within the next ten years. Accordingly, needs figures for expressways were adopted of approximately 10 miles of construction with an estimated expenditure of £54,000,000.

SUMMARY OF ESTIMATED COSTS

The total estimated need for all classified roads is £428,200,000. The composition of these amounts by road classification is shown in Table 2.

As well as indicating what works would be required over the ten-year period, the survey also determined the year in which each work would be needed in order to provide adequately for traffic. The relative amount of desirable expenditure in each of the ten years can be seen from Figure 4. It will be noted that about half the total expenditure is shown against the first of the ten years. This is because the works covered by this part of the programme are already needed. However, a practicable construction programme would require that the undertaking of works be spread out more uniformly over the ten-year period.

The above estimates are based on 1960 values. Having regard to past trends in the purchasing power of money, it was considered necessary to provide for a progressive increase in costs of 3 per cent. per year after 1960. On this basis, it was estimated that the total funds needed for the Main Roads of the State over the ten-year period would amount to £515,000,000 or about £200,000,000 more than the revenue likely to become available from current revenue sources.

A subsequent article will discuss briefly the methods used for the estimation of future revenues.

Portion of Wollongong from Mt. Keira Summit Park

WOLLONGONG

NEW BY-PASS ROAD NOW IN PARTIAL USE

WOLLONGONG, on the coast of New South Wales about fifty miles south of Sydney, has a population of 125,000, and is the third city in order of size in New South Wales. The Wollongong district is one of the two main centres of iron and steel production in Australia and the site of various other industries, including the refining and fabrication of non-ferrous metals and the manufacture of fertilisers. In addition Wollongong district is one of the principal coal mining areas of New South Wales. Population is rapidly increasing.

Traffic congestion on the Prince's Highway approaching the business centre has increased with the growth of population and motor vehicle registrations. To

Looking along the Prince's Highway towards main business centre of Wollongong

eira Street, Wollongong, route of Prince's Highway

provide relief, the Department of Main Roads commenced in 1959, the construction of an alternative route to by-pass the central business area. This by-pass was planned some twenty-five years ago, and most of the land required for the by-pass was acquired by the Department of Main Roads in subsequent years. An almost clear path for the by-pass road was thus available except for three houses, which require removal.

The by-pass as planned will have a total length of approximately 2.1 miles. It will have no frontage access. It will extend south-westerly from a point on the Prince's Highway about 1.2 miles north of the central business area, and will rejoin the Highway at a point about 1.5 miles south of the central business area. A link road, .9 miles long (shown by dotted line on locality sketch), will ultimately connect the by-pass to an existing Main Road (No. 513), known as Mount Ousley Road, which is an alternative route for part of the Prince's Highway leading to Sydney.

The by-pass is planned to be a divided four-lane road, each carriageway having a pavement twenty-three feet wide and a shoulder eight feet wide. As a first stage, only one of the carriageways is being constructed, although to facilitate complete construction later cuttings are being taken out now to full width.

All cross roads will ultimately be either carried over the new road or discontinued. Provision has been made for this immediate grade separation at the crossings of Gipps Road, Reserve Street and Mount Keira Road. Grade separation is planned to be provided at a later stage in the vicinity of Foleys Road.

The interchange between the main by-pass and the link to Mount Ousley Road will be effected in the area bounded by Gipps Road and Murphys Lane. In preparation for the construction of this interchange, the course of Fairy Creek in this area has been straightened.

Generally, the road pavement of the by-pass will consist of a base course of broken sandstone, an intermediate course of crushed slag and stone dust, and a surface course of pre-mixed bituminous macadam and asphaltic concrete. The northern half of the route is located on low-lying land, whereas the balance traverses higher ground with steep slopes involving a high proportion of rock excavation.

Work was commenced on the by-pass in May, 1959, and one carriageway of the first section, between the Prince's Highway at North Wollongong and Foleys Road, was opened to traffic shortly before Christmas, 1959. Traffic proceeds along the new work and thence temporarily uses local streets to by-pass the business centre.

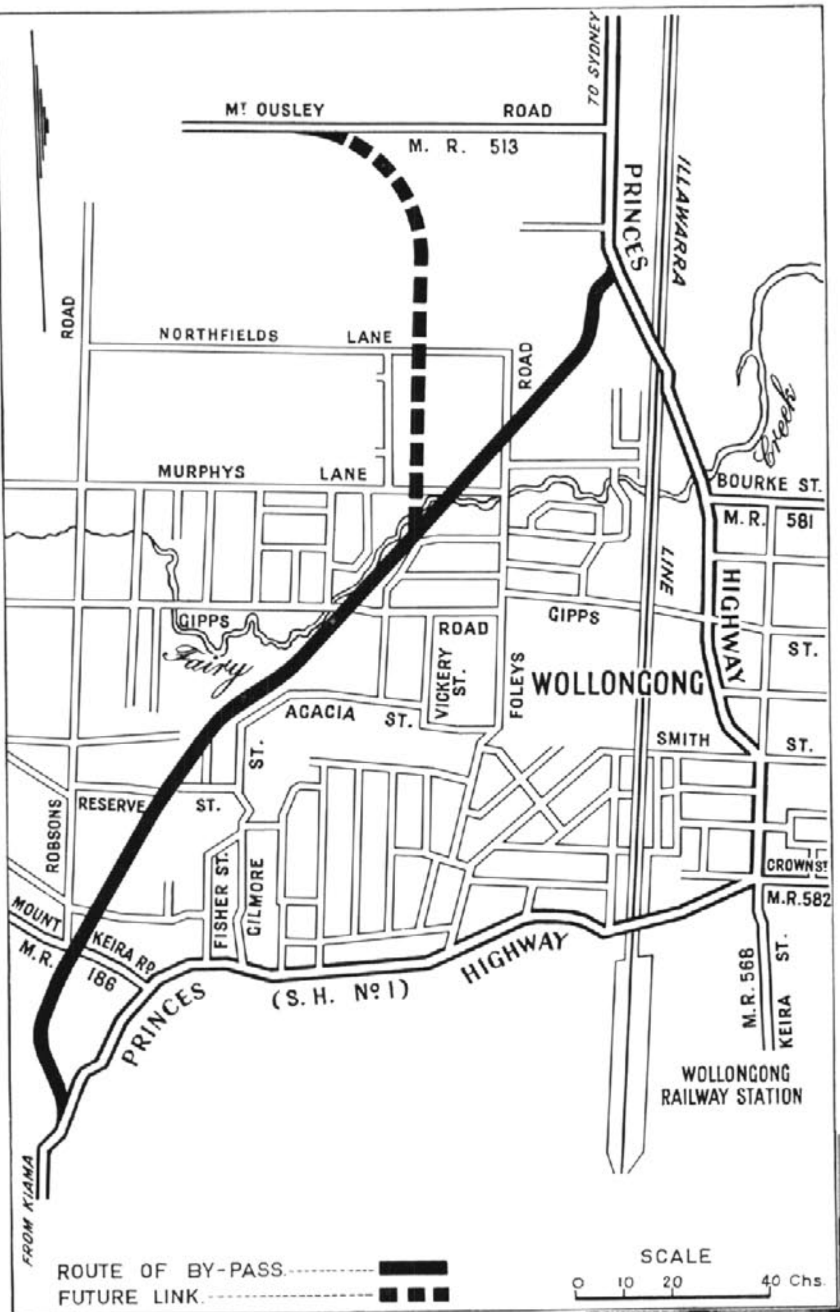
Traffic in Crown Street, Wollongong, also route of Prince's Highway

Excavation work on the Wollongong by-pass road

Work is proceeding on the remaining length of the by-pass. This involves heavy rock excavation. The softer rock (sandstone) is being loosened by ripping, but harder sections (quartzite) are being loosened by conventional drilling and blasting.

The by-pass at Wollongong will ultimately form part of an expressway being planned to pass from Sydney via Wollongong through the Illawarra district. The expressway will be a continuation of an expressway planned for the Sydney metropolitan area.

Construction of the by-pass is being undertaken by the Department of Main Roads by day labour, and is under the direction of the Department's Divisional Engineer at Wollongong, Mr. G. J. King.



Locality Sketch

The Wollongong by-pass road under construction south Reserve Street

g of formation in progress on the by-pass road

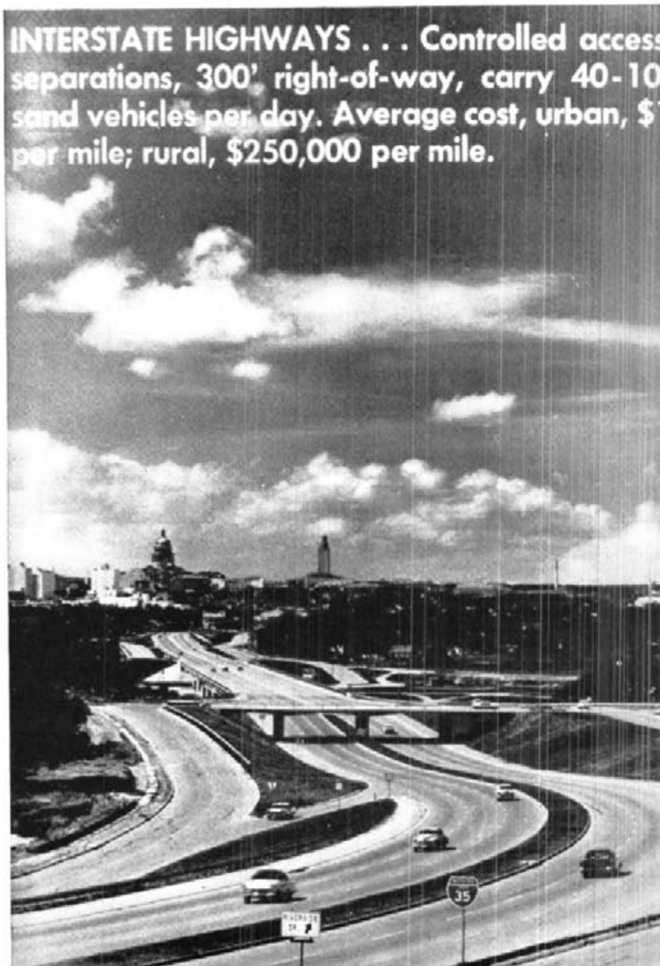
Completed section of the by-pass road near its junction with the Prince's Highway north o
Wollongong

The Future of Highways and Highway Transportation

Address by Dewitt C. Greer, Texas State Highway Engineer, Austin, Texas, delivered to the International Road Federation Pacific Regional Conference, Sydney, New South Wales, Australia, 27th February-3rd March, 1961

IT is with sincere humility that I appear today before this distinguished group. During the preceding days of this conference I have made and renewed many valued personal associations and have learned much from the constructive programme that we have enjoyed. The associations I shall warmly remember and the new found knowledge I shall gratefully carry with me to my native State of Texas, in order that I may apply it to the further development of our public roads system. I am sure that you join with me in sincere appreciation to the International Road Federation for the organisation of this conference that has brought together highway leaders from the Pacific area and some of us from the United States, permitting us to share together our thoughts and our experiences as we endeavour to make further advances in highway transportation in our respective countries.

As we begin this discussion we must definitely conclude that the future of highways and the future of highway transportation are definitely interlocked. Highway transportation has indeed a dismal future unless we can provide a better highway system. On the other hand, a better highway system would be of little value unless the future of highway transportation is assured.



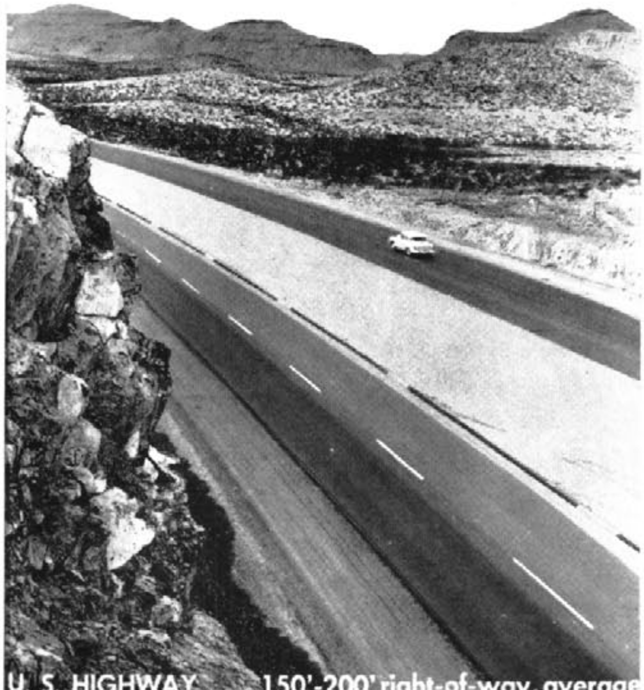
Let us therefore discuss for a moment the future of highway transportation itself. Over a period of many generations our people and our goods have been transported by water, by rail, by road, and in more recent years have been added the pipe lines and air transport. Due to the startling advances made in air transportation in recent years, some have hastily jumped to the conclusion that road or highway transportation will soon disappear from the picture and will have no place in the future of transportation.

It is only necessary to stop and think a few minutes as to where our people live, where do they farm, where are our manufacturing plants, and all of those things which sustain our economic and general growth. All of these things are on the ground, and consequently, ground transportation will be with us forever in one form or the other. It appears obvious that highways and roads will remain the favourite mode of transportation for intermediate and short haul movements all over the world. The pick-up and delivery pattern of goods and merchandise will continue to cater to this type of transportation. Our people will continue to desire in ever increasing numbers the privacy and unequalled convenience of the automobile as the answer to individual needs for private conveyance. Good highways will be in demand as never before.

It is true that we must be prepared for scientific changes and advancements in the motor transportation field. Electronic controls and other special automatic features will continue to show up in the development of the motor vehicles of tomorrow. Radical changes may be expected in the power units of our motor vehicles. New fuels and other almost fantastic power sources may be on the horizon. These new things that are to come will be merely an improvement, or a modernisation of highway transportation rather than a replacement.

In my opinion, highway transportation and public highways constitute one of the most powerful political forces in almost any country. Highways and highway transportation touch the private and business lives of all of our people. They are truly vital to their health, their happiness and their prosperity. In truth this force might be termed a giant but in many cases it is a sleeping giant. It must be stimulated into action. The question is how can this unquestioned public demand and public support be aroused into action to bring about that which the people desire and need.

Our experience in the United States teaches us that at first there must be an organised public support group such as a highway user group or a good roads association or some similar pattern that will give continuing support to a good sound highway programme. Such a public support group should not only work to arouse the public on the needs of a good highway programme, but should demand an efficient, non-politicial governmental agency to administer the highway programme from funds made available for such purpose.


U. S. HIGHWAY . . . 150'-200' right-of-way, average cost per mile $150,000, carry 4-8 thousand vehicles per day.

An efficient branch of the government to administer the planning, construction and maintenance of public highways must be staffed with trained and dedicated employees. Definite lines of authority and responsibility must be outlined in order that each branch of the organisation may do its work most efficiently under the general policies outlined by the administrative officials of the Department. By a proper delegation, both of authority and responsibility, the greatest advantages can be gained from the brains and skill of the workmen in each and every branch of the Department.

An overall highway plan looking ahead at least twenty years is highly desirable even though it might be classified by some as a wild dream, and recognizing that it will be necessary from time to time to make many changes in such a plan. The basic feature of a good highway plan for a State or for a Nation is the establishment of certain definite highway systems to accomplish the obvious objective of total road service to all the people. In our country, we have found such systems or road classifications to fall in four general categories.

The National System of Interstate Highways is a 41,000-mile network of heavy duty, high speed expressways that will link all areas of the United States from coast to coast and border to border. This system receives 90 per cent. of its financial support from the Federal government and 10 per cent. of its support from the State government. It is expected to be completed in the early 1970s, and it is estimated that this system will carry almost one-fourth of all of the traffic in the nation.

The Primary Highway System is that network of public highways that connects all of our cities and urban areas and feeds this traffic load into the heavy duty Interstate System previously described. This particular system receives 50 per cent. of its funds from the Federal government and 50 per cent. of its funds from the State government.

particular system is generally supported by 50 per cent. of the funds from the Federal government and 50 per cent. from the State Government; however, in many cases some financial support is provided by the City government involved.

Last, but not least by any means, is the Secondary Road System carrying the name in our particular State of Farm and Ranch to Market Roads. These roads fulfil the purpose of providing service to the land that produces our farm and ranch products, and permit the farmers and the ranchers to bring their stock, their produce, and crops to the market the year round. This type of road in our country receives partial support

STATE HIGHWAY . . . 120' right-of-way, average cost per mile $65,000, carry 1-4 thousand vehicles per day, 26' pavement, two 8' treated shoulders.

FARM-TO-MARKET ROADS . . . 80'-120' right-of-way, average cost per mile $16,000. Texas has 33,126 miles of these roads which carry an average of 330 vehicles per day.

The Urban Highway System is that group of our highways that is designed to carry the heavy volumes of traffic into, out of, and around our metropolitan areas. This is a rather new venture in our country brought about by the shift of our population from the rural areas to the urban areas. In our particular State this is taking on the general pattern of the "circle cross", the cross being the portion that carries the traffic into the heart and away from this heavily developed area of our cities, and the circle is the portion that carries traffic around the outskirts. This pattern seems to serve well the overall planning of our cities giving to these areas heavy duty facilities for a major portion of their transportation needs. This

from Federal grants in aid, but is principally developed from State and local revenue under the guidance of our State Highway Department. In our particular State we have built approximately 33,000 miles of these roads in the last ten years at an average cost of $15,500,000 per mile. All of these roads are two-lane asphalt surfaced roads and carry now an average traffic of 330 vehicles per day.

One might observe that all of this planning or so-called dreaming is well and good, but where is the present-day highway builder going to get the money to build any such facilities? We must always remember that this is not only what the people need, but what the people want. I have previously mentioned the possibility of the public support groups and the great assistance that they can render to the governmental agency carrying the responsibility for this particular function of the government. This is not enough. The highway administrator and the highway builder must do his part to help mould and hold public opinion behind a good, sound highway programme. First and foremost he must give an honest, efficient administration of the highway funds made available to him. He must do more than that. He must try to keep his construction programme in balance by avoiding a "crusade" for one or the other of the systems previously mentioned, but he must each year build many good samples on *each* of these systems, in order to prove to the public what can be done if funds are made available. Many times the highway administrator must plan ahead and plan well but must actually proceed by stage construction, building only a portion of that which will be the ultimate facility in order that he can make a definite mileage showing with the funds available to him. This has added merit in that he does not overbuild for the traffic presently involved, and also he has a distinct feeling of professional comfort in that each and every portion that is built into place by stages or increments will be a part of the ultimate facility to serve not only present but future generations.

The future of highways and highway transportation in the civilized world is what the highway leaders such as those assembled at this conference resolve to make of it. The possibilities have no limit.

Cleaning of the granite facing of the abutment towers and pylons and approach piers of the Sydney Harbour Bridge, is being carried out for the Department of Main Roads by contract. The granite facing came from a quarry at Moruya, about 150 miles south of Sydney. This photograph shows the pylons at the northern end of the bridge when the cleaning of one pylon was almost completed, and the other untouched

New bridge over the Murray River on the Hume Highway, Albury, at the border of New South Wales and Victoria

FOUR NEW BRIDGES

FOUR new bridges on Main Roads were officially opened between February and April, 1961. On 7th April, 1961, the Premier of New South Wales, the Hon. R. J. Heffron, M.L.A., opened a new Union Bridge over the Murray River at Albury, on the Hume Highway. On 22nd February, the Commissioner for Main Roads, Mr. H. M. Sherrard, opened two new bridges over the Namoi River, within the Shire of Namoi, one of which was the Tulladunna Bridge, 1.5 miles west of Wee Waa, on Main Road No. 343, and the other, at Harparary (7 miles from Boggabri) on Developmental Road No. 1167 between Baan Baa and Maule's Creek. On 24th March, 1961, Mr. Sherrard also opened a bridge over Bundaburrah Creek at Turner's Crossing on the New Grenfell Road (an unclassified road), approximately 6 miles from Forbes, within the Shire of Jemalong.

BRIDGE OVER THE MURRAY RIVER AT ALBURY

The new bridge over the Murray River at Albury was constructed at the joint expense of the Department of Main Roads, New South Wales and the Country Roads Board, Victoria. The old bridge was a timber truss structure built in 1896, which was in need of replacement.

The overall length of the new bridge is 300 ft. It was designed by the Department of Main Roads. Construction was carried out partly by contract and partly by day labour, by the Department of Main Roads. The bridge consists of three prestressed concrete spans each 100 ft. long supported on piers on pile foundations. Each span consists of 22 prestressed post-tensioned concrete girders. The carriageway is 28 ft. wide and there are two footways each 6 ft. 2 in. wide, together with two cycleways each 6 ft. wide.

The design of the bridge provides for widening at a later date of the roadway on the downstream side should traffic increase sufficiently to warrant the additional accommodation.

The cost of the bridge will be approximately £200,000, excluding the cost of approaches.

TULLADUNNA BRIDGE OVER THE NAMOI RIVER 1.5 MILES WEST OF WEE WAA

To replace an old timber truss bridge, which had been strengthened by temporary "Steele" bridging pending replacement, the Namoi Shire Council constructed by contract a new bridge over the Namoi River 1.5 miles west of Wee Waa. The bridge is 200 ft. long and consists of one steel truss span 121 ft. in length and two rolled steel joist approach spans each 39 ft. 6 in. long. The carriageway width is 24 ft.

The successful tenderer for construction of the bridge, and for construction of a three-cell 7 ft. x 5 ft. 3 in. reinforced concrete box culvert in approach, was Dayal Singh Constructions Pty. Ltd. Construction of the road approaches was carried out by the Council by day labour. The 121 ft. steel truss span was fabricated by the State Dockyard, Newcastle, under contract to the Department of Main Roads, and the remaining steelwork was fabricated by Armbow Engineering Pty. Ltd., also under contract to the Department.

It is expected that the cost of constructing the bridge and approaches will be approximately £67,500. Of this, the Department of Main Roads will contribute three-quarters, and the Council the balance.

New bridge over Namoi River, Wee Waa

BRIDGE OVER THE NAMOI RIVER AT HARPARARY

New bridge over the Namoi River, Harparary

The new high-level bridge over the Namoi River at Harparary, which replaces an old low-level timber structure, is a single lane bridge constructed to meet the needs of traffic on Developmental Road No. 1167 between Baan Baa and Maule's Creek.

The new bridge has an overall length of 396 ft. and was built by Central Constructions Pty. Ltd., under contract to the Namoi Shire Council. The contract also included construction of a three-cell 8 ft. x 4 ft. reinforced concrete culvert on the western approach to the bridge. The bridge consists of three steel truss spans each approximately 100 ft. in length, and three 30 ft. timber beam spans. The steelwork for the bridge was fabricated by Isles Forge and Engineering Pty. Ltd., under contract to the Department of Main Roads. The bridge has a width between kerbs of 12 ft. The road approaches were constructed by the Council by day labour.

The cost of the bridge and approaches will be approximately £47,000, to be shared equally by the Department of Main Roads and the Namoi Shire Council.

BRIDGE OVER BUNDABURRAH CREEK AT TURNER'S CROSSING ON THE NEW GRENFELL ROAD

Although the New Grenfell Road is not a proclaimed Main or Developmental Road, the Department of Main Roads has assisted the Jemalong Shire Council by providing three-quarters of the cost of constructing a bridge over Bundaburrah Creek, a flood channel of the Lachlan River, at Turner's Crossing, approximately 6 miles south of Forbes. This assistance has been granted because during times of flood, the proclaimed Main Roads south of Forbes are closed by overflow from the Lachlan River and the new bridge, which has been erected at the most practicable site available for bridging the flood waters, will, when used in conjunction with local roads connecting with the Main Roads system in the area, enable traffic from the south on both Main Roads and other roads to gain access to Forbes during times of flood.

The bridge has a carriageway width of 23 ft. 10 in. between kerbs and a length of 630 ft. It is comprised of five 126 ft. lattice girder spans on concrete piers and abutments. These lattice girders originally formed part of the old bridge over Iron Cove (an arm of the Parramatta River) between Rozelle and Drummoyne, which was opened to traffic in 1882. The girders, together with the girders from the other four spans of the Iron Cove Bridge, were hauled by road from Sydney by Mr. C. W. Jones of Forbes. The other four spans are being used elsewhere within the Shire.

The concrete piers and abutments to support the bridge at Turner's Crossing were constructed by Stanmore Construction Co. Pty. Ltd., under contract to the Council. The superstructure was assembled and constructed by the Jemalong Shire Council by day labour.

The bridge has been named "The Gordon Duff Bridge" in recognition of the services of the Council's Engineer, Mr. G. A. Duff, who was primarily responsible for the acquisition, haulage from Sydney and re-erection in the Forbes District of the old Iron Cove Bridge.

The total cost of the work will be approximately £45,000.

Left.—"The Gordon Duff Bridge" over Bundaburrah Creek at Turner's Crossing. Right.—Mr. G. A. Duff speaking at the opening ceremony

Financing

A NATIONAL ROAD SYSTEM

Paper by H. M. Sherrard, Commissioner for Main Roads, New South Wales, Australia, at the International Road Federation Pacific Regional Conference, Sydney, New South Wales, Australia, 27th February-3rd March, 1961

Three Essentials for Good Roads

To provide an effective and economical road system for a country requires the existence of certain things, especially the following:—

(1) Well trained highway engineers backed up by road and traffic research facilities.

(2) The classification of the roads, so that the function of each road may be defined. This makes it possible to allocate responsibility for the upkeep and improvement of the roads and for their financing.

(3) A system of financing which can produce a sufficient sum each year and which can be relied on to produce that sum, so that continuity will thereby be possible in organising, planning and carrying out road works.

The manner in which the problem of financing is solved will likely vary from country to country, depending on a number of factors. Among these are the following:—

(1) Stage of economic development;

(2) form of government;

(3) topography and rivers;

(4) population density.

Stage of Development of a Country as Affecting Road Finance

Consider first the stage of a country's economic development. Taxation on vehicles and on fuel may be fruitful and proper sources of road revenue in an economically well developed country like the United States, but may yield little or nothing in a primitive country such as New Guinea where the number of vehicles is insignificant. Between these two extremes there are countries in various stages of economic development.

The extent and quality of road systems vary from country to country, and in many instances they are inadequate to serve the full economic, social and governmental requirements of a modern state. Often countries with inadequate road systems are rich in economic resources, yet there may be the paradox of the bulk of the people living at a low standard.

The inadequacy of road systems arises from various causes. One common cause is the failure of some governments to recognise that good roads are vital to economic development. It is a prime function of the I.R.F. and its constituent bodies to point this out to such governments. While good roads are vital to economic advance, it cannot be claimed in every case that lack of good roads is the sole cause. There are various other causes of economic backwardness.

The governments of most countries endeavour to play some part in planning their economic development. Economic development is fully planned in those countries which have eliminated private economic interests.

Form of Government as Affecting Road Finance

The form of government varies greatly from one country to another, and affects road financing. One important group of countries has federal constitutions with a central government exercising some functions, while State or provincial governments exercise other functions, e.g., U.S.S.R., U.S.A., India, Malaya, Canada, Australia, Switzerland, West Indies, South Africa and others. Another large group of countries has a centralised government, as in Great Britain, France, New Zealand, Ghana, and so on. Then there are the "colonial" territories which are politically and economically controlled from outside, and may not be free to work out their own destinies in respect of roads or other matters.

Regardless of whether a country has a federal or a centralised government, and regardless of whether it is capitalist or socialist, it is usually the case that local affairs are dealt with locally by councils elected from local residents. There are big differences between countries in the powers given to locally elected bodies. Further in some countries, there are two tiers of local government. The upper tier may be not greatly different in practice from a provincial government under a federal system.

Thus not only is road finance in a country affected by its stage of development, but it is also affected by its form of government, whether it is federal or centralised, whether it is economically independent or dependent, and the nature and extent of the powers which are allocated to its local governing authorities.

Other Factors Affecting Road Finance

Topography, and the presence of rivers or other large internal waterways requiring to be bridged, may have a big effect on the cost of providing roads in a country, and thus affect the ease or otherwise with which its road network may be financed.

Another important factor affecting road finance is density of population. Traffic arises from people, and generally the more the people the more is the traffic. But the cost of roads is not necessarily proportional to the volume of traffic that uses them. For example, density of population has little bearing usually on the width provided for a suburban residential street, nor does density of population have much influence on width in the case of a road of access to a group of farms.

Again, the cost of a four-lane highway may be no more than twice that of a two-lane highway, but the traffic that a four-lane highway can carry is about four times that of the two-lane highway.

Density of population in California is about four times that of eastern New South Wales. California's roads are very superior, while those of New South Wales are of much lower standard. Yet the amount spent on roads *per head* of population in California appears to be only about 10 or 15 per cent. more than in New South Wales.* The ability to provide superior roads in California arises from the greater *total* annual sum available.

From the foregoing, it will be seen that there are many instances where road construction costs *per head* of population will be less where population density is high than where it is low, and this is a factor which affects road financing.

Sharing of Responsibility for Finance Between Local Government Authorities and Central Government

While there can be no uniformity among all countries in methods of road finance, past experience may give a guide as to how the problem should be tackled in any particular case.

* Available data appears to indicate that, in respect of road costs, $1 in California is equal to about 5s. in New South Wales.

It is generally accepted that roads serving entirely local uses should mainly be financed, cared for and controlled by the local people, through their local governing authority or council. Government assistance to local roads, as apart from Main Roads, may be confined to special expenditure such as—(*a*) repair of exceptional flood damage, (*b*) construction of new roads to open up new farm lands, or to provide access to isolated mines or forests, (*c*) construction of an occasional large and costly bridge which may be necessary for local purposes, and (*d*) roads to tourist resorts.

In a primitive country, local rural roads may need to be only of a low standard, and consequently come within the power of the local people to provide by local taxes or other community effort. As the standard of local road needs rises, the local people may need to seek loans repayable over a long term of years in order to construct their roads to the higher standard. Subsequently, the roads having been established, and their economic benefits being received, a local rural community may be able to support them to a large degree from locally raised revenue.

In other words, some inflow of loan money for construction may be necessary, principally in the earlier years. Otherwise local roads may depend mainly on local finance. This is commonly raised by local taxation on land, the amount of the tax being related to the productive value of the land, and thus on capacity to pay. Some countries, including Australia, supplement local revenues by allocating to local authorities for local roads a proportion of funds drawn from road users.

Roads which do not solely serve local people are not properly a full charge against local people, and should be partly or fully financially supported by the responsible government.

What Money Should be Used by the Government

In considering the source of finance for non-local roads, i.e. the roads linking together the larger communities, and which carry or are destined to carry the non-local traffic (although practically all roads also carry local traffic to some degree), the government of an undeveloped country may have little choice in the first place but to draw on either its general revenue or on loans, or both. This is because at an early stage in economic development, the number of vehicles and the fuel used by them may be insignificant as a source of taxation revenue in relation to the cost of establishing even a simple road network. Once the process of road development has been started, experience shows that in most instances the improvement and upkeep of the roads can, to an increasing degree, be met by the users themselves, who rapidly rise in numbers. Nevertheless it is logical for some contribution of general governmental revenue to continue always to be applied to roads, because of the direct benefits which governments, and peoples as a whole, receive from improved roads, for example in respect of police protection, fire protection, defence, education, postal services, ambulance and medical services and so on.

Taxation on road users can take various forms. Fuel taxation appeals to road users as being fair. However, while it may be fair as between vehicles of similar type, it can result in heavy vehicles paying less than appears equitable. This can readily be corrected by a suitably graded tax on motor vehicles to supplement the tax on fuel.

In Australia, unfortunately, the State Governments which are responsible for roads do not have the power to impose a fuel tax. Such a tax is imposed by the Federal government, which returns to the States an amount equal to about 80 per cent. of the petrol tax receipts.*

All States impose a graduated motor-vehicle tax, and some States in addition impose a ton-mile "road maintenance charge" on heavy vehicles.

Roads as a Public Utility

A question frequently posed is as to whether roads should be regarded as a public utility, and the government's share of their cost or most of it, recovered from the road users in the same way as the cost of service is recovered from users of gas, electricity, water, buses and trains, telephones, etc. In other words, should the users pay and, more important, should what the users pay be expended on the roads and on nothing else?

This argument was fought out in the United States many years ago in the early stages of that country's modern road development. The U.S. Federal Government of the time made it quite clear that revenue from road users should in its opinion be spent on roads. It is the general acceptance of this principle which subsequently has provided a basis for the vast road development which has occurred in the U.S.A. and which has been such a vital factor in the economic progress of that country. This principle is adhered to also by each of the Australian State governments in its taxation of road users.

On the other hand there are some economic theoreticians who take the view that all of a government's revenue should be placed in a central pool, that each year's needs in the various spheres of government activity should be assessed, and that the appropriate amounts should be allotted to each authority from the central pool each year, roads taking their chance with the rest. This seems to be the policy followed in Great Britain, and may well be the reason why that country's arterial roads seem to be no longer consistent with its population and traffic, and of some disadvantage to its economy.

Actually, the conception of the roads as a public utility, which has found such wide acceptance today, is also attributable to economists. Adam Smith in *Wealth of Nations*, Book V (1776), advocated such a course in the following words:—

> "When carriages which pass over a highway or a bridge . . . pay toll in proportion to their weight or their tonnage, they pay for the maintenance of those public works exactly in proportion to the wear and tear which they occasion to them. It seems scarce possible to invent a more equitable way of maintaining such work."

In most advanced countries today, decisions as to the details of the provision and improvement of arterial roads are not based on parliamentary processes, as applies to other government expenditure, but are based on factual studies of volume and nature of traffic both present and future, of population distribution and growth, and of productivity or potential productivity.

Economic growth is increasingly associated with road development. This is because road transport is overwhelmingly performing an economic function. Week-end and holiday travel may sometimes bulk large in the minds of those who work in city offices. The fact is, however, that week-end and holiday travel probably absorbs less than 20 per cent of all motor fuel used in a country such as Australia having a high motor vehicle ownership, and 80 per cent or more of all fuel is used for business purposes.

Road Classification and Cost Sharing

Earlier it was said that local roads should be mainly financed by local people, and that all roads were used to some extent by local traffic.

The roads of a country can readily be divided into classes according to their function, as follows:—

(1) The principal roads linking the major cities within the country and linking the country with adjacent countries.

(2) The roads linking the main regions of the country one to another.

(3) The roads linking local districts one to another.

(4) The roads providing for movement from place to place within a local district.

(5) The roads which give access to farms and other properties.

Each road in Class 1 usually serves also to some extent the functions of Classes 2, 3, 4 and 5. Likewise the roads in Class 2 serve also to some extent the functions of Classes 3, 4 and 5, and so on. So that if we adopt the principle that local people should pay for local roads, we could conclude that local people should make a rather small contribution to the roads in Class 1, a larger contribution to those in Class 2, a yet larger contribution to Class 3, and accept full responsibility for Classes 4 and 5. In practice, this would prove an administratively complex arrangement.

* The funds distributed to the States by the Australian federal (or "Commonwealth") government for roads are not divided proportionally to the amount collected in each State, but in accordance with a formula, namely one-third in respect of population, one-third in respect of number of motor vehicles, and one-third in respect of area. There is a further qualification, namely that not more than 60 per cent. of each State's quota may be spent on Main Roads.

In the United States and in Australia, as I interpret the position, usually Class 1, and sometimes Class 2, are fully paid for by the government. The cost of Classes 2 and 3 is sometimes shared between the government and local authorities.

Classes 1, 2 and 3 together may constitute about 15 per cent to 20 per cent of a country's road mileage, and yet sustain about 70 per cent to 80 per cent of all vehicle travel miles. They are the "main" roads as opposed to the "local" roads comprising Classes 4 and 5.

National Arterial Roads in a Federal Country

In a federal country, such as the United States or Australia, the States or provinces rather than the federal government have usually the function of providing the roads, either directly or through local governing bodies. However well they may develop arterial roads for State or provincial purposes, the country as a whole may still lack an adequate interconnected network at the Interstate or national level. In other words, the system of roads previously referred to as Class 1, if planned solely on the basis of State or provincial needs, may be incomplete as a national system unless the federal government takes positive action to achieve completion. Such action has been taken in the United States, but it yet remains to be taken by the Australian Federal government. However, the National Association of Australian State Road Authorities took the initiative at its 1960 meeting and decided to investigate the cost of construction to a suitable standard of a defined primary national network linking the principal cities of Australia. In this regard the populous south-western portion of Australia still lacks reasonably all-weather road links connecting it to the central, northern and western parts of the continent. A primary Australian road network would provide this, and would be of great economic benefit to Australia.

Finance based on Facts

One final word—in establishing or developing a system of road finance in a country, it is necessary to know the amount of finance which is needed. This should be determined from a detailed factual study of needs, including traffic surveys, traffic forecasts, inventory of existing roads, and so on. It is possible to carry out such studies without undue elaboration.

In an underdeveloped country, road standards aimed at in the first place should not be set too high. Far more economic benefit will usually result from a large, carefully selected mileage of moderately improved roads, than from a relatively short mileage of roads of highest standard. "Stage construction" is the principle which has usually been followed in Australia, and I warmly commend it to other developing countries, with the proviso, however, that adequate control over the loaded weight of vehicles is necessary.

Main Roads Funds

Receipts and Payments for the period from 1st July, 1960 to 31st March, 1961

General Purposes

Heading	County of Cumberland Main Roads Fund	Country Main Roads Fund
	£	£
RECEIPTS—		
Motor Vehicle Taxation (State)	1,351,686	5,407,825
Charge on heavy commercial goods vehicles under Road Maintenance (Contribution) Act, 1958 (State)	524,258	2,097,032
Commonwealth Aid Roads Act, 1959	1,141,977	4,417,908
From Councils under Section 11 of Main Roads Act and for cost of works	808,846	24,698
Other	233,624	580,786
Total Receipts	4,060,391	12,528,249
PAYMENTS—		
Maintenance and minor improvement of roads and bridges	1,014,441	4,279,750
Construction and reconstruction of roads and bridges	2,019,770	6,857,862
Land acquisition	661,453	69,141
Administrative expenses	139,291	531,039
Loan charges—		
Payment of interest, exchange, management and flotation expenses	13,110	190,921
*Miscellaneous	555,325	635,432
Total Payments	4,403,390	12,564,145

* Includes transfers to Special Purposes Accounts in respect of finance for Operating Accounts, Suspense Accounts and Reserve Accounts.

ROAD WARNING SIGNS

USE OF SYMBOLS

FOLLOWING the issue recently by the Standards Association of Australia of a revised edition of the Australian Road Signs Code, there was some reference in the Sydney press to the question as to whether such signs should convey their messages by means of symbols to a greater extent, practice in Europe being referred to. The S.A.A. Code in the main conforms with American practice, which is to use symbols to some extent but not in all instances.

The question of a universal code of road signs based on symbols has been studied over a number of years. As long ago as 1909, a number of European nations agreed on four standard symbol signs—see Figure 1. In 1926, it was decided that the four signs referred to should be triangular in shape. In 1931, under the auspices of the League of Nations, a series of circular regulatory signs and rectangular information signs were added, and some action was taken towards uniform practice in respect of colour.

The first general American standards were adopted in 1925. Practically all messages were expressed in words. Warning signs were mainly diamond shaped, regulatory signs rectangular with the longer dimension vertical, and direction signs rectangular with the longer dimension horizontal. The "stop" sign was octangular. In subsequent revisions of the American standards, symbols have displaced lettering, or have been used to supplement lettering, on many of the more commonly used signs.

In 1935, the first Australian Road Signs Code was published.

In 1949, the United Nations reviewed the signs which had been agreed on in Europe in 1926. Subsequently a committee was set up to review practices throughout the world and to attempt to combine the best of current standards, keeping in mind the need for maximum use of symbols. As a result of this committee's work, the symbol warning signs shown in Figure 2 were produced. (Shown as applied to diamond shaped boards as used in the United States of America and Australia). It will be noted that a substantial number of these are similar to current Australian standard signs.

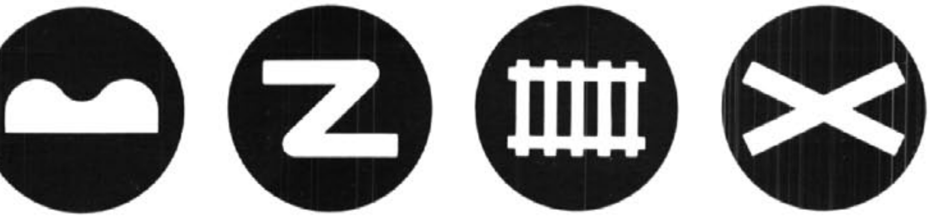


Figure 1. Symbol signs agreed on by some European Countries, 1909

The proposed universal code also provided for a series of prohibition signs, comprising a red ring surrounding a symbol. Where the red ring is supplemented by a red diagonal stripe, it means that the action shown by the symbol is *not* to be taken. For example, in Figure 3, diagram 1 means "Do not enter"; diagram 2 means "No left turn"; diagram 3 means "No U turn"; diagram 4 means "No passing"; diagram 5 means "Width limit"; diagram 6 means "Height limit"; diagram 7 means "Speed limit"; diagram 8 means "Keep right"; diagram 9 means "No trucks"; diagram 10 means "No motor vehicles"; diagram 11 means "No bicycles"; and diagram 12 means "Quiet Zone".

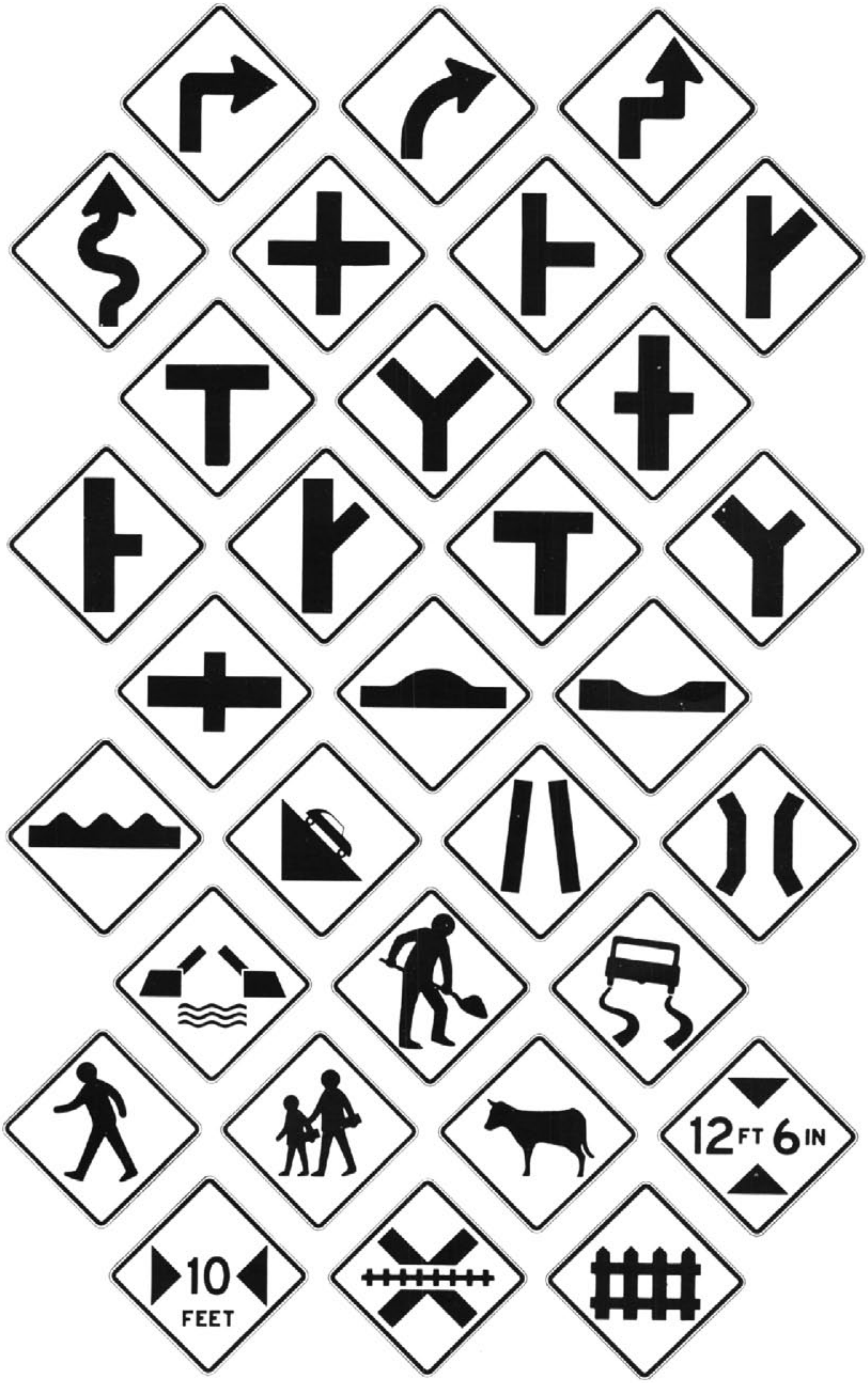


Figure 2. Symbol warning signs proposed by United Nations Committee, 1949

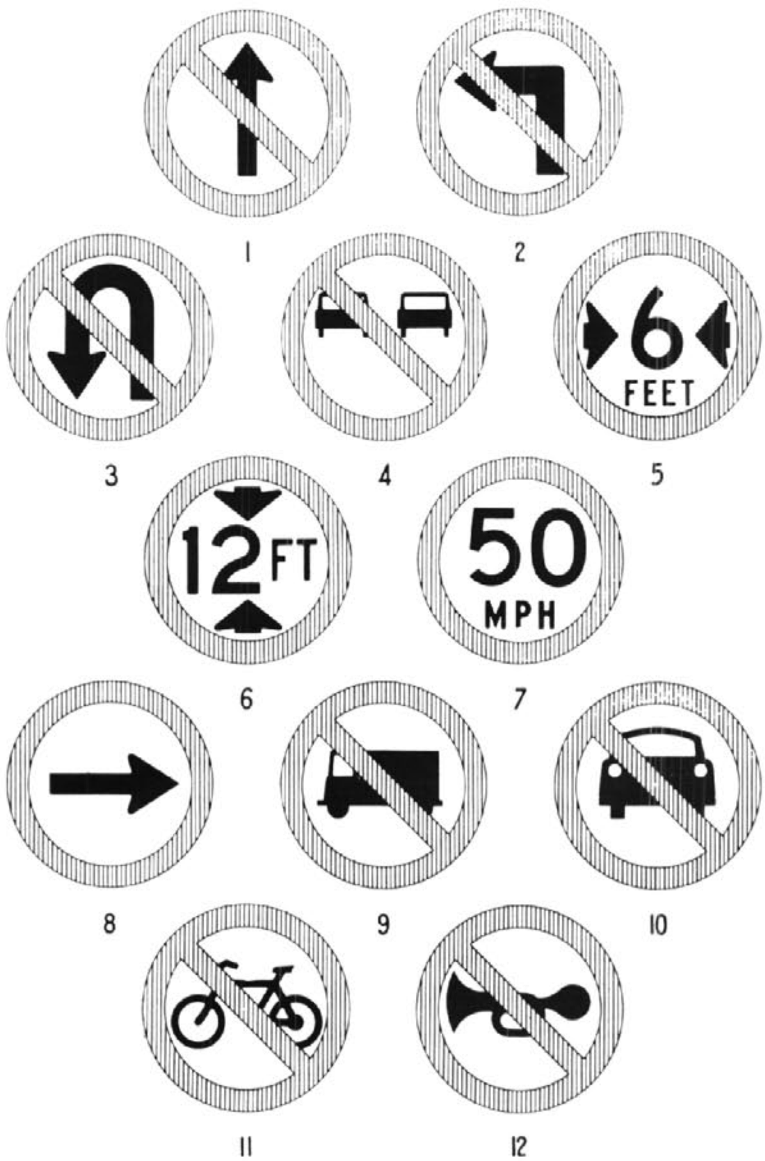


Figure 3. Prohibition symbol signs proposed by United Nations Committee, 1949

There is no doubt that many symbols, such as the curved arrow indicating a curve ahead which has been adopted in Europe, America, Australia and elsewhere, would be reasonably understood or their meaning grasped in practically all countries. On the other hand, it seems fairly clear that some of the symbols which have been proposed for universal adoption would only be understood with difficulty in a number of countries. Some symbols proposed would likely prove difficult for many to comprehend, even in a country such as Australia.

Having regard to the wide differences in outlook and experience that exist among the peoples of the world, it seems unlikely that the universal use of a uniform and comprehensive code of symbols is either practicable or advantageous at this stage. However, there may be some scope yet for an increase in Australia in the use of symbol warning signs, although the scope is limited because the warning signs most commonly used are already in the form of symbols. For example, a recent check on warning signs ordered during a twelve months period by the Department of Main Roads, New South Wales, showed that 64 per cent. employed symbols.

Figure 4 shows the symbol warning signs provided for in the Australian Code. In some instances a sign with words is allowed as an alternative.

Figure 4. Symbol signs already included in the Australian Standard Road Signs Code

Warning signs in the Australian Code which have words and no symbol include the following—"narrow bridge", "one lane bridge", "road narrows", "divided road", "divided road ends", "traffic island", "low clearance ft. in.", "ferry", "opening bridge", "steep descent", "steep climb", "causeway", "ford", "dip", "floodway", "low level bridge", "crest", "hump", "gate", "grid", "slippery when wet", "gravel road", "trucks crossing", "stock crossing", "stock droving", "merging traffic", "children", "school", "playground", "hospital", "pedestrian crossing ahead". A few of these seem to lend themselves to expression by symbols which could be understood in most countries, but others either do not appear to do so, or are so seldom used that symbols, if applied, would seem likely not to be widely understood.

The Joint Committee which prepared the current manual of road signs in use in the United States has called for initiation of a programme of research to determine the extent to which symbols can be used to advantage in traffic signs. The Committee comprises representatives of the American Association of State Highway Officials, the Institute of Traffic Engineers, and the National Conference on Street and Highway Safety.

The information herein of efforts to obtain world uniformity of road signs is based on an article by William G. Eliot III., U.S. Bureau of Public Roads, in "Traffic Engineering", December, 1960, the official publication of the Institute of Traffic Engineers, U.S.A.

Use of Helicopter i

DURING each Easter week-end, a concentration of traffic occurs in the Moore Park-Randwick area of the Sydney eastern suburbs, on account of the holding simultaneously of the Royal Agricultural Show and race meetings at Randwick Racecourse. Over 600,000 persons attend these attractions, only a mile apart, on Good Friday, Easter Saturday and Easter Monday.

It was decided that the Department of Main Roads would make observations from a helicopter and undertake a traffic survey of the arterial roads leading to the area, with a view to determining the nature and extent of any congestion occurring, so that means might be devised, if possible, to relieve it. The observations and survey were carried out at Easter, 1961, with the co-operation of the Police Department and of the Sydney City Council.

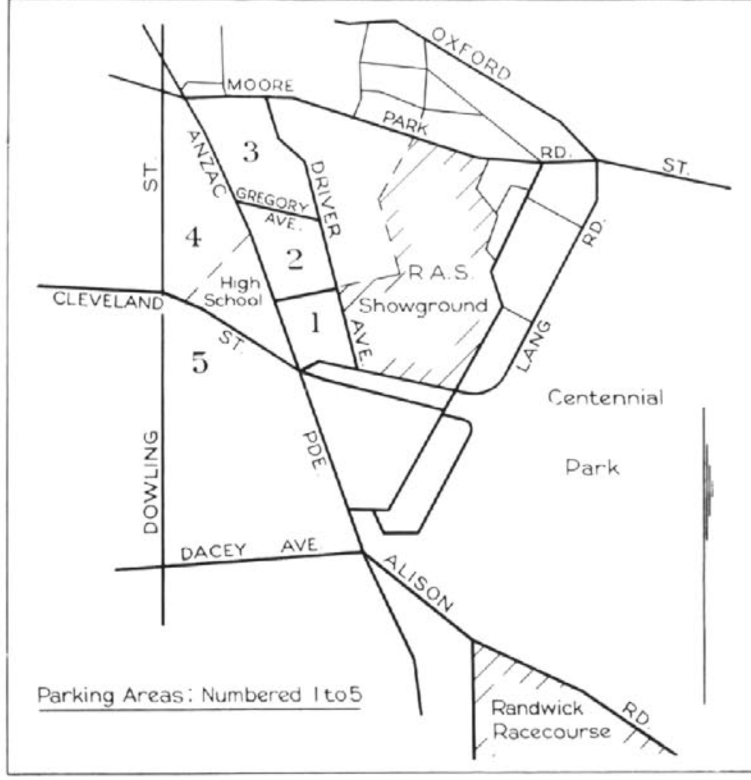
Traffic counts were made on a cordon line established around an area bounded generally on the north by Moore Park Road, on the east by Centennial Park, on the south by the University of New South Wales, and on the west by Moore Park. All traffic entering or leaving the cordoned area was counted on the afternoons of Good Friday and Easter Monday and between 8 a.m. and 6.30 p.m. on Easter Saturday. In addition, traffic making turning movements at each of four major intersections in the area was counted.

The helicopter used to observe traffic movements was in the air for twelve hours spread over Good Friday, Easter Saturday and Easter Monday. It carried two passengers in addition to the pilot, and was normally occupied by a traffic engineer and a photographer. The engineer recorded observations by means of a battery-operated portable tape recorder with a throat microphone and at the same time used a transceiver set to convey the same information to a ground station.

This was the first occasion the Department of Main Roads had used a helicopter for traffic observation, and its use proved highly successful. Observations were made of approach roads, operation of intersections, difficult turning movements, and operation of parking areas, especially those adjoining the Showground. Police officials at the ground stations received immediate reports on traffic conditions. Photographs were taken from the helicopter where considered desirable to have a permanent record of traffic conditions.

Ground station at Victoria Barracks, Sydney. Helicopter taking off for flight over the survey area

affic Survey



Locality sketch of survey area

The following are some of the results of observations from the helicopter:—

1. Movement into Showground Parking Areas

The locations of the main Showground parking areas are shown in Figure 1 and are numbered 1 to 5. Numbers 1 to 3 are on the east of Anzac Parade, and are nearest to the Showground . It is customary to fill these parking areas in their order as numbered.

The main entrance into parking areas numbers 1, 2 and 3 is at the Cleveland Street-Anzac Parade intersection. Entering traffic moves slowly, and as soon as No. 1 parking area is filled traffic tends to queue up from the intersection (see Photograph 1).

When these three parking areas are filled, traffic continues to enter the entrance at the Cleveland Street-Anzac Parade intersection, but continues along Gregory Avenue and thence back into Anzac Parade, where it moves into No. 4 parking area. At the same time some vehicles turn left from Cleveland Street into Anzac Parade in order that they may proceed directly along Anzac Parade to the entrance of No. 4 parking area. When these two movements are in progress, traffic congestion may occur in Anzac Parade and may cause a multiple lane queue extending back along Anzac Parade to and along Cleveland Street (see Photograph 2).

There is an entrance to parking area No. 4 at the junction of Cleveland and Dowling Streets. This is substantially similar in position to the entrance at the intersection of Cleveland Street and Anzac Parade, and could result in similar queuing. However, this did not occur because little use was made of this entrance at Easter, 1961 (see Photograph 3).

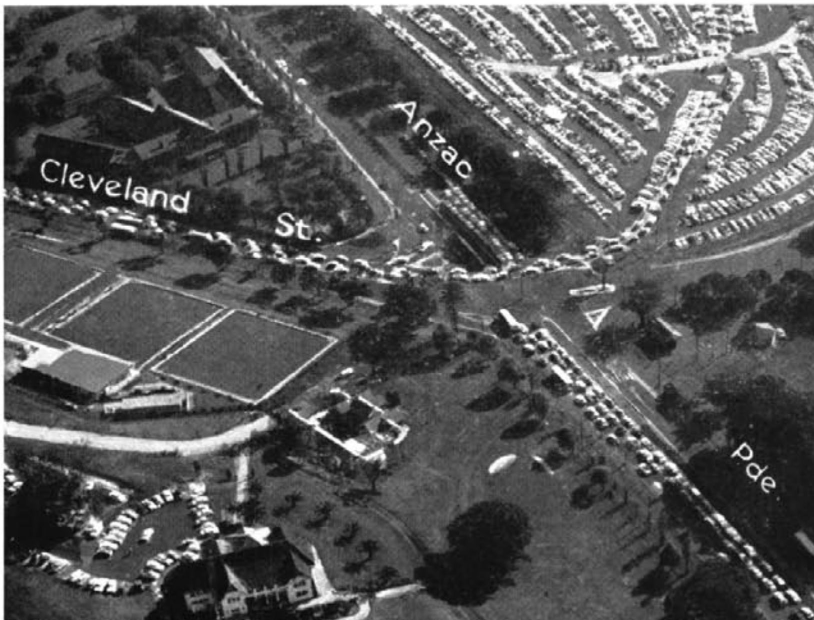
The entrance to No. 5 parking area is also located at the junction of Cleveland and Dowling Streets. Little use was made of this entrance and no queues were observed.

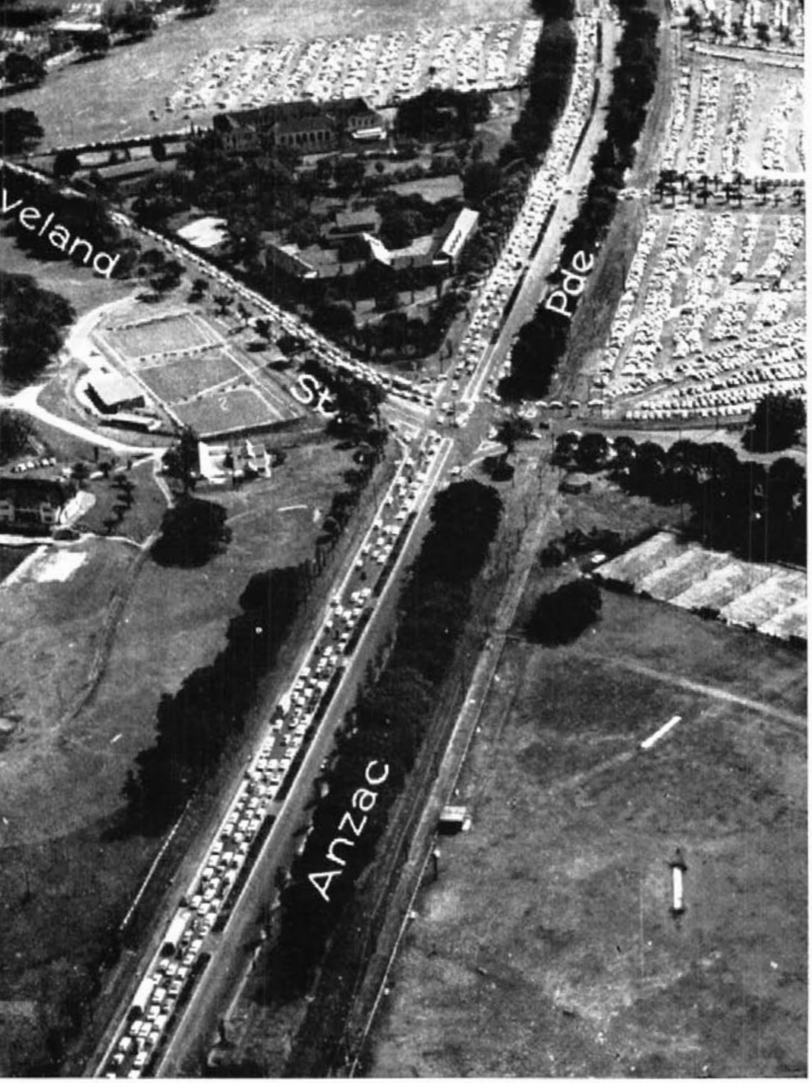
2. Movement in vicinity of Racecourse

Congestion was noted in Alison Road at the main entrance to Randwick Racecourse just prior to the first race. This appeared to be caused by the right turning of vehicles into the Racecourse area and the heavy U-turning movement of taxis setting down on the Racecourse side of Alison Road. Photograph 4 illustrates this.

The only intersection where capacity was exceeded because of race traffic was the intersection of Anzac Parade and Alison Road. Immediately after the end of the last race, a heavy flow of traffic passes through

Cleveland Street–Anzac Parade intersection. View showing queue at entrance to parking area extending west along Cleveland Street





Congestion in Anzac Parade when traffic from the west crosses Anzac Parade twice before entering No. 4 parking area

this intersection and congestion occurs for a limited period. North-bound traffic may be diverted into Dacey Avenue, to get traffic through the Anzac Parade-Alison Road intersection more quickly. This results in the formation of multi-lane queues at the intersection of Dacey Avenue and Dowling Street.

3. Parking in the vicinity of the Showground and Racecourse

The Police Department, which co-operated with the Department in the conduct of the traffic survey, arranged for counting of vehicles parked in streets near the Showground and in Centennial Park. From photographs taken from the helicopter, it was possible to add to this the number of vehicles parked in the Showground parking areas, Randwick Racecourse and streets adjacent to Randwick Racecourse.

For Easter Monday, the number of parked vehicles counted included:—

Showground parking areas	5,240
Centennial Park	3,000
Randwick Racecourse	4,970
Streets adjacent to Showground ..	3,400
Streets adjacent to Racecourse ..	1,240
or a total of	17,850

Entrance to No. 4 parking area near the Dowling Street Cleveland Street intersection

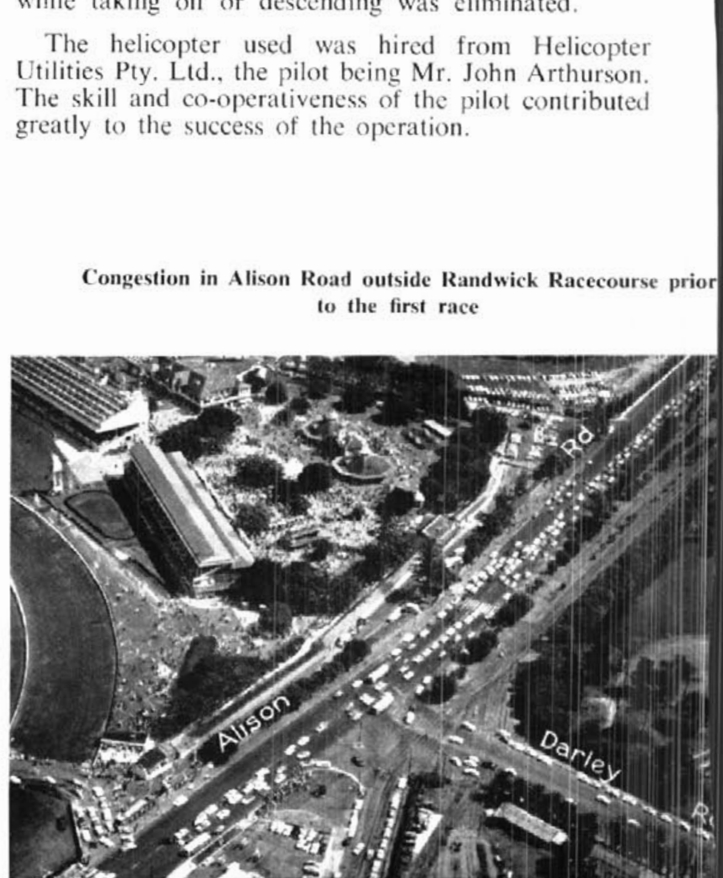
This total was the maximum observed at one time, and did not include any turnover. The traffic survey showed that during Easter Saturday between the hours of 8.0 a.m. and 6.30 p.m., 72,100 vehicles entered and 63,300 vehicles left the cordoned area.

The traffic survey counts around the cordoned area are being analysed and will be used in conjunction with the data from helicopter observations to develop proposals for improved traffic arrangements serving the area.

The use of the helicopter was greatly aided by the Army authorities allowing the use of the oval within Victoria Barracks, adjacent to Moore Park as a base station. As a result the helicopter and the Departmental and Police personnel involved were sheltered from outside interference, and any risk to the public while taking off or descending was eliminated.

The helicopter used was hired from Helicopter Utilities Pty. Ltd., the pilot being Mr. John Arthurson. The skill and co-operativeness of the pilot contributed greatly to the success of the operation.

Congestion in Alison Road outside Randwick Racecourse prior to the first race



SYDNEY HARBOUR BRIDGE ACCOUNT

Receipts and Payments for the period from 1st July, 1960, to 31st March, 1961

Receipts	£	*Payments*	£
Road tolls	1,094,276	Cost of collecting road tolls	113,800
Contributions—		Maintenance and minor improvements	167,521
Railway passengers	110,815	Interest, exchange and management expenses on loans	287,685
Omnibus passengers	11,901	Provision of traffic facilities	21,260
Rents from properties	18,124	Alterations to archways for occupation by tenants	9,505
Other	3,531	Administrative expenses and miscellaneous charges	22,892
		Transfers to Expressways Fund	435,000
	£ 1,238,647		£ 1,057,663

Tenders Accepted by the Department of Main Roads

The following tenders (in excess of £3,000) for road and bridge works were accepted by the Department of Main Roads during the three months ended 31st March, 1961

Work or Service	Name of Accepted Tenderer	Amount £ s. d.
State Highway No. 1—Prince's Highway. Municipality of Kogarah. Reconstruction from Rocky Point Road to Park Road.	Golding Constructions Pty. Ltd.	82,993 0 0
State Highway No. 2—Hume Highway. Municipality of Yass. Construction of a bridge over O'Brien's Creek 1.5 m. east of Yass.	Messrs. Burden and March	10,333 8 0
State Highway No. 9—New England Highway. Shire of Patrick Plains. Supply and delivery of 26,000 cu. yds. of material for approaches to new bridge over Mudie's Creek, 4.5 m. from Singleton.	Moores Earthmoving Pty. Ltd.	6,500 0 0
State Highway No. 10—Pacific Highway. Shire of Tintenbar. Construction of bridge over Richmond River at Wardell.	Dayal Singh Constructions Pty. Ltd.	321,660 10 0
State Highway No. 21—Cobb Highway. Shire of Carrathool. Construction of four-cell 8 ft. x 4 ft. 6 in. R.C. box culvert 36 m. north of Booligal.	K. Humphries Pty. Ltd.	3,292 13 0
State Highway No. 22—Silver City Highway. Trunk Road 66 and Trunk Road 68. Broken Hill District. Construction of bridges over Pine Creek, Stephens Creek and Menindee Billabong.	L. M. Robertson Construction Co.	31,948 0 0
Main Road No. 101—City of Maitland. Supply, manufacture and delivery of steelwork for bridge over Hunter River at Maitland.	Electric Power Transmission Pty. Ltd.	57,211 7 0
Shire of Darling. Construction of piers, abutments, deck, and erection of steelwork and superstructure for bridge over the Darling River at Louth.	A. R. Dickinson	99,099 8 0

Tenders Accepted by Councils

The following tenders (in excess of £3,000) were accepted by the respective Councils for road and bridge works during the three months ended 31st March, 1961.

Council	Road No.	Work	Name of Accepted Tenderer	Amount £ s. d.
Ashford S. ..	16	Construction of a 4-span timber beam bridge over Camp Creek 9.0 m. west of Texas.	Town and Country Road Works.	12,571 0 0
Bogan S. ..	424	Clearing, forming, gravelling and construction of culverts from 23.75 m. to 30.91 m. east of Coolabah.	Furney and Johnston ..	5,993 13 6
Boree S.	61, 237, 310, 377	Supply and delivery of 1,298 cu. yds. ½-in. aggregate to various locations.	Orange Blue Metal Pty. Ltd.	3,861 7 10
Burrangong S. ..	78, 239, 241	Supply and delivery of 1,180 cu. yds. of aggregate to various locations.	Porters Quarries Pty. Ltd...	4,484 19 0
Carrathool S. ..	244, 321	Bitumen surfacing of various lengths	Allen Bros. Pty. Ltd. ..	7,395 0 4
Cobar S.	..	Bitumen surfacing of various Trunk and Main Roads..	Shorncliffe Pty. Ltd. ..	4,248 6 9
Culcairn S. ..	331, 370, 547	Supply and delivery of 6,720 cu. yds. of aggregate to various locations.	T. G. Kirk	3,348 0 0
Cudgegong S. ..	55	Supply and delivery of 2,367 cu. yds. of aggregate between 12.00 m. and 22.00 m. north of Gulgong.	K. E. Bailey	5,817 5 2
Drummoyne M.	395	Reconstruction of side strips in Lyons Road between Great North Road and Russell Street.	Leewil Constructions Pty. Ltd.	39,987 0 0
Gilgandra S. ..	11	Construction of R.C. bridge and approaches over Five Mile Creek.	Ajax Construction Co. ..	10,989 2 2
Goobang S. ..	61	Reconstruction and bitumen surfacing from 5.05 m. to 14.96 m. west of Parkes.	E. Short	25,732 9 0
Jemalong S. ..	17, 56, 377	Bitumen surfacing of various lengths	Allen Bros. Pty. Ltd. ..	9,937 13 9
Jemalong S. ..	61	Construction of 17 R.C. box culverts between 57.26 m. and 41.88 m. west of Parkes.	J. Miller	15,217 0 0
Murrurundi S. ..	358	Construction of R.C. bridge over Big Jack's Creek 9.6 m. south-west of Willow Tree.	Brown's Constructional Enterprises.	23,065 0 0
Murrurundi S. ..	3104	Construction of three-span pre-stressed concrete bridge over Miller's Creek 15.0 m. from Willow Tree on Blackville Road.	Brown's Constructional Enterprises.	7,144 8 3
Narrandera S. ..	387	Supply and delivery of 1,494 cu. yds. of aggregate between 13.0 m. and 21.0 m. west of Coolamon Shire boundary.	Nobles Narrandera Quarries	5,333 14 0
Narrandera S. ..	387	Bitumen surfacing between 13.0 m. and 21.0 m. west of Coolamon Shire boundary.	B.H.P. By-Products Pty. Ltd.	7,887 12 3
City of Newcastle	..	Construction of R.C. bridge 100 ft. long over Leneghan's Flat on Thornton-Minmi Road.	Brown's Constructional Enterprises	16,215 14 6
City of Newcastle	..	Bitumen surfacing of 5,700 ft. of roadway at Leneghan's Flat on Thornton-Minmi Road.	G. Hawkins & Sons Pty. Ltd.	24,573 16 8
Oberon S. ..	256	Supply of 12,170 cu. yds. of gravel between 3.94 m. and 6.25 m. north of Goulburn.	C. T. Ison	5,602 17 0
Strathfield M. ..	..	Reconstruction of Roberts Road south of Hume Highway.	Road Constructions Pty. Ltd.	27,595 15 0
Tenterfield S. ..	16	Bitumen surfacing of various sections between 13.56 m. and 20.1 m. east of Tenterfield.	Emoleum (Australia) Ltd...	5,514 16 0
Timbrebongie S. ..	89	Construction of R.C. box culvert at Yellow Tank ..	J. C. Beaumont	4,015 5 6
Tumbarumba S.	85	Bitumen surfacing between 1.53 m. and 5.47 m. north of Tumbarumba.	Allen Bros. Pty. Ltd. ..	3,163 7 8
Tumut S. ..	4, 85, 200, 280	Supply and delivery of aggregate to various locations ..	J. Henricks & Sons.. ..	5,693 15 6
Tumut S. ..	85	Construction of R.C. bridge over Gilmore Creek and approaches.	Tumbarumba Constructions	6,018 11 0
Warringah S. ..	530	Construction of deviation from Pittwater Road to junction of Lawrence and Oliver Roads.	Bowers Constructions Pty. Ltd.	42,375 9 3
Weddin S. ..	6	Supply, delivery and spreading of 22,776 cu. yds. of gravel between Caragabal and 6.0 m. west.	E. Drogemuller	3,541 18 0
Wellington S. ..	1007	Construction from 4.99 m. to 6.00 m. north of Walmer..	A. C. Stephens & Sons ..	4,491 17 1
Wentworth S. ..	68	Supply of aggregate between 0.25 m. and 5.42 m. north of Wentworth.	Fraser & Adams	3,088 16 0
Wentworth S. ..	68	Bitumen surfacing between 0.25 m. and 5.42 m. north of Wentworth.	Emoleum Pty. Ltd. ..	5,829 12 9

MAIN ROADS STANDARD SPECIFICATIONS DRAWINGS AND INSTRUCTIONS

NOTE: Drawings are prefixed by letter " A ", instructions are so described; all other items are specifications or forms. Year of revision, if within last 10 years, is shown in brackets.

Form No.

ROAD SURVEY AND DESIGN

A 478, A 478A Specimen drawings, country road design.
A 478C Specimen drawing, flat country road design.
A 478B Specimen drawings, urban road design.
A 1645 Stadia reduction diagram.
355 Design of two-lane rural highways. (Instruction.)
369 Design of urban roads. (Instruction.)
288 Design of intersections. (Instruction.) (1952.)
402 Design of acceleration and deceleration lanes. (Instruction.)
499 Design of kerb-lines and splays at corners. (Instruction.) (1952.)
A 1614 Widening at points of " A " sight distance.
A 83 Earthwork quantity diagram.
A 1640 Mould for permanent mark block.
Manual No. 2—Survey and design for main road works*.
Policy for geometric design of rural roads—State Road Authorities*

STREET DRAINAGE

243 Integral concrete kerb and gutter and vehicle and dish crossing, and drawing. (A 134A.)
245 Gully pit and drawings: with grating (A 1042); kerb inlet only (A 1043); with grating and extended kerb inlet (A 1352) extended kerb inlet (A 1353), (1956).
A 190 Gully grating.
A 1418 Concrete converter.
A 3491 Perambulator ramp.
A 3536 Mountable type kerb with reflectors.

CULVERTS

138 Pre-cast concrete box culvert (1957) and drawing: 12 in., 18 in., 24 in., and 30 in. high (A 3847).
206 Re-inforced concrete culvert (1948) and instruction sheets. (A 304, A 305, A 306, A 359.)
A 1012-20 Single cell reinforced concrete box culvert: 6 in. to 1 ft. 3 in. (A 1012); 1 ft. 4 in. to 3 ft. (A 1013); 4 ft. (A 1014); 5 ft. (A 1015); 6 ft. (A 1016); 7 ft. (A 1017); 8 ft. (A 1018); 9 ft. (A 1019); 10 ft. (A 1020); 11 ft. (A 1020A); 12 ft. (A 1020B).
A 1021-29 Two cell, reinforced concrete box culvert: 6 in. to 1 ft. 3 in; (A 1021); 1 ft. 4 in. to 3 ft. (A 1022); 4 ft. (A 1023); 5 ft. (A 1024) 6 ft. (A 1025); 7 ft. (A 1026); 8 ft. (A 1027); 9 ft. (A 1028); 10 ft. (A 1029).
A 1031-36, A 1038, A 1040 Three cell, reinforced concrete box culvert: 6 in. to 1 ft. 3 in. (A 1031); 1 ft. 4 in. to 3 ft. (A 1032); 4 ft. (A 1033); 5 ft. (A 1034); 6 ft. (A 1035); 7 ft. (A 1036); 8 ft. (A 1038); 9 ft. (A 1040).
25 Pipe culverts and headwalls, and drawings: single rows of pipes: 15 in. to 21 in. dia. (A 143); 2 ft. to 3 ft. dia. (A 139); 3 ft. 6 in. dia. (A 172); 4 ft. dia. (A 173); 4 ft. 6 in. dia. (A 174); 5 ft. dia. (A 175); 6 ft. dia. (A 177); Double rows of pipes: 15 in. to 21 in. dia. (A 211); 2 ft. to 3 ft. dia. (A 203); 3 ft. 6 in. dia. (A 215); 4 ft. dia. (A 208); 4 ft. 6 in. dia. (A 207); 5 ft. dia. (A 206); 6 ft. dia. (A 213). Treble rows of pipes: 15 in. to 21 in. dia. (A 210); 2 ft. to 3 ft. dia. (A 216). Straight headwalls for pipe culverts: 15 in. to 24 in. dia. (A 1153) (1957).
A 1 Joint for concrete pipes.
A 142 Inlet sump for pipe culvert 3 ft. dia. or less. (1947.)
139 Timber culvert (1950) and drawings, 1 ft. 6 in. high (A 427); 2 ft. (A 428); 3 ft. (A 429); 4 ft. (A 430); 5 ft. to 8 ft. high (A 431).
A 1223 Timber culvert 20 ft. roadway. (1949.)
A 3472 Timber culvert 22 ft. roadway. (1949.)
303 Supply and delivery of pre-cast reinforced concrete pipes.

BRIDGES AND FERRIES

18 Data for bridge design. (1948.)
371 Waterway calculations. (Instruction.)
300 Pile driving frame, specification for 25 ft. and drawings for 50 ft. (A 209); 40 ft. (A 253); and 25 ft. portable (A 1148).
A 3693 Pontoon and pile driving equipment.
164 Timber beam bridge (1947) and instruction sheets, 12 ft. (A 3469); 20 ft. (A 70) (1949); and 22 ft. (A 1761) (1949).
326 Extermination of termites in timber bridges. (Instruction.)
350 Reinforced concrete bridge. (1949.)
495 Design of forms and falsework for concrete bridge construction. (Instruction.)
314 Regulations for running of ferries. (1955.)
A 4 Standard bridge loading. (Instruction.) (1957.)
A 26 Waterway diagram. (1943.)
A 1886 Arrangement of bolting planks. (1948.)
A 45 Timber bridge, standard details. (1949.)
A 1791 Timber beam skew bridge details. (1949.)
A 3470, A 3471 Low level timber bridge, for 12 ft. and 20 ft. between kerb. (Instruction.) (1949.)
A 1216 Running planks.
A 1207 Reinforced concrete pile—25 tons. (1945.)
A 1208 Reinforced concrete pile—35 tons. (1957.)
A 1621 Reflector strip for bridges.
Highway Bridge Design Specification of State Road Authorities.*

FORMATION

70 Formation. (1955.)
520 Sub-soil drains. (1957.)
A 1532 Standard typical cross-section.
A 4618 Flat country cross-section, Type A. (1955.
A 4619 Flat country cross-section, Type B. (1955.)
A 4620 Flat country cross-section, Type C. (1955.)
A 4621 Flat country cross-section, Type D. (1955.)

Form No.

A 1101 Cross-section one-way feeder road.
A 1102 Cross-section two-way feeder road.
A 114 Rubble retaining wall.

PAVEMENTS

71 Gravel pavement. (1949.)
228 Reconstruction with gravel of existing pavement.
254A Supply and delivery of gravel.
72 Broken stone base course. (1956.)
216 Telford base course.
68 Reconstruction with broken stone of existing pavement to form a base course.
257 Haulage of materials
65 Waterbound macadam surface course.
230 Tar or bitumen penetration macadam surface course, 2 in. thick.
66 Tar or bitumen penetration macadam surface course, 3 in. thick.
125 Cement concrete pavement, and plan and cross-section. (A 1147.)
A 380 Galvanised iron strip for deformed joint.
A 381 Bituminous filler strip for transverse expansion joint.
493 Supply of ready mixed concrete.
266 Asphaltic concrete pavement.

SURFACE TREATMENT

93 Surfacing and resurfacing with bitumen, tar-bitumen mixture, or tar. (1957.)
466 Fluxing of binders for bituminous flush seals and reseals. (Instruction.)
351 Supply and delivery of cover aggregate for bituminous surfacing work (1957.)
167 Resheeting with plant-mixed bituminous macadam by drag spreader. (1951.)

FENCING AND GRIDS

141 Post and wire fencing (1947) and drawings: plain (A 494); rabbit-proof (A 498); flood gate (A 316).
143 Ordnance fencing and drawing. (A 7.)
144 Chain wire protection fencing and drawing. (A 149.)
246 Location of protection fencing. (Instruction.)
224 Removal and re-erection of fencing.
A 1705 Plain wire fence for use in cattle country.
A 3598 Wire cable guard fence.

ROADSIDE

A 1337 Concrete mile post, Type A.
A 1338 Concrete mile post, Type D.
A 1366 Standard lettering for mile posts.
A 1367 Timber mile post, Type B1.
A 1368 Timber mile post, Type B2.
A 3497 Timber mile post, Type B3.
A 2815 Concrete kerb mile block.
A 1420 Steel mould for concrete mile posts.
A 1381-3, A 1452-5 Tree guards, Types A, B, C, D, E, F, and G.
Manual No. 4—Roadside Trees.

MATERIALS

296 Tar. (1949.)
337 Residual bitumen and fluxed native asphalt.
305 Bitumen emulsion. (1953.)
349 Light and medium oils for fluxing bitumen. (1948.)
A 27 Slump cone for concrete.
A 178 Mould for concrete test cylinder.
76 Design of non-rigid pavements. (Instruction.)
Manual No. 3—Materials.*

TRAFFIC PROVISION AND PROTECTION

121 Provision for traffic (1954) with general arrangement (A 1323), and details (A 1325) of temporary signs. (1947.)
252 Supply and delivery of guide posts.
253 Erection of guide posts. (Instruction.)
A 1342 Temporary warning sign, details of construction.
A 1346 Iron trestle for road barrier.
A 1341 Timber trestle and barrier.

PLANT

A 1414 Gate attachment for lorries with fantail spreader.
A 1450 Half-ton roller with pneumatic tyres for transport.
A 2814 Two-berth pneumatic tyred caravan.
A 2828 Multi-wheeled pneumatic tyred roller.
A 2976 Fantail aggregate spreader.
A 3530 Benders for steel reinforcement.
A 3547 Steel bar cutter.

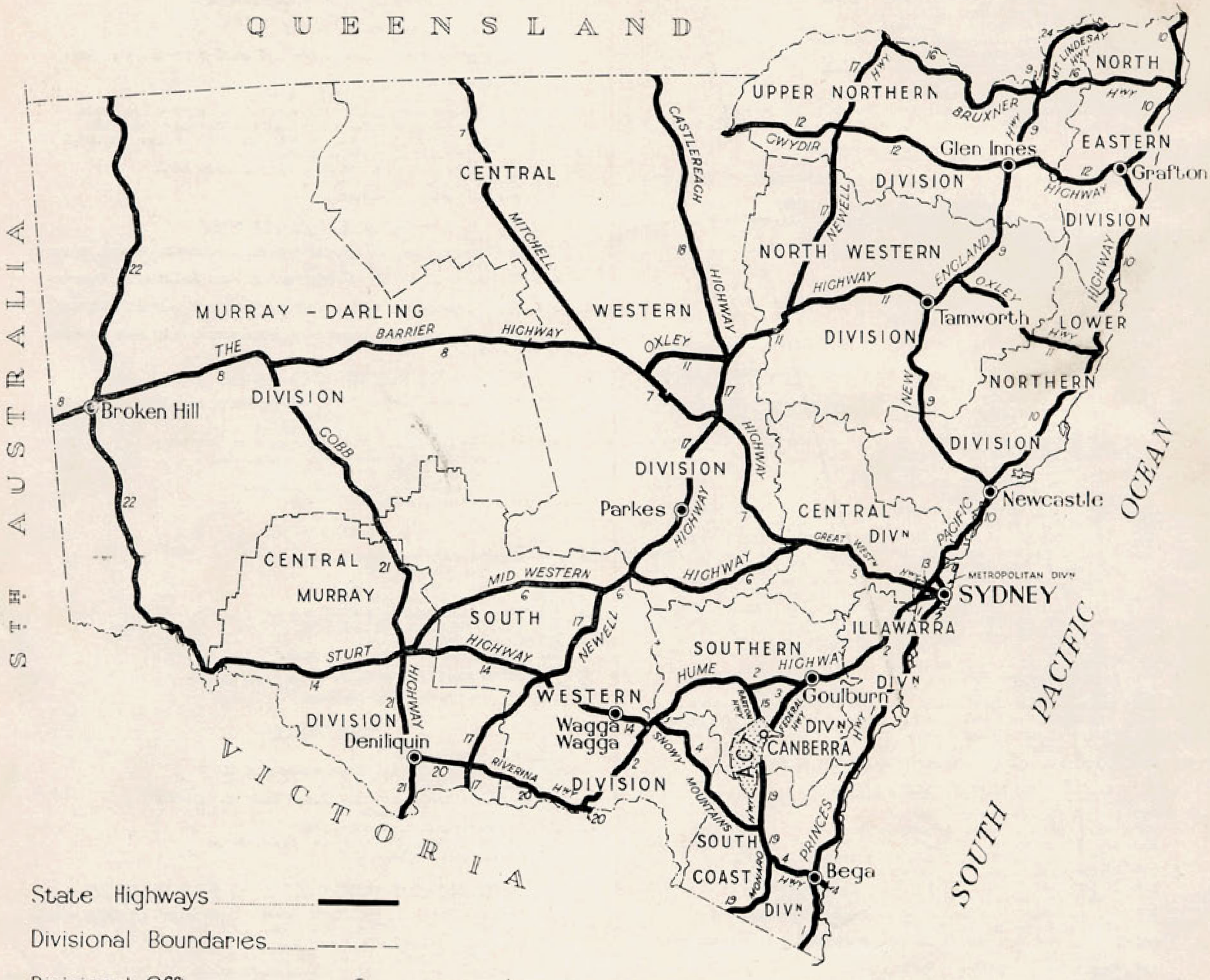
CONTRACTS

24B General conditions of contract, Council contract. (1956.)
342 Cover sheet for specifications, Council contract. (1950.)
64 Schedule of quantities form.
39 Bulk sum tender form, Council contract. (1946.)
38 Bulk sum contract form, Council contract.
193 Duties of superintending officer. (Instruction.)
498 Caretaking and operating ferry.

All Standards may be purchased from the Head Office of the Department of Main Roads, 309 Castlereagh Street, Sydney. Single copies are free to Council except those marked *.

Sydney: V. C. N. Blight, Government Printer—1961

State Highway System of the State of New South Wales



Area of New South Wales, 309,433 square miles.
Length of public roads within New South Wales, 126,988 miles.

MILEAGE OF MAIN AND DEVELOPMENTAL ROADS, AS AT 30th JUNE, 1960.

State Highways	**6,503**
Trunk Roads	**4,181**
Main Roads	**11,727**
Secondary Roads (County of Cumberland only)	**87**
Developmental Roads	**2,864**
	25,362
UNCLASSIFIED ROADS, in Western part of State, coming within the provisions of the Main Roads Act	**926**
TOTAL	**26,288**