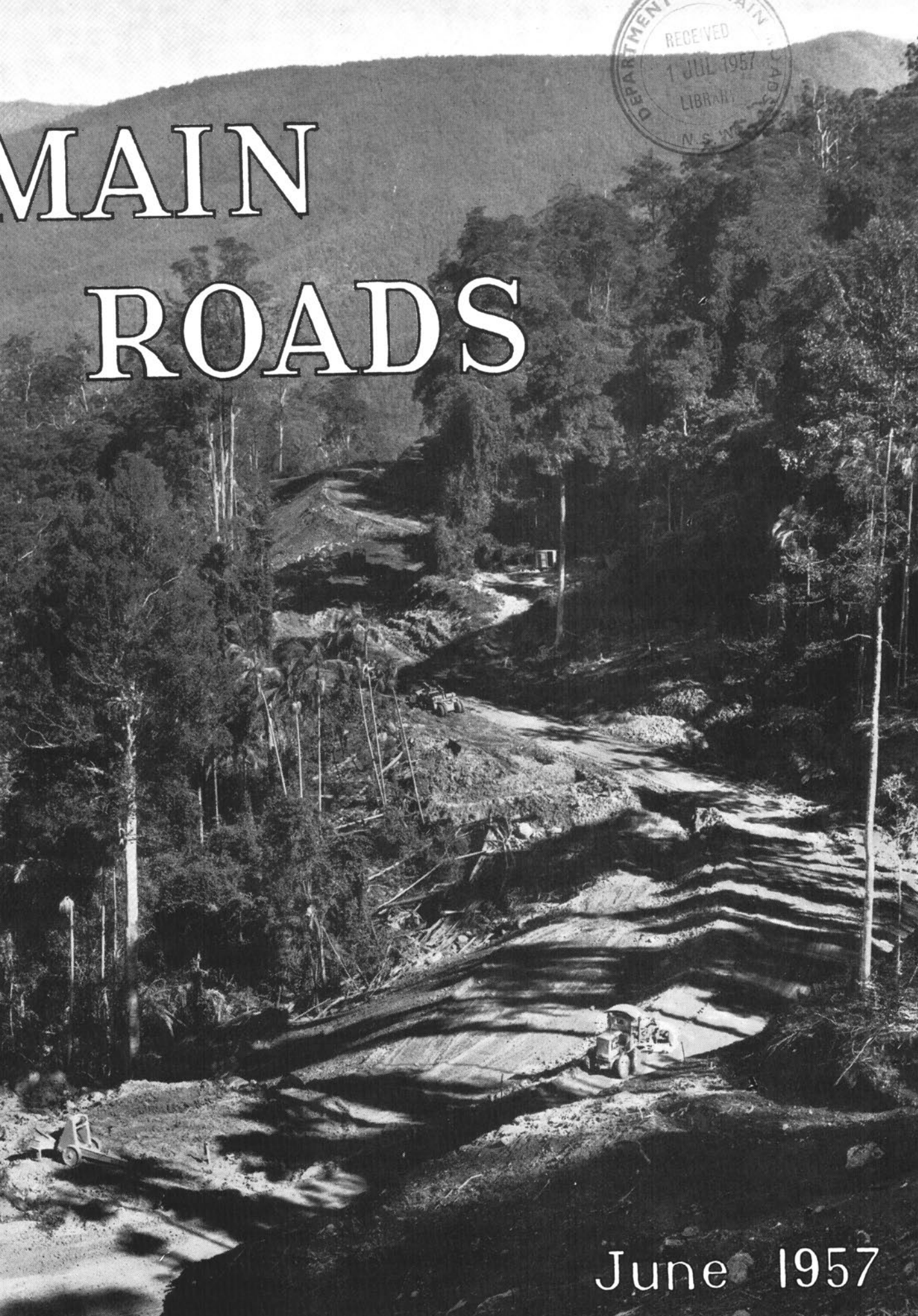
MAIN ROADS



June 1957

MAIN ROADS.

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Construction Work on the new route of the Gwyder Highway.

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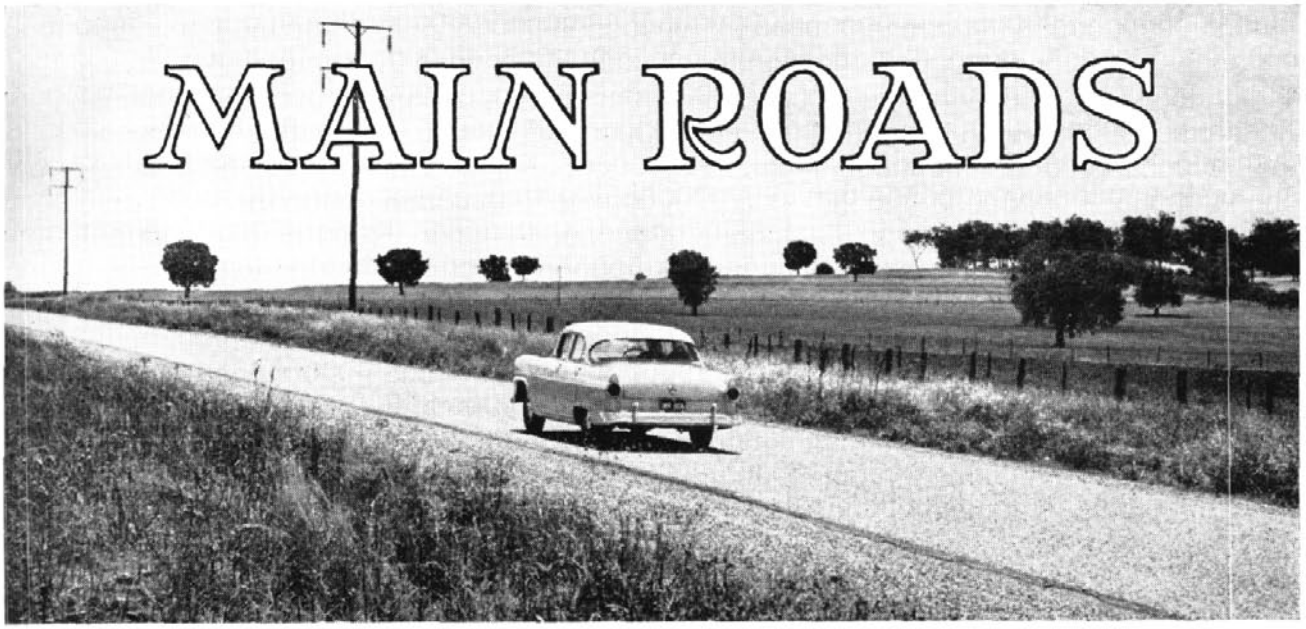

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Commonwealth Aid to the States for Roads.

Its History and Some Analytical Graphs.

1923-1925.

The provision of money by the Commonwealth Government for expenditure by the States on roads commenced in 1923 with the passing by the Commonwealth Parliament of the Main Roads Development Act. By this Act the Commonwealth provided £1,750,000 to the States between 1922-23 and 1925-26 subject to the States providing an amount of £1,500,000. The Commonwealth money was divided among the States on the basis of three-fifths in respect of State population, and two-fifths in respect of State area, and was to be spent on construction only, on the following classes of roads:—

(*a*) Main Roads which open up and develop new country;

(*b*) Trunk Roads between important towns; and

(*c*) Arterial roads.

While the assistance to the States under this Act was relatively small, it was a prelude to a succession of subsequent Acts providing a substantial degree of assistance. The essential features of these are outlined hereunder, including the methods of assessing the amounts paid, and the conditions attaching to payments. At the end of the article, there are tabular statements showing—(*a*) total amount of petrol tax collected by the Commonwealth under each of the schemes, and amounts paid to the States; and (*b*) rates of petrol taxation and proportion paid to the States. There are also some graphs analysing payments since 1926 from various angles. To avoid undue complexity, some minor aspects have been disregarded in preparing the graphs.

1926-27 to 1930-31.

In August, 1926, the Commonwealth Parliament passed a Federal Aid Roads Act which provided for the execution of formal Agreements between the Commonwealth and States whereby a total of £35,000,000 would be spent on road works over a period of ten years from the 1st July, 1926. The Commonwealth Government undertook to provide a fixed amount of £2,000,000 per annum, three-fifths of the total to be distributed among the States on the basis of population, and two-fifths on the basis of area. The States were required to find 15s. for each £1 contribution by the

* 6642—1

Commonwealth, a total of £1,500,000 per annum. Under this Agreement the classes of roads eligible for Federal assistance were the same as in the Main Roads Development Act, 1923-1925.

While at least one-fourth of the money provided for each State was required to be spent on construction, the whole of it had to be expended on construction and reconstruction, it being left entirely to the States to provide for maintenance. Commonwealth approval was required for each individual work proposed by a State.

1931-32 to 1936-37.

In May, 1929, an amendment of the Agreement was mooted because of the difficulty being experienced by the States in providing their contributions, and the need was expressed by several States for the expenditure of some portion at least of the Commonwealth money on maintenance and repair works, rather than on new construction and reconstruction. From the Commonwealth point of view, too, there was a need for a revision of the Agreement, for the reason that whilst the Commonwealth proportion had been found originally by an increase in the customs and excise duties on petrol and imported motor bodies and parts, the general economic depression was considerably reducing importations of petrol and motor accessories by the latter end of 1929. In November, 1929, the Commonwealth Government indicated that it would be agreeable to amend the Agreement so as to discontinue the requirement for the State contributions and also to provide for the expenditure of the money in such a way as would best meet the needs of each State.

These proposals were embodied in an amendment of the Federal Aid Roads Agreement which was adopted as from the 1st July, 1931. The following were the principal variations resulting from the amendment:—

(*a*) The States were relieved as from the 1st July, 1931, of the obligation to contribute pro rata with the Commonwealth.

(*b*) The Commonwealth grant to the States was to be as follows:—

2½d. per gallon on imported petrol from a total tax of 7d. per gallon collected by the Commonwealth Government.

1½d. per gallon on locally refined petrol from a total tax of 4d. (increased to 5½d. in May, 1932) per gallon collected by the Commonwealth Government.

(*c*) The money could be expended in the maintenance, repair, reconstruction or construction of roads irrespective of their classification.

(*d*) Commonwealth approval to individual works to be carried out was no longer required.

1937-38 to 1946-47.

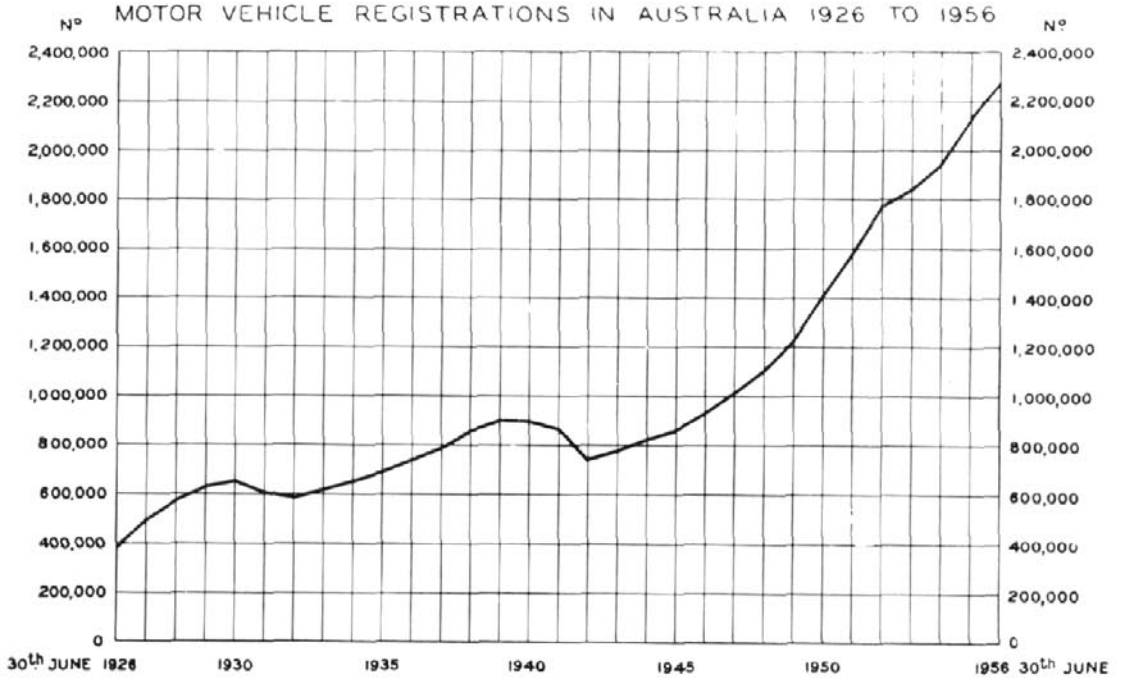
New Agreements to operate for ten years from the 1st July, 1937, to 30th June, 1947, were entered into following the passage of the Federal Aid Roads Act, 1937. The new Agreements continued the form of Commonwealth assistance much along the lines of the old Agreements; matters of interest connected with the new Agreements are as follows:—

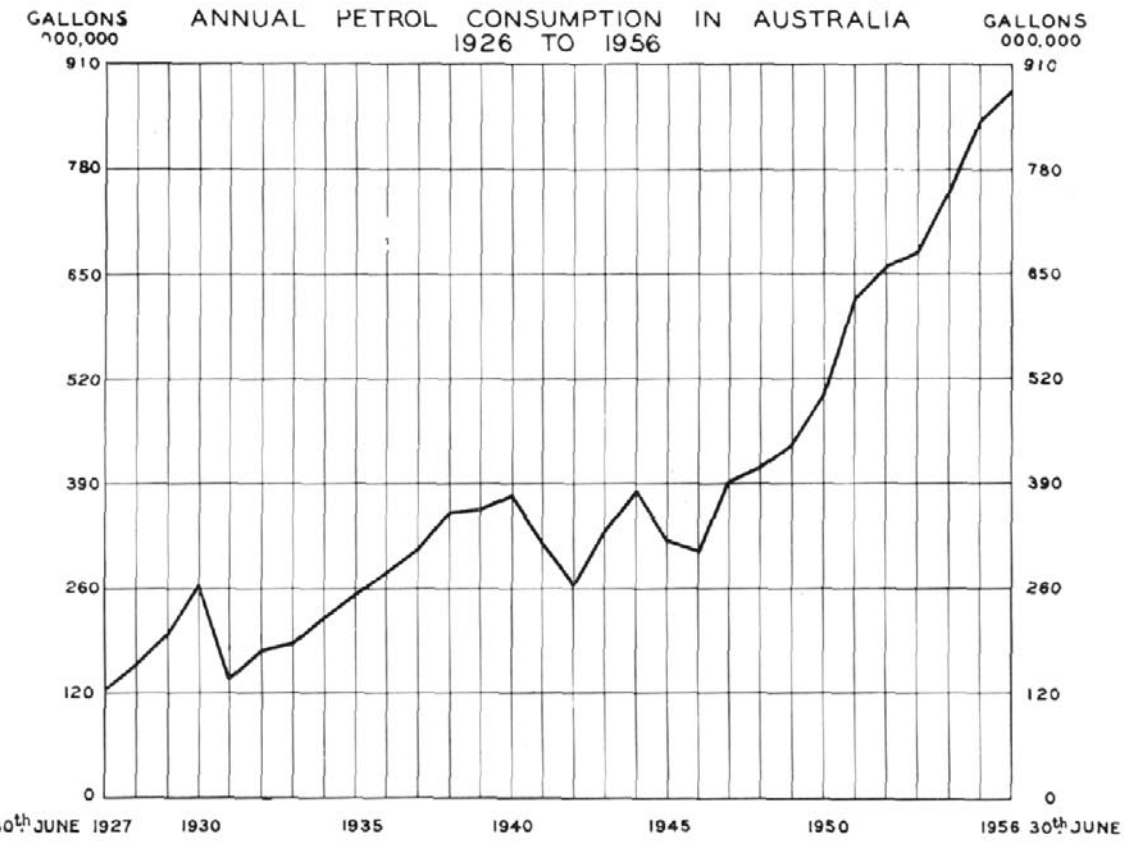
(*a*) The proportion of the taxes on petrol made available for distribution between the States was increased to the following amounts:—

3d. per gallon on imported petrol;

2d. per gallon on locally refined petrol.

Note.—At the commencement of the 1937 Act the Commonwealth Government was collecting 7d. and 5½d. per gallon on imported and locally refined





petrol, respectively. During the currency of the Act these taxes were gradually increased until at the time the Act expired they were 10d. on imported petrol and 8½d. on locally refined petrol.

(*b*) Five per cent. of the total grant was to be paid to the State of Tasmania, and the remaining 95 per cent. was to continue to be distributed between the other States on the basis of three-fifths according to the population of each State and two-fifths according to the area of each State.

(*c*) Certain amounts due to the National Debt Sinking Fund on account of loan moneys provided by the States under an earlier Agreement were deducted from the amounts payable to the States.

(*d*) The proceeds of all but ½d. per gallon of the grant paid to the States were required to be spent on roads. The proceeds of ½d. per gallon might be spent on roads or on other works connected with transport, as determined by the State, except that one-twelfth of the proceeds of the ½d. mentioned could be required by the Commonwealth to be spent on the maintenance and repair of roads which approach or adjoin Commonwealth properties.

1947-48 to 1949-50.

In 1947, the Commonwealth Aid Roads and Works Act, 1947, was passed by the Commonwealth Parliament. It was to apply for a period of three years from 1947-48 to 1949-50. The completion of formal Agreements with the States was discontinued.

The new Commonwealth legislation provided for a continuation of the payment to the States of 3d. per gallon on imported petrol and 2d. per gallon on locally-refined petrol (excluding petrol used for aviation purposes) for expenditure on the construction, reconstruction, maintenance and repair of roads, the distribution between the States to be on the same basis as previously. Petrol taxation levied by the Commonwealth Government continued during the currency of this Act at the same rates as obtained at the expiry of the 1937 Act, namely 10d. per gallon on imported petrol and 8½d. per gallon on locally refined petrol. The following were the principal changes incorporated in the 1947 Commonwealth Act:—

(*a*) A new principle was introduced in this legislation in that the new Act specifically provided that there would be expenditure of Commonwealth Aid on local rural roads (i.e., rural roads which are not Main Roads). In implementing this new principle a fixed amount of £1,000,000 per annum, over and above the gallonage payment, was to be distributed to the States for expenditure upon the construction, reconstruction, maintenance and repair of roads through sparsely populated areas, timber country and rural areas, or, if the State thought fit, upon the purchase of road-making plant for use in areas where the purchase of such plant was

beyond the resources of the local authorities; the money was not to be spent on proclaimed State Highways, Trunk Roads and Main Roads without the approval of the Commonwealth Minister. The original amount of £1,000,000 per annum was increased to £2,000,000 in 1948-49, and to £3,000,000 in 1949-50. The distribution of this money between the States was on the same basis as applied to the distribution of the proceeds of the gallonage payment.

(*b*) The amounts made available to the States were to be expended in accordance with Commonwealth policy.

(*c*) A maximum of one-sixth of the gallonage payment to the States could be spent on works connected with transport other than roads.

(*d*) Expenditure on strategic roads and roads of access to Commonwealth property was not (as previously) required to be met from the funds made available to the States.

1950-51 to 1953-54.

The Federal Parliament passed the Commonwealth Aid Roads and Works Act, 1950, which provided the machinery for payment of roads funds to the States for a period of five years from 1950-51 to 1954-55. The features extant in the previous scheme were to be continued with the exception that—

(*a*) Payments to the States were to be at the rate of 6d. per gallon on imported petrol and 3½d. per gallon on locally refined petrol. Petrol tax rates levied by the Commonwealth Government remained unaltered at 10d. and 8½d. per gallon, respectively.

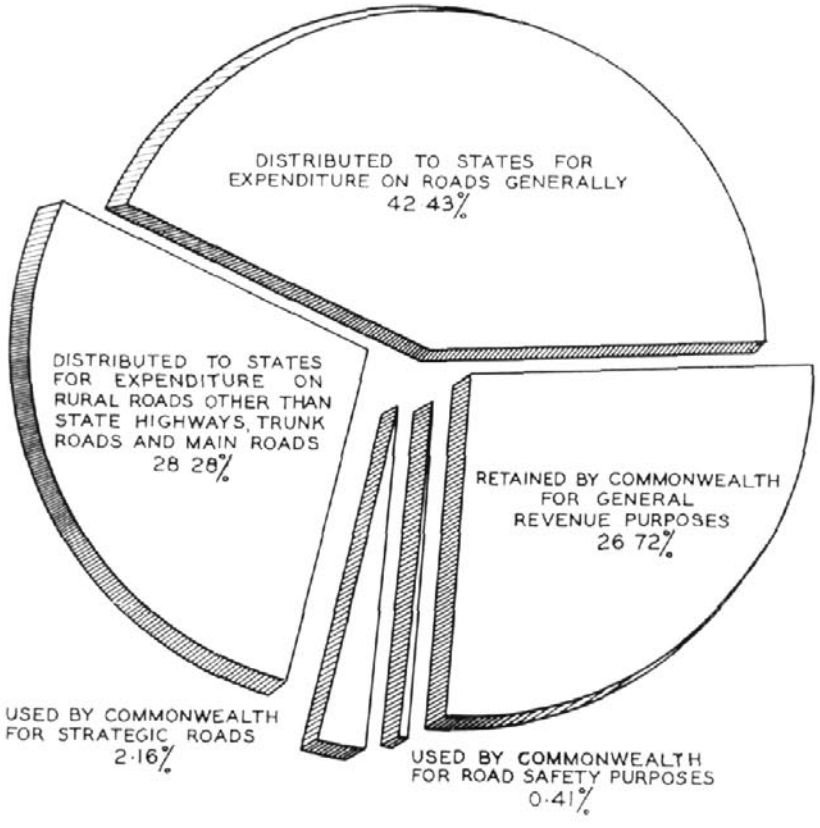
(*b*) Of the amounts payable to the States, after payment of 5 per cent. to Tasmania—

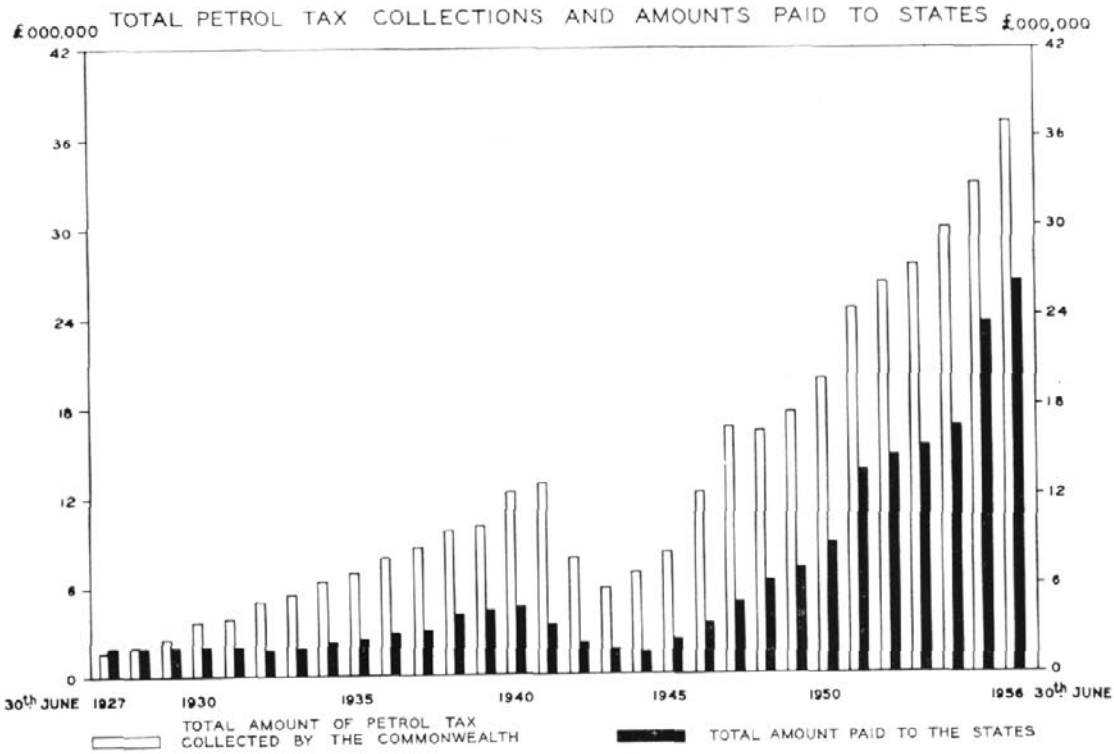
(i) 65 per cent., less £600,000 expendable directly by the Commonwealth Government on strategic roads, roads of access to Commonwealth properties and the promotion of road safety practices, was to be available for expenditure on roads generally.

(ii) 35 per cent. was to be expended on rural roads, including developmental roads, feeder roads, roads in sparsely populated areas and in soldier settlement areas, but excluding State Highways, Trunk Roads and Main Roads; also on the purchase of road-making plant for use on the rural roads thus defined.

(iii) The only Commonwealth control exercised on the expenditure of the money made available to the States was to be a state-

PRINCIPAL DISTRIBUTION OF TOTAL PETROL TAX COLLECTED BY THE COMMONWEALTH GOVERNMENT IN 1955-56





ment certified by the State Auditor-General as to the expenditure of the Commonwealth funds forwarded annually by the States to the Commonwealth.

1954-55 to 1958-59.

A new Commonwealth Aid Roads Act came into force on the 1st July, 1954, in replacement of the Commonwealth Aid Roads Act, 1950. The 1950 Act was not due to expire until the 30th June, 1955, but in order to correct a situation brought about by the rapidly increasing quantity of petrol refined locally, on which a lower tax rate was payable than on imported petrol, a situation which was adversely affecting the amount received by the States, the Commonwealth Parliament repealed the 1950 Act one year before its expiry date.

The principal effects of the 1954 Act are as follows:—

(1) A uniform and increased rate of 7d. per gallon of petrol is to be paid to the States in respect of both imported petrol and petrol refined in Australia, taxation on which continued at 10d. and 8½d. per gallon, respectively.

(2) At least 40 per cent. of the amounts paid to the States is to be set aside for expenditure on local roads in rural areas which are not State Highways, Trunk Roads and Main Roads. (The percentage provided in the previous Act was 35 per cent.)

(3) An additional sum of £300,000 per annum is to be retained by the Commonwealth Government for expenditure on road safety practices; strategic roads; roads of access to Commonwealth property; and other roads serving, or likely to serve, Commonwealth purposes. The amount to be retained is thus increased to £900,000 per annum.

(4) The basis of distribution between the States (i.e., 5 per cent. to Tasmania, and the balance among the other five States on the basis of three-fifths in respect of population and two-fifths in respect of area) is to be continued as in previous Acts, but the 1954 census replaces the 1947 census for the purpose of establishing the population of the various States.

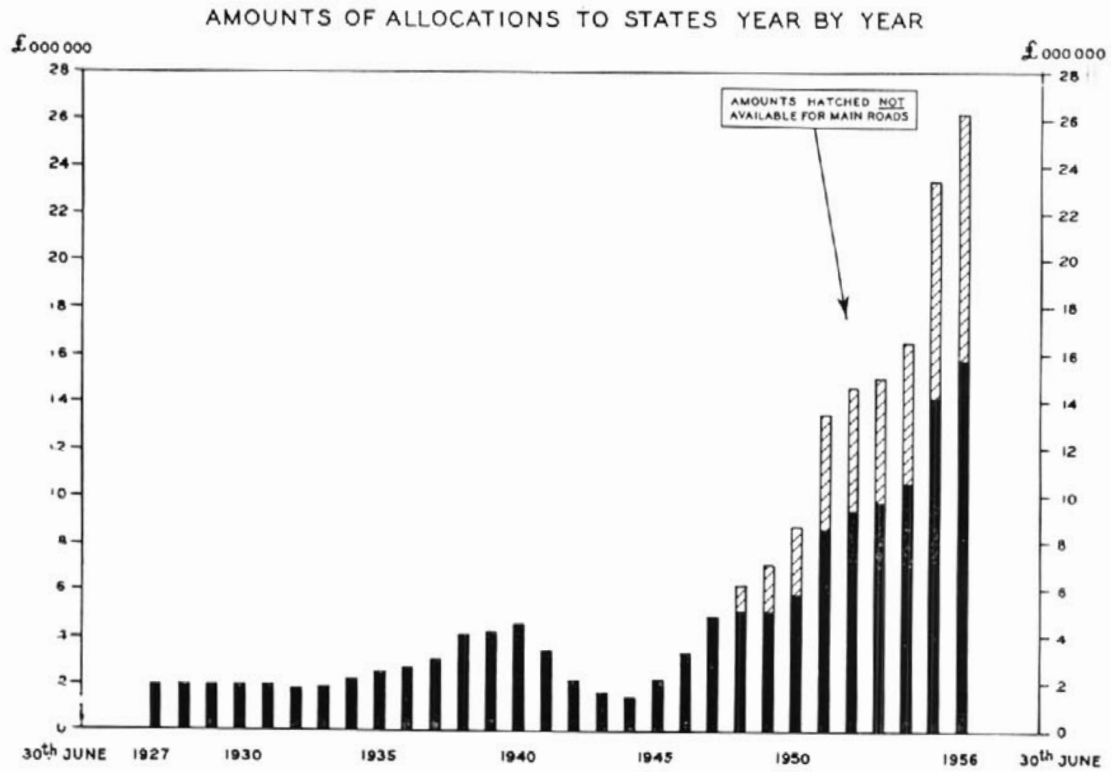
Amendments to the Commonwealth Aid Roads Act, 1954.

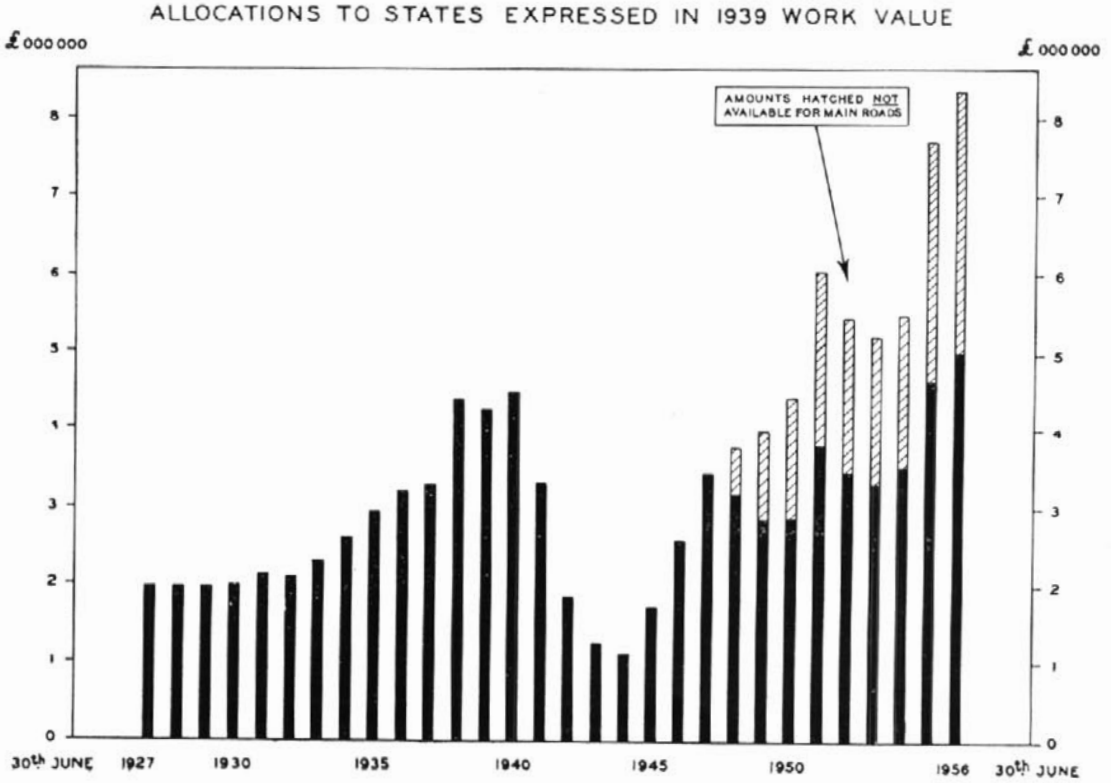
The Commonwealth Aid Roads Act, 1954, has subsequently been amended as follows:—

(*a*) 1955 Amendment—As from 1st July, 1955, the amount originally retained by the Commonwealth Government for road safety practices (£100,000 per annum) has been increased to £150,000 per annum. The amount of £800,000 per annum for strategic roads, roads of access to Commonwealth property, and for other roads serving or likely to serve Commonwealth purposes, remains unaltered.

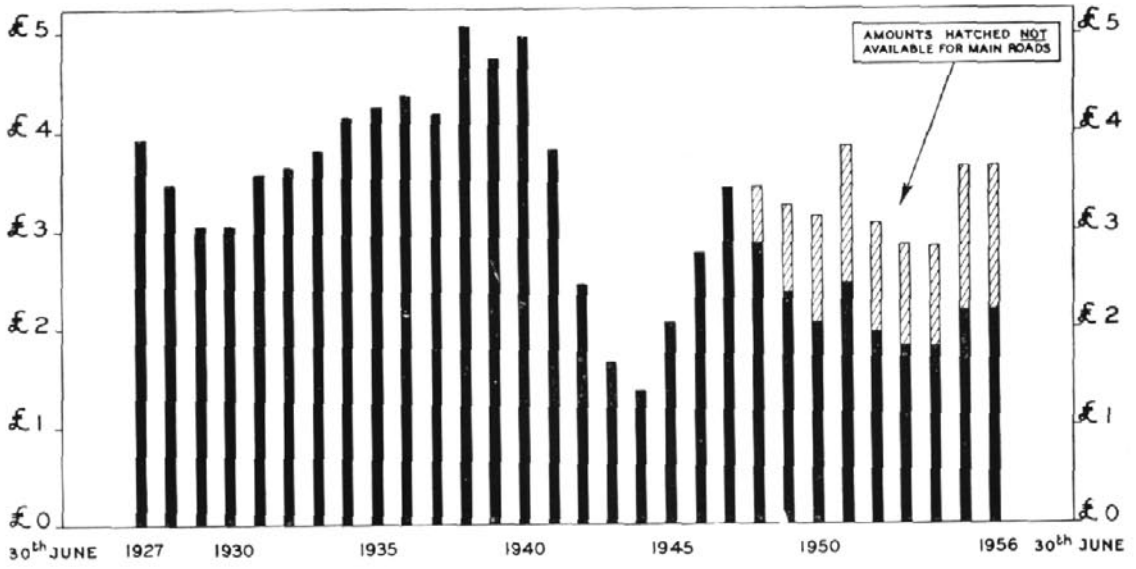
(*b*) 1956 Amendment—As from 1st April, 1956, the payment to the States of 7d. per gallon in respect of both imported petrol and petrol locally refined in Australia is raised to 8d. per gallon, coincident with an increase of petrol taxation levied by the Commonwealth from 10d. to 1s. 1d. on imported petrol and 8½d. to 11½d. on locally refined petrol.

Commonwealth Aid for Roads.





ALLOCATIONS TO STATES PER REGISTERED MOTOR VEHICLE CONVERTED TO 1939 WORK VALUE.



TOTAL AMOUNT OF PETROL TAX COLLECTED BY THE COMMONWEALTH AND AMOUNT PAID TO THE STATES.

Commonwealth Act under which Moneys made Available.	Term of Operation of the Act.		Total Petrol Tax Collected by the Commonwealth.	Total Amount Paid to the States.	Average Annual Payments to the States.
	Years.	Dates.	£	£	£
Main Roads Development Act, 1923–25 ...	4	1–7–22 to 30–6–26	1,750,000	.....	437,500
Federal Aid Roads Act, 1926— (*a*) Up to 1931	5	1–7–26 to 30–6–31	13,939,000	10,000,000	2,000,000
(*b*) Under the Act as amended in 1931	6	1–7–31 to 30–6–37	40,447,000	14,226,000	2,371,000
Federal Aid Roads Act, 1937	10	1–7–37 to 30–6–47	102,989,000	32,308,000	3,231,000
Commonwealth Aid Roads and Works Act, 1947	3	1–7–47 to 30–6–50	53,544,000	21,607,000	7,202,000
Commonwealth Aid Roads and Works Act, 1950	4	1–7–50 to 30–7–54	107,951,000	59,753,000	14,938,000
Commonwealth Aid Roads Act, 1954 (amended by the Commonwealth Aid Roads Act, 1956)	5	1–7–54 to 30–6–59	*	†	†

* Not available. The estimated figure for 1956–57 is £47,000,000.

† Not available. The estimated figure for 1956–57 is £31,000,000.

RATES OF PETROL TAX PER GALLON, AND AMOUNT PER GALLON PAID TO STATES.

Commonwealth Act.	Levied by Commonwealth Government.				Paid to the States.			
	Imported Petrol.		Locally Refined.		Imported Petrol.		Locally Refined.	
	Per gallon.	Commencing Date.	Per gallon.	Commencing Date.	Per gallon.	Commencing Date.	Per gallon.	Commencing Date.
	d.		d.					
Main Roads Development Act, 1923-25	1	25-3-20	Nil	...	A fixed amount per annum paid to States.			
Federal Aid Roads Act, 1936—								
(*a*) Up to 1931	3	9-7-26	...	...	A fixed amount per annum paid to States.			
	4	21-11-29	1	22-8-29	,,	,, ,, ,,	,,	,,
	7	9-7-30	4	9-7-30	,,	,, ,, ,,	,,	,,
(*b*) Under the Act as amended in 1931	7	...	4	...	d. 2½	1-7-31	d. 1½	1-7-31
	...	...	5½	25-5-32	...	...	...	...
Federal Aid Roads Act, 1937 ...	7	...	5½	...	3	1-7-37	2	1-7-37
	8	9-9-39	6½	9-9-39	3	...	2	...
	11	3-5-40	9½	3-5-40	3	...	2	...
	†11½	19-12-41	†10	19-12-41	3	...	2	...
	11	5-9-45	9½	5-9-45	3	...	2	...
	10	18-11-46	8½	18-11-46	3	...	2	...
Commonwealth Aid Roads and Works Act, 1947	10	...	8½	...	3	...	2	...
Commonwealth Aid Roads and Works Act, 1950	10	...	8½	...	6	1-7-50	3½	1-7-50
Commonwealth Aid Roads Act 1954 (amended by the Commonwealth Aid Roads Act, 1956) ...	10	...	8½	...	7	1-7-54	7	1-7-54
	18. 1d.	1-4-56	11½	1-4-56	8	1-4-56	8	1-4-56

† Includes ½d. paid into special fund to meet increased costs connected with storage of petroleum products.

Restoration Work on Hume Highway Completed.

During the winter of 1956, heavy and protracted rainfalls on the south-western slopes brought about a weakening of the foundation of the pavement on portion of the Hume Highway, and as a result heavy vehicles broke through the bitumen surfaced gravel road pavement in a number of places, principally located between Tarcutta and Holbrook. Movement of heavy vehicles on the portion of the Hume Highway affected was stopped for about two weeks and lighter vehicles were delayed or stopped for shorter periods, while emergency repairs were effected.

Further repair work on the road has continued since the trouble originally occurred, and restoration was finally brought to completion early in April, 1957, when the Minister for Highways, the Hon. J. B. Renshaw, M.L.A., announced that the repair of all those lengths on the Hume Highway which had been damaged during last winter's flood rains had been completed, and the bitumen surface restored.

The Minister added that it was not to be assumed that the Highway could be relied on to carry traffic without interruption should similar exceptional rainfall conditions occur again. The road was being asked to sustain a weight and volume of traffic far in excess of that in sight when it had been built, mostly between 25 to 30 years ago. Until such time as funds could be made available to strengthen the Hume Highway over long lengths, there would remain a risk of breakdown in periods of prolonged wet weather.

Progress on New Glen Innes-Grafton Road.

Investigations for New Route.

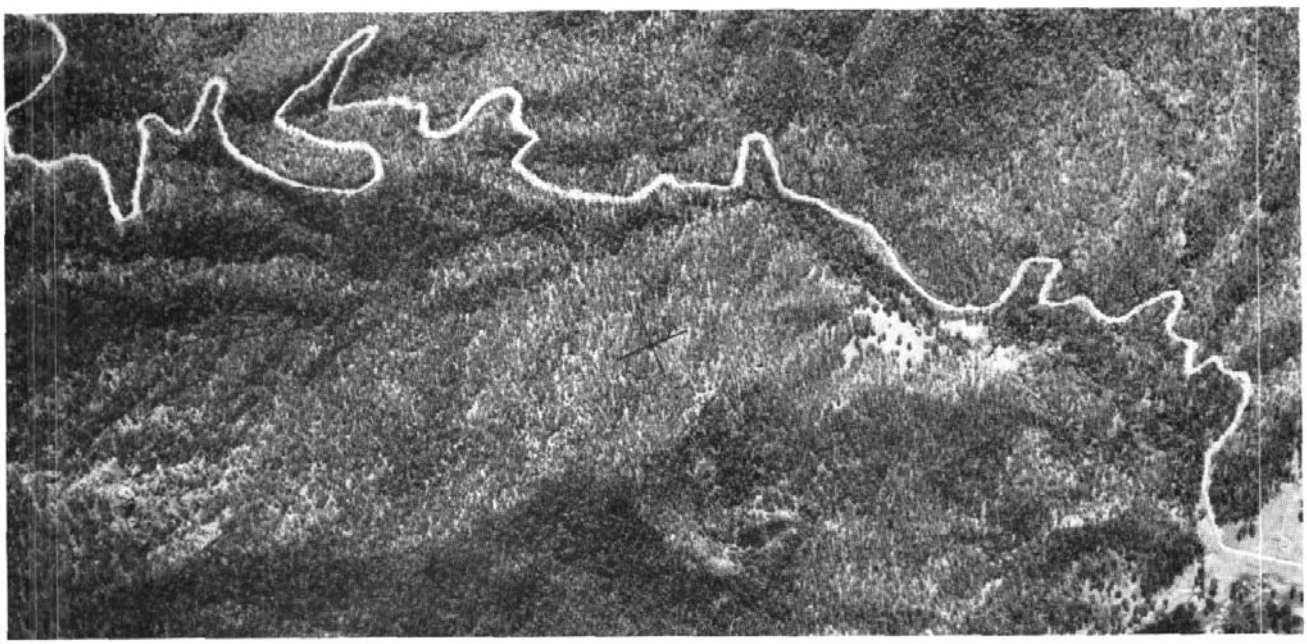
For a number of years construction has been proceeding on the establishment of a new road linking Glen Innes on the New England tableland, and Grafton near the coast, in northern New South Wales. There is no direct railway between these two centres, and the movement of goods by rail involves a journey of 615 miles, via Maitland. The new road is planned to provide better general intercommunication between the inland and coastal areas, which are separated by a wide stretch of steep mountainous country—some of the roughest in the State. In addition, the road will provide ready access to the new deep-sea port being developed at Iluka, near the mouth of the Clarence River. The work is, in effect, a deviation of the Gwydir Highway, about 74 miles long, and leaves the existing Highway route 21 miles from Glen Innes, and rejoins it 5 miles from South Grafton.

The country between Glen Innes and Grafton falls with an abrupt escarpment generally about 3,000 feet high from the tableland to the foothills adjoining the coastal plain. Major waterways flowing from the tableland have carved deep winding valleys through the escarpment leaving high residual spurs. Thus on the direct line between Glen Innes and Grafton, the main areas of tableland and foothill country are separated by a particularly rugged strip of country about 30 miles wide. Neither the ridges nor valleys through this strip are favourable to road location as the ridges are broken by deep saddles and steep to precipitous slopes fall directly into the stream beds in many places.

The existing Highway descends from the tableland to the Mann River valley and crosses a low saddle in a watershed to reach the Little River which it follows for 27 miles between steep mountain sides to the Nymboida River. Easy foothill country east of the Nymboida River is then traversed to South Grafton. The descent of about 2,200 feet into the Mann River valley is spread over a distance of about 7 miles and is made in three stages, separated by easy or adverse grades. The alignment on the descent is tortuous, particularly on the steep intermediate stage known as the Big Hill (see aerial photograph). On the Big Hill the road falls a little more than 1,000 feet in 2½ miles and follows a zig zag course with hairpin turns in order to make sufficient distance for the grade. Parts of the road along the Little River are in narrow cuttings in steep rock side slopes. In one place a very steep rock bluff alongside the Little River is negotiated by means of a short tunnel.

Investigations for a road suitable for modern traffic were commenced in 1935. It was found that local improvements and widening on the existing road would involve extremely heavy expense without providing a satisfactory road on some sections. No suitable location was found in the vicinity of the existing route and attention was directed to a locality to the north near

Aerial photograph of the existing route of the Gwydir Highway on the descent from the New England Tableland to the Mann River Valley.



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Jackadgery where major streams converge to a single stream (the Mann River) and the tableland projects easterly along Cangai Spur to meet the easier foothill country. An attempted ascent to Cangai Spur was abandoned on account of difficulties encountered on the escarpment and at a saddle in the Spur which is broken by granite cliffs.

Investigations then carried out near Dandahra Creek, a tributary of the Mann River further downstream, indicated more suitable conditions for an ascent and at that stage in 1937 aerial photographs were taken to cover the escarpment in the Big Hill and Dandahra Creek areas. These aerial photographs were the first used by the Department of Main Roads for road location purposes in New South Wales. The photographs revealed no new possibilities in the Big Hill area and in these circumstances further investigation for the descent was confined to the Dandahra Creek area. A map of the topographical features in the Dandahra Creek area was compiled by a minor control plot from aerial photographs and field investigation was recommenced in 1938.

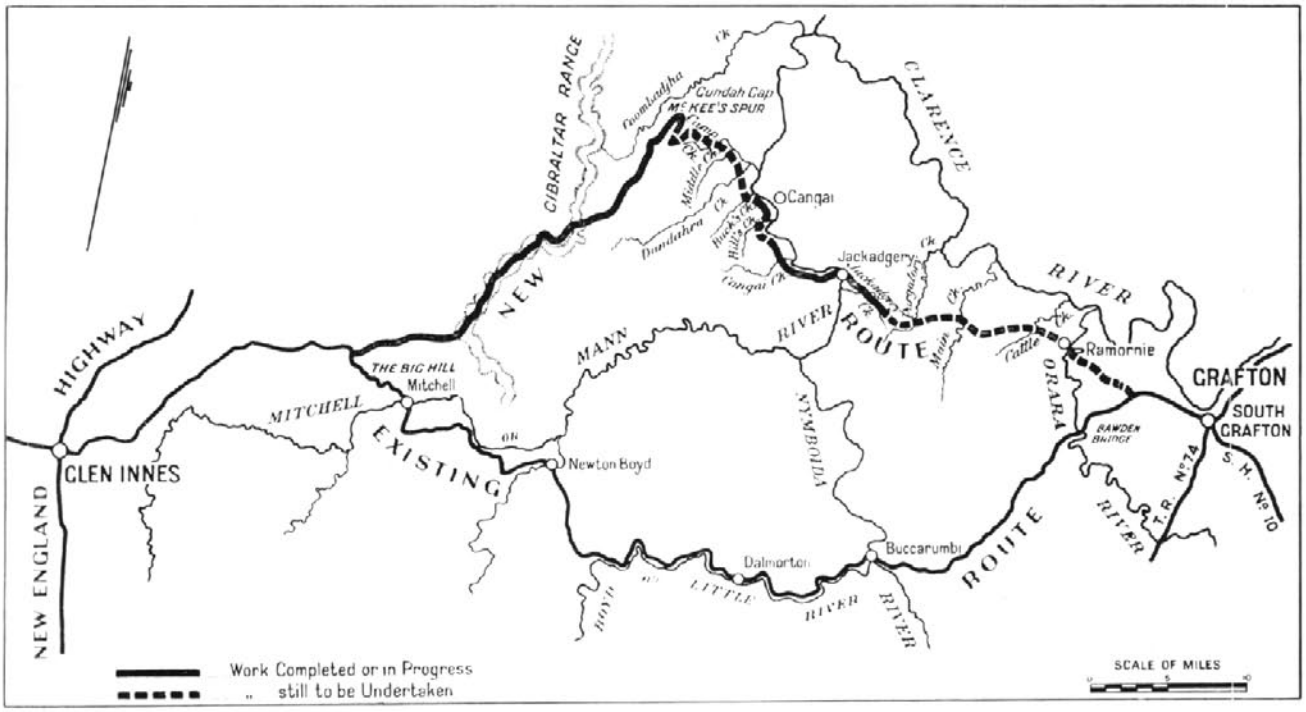
The main problem was to find a continuous strip of suitable country on the escarpment about 10 miles long to support a descent of about 3,000 feet from the tableland. Suitable country was available on the easier slopes near the crest of watersheds but the lower slopes were generally too steep and broken by deep gullies to support a road.

The most favourable feature to support about half of the descent was the main spur between Coombadjha Creek and Dandahra Creek, which fell in stages towards a saddle known as Gundah Gap. A line was located near the crest of this spur and continued for the remaining descent beyond Gundah Gap thence following minor spurs to the foot. The lower part of this line had to be abandoned when tests were made later on account of the doubtful stability of a short length. The abandoned section was replaced by a line following a spur known as McKee's Spur rising from Camp Creek.

Description of New Route.

The new route from Glen Innes to Grafton follows the existing road over rolling to hilly tableland country to a point 21 miles east of Glen Innes. The deviation then passes for about 25 miles through eucalyptus forests and undulating tableland country in the vicinity of Gibraltar Range on an elevation corresponding approximately to that of Glen Innes, about 3,500 feet. The descent of about 3,000 feet from the tableland is then made on a length of about 11 miles on an average grade of about 5.3 per cent. with maximum grades of 7 per cent. This descent is mainly through dense rainforest interspersed with hardwood timber on side slopes which although steep are considerably easier and less broken than the average slopes of the escarpment. Splendid views of the Mann River valley are obtainable. From the foot, the route follows up the Mann River

Typical view of country passed through on the existing route of the Gwydir Highway between Glen Innes and Grafton.



Plan of existing and new routes of the Gwydir Highway, showing stage of progress on new route.

valley on undulating grades with occasional heavy cuts to cross the Mann River at Jackadgery, where a narrow low level bridge is available for temporary use. From Jackadgery to the existing Gwydir Highway near South Grafton, the general route of a local access road is followed through the foothills. There is an existing low level bridge over the Orara River on this length.

On the descent into the Mann River valley the road is designed for speeds as follows:—

1 mile at 50 m.p.h.
1 mile at 40 m.p.h.
5½ miles at 30 m.p.h.
3½ miles at 20 m.p.h.

On the remainder of the new road, the alignment and grades will be suitable over the greater part for travel at 50 m.p.h.

The distance betwen Glen Innes and South Grafton via the new road, when completed, will be about 101 miles compared with 108 miles on the existing road and travelling time by car will be reduced from about 3¾ hours to about 2¼ hours. The formation will be mostly 28 feet wide with a 20 feet pavement but widths will be reduced to a 24 feet formation with an 18 feet pavement for a length of 7 miles on the mountain section. Travelling conditions will thus be vastly superior to those on the existing road where in many places the formation is barely wide enough for two vehicles abreast.

Action is being taken with the co-operation of the Department of Lands and the Forestry Commission, to preserve large areas of the natural forest growth, mostly softwood, on the mountain sides where the road descends to the Mann River valley. This action, apart from retaining the natural beauty along the road, is necessary to ensure that roadworks will not be affected by erosion in the future.

Construction Operations.

On account of the magnitude of the work, it was apparent that special financing would be necessary if it were to be completed quickly. Failing this, its undertaking would necessarily have to be spread over a long term of years in order not to interfere unduly with Main Road improvement work elsewhere in the State.

It so happened that in 1939 there was a need to provide works for the relief of unemployment, and the new road construction was put in hand on this basis from centres established at Gibraltar Range and at Jackadgery. By October, 1942, war-time activities made it necessary to suspend operations.

At the end of 1946, work was resumed on a normal basis, but was suspended about a year later when it became necessary to divert men and plant to construct forestry roads in the upper Hastings River area considered urgent and essential to facilitate timber production for housing purposes. Financial difficulties arising from rising costs, and the urgency of works elsewhere, rendered it impracticable to resume operations until January, 1955, when road construction was again put in hand in the Gibraltar Range area, and bridge construction and minor earthworks were put in hand in the Mann River valley.

The map above shows the present stage of progress throughout the 74 miles of new road required. Total expenditure on the new road at the end of 1956 amounted to approximately £800,000.

The Mann River Valley seen from Old Smokey on the new route of the Gwydir Highway, 47.5 miles from Glen Innes.

Current Work in Gibraltar Range Area.

Road work at present in progress is being concentrated on the Gibraltar Range descent to the foot of McKee's Spur at Camp Creek. It is being controlled by an organisation with headquarters at Dandahra Creek some 42 miles from Glen Innes, where an office, store, and staff quarters have been established, with a plant repair workshop, blacksmith's shop and subsidiary

A completed section on the new route of the Highway near the Summit, 45 miles from Glen Innes.

Construction in progress on steeply sloping ground.

buildings erected nearby. The depot buildings have been provided with electric light, and a good water supply is available from the permanent stream of Dandahra Creek.

The labour force varies between fifty and sixty personnel. The employees are provided with individual hut accommodation at a camp some 45 miles from Glen Innes.

The work is organised into three major and two minor gang units, which are engaged on clearing, earthworks, pavement and drainage work.

Clearing.—Gibraltar Range is heavily timbered, and clearing is a major part of the work, many trees of up to 5 feet in diameter being encountered. The average clearing width is about 100 feet, and the work is carried out by a gang comprising ten to twelve men with tractor-dozers. Owing to the steep side slopes, it has been found by experience that clearing is best effected by dozing straight down the slopes. Use of cables and logging winches has not proved satisfactory.

The general procedure is to clear all timber and undergrowth which can be handled by the dozers, leaving trees greater than about 18 inches in diameter standing in the open. These larger trees are then auger bored radially and shattered with explosives, so that they can be handled by the dozers.

Construction through dense rain-forest.

On rocky sideling ground, falling of timber by hand is at times necessary. The timber is then pulled clear with tractors and ropes.

Earthworks.—The work now in progress involves up to 80,000 cubic yards of earthworks per mile in steep sideling country, which can be classed as very heavy construction.

The gang engaged on the work comprises twelve to fourteen men using the following plant combinations:—

One heavy tractor-dozer with power ripper or 12/15 cu.yd. scoop.

One heavy tractor-dozer with 12 cu.yd. scoop.

Two medium tractor-dozers with 9 and 6 cu.yd. scoops or sheepsfoot roller.

One two-jackhammer air compressor.

Formation work is commenced by cutting a scoop track along the tops of cuttings and toes of fills, the latter serving to key the filling into the natural surface. Earth is moved by dozing on short leads and also where a predominance of granite boulders prohibits the use of tractor scoop units. As the fillings gain height, additional benches are cut into the natural surface to assist bond.

Drilling and blasting are restricted to large granite boulders, which are blasted to a size within the capacity of the earth-moving plant, or to outcrops of silicified shale. Considerable drilling and blasting are necessary, and consumption of explosives is up to 1,000 pounds per week. The use of tungsten carbide tipped drill steels gives drilling rates up to 6 inches per minute in granite and 9 inches per minute in shale.

The area in which work is at present in progress is subject to rainfall of upwards of 90 inches per year and tests have indicated that, even in fine weather, the moisture content of the soil is of the order of 30 per cent.; compaction of fills therefore requires careful treatment. It has been found that careful routing of plant supplemented by the sheepsfoot roller has resulted in 95 per cent. compaction at optimum moisture content of about 20 per cent.

Pavement.—There are very few deposits of suitable natural gravel in the area, and silicified shale is being used for base course material to conserve the limited quantities of granite gravel for a surface course prior to surfacing with bitumen.

The gang working on pavement construction comprises ten to twelve men with a ¾ cubic yard mechanical excavator and attendant lorries, two air compressors operating four jackhammers, and a heavy-duty motor grader.

The shale is in general obtained from widened cuttings by drilling and blasting, loading by excavator, haulage by lorries, and after spreading, is broken down and compacted by roller and grader.

Drainage.—A small gang of five or six men is engaged on pipe culvert construction. Where deep fills are necessary culverts are generally constructed on the flanks of gullies as the fills rise, to economise on length

Power shovel at work.

Local office and quarters at Dandahra Creek, 42.75 miles from Glen Innes.

and avoid excessive loading on the pipes. Pitched outlets are generally constructed at each culvert to avoid the possibility of future scour at the toes of fills.

Another small gang is engaged on subsoil drainage, guide-posting, protection fencing and other miscellaneous work.

Current Work in Mann River Valley.

Two bridges are at present under construction by contract over Cangi Creek and Buck's Creek, 35 miles and 40¾ miles respectively from South Grafton. Each bridge is of five-span timber beam construction, 20 feet wide between kerbs. Preparations are also being made for the early construction of bridges at Hill's Creek and Dandahra Creek.

Work Still Required.

There are some 5½ miles of heavy construction still to be completed on the descent of Gibraltar Range to link up at Camp Creek with the partially completed work previously carried out from Jackadgery.

Considerable work is still required to restore and complete the work on the 20 mile section skirting the Mann River from Camp Creek to Purgatory Creek, including the provision of bridges over the following streams:—

Camp Creek at 44½ miles from South Grafton.
Middle Creek at 43¼ miles from South Grafton.
Dandahra Creek at 42 miles from South Grafton.
Hill's Creek at 38 miles from South Grafton.
Mann River at Jackadgery at 30 miles from South Grafton.
Jackadgery Creek at 29½ miles from South Grafton.
Purgatory Creek at 24½ miles from South Grafton.

New construction is required between Purgatory Creek and the point where the new road rejoins the existing Gwydir Highway 5 miles west of South Grafton, including bridges over Main Creek at 21 miles from South Grafton and Cattle Creek at 16 miles from South Grafton.

Supervision.

The work in the Gibraltar Range area is under the general direction of the Department's Divisional Engineer, Glen Innes, at present Mr. G. H. Linton, and that in the Mann River valley and Jackadgery area under the general direction of the Department's Divisional Engineer, Grafton, at present Mr. A. H. Moroney.

Towards a National Road System.

Inaugural address by H. M. Sherrard (Commissioner for Main Roads, New South Wales), Chairman, New South Wales Centre Institute of Transport, Sydney, 28th March, 1957.

Principles in Road Development.

IN September last, the New South Wales Minister for Highways (Hon. J. B. Renshaw) announced the New South Wales Government's support for an Australian national system of primary roads. My object in this address is to discuss the principles involved in the development and improvement of the roads of a country, and to show how a national road system is a logical and necessary development.

The foundation of any programme of road improvement is comprised in two things, namely—(*a*) classification of roads, and (*b*) systematic finance. This applies whether we are dealing with a small State or a large country.

I propose first to elaborate what is meant by classification and by systematic finance in relation to roads.

Classification.

By classification is meant distinguishing between roads in respect of the functions they serve. For example, in New South Wales, six broad classes of road can be distinguished, as follows:—

(1) Roads or streets which merely give access to property.

(2) Roads which collect the traffic from access roads or streets and which carry it either to a centre of some sort, be it town or village or railway station, or to an arterial road.

(3) Arterial roads which link adjacent districts.

(4) Arterial roads which link the larger regions of the State.

(5) Arterial roads which connect this State with adjacent States, or link the coast of the State with the far interior.

(6) Arterial roads which connect the principal Australian centres of population, regardless of State boundaries, or which provide the principal routes for Australia-wide traffic movement. These are the roads of national significance. They can be identified on a map of Australia, but not on a map of a single State.

The functions of the majority of roads can readily be determined in practice, but there are always some roads which are difficult to classify on account of overlapping functions. The fact is that many roads serve more than one function,—for example, every arterial road, unless it is a road of restricted access, serves also as an access road to properties which front on to it.

Unless roads were classified, there would be little guide as to the standard of improvement which should be aimed at on any particular road; such works as are carried out would likely be sporadic and unco-ordinated, and selected under the influence of short-term thinking rather than long-term thinking. The net result would be a lack of continuity of road improvement, and funds not spent to best advantage.

Finance.

A satisfactory road classification makes possible the assignment of financial responsibility among the various organs of government concerned. For example, in New South Wales, roads essentially of local interest are a responsibility of local governing bodies. Arterial roads of State-wide interest are a State responsibility (i.e., the "State" Highway). Arterial roads which connect regions or districts within the State, but are not of State-wide interest, are a joint financial responsibility of the State and local governing bodies.

After classifying the roads of a country and assigning financial responsibility, the next step is to see that adequate finance is regularly available, so that programmes of work may be planned and organised, and proceed steadily, and so that constructional and supervisory organisations may be developed and kept continuously in operation. In these days where skill is increasingly necessary, jobs cannot be started and stopped like turning a tap on and off, if we are to have regard to the efficiency of an organisation, including its morale.

Broadly, it may be stated that each Australian State already has its roads classified from the State aspect somewhat as described; has assigned financial responsibility for its roads among local governing bodies and a State road authority; and has provided regular finance to the State road authority by means of receipts from motor vehicle taxation and, to the extent available, receipts from the petrol tax grants received from the Commonwealth Government. Local governing bodies draw their revenue largely from rating on land.

The National Level.

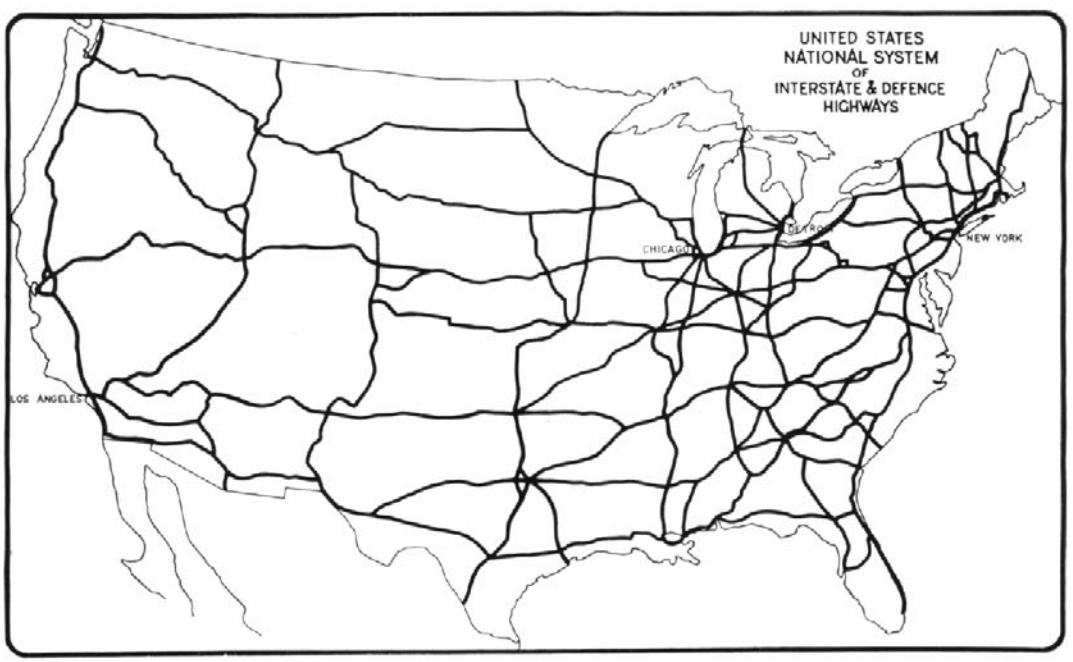
Hitherto in Australia we have had no recognised road classification at the national level, i.e., we have not identified the roads of Australia-wide interest, disregarding State boundaries.

The people of the United States some years ago set to work to define such a national road system in their country, and last year under pressure from President Eisenhower, the U.S. Congress established means of

constructing or improving the system over a 13-year period. It is known as the National System of Interstate and Defence Highways, and extends over 41,000 miles, about 1.3 per cent. of the mileage of all United States roads (see map below). Most of the 41,000 miles of road referred to already exist, and the plan provides for their improvement to standards appropriate to their future traffic importance.

In the case of the New South Wales Government's proposal for defining a System of Australian Primary Roads, it has been proposed that the roads included in the system should be financed from that part of the petrol tax receipts at present retained by the Commonwealth Government, supplemented by a contribution from Commonwealth general revenues, having regard to the value of the roads to the Commonwealth Government. A construction period of 15 years has been of a bituminous or other type of dustless surface, the amount of funds required to bring the proposed system in the rural areas throughout Australia to the required standard is considered likely to be between £350,000,000 and £400,000,000.

The map on the following page shows the suggested Australian national road system. It comprises 17,500 miles, a little over 3 per cent. of the total Australian road mileage; it includes what are judged to be the most suitable direct connections between all capital cities; the route around the coast from Cairns to Adelaide; connections to Darwin, and connections to Canberra. The system proposed is considered to be the minimum necessary to link effectively all the principal population centres and productive areas of the Commonwealth, and to serve defence needs.



suggested. As in the case of the United States national system, the roads of the proposed Australian national system already exist in most cases, but require much improvement to meet present and future needs. Broadly, they fall into two groups,—(1) those roads which already are serving a national function to some degree, but require much improvement, e.g., the Hume Highway in New South Wales, and (2) those roads whose present condition almost entirely prevents them from performing the national function for which their situation fits them, e.g., the direct routes from Melbourne to Brisbane, and from Adelaide to Brisbane, both of which cross western New South Wales, and are practically impassable over long lengths in prolonged wet weather.

Information is not yet available which would enable reliable estimates of cost to be prepared of the proposed national road system, but based on the provision

The putting forward of the national roads scheme could be regarded as an effort to direct the attention of the Commonwealth Government to those roads which are of national concern; if the Commonwealth Government would accept financial responsibility for these roads, the relief thereby given to the States would go far in enabling the States to solve the problem of financing their remaining roads.

As the Minister for Highways has said, the proposed Australian national system of primary roads is planned to do for Australia, on a more modest scale, what President Eisenhower's National System of Interstate and Defence Highways will do for the United States of America.

The Australian national system would provide the principal roads needed for interstate trade and travel, in both peace and war. It would bind Australia closer together, and it would make remote parts much more

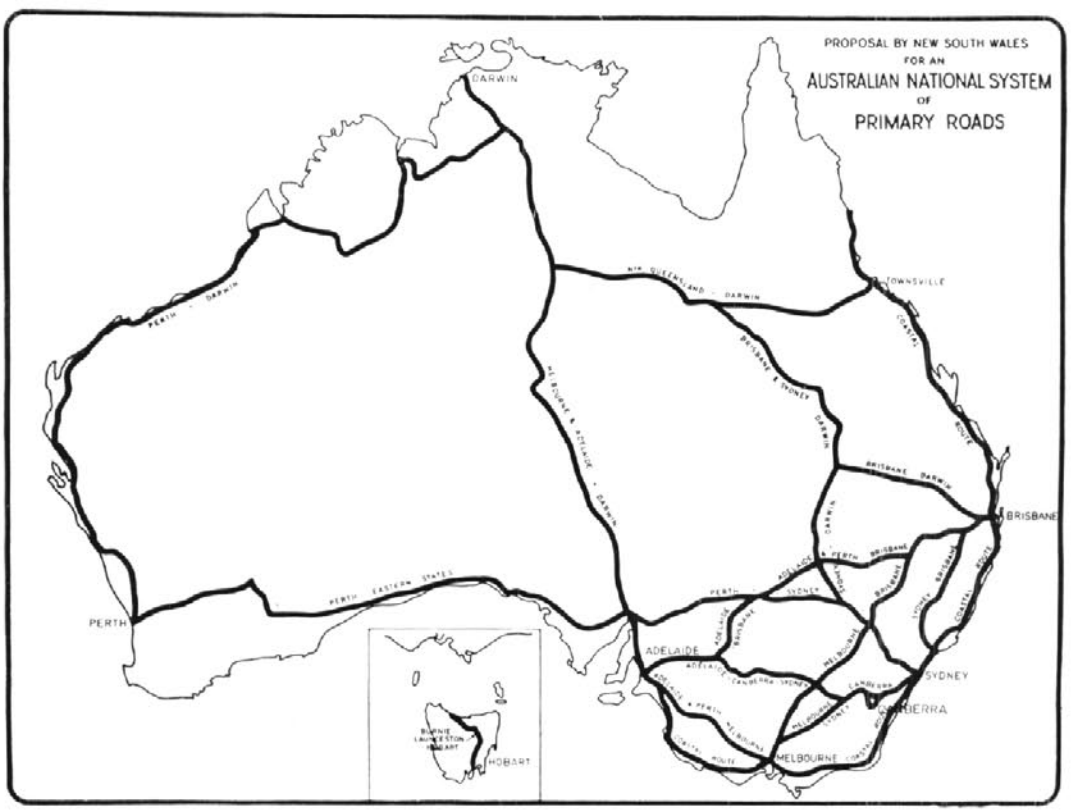
readily available for development than at present. The creation of the national primary road system would be a permanent investment which would yield increasing dividends as the years pass. It would not involve setting up any new Commonwealth constructional organisation, as all work (apart from that in the Northern Territory) could be carried out by the States.

Finance for an Australian National Road System.

The arterial roads of the Australian States are at present financed mainly from three sources, namely, motor vehicle taxation; portion of the petrol tax; and local council rating. A tax on a motor vehicle is usually regarded as a payment for the right to use the vehicle on the roads, whereas petrol tax is to some degree a measure of the actual use made of the roads. Motor vehicle taxation provides the preponderating share of revenue for main roads in New South Wales, and provides more than half the combined revenue of the six Australian State road authorities. By contrast, in the United States petrol taxation imposed by the individual States provides about two-thirds of total State road revenues.

Of the total petrol tax collected by the Commonwealth Government, about half may be spent by the States on arterial roads. This is divided among the States on the basis of three-fifths in proportion to population and two-fifths in proportion to area. The method of partial distribution in proportion to area is not altogether satisfactory, mainly because some States have large areas of arid country which require little road expenditure. Perhaps if the areas having less than, say, a 10-inch rainfall were disregarded in applying the formula, a more equitable result would be secured.

It was stated earlier that it was considered that the proposed national roads system should be financed by utilising the amount from the petrol tax at present retained by the Commonwealth Government, supplemented by a contribution from general revenue by reason of the benefits accruing to the Commonwealth Government from roads. I will now describe the case in support of the use of each of these revenue sources as put forward by New South Wales.



A Case for Expending All Petrol Tax Revenue on Roads.

Petrol taxation appears to be the best means available of proportioning charges for road use to the actual benefit received by each road-user. It is not a precise measure of road use, but by and large it is sufficiently exact, and its inadequacies can be made up by supplementary taxation, as may be needed.

It provides the only means of "metering" road use on a reasonably equitable basis, and thereby making road transport self-supporting. We can "meter" the use made of electricity, water, gas, and telephones, and users of these can be required to pay in proportion to use made; it is a commercial transaction. Likewise, we can by means of petrol taxation to some degree

measure the use made of roads and charge accordingly; it is a form of toll. Such a system is equitable and fair, and corresponds with the freight charge or passenger charge on a railway. The Americans use petrol taxation as the major source of revenue funds for work on their Main Roads system.

To tax road-users as a class for purposes *other* than roads means that the opportunity to *tax* for road needs is correspondingly reduced. On the other hand, taxation of road-users for road purposes creates improved roads, from which not only do road-users benefit by lower transport costs, but the country's economy benefits as a whole, and this in turn is reflected in better yields from other taxation fields. Bad roads mean higher cost of vehicle operation than good roads, because of greater repair bills, increased tyre wear and petrol consumption, and longer time of travel.

Costs of transport, especially of road transport, in varying degrees, affect the prices of practically all goods produced. To compete better with overseas countries, it is vital to keep down costs, and especially so in a country, such as Australia, of long distances and sparse population. However, a tax on road-users for general taxation purposes has just the reverse effect, and seems to be contrary to Australia's best interests. This is because such a tax must all be paid before the goods are marketed; in other words, before income has been earned. It is thus a tax on production, but must be paid before the goods are produced. Taxation should preferably not be in a form which restricts production, but rather should be imposed after production has occurred. The use of petrol taxation for general revenue purposes is thus a brake on enterprise; further, being a flat rate tax, it hits the small man relatively more severely than the established firm. It is the less developed parts of a country which as a rule stand to gain most from road transport, and which are most penalised by taxation applied for non-road purposes.

Road transport is not an enemy to be fought at all costs. It is one of the most powerful factors working for economic progress in the world, and because of the contribution it can make to economic development and thus to national income, we cannot afford not to take advantage of it in these fields where it offers true economy.

It has been argued on occasions that petrol tax is a way of taxing ownership of those vehicles used only for recreation or "pleasure". However, the week-end driver does a relatively small annual mileage. By far the bulk of petrol tax receipts comes from the business user, i.e., from commerce and from primary and secondary industry.

Another argument sometimes brought forward is that if beer or whisky is taxed for general revenue, then why not petrol. The difference is fundamental. Petrol is used for the greater part for essential business, and its taxation for general revenue purposes adversely affects the cost of production of goods of all kinds. To tax petrol for general revenue purposes is just as if a tax were imposed on the coal used in railway locomotives and the proceeds of that were paid to general revenue.

Nobody disputes the right of the Commonwealth Government to tax the motor industry. Additional to petrol tax, that industry already contributes about £60,000,000 per annum through sales tax, customs duty and primage alone, quite apart from pay-roll tax and income taxes. Such taxes are imposed on all industries, however, and do not in any way encroach on what is considered to be the logical and equitable field of taxation for road finance, namely petrol taxation. To tax petrol for general revenue purposes appears to be highly inexpedient, not only because it hampers production, but also because it is considered wrong in principle, and interferes with the establishment of a logical method of financing and developing an adequate Australian road system.

A Case for the Commonwealth Government to Contribute to Roads Finance from its General Revenue.

In addition to the allocation of the full amount of petrol taxation to road use, it appears entirely reasonable and proper that the Commonwealth Government should contribute to roads from its general revenues, for the following reasons:—

(*a*) the roads are used extensively for Commonwealth purposes, in fact without them government would be almost impossible. They are used for the distribution of mails; for the provision and maintenance of telephone and telegraph services; for defence, including defence industries; for interstate travel and trade; for access to Commonwealth properties; and in all aspects of Commonwealth administration. (The defence aspect is dealt with more fully later.)

It is for such reasons as these that the New Zealand Government contributes £1,000,00 per annum to Main Highways, in addition to setting aside all petrol tax receipts and other motor receipts for this purpose.

(*b*) the roads are essential to production, and it is production which at some stage supports all Commonwealth taxation.

(*c*) Commonwealth vehicles do not pay motor vehicle registration tax to the States in which they operate.

(*d*) road transport is a large contributor to Commonwealth revenue.

The Defence Aspect.—In view of the importance, from the aspect of defence, placed on arterial roads in the United States, it seems worthwhile to refer to this more fully.

The Commonwealth Government hitherto appears never to have displayed great interest in roads from the aspect of defence, or to have attempted to influence road policy, presumably having assumed that any war in which Australia is involved will be fought overseas. However, immediately before the last war a Commonwealth interest was disclosed, as a result of which the co-operation of the States was sought, and a number

of special roads were built by the States to meet defence needs. These roads fall into two groups—

(i) long-distance roads, such as Alice Springs to Darwin; Mt. Isa to Tennants Creek; Port Augusta to Kalgoorlie; and Rockhampton to Charters Towers.

(ii) relatively short connecting links, such as a number of roads built in New South Wales, mainly in the Sydney-Newcastle region.

The Commonwealth's post-war apparent lack of defence interest in roads is in contrast with the position in the United States. In that country, military leaders have repeatedly emphasised the need for improved roads for defence purposes. A special report to Congress on "Highway needs in the National Defence" was prepared in 1949. The Secretary for Defence, in submitting the report, stated that—"The National Military Establishment considers a relatively small 'connected system of highways interstate in character', constructed to the highest practical uniform design standards, essential to the national defence. Because of the time required, and cost, such a system must be planned for and constructed during peace-time".

President Eisenhower has recently taken the lead in sponsoring such a system, and as a result, Congress in 1956 defined a national system of "Interstate and Defence" roads totalling 41,000 miles, and has provided a means of financing their construction over a period of 13 years.

The following is quoted from Major-General Paul F. Yount, present Chief of Transportation of the U.S. Army—"Today's crucial national defence needs lie in improving to modern standards the 40,000 mile interstate Highway System. This vital network must be able to handle the tremendous volume and weight of military, industrial, and civilian traffic that will flood our arterial highways in the event of a national emergency."

It will be seen therefore that a good road network is rated high as a defence measure in the United States. This gives rise to the belief that Australian defence potential also would be strengthened by better roads, and that defence value is one of a number of reasons why the Commonwealth Government might reasonably contribute to roads from its general revenues.

Summary.

I have endeavoured to put to you that road classification, together with assurance of regular and adequate road finance, is the basis of successful road development; that within the States this has been recognised; but that we still lack the national approach. Until we get that approach, we are unlikely to see the full development of all the roads shown in the proposed national road system, and easy and direct movement by road about our continent will not be achieved.

The proposal put forward by New South Wales for a national road system, and for a means of financing it would be of direct benefit to the people of New South Wales, as it would be to those in other States. It has been put forward, however, not only because it would benefit the people of New South Wales, but also because of its value to Australia as a whole.

SYDNEY HARBOUR BRIDGE ACCOUNT.

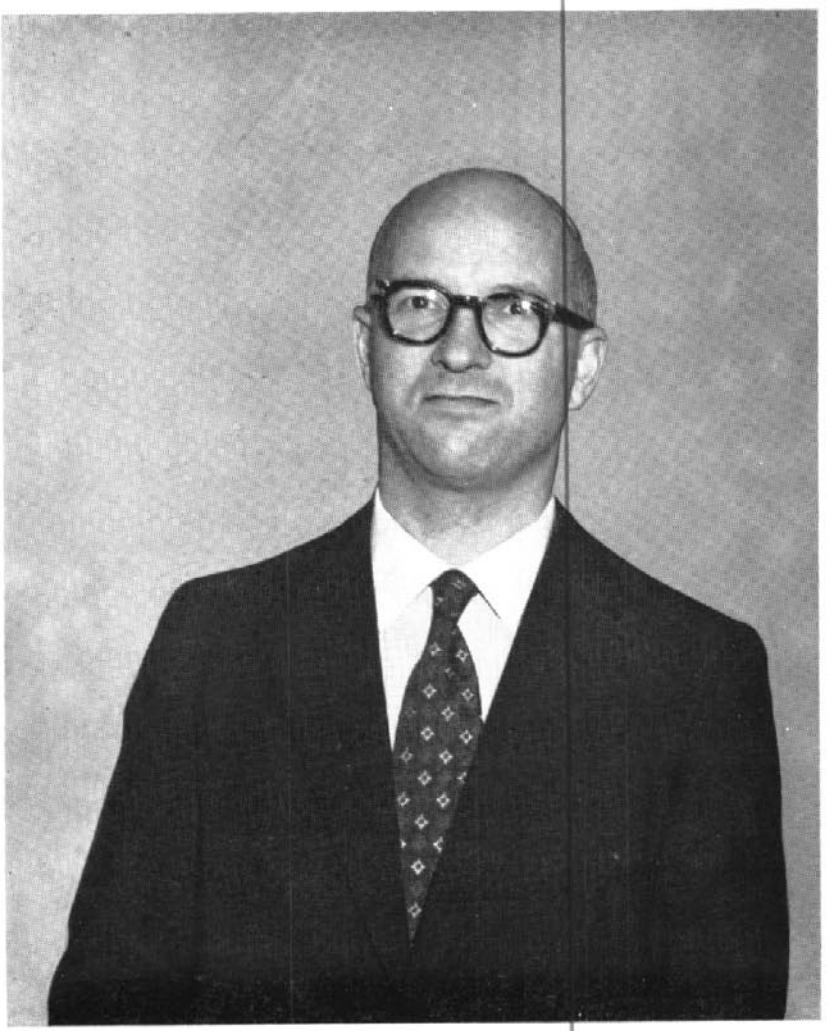
Income and Expenditure for the period 1st July, 1956 to 31st March, 1957.

Expenditure.

	£	£
Cost of Collecting Road Tolls		64,771
Provision for Traffic Facilities		3,711
Alteration to Archways		4,304
Maintenance and Minor Improvements		118,088
Adminstrative Expenses		3,226
Loan Charges—		
Interest	189,129	
Exchange	12,262	
Sinking Fund	72,332	
Management Expenses	809	
Flotation Expenses	34,200	
		308,732
Miscellaneous		1,961
Construction of new Toll Office and Barrier		5,277
		£510,070

Income.

	£
Road Tolls	597,259
Contributions—	
Railway Passengers	96,391
Tramway and Omnibus Passengers	15,633
Rents from Properties	18,074
Miscellaneous	463
	£727,820



Professor D. F. Orchard, foundation Professor of Highway Engineering in the New South Wales University of Technology, who took up duty at the University in April, 1957.

REVISION OF MAIN ROADS MAP.

The Department of Main Roads official map of the Main Roads system of New South Wales has recently been revised and the revised map has been printed by the Department of Lands. As previously, the map is to a scale of 16 miles to an inch; in addition to the Main Roads system it shows Developmental Roads, Municipal and Shire boundaries, physical features, and principal place names. Inset maps to larger scales are provided for the metropolitan area; the far north coast; the Newcastle area; and the district around Wollongong. A copy of the new map is being supplied to each Municipal and Shire Council in New South Wales.

General View of New Bridge.

New Bridge Over Tuross River, Bodalla.

A LARGE new steel and concrete bridge over the Tuross River, about one mile north of Bodalla, on the Prince's Highway, was opened to traffic on Saturday, 16th March, 1957, by the Commissioner for Main Roads (Mr. H. M. Sherrard). The bridge was built for the Department of Main Roads by contract.

Contracts for the manufacture and supply of the steelwork and for the erection of the bridge were let in 1948, but a nation-wide shortage of steel delayed the work, and construction of the bridge did not actually commence until the middle of 1954.

In the meantime, a pier of the old bridge, which was built in 1882, collapsed in April, 1954, due to abnormal infestation by marine borer, and a temporary low-level bridge, 503 feet in length and 12 feet wide, was built to carry traffic, pending completion of the new structure. Construction of the temporary bridge was completed in just under two months, traffic using a detour while the bridge work was going on.

The new bridge has an overall length of 630 feet and a carriageway 24 feet wide between kerbs. It consists of four steel truss spans, each 120 feet long, and four 35 feet long steel girder spans, two at each end of the structure. The deck is of concrete.

The piers supporting the truss spans consist of concrete cylinders founded on rock. The northern abutment and the northern pier carrying the two approach spans rest on driven reinforced concrete piles. At the southern end the abutment and the corresponding pier are carried on spread concrete footings founded on rock.

The bridge has been designed to pass all flood waters at the highest flood level previously recorded, but in case of an abnormal flood reaching a higher level, the road approaches to the bridge have been kept down to a level on each side so as to act as an emergency flood relief should this be needed.

The new bridge is located some 200 yards upstream from the site of the original bridge, and the approaches on each side have been realigned by a deviation of the Highway extending over a total length of about 2¼ miles. The deviation was built by the Department of Main Roads, by direct labour, at a cost of approximately £80,000, and included the provision of three small bridges over flood channels and a tributary (Rhodes Creek) of the river.

Manufacture and supply of the steelwork were carried out by a contract with the Clyde Engineering Company Pty. Ltd. for an approximate cost of £47,000. Hornibrook, McKenzie, Clark Pty. Ltd. were the contractors for the construction of the piers and abutments, erection of the steelwork, laying of the reinforced concrete deck and the final completion of the bridge, in an amount of approximately £149,000.

The steelwork contract was supervised directly from the Department's Head Office. The contract for the work at the site, together with the approaches, was

School children marching over the bridge after the official opening.

supervised from the Department's Divisional Office at Bega under the direction of the Divisional Engineer, Mr. R. W. P. Hirt.

Earlier Crossings.

The first crossing of the Tuross River was by means of a ford at Widgett, a considerable distance upstream from the present bridge site. The crossing place was on the property of John Hawdon, the original settler in the district, whose holding was named "Boat Alley". The main road from Sydney to Twofold Bay passed through Hawdon's estate.

A new line of road was marked out in 1859. This line crossed the river at Trunketabella Plain, and provision was made for the establishment of a punt. Tenders for its construction were called in 1861, and by proclamation made on the 17th October, 1863, the crossing was declared a public ferry "at which on and after the first day of January next (1864) tolls shall be demanded, levied and taken".

In 1878, tenders were invited for the construction of a bridge to replace the ferry and in the Government Gazette of the 18th April, 1879, acceptance of a tender by J. Atkinson was notified. The bridge was opened for traffic early in 1882, the writer of an article contributed to the "Moruya Examiner" of the 8th April, 1882, describing it as "one of the most expensive and faithfully built structures of its kind in the country".

The bridge comprised 16 timber beam spans with an overall length of 598 feet. In 1891, the bridge was severely damaged by flood waters, and several spans were washed away. Proposals were made for the replacement of six 45 feet spans with three timber truss spans of 90 feet each, and a contract for this work was entered into with Edward William Fitzgerald. It was later decided to replace eight of the timber beam spans, and the work was completed in 1894, although the reconstructed bridge was opened to traffic in May, 1893. It continued in use until 1954.

The President of the Eurobodalla Shire Council, Councillor D. Thomson, speaking at the opening ceremony.

Soils and Rocks in Road Construction in New South Wales.

PART III. ROCKS—THEIR USE IN VARIOUS TYPES OF ROADWORK; QUALITY REQUIREMENTS AND TESTING.

THE two previous articles in this series were published in the June 1956 and September 1956 numbers and dealt with the occurrence, classification, and test results of the principal soils of New South Wales which are important as road foundations. Part III deals with the use of rock as a road-making material; it indicates what qualities are desirable for particular types of construction and briefly describes the tests that are used by the Department of Main Roads in assessing the quality of rock for road-making purposes.

General Use of Rock.

Apart from its incorporation in road embankments and miscellaneous use as a protective material against wind or water erosion, the principal uses of rock as a road-making material in New South Wales, are as follows:—

(*a*) "Gravel" type pavements constructed from shale or other soft rocks.

(*b*) Sandstone pavements comprising hand-pitched material or smaller gauge broken stone constructed in the same manner as ordinary gravel pavement.

(*c*) Fine crushed rock pavements, comprising graded mixtures of crushed aggregate.

(*d*) Macadam type pavements, such as water-bound macadam, which consist of a layer of coarse aggregate the voids of which are incompletely filled with smaller aggregate.

(*e*) Bituminous penetration macadam pavements.

(*f*) Bitumen-aggregate mixtures (open-graded or dense-graded).

(*g*) Light bituminous surface treatments.

(*h*) Portland cement concrete for rigid pavements.

(*i*) Portland cement concrete for bridges, culverts and other structures.

Rocks commonly available for roadwork in New South Wales include basalts, dolerites and andesites, granites, porphyries, quartzites, sandstones, shales and limestones. Some details of their occurrence and use will be given in a succeeding article.

Quality Requirements of Rock for the Production of Aggregate.

The properties of road-making stones may be considered in two groups—properties which are inherent (e.g., strength, soundness, specific gravity, absorption, moisture content) and properties which can be partly controlled (e.g., grading, silt content, organic matter content). Shape is controllable to some degree in crushed stone but is also dependent on the nature of the rock from which the stone is crushed.

The important properties required in a rock to be used for crushed stone courses are toughness to resist fracture under load; resistance to abrasion; durability to guard against deterioration due to weathering. Good shape of crushed aggregate (i.e., freedom from elongated or flakey particles) is necessary to ensure easy compaction. The cementitious properties of rocks are less important than formerly because most pavements built from the harder rocks are usually covered by or incorporate some form of bituminous treatment.

In the case of bituminous work, it is desirable also to choose a stone which has a good affinity for the bituminous binder with which it is to be used. Otherwise, the binder may "strip" from the stone under wet conditions. Another aspect to be considered with aggregates used for bituminous surfaces is the tendency of some stones to become rounded and polished by traffic and so produce a smooth surface which is liable to become slippery in wet weather.

In the case of Portland cement concrete, important qualities are toughness, durability and resistance to abrasion. Other properties such as specific gravity, absorption, and shape of coarse and fine aggregate may also have to be considered for the purpose of designing concrete mixes.

Some stones may cause gradual disruption of concrete because they react unfavourably with the alkali in the cement. Although some cases of this nature have been reported in Australia, none has come under notice with aggregates hitherto used by the Department of Main Roads in New South Wales.

Methods Used for Testing Quality of Rock.

1. *Abrasion Test.*—In the early 1930's a variety of equipment was used to determine the hardness and toughness of stone, including the following:—

(*a*) The Page impact machine, which subjected small cylindrical cores of rock to progressively increasing impact until fracture occurred;

(*b*) Dorry hardness machine, in which small cylindrical cores cut from the rock were ground with specially prepared crushed quartz fed between the end of the cores and a revolving metal disc.

(*c*) Deval abrasion machine in which samples of the aggregate were abraded by placing them in a revolving cylindrical drum mounted at an angle to its axis of rotation.

(*d*) "Cementing value" was determined by wet grinding the stone in a ball mill, moulding cylindrical specimens from the resulting paste and testing them under a small impact machine.

(Details of these tests were given in "Main Roads", Vol. 1, No. 10, July, 1930, pp. 232-4.)

The Department now uses the Los Angeles Machine as the chief means of assessing the abrasion resistance and toughness of rock. This apparatus consists of a hollow metal cylinder 28 inches diameter and 20 inches long driven to rotate about a horizontal axis. A shelf extending the full length of the machine projects radially $3\frac{1}{2}$ inches into the cylinder.

Los Angeles Abrasion Machine (lid removed) and charge of aggregate and balls. The cylinder is housed in a sound proof cabinet.

The test sample is prepared in accordance with a prescribed procedure which specifies a standard grading for each of several gauges of stone ranging from $\frac{1}{4}$ inch to 3 inches maximum size, and also the size of sample (ranging from 2,500 to 3,000 grams) to be used for each particular grading. The sample is placed in the cylinder together with an abrasive charge of cast-iron balls $1\frac{7}{8}$ inches in diameter and the machine is rotated at a speed of 30 to 33 r.p.m. Rotation is continued for 500 revolutions for the smaller gauges of aggregate and 1,000 revolutions for the larger sizes. The test is more fully described in American Association of State Highway Officials, standard test No. T96-51. Some typical test results for New South Wales rocks are given in the following Table.

Typical Los Angeles Abrasion Test results for some New South Wales rocks:—

No.	Type of Rock.	Source.	Los Angeles Loss per cent.
1	Altered shale ...	Canberra	8
2	Andesite	Port Kembla ...	18
3	Basalt	Casino	9
4	Basalt	Bathurst	10
5	Basalt	Bombo	12
6	Basalt	Kempsey	14
7	Granite	Lett River	22
8	Granite	Bluff Rock	36
9	Granite	Yetholme	53
10	Limestone	Forbes	18
11	Limestone	Wellington	24
12	Limestone	Galong	30
13	Limestone	Caloola	42
14	Quartz	Newbridge	22
15	Quartz	Lake George... ...	50
16	Quartzite	Bumbaldry	16
17	Quartzite	Marangaroo	38
18	River Gravel ...	Jugiong	18
19	River Gravel ...	Narromine	26
20	River Gravel ...	Canberra	44
21	Sandstone	Cambewarra Mt. ...	24
22	Sandstone	Oxford Falls... ...	53
23	Sandstone	Colo	98
24	Syenite	Bowral	21
25	Trachyte	Tenterfield	33

Specification limits for Los Angeles abrasion loss are usually fixed with due regard to the position which the stone is to occupy in the pavement. In light bituminous surface treatments, the cover aggregate usually projects well above the binder and is exposed to the full impact and abrasion effects of traffic. An especially hard, tough aggregate is therefore required. For this type of construction it is desirable that the Los Angeles loss should not exceed 20 per cent. if traffic is heavy. For light traffic (say less than 200 vehicles per day) a figure of 35 might be accepted. In bitumen-aggregate mixtures the aggregate is better protected and cushioned against the destructive action of traffic, and somewhat higher figures are often acceptable.

The Los Angeles test gives consistent results with homogeneous materials. With non-uniform materials, such as river gravels, some weathered igneous rocks, blast furnace slag, etc., testing of a composite sample does not give a true guide as to the amount and the relative hardness of the weaker particles, e.g., a sample of river gravel giving a satisfactory Los Angeles result of 25, may comprise 75 per cent. of hard stones and 25 per cent. of very weak particles which tested alone might give a Los Angeles figure of 40 or more. For surface treatment work in particular, it is desirable to conduct a separate test on a selection of the obviously weaker particles in order to determine whether a significant part of the aggregate is too soft to ensure satisfactory performance as a cover stone. A very low Los Angeles loss usually indicates a material that is expensive to crush.

2. *Accelerated Weathering Test.*—In order to test the durability of shales and other relatively soft rocks for flexible pavement base courses, the Department of Main Roads uses an accelerated weathering test to measure the break-down that occurs when the stone is subjected to a compaction treatment together with ten cycles of wetting and drying. (For full particulars of this test see "Main Roads", March, 1948, page 85, or Highway Research Board Proceedings, 1947, page 122.)

Hard rocks showing jointing planes of suspected weakness may be subjected to a Sulphate Soundness Test (American Association of State Highway Officials, test designation T.104-46). This test is used primarily to check the effect of freezing (which is not important in New South Wales) but it can also be useful as a general weathering test when adequate information is not available from service records of the material exposed to actual weathering conditions.

3. *Maximum Dry Compressive Strength.*—Graded aggregate mixtures produced from shales, or fine crushed rock material produced by crushing clean hard stone, may be unsatisfactory because the finer particles have insufficient cementing power to ensure adequate strength. To test this property the Department uses an unconfined compression test conducted as follows:—

> Portion of the sample passing a three-quarter inch square mesh laboratory screen is slightly moistened with water and rammed into a lightly greased cubical metal mould of between two and three-quarters and three inch edge, by means of 450 blows of a Bohme hammer. The resultant cube is dried in the mould to constant weight at a temperature of 105 degrees C., then removed from the mould and tested for compressive strength. The result is expressed as pounds per square inch.

A compressive strength of 400 lb./sq. in. is usually specified but this may be reduced to 250 lb./sq. in. if bituminous surface treatment is to follow quickly after the pavement has been compacted.

4. *Aggregate Crushing Test.*—An aggregate crushing test is described in British Standard No. 812-1951. Briefly, the procedure is as follows:—

(i) A sample of ½ in. to ⅜ in. dry aggregate prepared from the rock under test is tamped to a depth of 4 inches into an open metal cylinder 6 inches in diameter and 5½ inches high.

(ii) The surface of the aggregate is levelled and a cylindrical plunger placed on it.

(iii) A load of 40 tons is applied to the plunger at a rate of 4 tons per minute.

(iv) The load is released and the aggregate sieved over a No. 7 B.S. sieve. The percentage by weight finer than this sieve is reported as the aggregate crushing value.

Apparatus for British standard aggregate crushing test; sieve, plunger, test cylinder and measuring cylinder.

The Department of Main Roads uses this test in a slightly modified form for assessing the value of sandstones for use in pavement base courses; the stone is broken to ¾ inch to ½ inch gauge and tested wet after soaking in water for 24 hours.

Material to receive a thin bituminous surface course only is required to have an Aggregate Crushing value of from 30 to 55, preferably 35 to 50. If the pavement is to receive a thicker surface course these limits may be extended to 30 to 50, preferably 35 to 55. Values less than 30 indicate that the material is too hard for a "gravel type" pavement but suitable for broken stone construction where the strength of the pavement lies largely in the mechanical interlocking of the larger stones.

5. *Adhesion Test.*—Some rocks show poor adhesion to bitumen in the presence of moisture; such stones are said to be hydrophilic. Unless the stone or the bitumen is treated with an adhesion agent the bitumen is liable to "strip" from the stone under wet conditions particularly in the case of open graded mixtures or freshly constructed surface dressings.

The test used by the Department in determining the adhesive properties of aggregate for thin bitumen surface treatment is known as the "Plate Test" and is described in the June 1955 number of "Main Roads".

Use is also made of an "Immersion-Compression" test for determining the effect of water on aggregate to be used in bitumen-aggregate mixtures (see "Main Roads", March 1952).

6. *Mortar Test for Fine Aggregate for Portland Cement Concrete.*—The Department's specifications for concrete require that fine aggregate be subjected to a mortar strength test. Mortar cubes made with one part of Portland cement to three parts of the test aggregate are compared for compressive strength with similar specimens made from a standard sand (Leighton-Buzzard). The method of test is generally in accordance with the mortar test procedure described in Australian Standard A2-1953 for the testing of Portland cement.

7. *Miscellaneous Tests.*—In addition to the quality tests outlined above, several tests are made for special purposes, e.g., specific gravity, absorption, bulk density and moisture content are usually required for designing graded mixtures for cement concrete or bituminous surface courses.

Tests may also be done to determine certain properties which can be controlled to varying degrees at the source of production, e.g., grading; silt or dust content; organic impurities in fine aggregates for concrete and bituminous work. Although some rocks naturally crush to better shaped aggregate than others, shape can often be improved during crushing operations by choosing a suitable type of crusher and by avoiding too large a size reduction at each stage of crushing.

Visual inspection of hand specimens and study of slides under a petrological microscope can be of value in detecting certain properties of stones such as porosity, chemical instability, and planes of weakness.

(To be continued.)

RECEIPTS AND PAYMENTS—MAIN ROADS FUNDS.

For period from 1st July, 1956 to 31st March, 1957.

Heading.	County of Cumberland Main Roads Fund.	Country Main Roads Fund.
	£	£
Receipts.		
Motor Vehicle Taxation levied by the State Government	1,160,568	4,642,271
Petrol Taxation paid to the State by the Commonwealth Government	762,163	3,076,026
Contributions by Councils	414,481	6,164
Repayable Loan Money provided by State Government	...	100,000
Temporary Advance by the State Government	150,000	...
Other Receipts	125,325	148,821
	£2,612,537	£7,973,282
Payments.		
Maintenance and Minor Improvements—		
Ordinary Works	776,790	4,064,032
Construction and Reconstruction		
Ordinary Works	1,331,665	3,364,959
Special works on behalf of State and Commonwealth Authorities	...	172,186
Acquisition of land and buildings for road widening and other road works	254,987	24,666
Loan charges (Repayment of Principal and Payment of Sinking Fund, Interest, Exchange, etc. on loans)	...	152,829
Suspense Items, including purchase and operation of Department's Plant and Motor Vehicles	(—) 8,205	(—) 106,971
Other Payments	255,303	460,693
	£2,610,540	£8,132,394

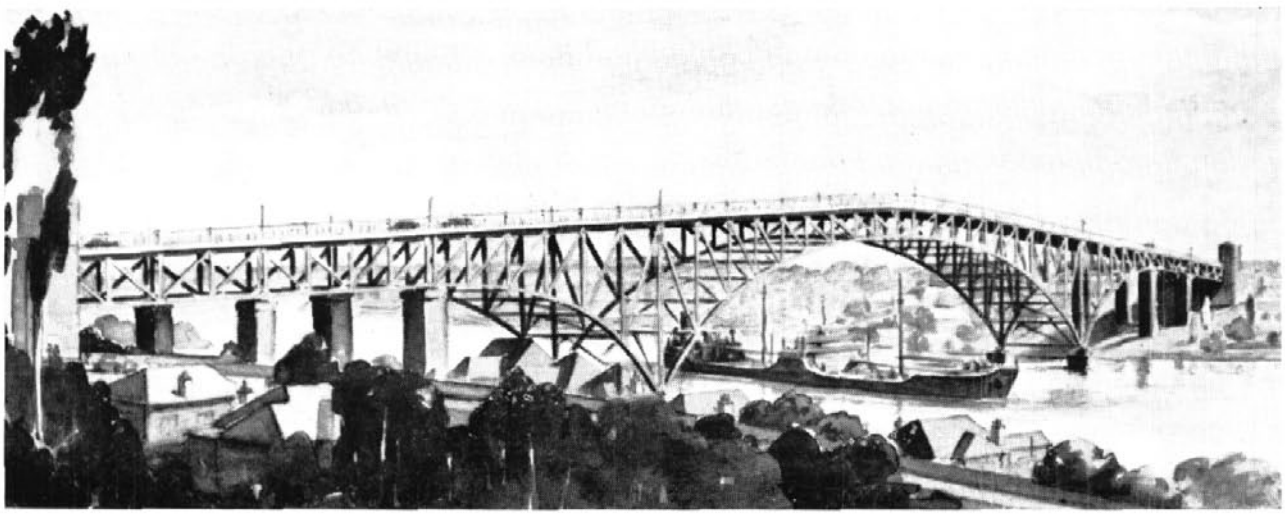
Proposed New Bridge over the Parramatta River at Gladesville.

The Department of Main Roads has invited tenders both overseas and in Australia, for the construction of a large new bridge over the Parramatta River at Gladesville.

The new bridge is to take the place of the existing Gladesville Bridge, which was built in 1884 and is now inadequate in strength and width for the increasing weight and volume of road traffic, whilst its narrow swing span is insufficient for future shipping requirements. When the bridge has to be opened to shipping in or near busy periods road traffic is considerably inconvenienced. The new bridge will take off from high ground at the end of Cambridge Street, Drummoyne, and connect to high ground at Huntley's Point, thereby enabling it to be placed at a higher level than the old bridge; in addition, much straighter road approaches will be possible on both sides of the river than in the case of the old bridge. The level of the new bridge will be sufficient for ships to pass beneath it, and thus no opening span will be required. The height and span of the bridge have been determined largely by the requirements of the Maritime Services Board, which has taken account of future port developmental needs in that part of the harbour upstream of the bridge. The new bridge will accommodate six lanes of vehicular traffic, and will have two footways; its roadway will be wider than that on the Sydney Harbour Bridge.

Detailed drawings and specifications have been prepared by the Department of Main Roads for a steel bridge as illustrated. Tenderers may submit tenders to this design, or a tenderer may submit his own design, and may provide for construction in either steel or concrete. The closing date for tenders is 17th October, 1957, and after the letting of a tender 3½ years is allowed for the completion of the bridge.

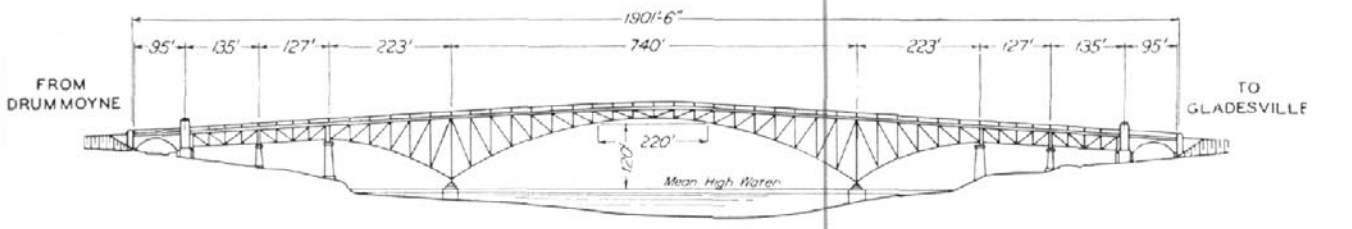
The new bridge has been so planned as later to form part of the proposed northern expressway which will extend to beyond Hornsby, and will pass through part of the Lane Cove River Valley. The replacement of the Fig Tree Bridge over the Lane Cove River by a wider bridge is also being planned for, on account of the age and narrowness of the existing bridge. The new bridge at Fig Tree will also be designed to form part of the northern expressway.



An artist's impression of the proposed new bridge over the Parramatta River at Gladesville.

These two bridges and associated works will greatly increase cross-harbour traffic facilities, and provide a favourable route for part of the traffic which otherwise would tend to use the Harbour Bridge.

The design of the proposed new bridge at Gladesville as prepared by the Department of Main Roads provides for a steel double cantilever truss bridge with a suspended truss span between the two cantilever arms and two balancing anchor arm shore spans. Including the



Sketch elevation of the proposed bridge showing principal dimensions.

approach spans and abutments, the overall length of the proposed bridge is 1,901 feet 6 inches. The carriageway will be 72 feet wide between kerbs, and the footways each 8 feet wide. To provide required clearance for shipping, the underside of the bridge will be at least 120 feet above high water level for a width of 200 feet at the middle of the bridge. To obtain the height necessary to provide this shipping clearance the bridge will be graded up to the centre from each approach, the maximum grade being 6 per cent.

Further Experiments in Mistletoe Eradication.

In the March, 1953 issue of *Main Roads*, there were described some tests carried out by the Forestry Commission of New South Wales in co-operation with the Department of Main Roads for the eradication of mistletoe on roadside eucalyptus trees by the application of hormone sprays.

The tests were undertaken on Main Road No. 154 in the Municipality of Penrith, and demonstrated the comparatively high resistance of eucalypts to the synthetic hormone type chemical and the effectiveness of spraying as a means of destruction of the mistletoe. Within a few weeks of the treatment being applied, withering of the mistletoe was noted, but in no case was there evidence of damage to the trees. In this series of tests 254 trees were treated.

A method of control by injection of 2, 4-D sodium salts into the butt or bole of infested trees was later reported by the Division of Plant Industry of the Council of Scientific and Industrial Research Organization. Some details were obtained in 1953, and with a view to testing the efficacy and practicability of the method and some variants, a large scale practical experiment was undertaken, as a joint project, by the Division of Wood Technology of the Forestry Commission of New South Wales, and the Department of Main Roads. The work was carried out on a 14-mile length of the New England Highway (State Highway No. 9) between Bendemeer and Uralla, some 1,000 trees infested with mistletoe being treated.

It was hoped that by the injection method slow movement of the chemical would take place within the trees, which would lead to the death of the adhering mistletoe over a period of from twelve to eighteen months. The object of the experiment was to determine whether the injection method would give a sufficiently high degree of control as to warrant its being recommended for practical operations.

Five different methods of injection were tested, and for comparison, some of the trees were treated by spraying. The chemical preparations used comprised pastes containing 2, 4-D, an amine solution, and a spray concentrate diluted with water.

No definite conclusions were reached, but the results confirmed earlier indications that control can be exercised with hormone spraying. Results to date have not, however, been uniformly good.

It is concluded from this experiment that the injection technique cannot be recommended at this stage for the control of mistletoe under practical conditions; however, sufficient evidence of the partial effectiveness of 2, 4-D sodium salt, whether used as a spray or by injection, to control mistletoe infestation has been obtained to warrant further investigation. It is considered that this could more appropriately take the form of research at this stage rather than the field testing.

(Published with the concurrence of the Forestry Commission of New South Wales.)

Permanent International Association of Road Congresses.

REPUBLICATION OF AUSTRALIAN REPORTS SUBMITTED TO TENTH CONGRESS AT ISTANBUL.

The Conference of Australian State Road Authorities has recently republished the reports presented by Australia to the Istanbul (1955) Congress of the Permanent International Association of Road Congresses. A copy of the reports has been supplied by the Department of Main Roads to each Municipal and Shire Council in New South Wales.

The Permanent International Association of Road Congresses was formed to continue the work of the first International Roads Congress held in Paris, France, in 1908. The object of the Association is to promote progress in the construction and maintenance of roads and the control of road traffic. Membership comprises, governments, corporations (which include public departments, provincial governments, municipalities and other bodies), private members and honorary members. The constitution of the Association provides for the formation in member countries of national organising committees. Australia is a member of the Association and the Conference of State Road Authorities functions as the Australian Organising Committee. The Australian Transport Advisory Council is represented on this Committee by an officer of the Commonwealth Department of Shipping and Transport.

Congresses are held at four-yearly intervals at which questions of major current importance are discussed. The questions for discussion are determined by a permanent committee before each Congress and reporters (with a co-ordinating reporter for each question) are appointed to submit papers embracing the experience of their respective countries on the questions selected. The reports from each country are examined by a general reporter attached to the country in which the Congress takes place and a summarised report is placed before the Congress for consideration. After full discussion general conclusions are reached and adopted by the Congress.

The reports submitted from member countries are printed by the Association, as are also the proceedings and conclusions of each Congress, and supplied to members. As the number of members in Australia is limited, the Australian Organising Committee decided to republish for the information and assistance of those interested a volume containing the reports submitted by Australia to the last Congress.

The titles and writers of the Australian reports are as follows:—

The design and construction of thin, jointless, prestressed concrete pavements over a flexible base. D. V. Issaacs, Director, Commonwealth Experimental Building Station and L. L. Simon, Supervising Engineer and Aerodrome Engineer, New South Wales Commonwealth Department of Works.

Examination of the bearing capacity of soils by the use of cone penetrometers. A. H. Gawith, Materials Research Engineer, Country Roads Board, Victoria.

Flexible Pavements—Design methods and test procedures used by Department of Main Roads, New South Wales. Stabilization of soils on main roads in New South Wales. T. M. Coulter, Materials and Research Engineer, Department of Main Roads, New South Wales.

Use of low cost material for road construction in Victoria. F. West, Country Roads Board, Victoria.

Use of laterite gravels for low cost road construction in Western Australia. J. J. G. Punch, Main Roads Department, Western Australia.

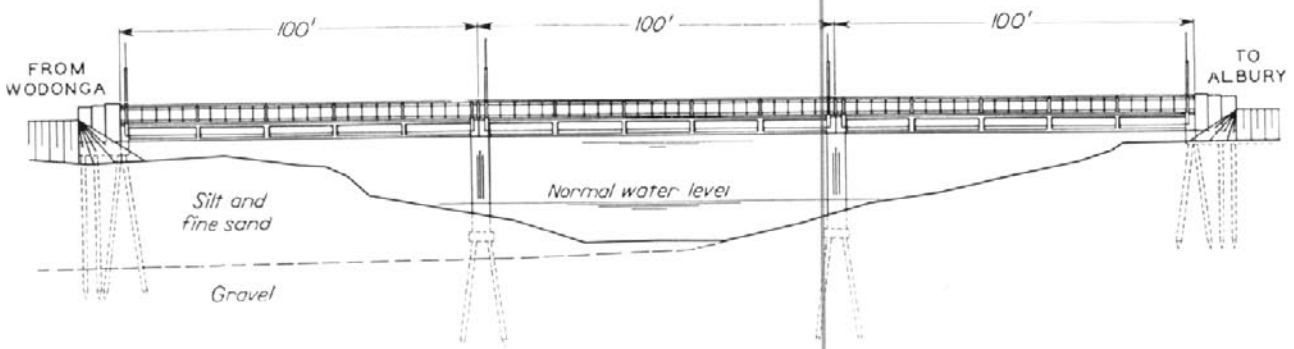
Traffic behaviour and road capacity study. H. P. George, Traffic and Location Engineer, Country Roads Board, Victoria.

Design of road grading as determined from the performance of the "average" passenger car in use in Australia. R. E. Johnston and M. B. Fairlie, Department of Main Roads, New South Wales.

New Union Bridge Between Victoria and New South Wales.

A new bridge is to be constructed on the Hume Highway over the Murray River at Albury, at the joint expense of the New South Wales and Victorian road authorities. The existing timber truss structure, known as Union Bridge, was built in 1896 and is in need of replacement. A tender for the new bridge has now been let by the Department of Main Roads, New South Wales, to Brown's Constructional Enterprises Pty. Ltd., the contract price being £155,084 15s. 0d.

The new bridge will have three spans each 100-feet long of prestressed concrete construction and will provide a 28-feet wide roadway with a cycleway and a footway each 6-feet wide on each side of the roadway. In designing the bridge, provision has been made to permit the widening of the roadway at a later date when traffic has increased sufficiently to warrant the additional accommodation.



Sketch elevation of the new bridge to be constructed on the Hume Highway over the Murray River at Albury.

Tenders Accepted by the Department of Main Roads.

The following Tenders (exceeding £3,000) were accepted by the Department during the months of January, February, and March, 1957 :

Work or Service.	Name of Accepted Tenderer.	Amount of Tender.
		£ s. d.
State Highway No. 9—New England Highway. Shire of Murrurundi. Construction of reinforced concrete box culverts at Doughboy Hollow Creek.	Central Construction Company ...	24,056 0 0
Haulage of Bulk Tar and Creosote	Bitumen Freight Lines Pty. Ltd.	*Hauls up to* 100 *Miles.*—£1 10s. 0d. per ton within radius of 15 miles, thence 10½d. per ton per mile up to and including 100 miles. *Hauls over* 100 *miles.*—9d. per ton per mile.

Tenders Accepted by Councils.

The following Tenders (exceeding £3,000) were accepted by the respective Councils during the months of January, February and March, 1957 :—

Council.	Road No.	Work.	Name of Accepted Tenderer.	Amount.
				£ s. d.
Bland S. ...	17	Construction of five span timber beam bridge over Mirrool Creek at Mirrool.	H. E. Ibbotson and Son ...	11,230 8 0
Boree S.	61, 377	Supply and delivery of 2,200 cu. yds. aggregate at various locations.	Western Blue Metal Co. Pty. Ltd.	7,383 0 0
Cockburn S. ...	3,061	Construction of overbridge at Danglemah	S. J. Frost	3,199 18 6
Coolamon S. ...	1,155	Construction of four span R. C. bridge over Redbank Creek, 2·15 m. north of Matong.	Boulder Pty. Ltd.	8,843 0 0
Culcairn S. ...	331	Supply and delivery of 7,865 cu. yds. of gravel ...	T. G. Kirk	3,935 1 0
Culcairn S. ...	331	Bituminous surfacing between 0 m. and 5 m. from Holbrook Shire Boundary.	B.H.P. By-Products Pty. Ltd.	3,286 1 9
Greater Wollongong C.	568	Construction of bridge over Allen's Creek—Manufacture, supply and delivery of 210 precast, prestressed concrete bridge units.	Concrete Industries (Aust). Ltd.	12,967 10 0
Gloucester S. ...	90	Construction of two span R.C. bridge over Hambergers Creek 11·1 m. north or Gloucester.	Stanmore Construction Co.	5,392 2 6
Holbrook S. ...	331	Bituminous resurfacing between 0 m. and 6 m. east of Holbrook	B.H.P. By-Products Pty. Ltd.	3,124 9 10
Kyogle S. ...	361	Bituminous surfacing 33·8 m. to 41·73 m.	B.H.P. By-Products Pty. Ltd.	5,367 16 5
Lockhart S. ...	57	Construction of five span R.C. bridge over Burke's Creek at The Rock	H. Mueller and Co. Pty. Ltd.	27,112 15 0
Manning and Stroud S.	3,083	Construction of 3/30 ft. span timber beam bridge over Bunyah Creek on Upper Myall to Krambach Road.	E. W. Milligan	6,220 7 0
Mitchell S. ...	240	Bituminous surfacing 8·35 m. to 17·55 m. from Wagga Wagga.	B.H.P. By-Products Pty. Ltd.	6,345 15 9
Murrumbidgee S.	14	Supply and delivery of 14,960 cu. yds. of loam to selected lengths.	A. Hunter-Boyd	3,192 6 4
Ryde M. ...	139	Construction in reinforced concrete north-east kerb side lane Blaxland Road from Anzac Avenue to Terry's Creek and subsidiary work.	Golding Constructions Pty. Ltd.	29,142 0 0
Upper Hunter S.	1,109	Construction from 0·61 m. from Main Road No. 105 to 1·21 m. between Shallow Crossing and Dry Creek.	J. Wright	11,964 2 6
Walgett S. ...	18	Supply and delivery of sand and gravel at Walgett ...	E. G. Muggleton	10,885 11 9
Waradgery S. ...	6	Supply and delivery of—	T. Hardman	11,525 14 0
	14	(*a*) 1,680 cu. yds. of ¾ inch aggregate and		
	21	(*b*) 558 cu. yds. of ⅜ in. aggregate to various stock piles.		
Waradgery S. ...	501	Shouldering and loaming between 8 m. and 15 m. ...	L. G. Jones	4,424 0 0
Warringah S. ...	159, 164	Supply and delivery 1,420 tons ready mixed concrete ...	Dee Why Ready Mixed Concrete Pty. Ltd.	5,893 0 0
Wingecarribee S.	...	Supply and delivery of 2,971 tons of aggregate for State Highway No. 2 and Trunk and Main Roads.	Blue Metal and Gravel Co. Ltd.	5,486 0 0
Wollondilly S. ...	259	Supply and lay hot-mix and asphalt	Bituminous Pavements Pty. Ltd.	16,070 6 8
Wollondilly S. ...	179	Supply, delivery, laying compaction and rolling 700 tons of ¾ inch bituminous macadam and 430 tons of ⅜ in. asphaltic concrete.	Bituminous Pavements Pty. Ltd.	7,456 17 7
Yalloroi S. ...	12, 63	Supply and delivery 1,480 cu. yds. of ¾ in. and ⅜ in. aggregate to various stockpiles.	R. E. Johnston	3,379 18 6

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 Reinforced 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); 4ft. (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); 11ft. (A 1020A); 12ft. (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); 6ft. (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); 5ft. 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).
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.) (1948.)
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. (1945.)
A 1621 Reflector strip for bridges.
Highway Bridge Design Specification of State Road Authorities.*

FORMATION.

70 Formation. (1955.)
513 Subsoil and subgrade drainage. (Instruction.)
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.

301 Supply and application of binder. (1950.)
122 Surfacing with tar. (1949.)
145 Surfacing with bitumen. (1949.)
93 Re-surfacing with tar. (1949.)
94 Re-surfacing with bitumen. (1952.)
466 Fluxing of binders for bituminous flush seals and reseals. (Instruction.)
351 Supply and delivery of aggregate.
354 Road-mix resealing. (1949.)
397 Fluxing for tar road-mix reseal. (Instruction and chart.)
A 1635 Fluxing chart for bitumen road-mix reseal.
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—Preservation of 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.

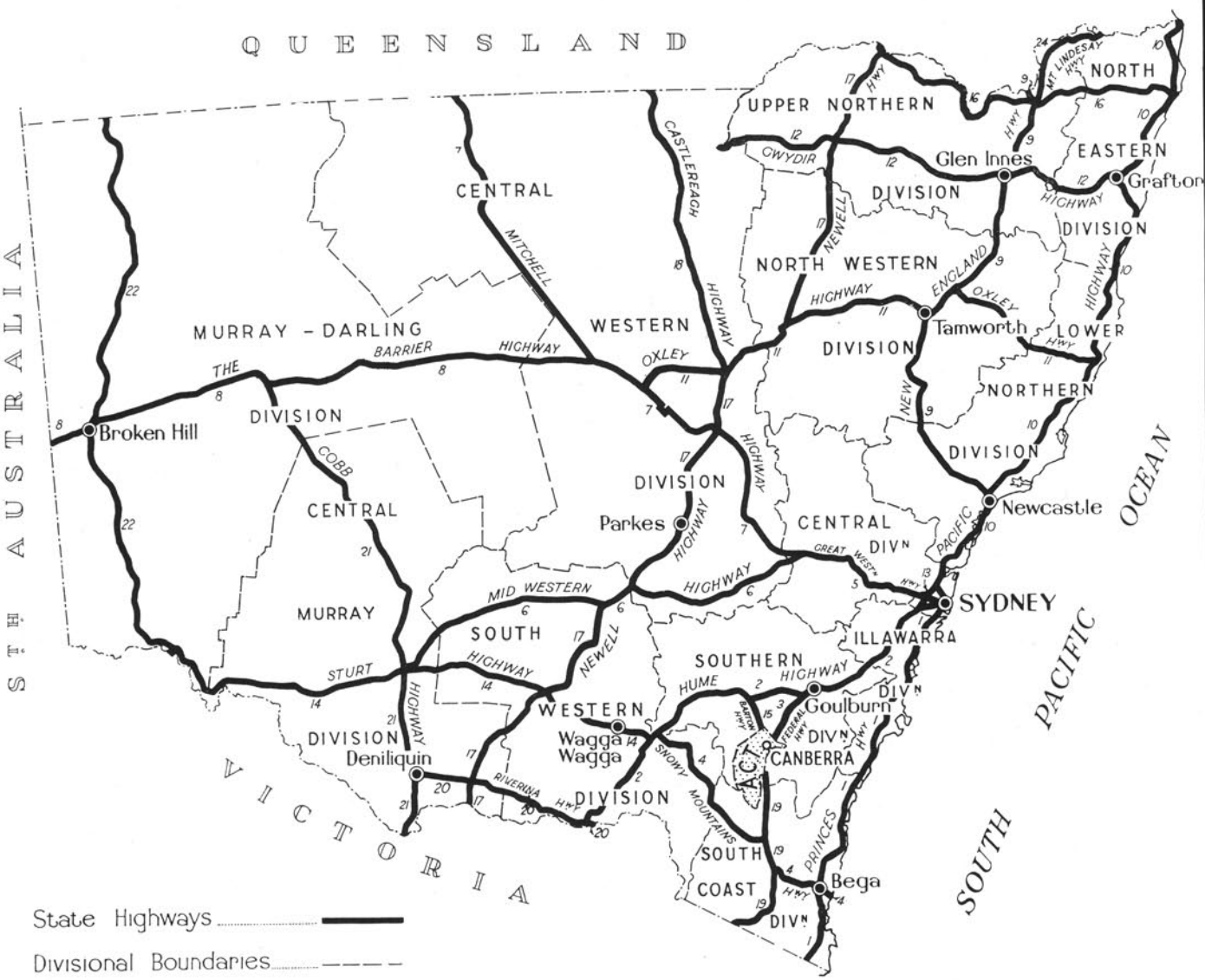
CONTRACTS.

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 Councils except those marked *.

Sydney: A. H. Pettifer, Government Printer—1957.

State Highway System of the State of New South Wales



State Highways .....

Divisional Boundaries .....

Divisional Offices .....

SCALE OF MILES

0 20 0 40 80 120 160 200

Area of New South Wales, 309,433 square miles.
Length of public roads within New South Wales, 124,879 miles.

MILEAGE OF MAIN AND DEVELOPMENTAL ROADS, AS AT 30th JUNE, 1956.

State Highways	6,523
Trunk Roads	4,188
Main Roads	11,752
Secondary Roads (County of Cumberland only)	76
Developmental Roads	2,769
	25,308
UNCLASSIFIED ROADS, in Western part of State, coming within the provisions of the Main Roads Act	3,116
TOTAL	28,424