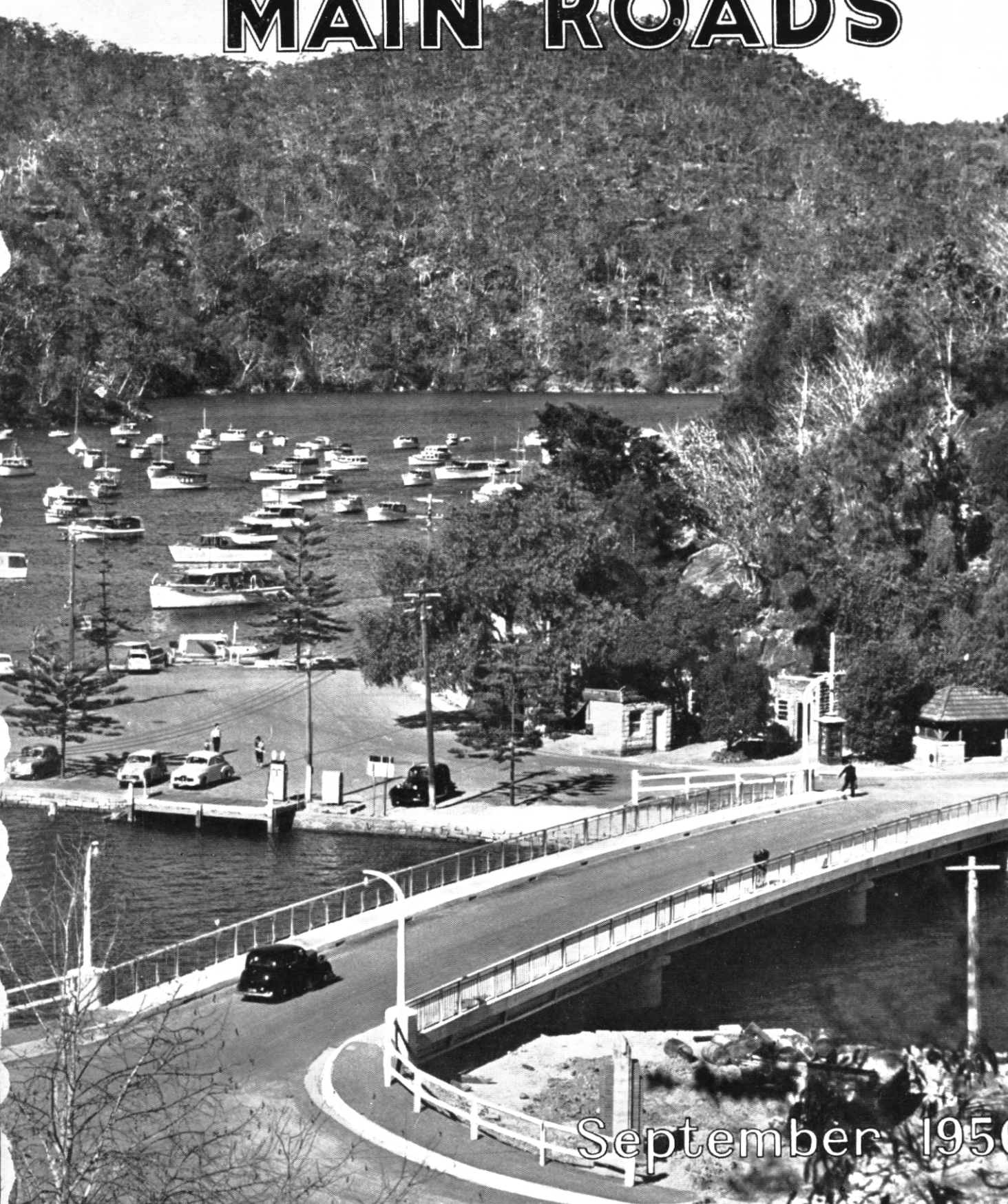




MAIN ROADS



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Cover Page

New Bridge over Cockle Creek at Bobbin Head, Ku-ring-gai Chase.

(See article page 29.)

Next Issue: December, 1956.

MAIN ROADS



Recent Amendment of the Commonwealth Aid Roads Act.

•

It has been the practice since 1st July, 1926, for portion of the proceeds of petrol taxation collected by the Commonwealth Government to be paid to the States for expenditure on roads and other works connected with transport. By virtue of recent Commonwealth legislation connected with an increase of threepence per gallon in petrol taxation, one penny of that amount is to be allocated to the States for expenditure on roads in addition to the previous allocations. It is appropriate at this stage, therefore, to set out the present position in regard to Petrol Tax as affecting Main Roads finance in New South Wales.

The Commonwealth Aid Roads Act, 1954, which came into force on 1st July, 1954, provided for a flat rate payment to the States of 7d. per gallon on both imported and locally refined petrol, in lieu of the previous differential rates of 6d. per gallon on imported petrol and 3½d. per gallon on locally refined petrol. Before this money is distributed to the States, certain sums are reserved by the Commonwealth for specific purposes—namely, £800,000 per annum for Strategic Roads, and £150,000 per annum for road safety practices. Of the remaining amount, at least 40 per cent.

is required to be spent on local rural roads not proclaimed as Main Roads.

The amendment of the Commonwealth legislation recently passed by the Federal Parliament provides that the payment to the States shall be increased from 7d. to 8d. per gallon. The total Petrol Tax now levied by the Commonwealth is 1s. 1d. per gallon on imported petrol and 11½d. per gallon on locally refined petrol. At these new rates of tax and on the volume of petrol consumed during 1955-56, the Commonwealth will collect approximately £45,500,000 per annum. The Commonwealth will retain £15,500,000 for revenue purposes and spend £800,000 on strategic roads (none of which is in New South Wales) and £150,000 on road safety practices. The States would then share the remaining amount of £29,050,000 as shown on page 2.

The amount of petrol tax per vehicle paid to New South Wales in the pre-war year of 1939-40 for expenditure on Main Roads was £3 17s. 2d. This amount increased during the post-war years until, as a consequence of the 1956 amendment of the Commonwealth Aid Roads Act, 1954, it has reached a figure of

State.	Minimum amount expendable on roads other than proclaimed Main Roads.	Maximum amount expendable on pro laimed Main Roads.	Total.
	£	£	£
*New South Wales	3,191,000	4,786,000	7,977,000
Western Australia	2,260,000	3,403,000	5,672,000
Queensland	2,233,000	3,350,000	5,583,000
Victoria	2,042,000	3,063,000	5,105,000
South Australia	1,304,000	1,956,000	3,260,000
Tasmania	581,000	872,000	1,453,000
	11,620,000	17,430,000	29,050,000

* The Commonwealth Aid Roads Act formula for apportioning Petrol Tax between the States provides for distribution of the tax on the basis of three-fifths population and two-fifths area. The effect of this is that of the total tax amounting to approximately £9,870,000, collected in New South Wales, something like £1,890,000 is diverted to other States.

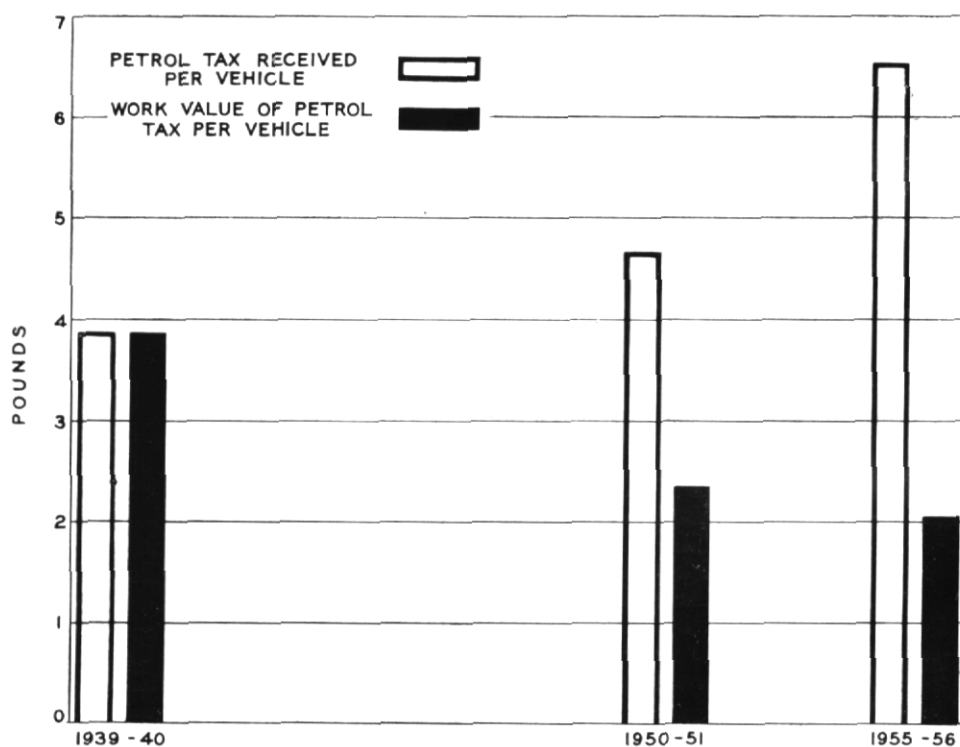
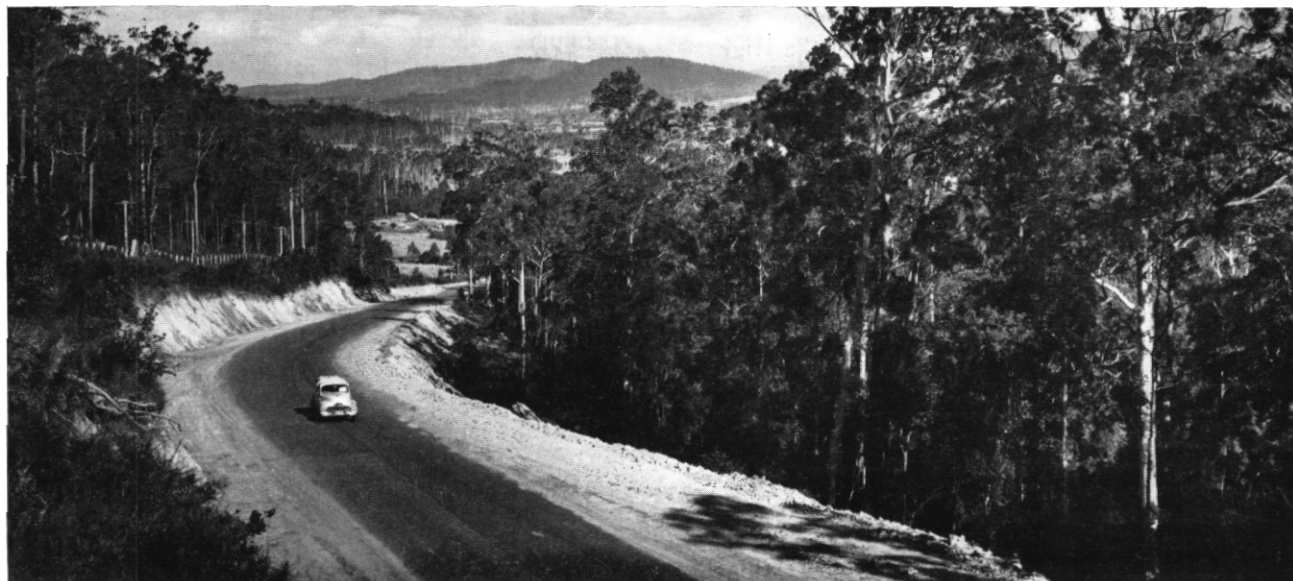


Diagram showing Declining Work Value of Petrol Tax received per vehicle for Main Roads in New South Wales.

£6 10s. 2d. per vehicle. To see this change in its true perspective, however, it is necessary to bring into consideration the extent to which the fall in the value of the pound since the pre-war period has affected the cost of roadworks. When this is done, the comparative figures per vehicle are £3 17s. 2d. for the year 1939-40 and £2 1s. 3d. for the year 1955-56. This decline is illustrated in the accompanying graph in which also the year 1950-51 has been included—that being the

first full year after the war during which petrol rationing was not imposed and also the first year of the operation of the 1950 Commonwealth Aid Roads Act.

It will be seen that measured in terms of roadwork output, the present contribution per vehicle to Main Roads finance from petrol taxation falls far short of that which prevailed before the war. It may be said that the pre-war roadwork output was reasonably satisfactory. The same cannot be said of the position as it is to-day.



Pacific Highway, S.H. 10. Reconstruction on Coolongolook Hill, including third lane to facilitate overtaking of slow moving traffic.

Construction of the New Route of Pacific Highway between Newcastle and Taree.

•

At the end of World War II the proclaimed route of the Pacific Highway north of Newcastle was via Raymond Terrace, Stroud, Gloucester, Krambach, Taree and thence generally parallel to the coast to the Queensland border. Following detailed investigation of various alternatives, the conclusion was reached that the route of the Pacific Highway between Newcastle and Taree should be shifted eastward to pass along or near existing roads via Karuah, Bulahdelah, Nahiack and Purfleet. This route follows easier terrain than the original route through Gloucester, and the distance between Newcastle and Taree is approximately 18 miles shorter. Furthermore, it would serve an area which is rather distant from any railway. The new route was proclaimed by notification in Government Gazette No. 167 of 22nd August, 1952.

Conditions in 1952.

When the new route was proclaimed, a bituminous pavement was available between Newcastle and the point where the new route diverged from the old at about 12 miles north of Raymond Terrace, at "Twelve Mile" Creek. From here to the Karuah River, a distance of 6.2 miles, the route followed an existing gravel surfaced Main Road with easy grades and good alignment. The crossing of the Karuah River is effected by a power-driven rope-hauled ferry. Thence for

8 miles the route of the Highway follows the Main Road to Tea Gardens, leaving it near Bundabah Creek; the road is a winding and undulating gravel road which carries timber traffic, and in the holiday season fairly heavy tourist traffic to Tea Gardens.

Between Bundabah Creek and Bulahdelah, a distance of 19 miles, the new route of the Highway is close to that of an existing road of light construction and narrow in width; in wet periods it became almost impassable due to insufficient drainage and lack of pavement materials.

Northwards from Bulahdelah the route follows an existing Main Road through to Taree. From Bulahdelah to the common boundary of the Manning and Stroud Shire areas at Wang Wauk River, extensive realignment and drainage improvements had been accomplished as unemployed relief work immediately prior to 1940.

From the Wang Wauk bridge to Taree the existing gravel surfaced Main Road, though narrow and of generally low standard alignment and grading, provided fair travelling conditions except in times of flood when traffic was blocked at a concrete ford crossing of the Wallamba River immediately south of Nahiack.

With the exception of modern bridges over the Mvull River at Bulahdelah and the Wang Wauk River near Coolongolook, all bridge structures on the new route were of timber and in generally poor condition.

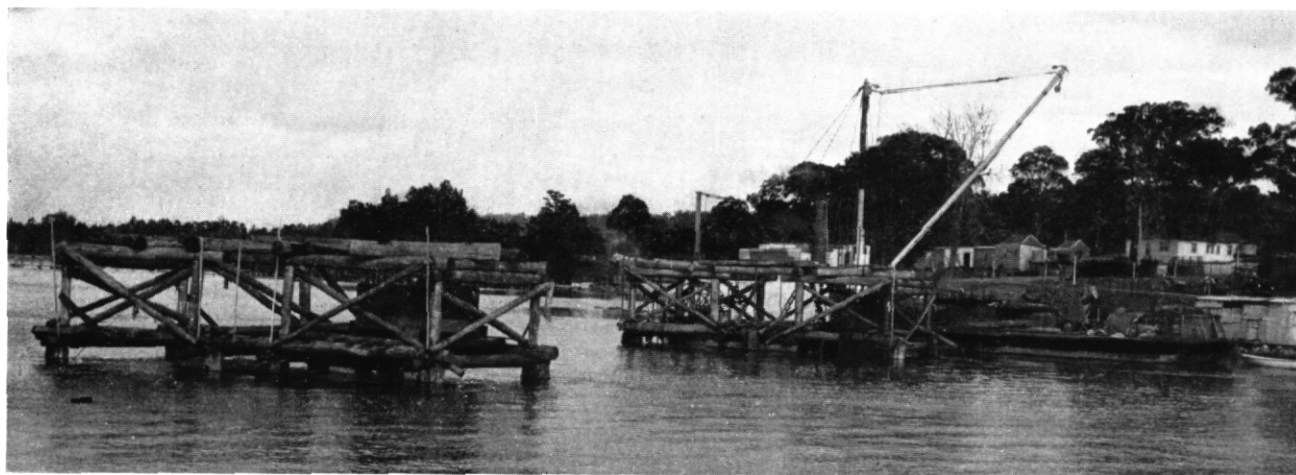
Priorities for Improvement and Bitumen Surfacing.

Upon proclamation of the new route of the Highway, consideration was given to a priority of works which would give the greatest benefit to traffic in the shortest time with the funds available. In view of the extensive work required to place the section between Twelve Mile Creek and Bulahdelah in condition suitable for through traffic, and the necessity to bridge the Karuah River, it was considered more advantageous to provide first for the strengthening and bitumen surfacing of the section between Bulahdelah and the Stroud-Manning Shire boundary at Wang Wauk River. It was appreciated that the improvement of travelling conditions on this section would attract a large part of the through traffic which had formerly taken the old route of the Pacific Highway. In view of this, it was decided, in conjunction with the Stroud Shire Council, to provide a bitumen surface on a Main Road which connects Bulahdelah to the old route of the Pacific Highway at Booral from which point a bitumen surfaced pavement is available through to Newcastle. This Main Road

58 miles of road to 50 m.p.h. standard, 13 miles to 40 m.p.h., 3.6 miles to 30 m.p.h., and a short section of 2.2 miles over the steep range at O'Sullivan's Gap, about 8 miles north of Bulahdelah, to a standard slightly below 30 m.p.h. design. The design includes a climbing lane for slow-moving vehicles on long steep grades in approach to the Coolongolook Gap in another range.

Materials Survey.

Field investigations to assess the road building material resources of the areas within economical haulage distance of the new Highway route were commenced early in 1953 and testing of pilot samples was carried out in the Department of Main Roads Divisional Testing Laboratory at Newcastle. It was soon apparent that the only pavement materials available which could be used without prior crushing were shales of varying quality which generally did not conform to the Department's requirements for a pavement surface course to receive a bitumen surface, but were acceptable in base courses. Further field search is proceeding in an



Bridge under construction at Karuah. Cylinder sinking in progress.

could then be used by State Highway traffic until such time as the bridging of the Karuah River was completed and the new road constructed between Karuah River and Bulahdelah.

The next priority was given to the reconstruction of the existing road north of the Manning-Stroud Shire boundary to Taree in order to provide a continuous bitumen surfaced road between Newcastle and Taree.

Standard of Design.

Detail surveys were made by the Department of Main Roads of the whole length of 77 miles between Twelve Mile Creek and Purfleet about 2 miles south of Taree, and designs were prepared. A design speed of 50 m.p.h. throughout was the objective, but because some sections of the route passed through areas of difficult country where the cost of construction to 50 m.p.h. design speed would be excessive, a lower standard was accepted. This applies particularly on lengths constructed immediately prior to 1940, which were accepted with only minor improvement. The final design provides for

endeavour to locate a material for surface course which may be used without crushing.

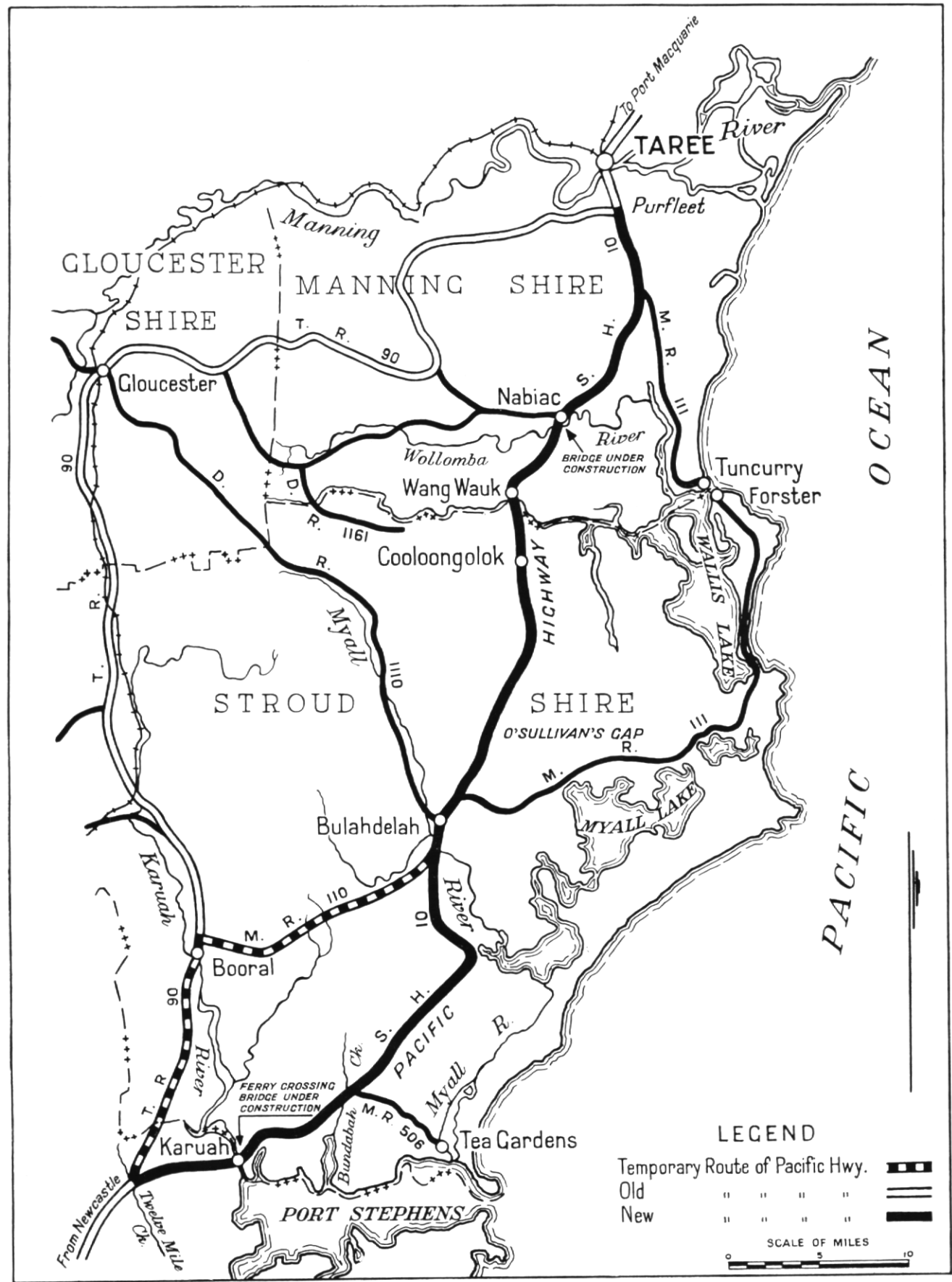
In conjunction with the materials investigation, soil surveys were carried out along the route to assist in the determination of the most economical grade line and the depth of pavement required over the subgrade.

Work Involved.

When the new route was proclaimed 72 miles of the 77 miles' section between Twelve Mile Creek and Taree lacked a bituminous pavement and was generally unsatisfactory for modern traffic.

In order to provide a satisfactory standard of construction it was estimated that the following major items of work would be required:—

Earthworks	688,000 c. yds.
Gravel or shale pavement	1,000,000 sq. yds.
Bitumen surfacing ..	900,000 sq. yds.
Concrete in box culverts	4,500 c. yds.
Pipe culverts	14,000 lin. ft.





Improvement at Devil's Elbow between Bulahdelah and Booral on route being temporarily used by Pacific Highway traffic.

In addition, major bridges were required over the Karuah River at Karuah and the Wallamba River at Nahiab.

The structure at Karuah is to be a steel and concrete bridge 24 feet wide between kerbs and 716 feet in length, made up by five 122 feet and one 62 feet through truss spans and decked abutment spans. A footway 6 feet 6 inches wide will be provided on one side. The crossing of the Wallamba River will be effected by means of a steel and concrete bridge also 24 feet wide between kerbs and 668 feet long, made up by two 120 feet through truss spans, seven 57 feet beam spans and decked abutments.

Other bridges of lesser size are required throughout the route to replace existing aged and narrow structures.

Progress with Road Works at 30th June, 1956.

Reconstruction of the section between Bulahdelah and the Manning-Stroud boundary at Wang Wauk River was authorised to commence by day labour during the latter part of 1953. In July, 1953, an office was established at Bulahdelah and the general improvement and paving of the existing road was commenced working northward from Bulahdelah. Rapid progress was made and by December, 1955, a bitumen surfaced pavement had been provided throughout the 23-mile section between Bulahdelah and Wang Wauk Bridge. The bitumen has been applied to what is intended ultimately to be the base course, and a surface course will be added later.

New construction in progress 6 miles north of Coolongolook.





Excavation in progress near Nabiac.

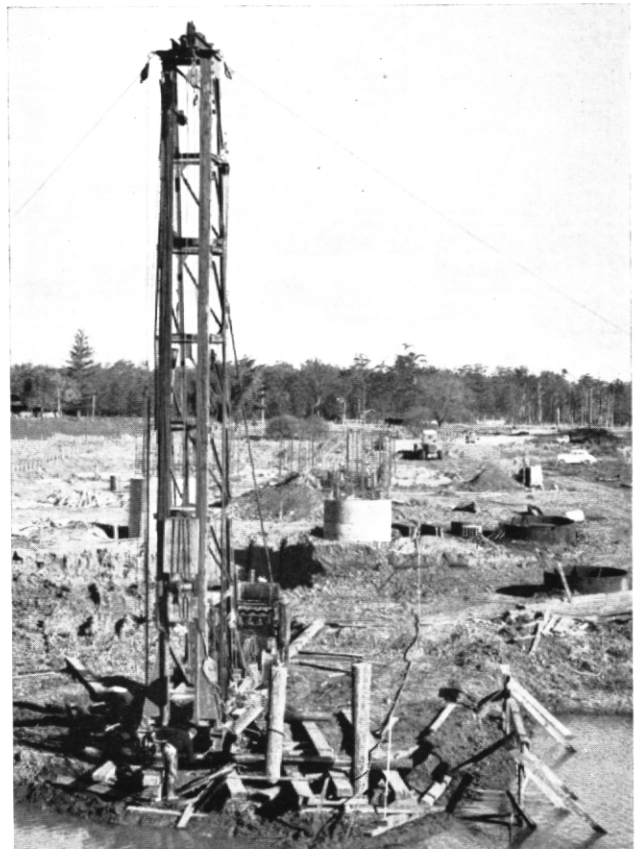
In addition to the work on the permanent route of the Highway the Department of Main Roads, in conjunction with the Stroud Shire Council, undertook the strengthening and bitumen surfacing of 15 miles of the Main Road between Booral and Bulahdelah. This work was completed and opened for traffic in December, 1955.

Operations then commenced on a section of 11 miles north of Wang Wauk Bridge extending to Bungwahl Creek. Although progress was impeded by the very wet weather conditions experienced early in 1956, it is expected that this section will be completed and provided with a bitumen surface by June, 1957.

For the construction of the length from Bungwahl Creek to Purfleet (near Taree) a length of about 9 miles, a contract has been let to Tarjan Construction Co. Pty. Ltd., for earthworks, culverts and base course, etc. The due date of completion of this contract is July, 1957.

Bridges and Culverts.

In the case of the bridge required over the Karuah River at Karuah, the work has been divided into two contracts—(1) the manufacture, supply and delivery of steelwork, and (2) the construction of piers, erection of steelwork and final completion. Contracts were awarded in August, 1955, and unless unforeseen difficulties are met, the new bridge should be available for traffic by the end of 1958. The contractors for the supply and fabrication of the steelwork are Horseley Bridge and Thomas Piggott Ltd., England. For the erection and final completion of the bridge the contractors are Electric Power Transmission Pty. Ltd.



Bridge under construction over Wallamba River at Nabiac.

In the case of the bridge required over the Wallamba River at Nabiac, it was decided to let three contracts, as follows: (i) Construction of substructures, (ii) supply, delivery and erection of structural steel, and (iii) the construction of concrete deck and final completion. Contracts for (i) and (ii) were awarded in December, 1955. Work on the substructure commenced in January, 1956, and by 30th June, 1956, all concrete piles had been driven and the sinking of cylinders for the truss span piers was in hand. The contractors for the construction of the substructure are Brown's Constructional Enterprises Pty. Ltd. Messrs. G. H. and

J. A. Watson Pty. Ltd. are the contractors for the supply and erection of steelwork.

In addition to the above two major bridge works, contracts have been let for the construction of reinforced concrete bridges over Fry's Creek 2 miles north of Bulahdelah and over Cureeki Creek, near Coolongolook.

Between Twelve Mile Creek and Karuah a contract has been let for the construction of six reinforced concrete box culverts and work on these is now in progress under the supervision of the Port Stephens Shire Council.

Chair of Traffic Engineering at the New South Wales University of Technology

The New South Wales University of Technology has appointed Mr. William Ross Blunden to the Foundation Chair of Traffic Engineering. Establishment of this Chair was assisted by a gift of £25,000 by the Australian Automobile Association.

Mr. Blunden is a graduate in science and engineering of the University of Sydney and is also a graduate of the Royal Military College of Science (England). Prior to the Second World War he was a member of the staff of the Department of Main Roads, New South Wales, engaged in road survey, design and construction. After the outbreak of war he enlisted and was appointed to the staff of Australian Army Headquarters from which he was seconded to the Admiralty Re-

search Laboratories at Teddington, England. Until his appointment by the University, Mr. Blunden was Scientific Adviser to the Australian Military Board.

Professor Blunden has already taken up duty at the University but he is to spend some time in the study of traffic engineering overseas before undertaking the development of a school of traffic engineering at the University.

Establishment of this Chair, together with the Chair of Highway Engineering referred to in the June, 1956, issue of "Main Roads", will provide at the University of Technology an Australian centre for studies and research into all aspects of roads and road traffic.

SYDNEY HARBOUR BRIDGE ACCOUNT.

Income and Expenditure for the period 1st July, 1955 to 30th June, 1956.

<i>Expenditure.</i>	<i>£</i>	<i>Income.</i>	<i>£</i>
Cost of Collecting Road Tolls	74,732	Road Tolls	762,158
Provision for Traffic Facilities	4,734	Contributions—	
Alterations to Archways	22,499	Railway Passengers	152,291
Maintenance and Minor Improvements	141,558	Tramway and Omnibus Passengers	25,901
Administrative Expenses	3,915	Rents from Properties	19,172
Loan Charges—	<i>£</i>	Miscellaneous	3,164
Interest	236,776		
Exchange	14,478		
Sinking Fund	59,656		
	310,910		
Miscellaneous	(Cr.) 237		
	<u>£558,111</u>		<u>£962,686</u>

NOTE.—The figures in the above statement are subject to adjustment upon completion of accounts for the year.

Soils and Rocks in Road Construction in New South Wales.

PART II—SOILS—DESCRIPTION AND TYPICAL TEST FIGURES FOR COMMON TYPES.

Part I of a series of articles under the above general title was published in the June, 1956, issue of "Main Roads" and dealt with the occurrence and classification of the principal soils of New South Wales which are important as road foundations. Part II gives a general description and typical test figures for a selection of these soils grouped under the following common names:—

- Decomposed granite.
- Red brown soil.
- Western suburbs (Sydney) heavy clay soil.
- Sandy loam.
- Mallee soils.
- Black soil (plains).
- Basaltic and red loam.
- Basaltic soil.

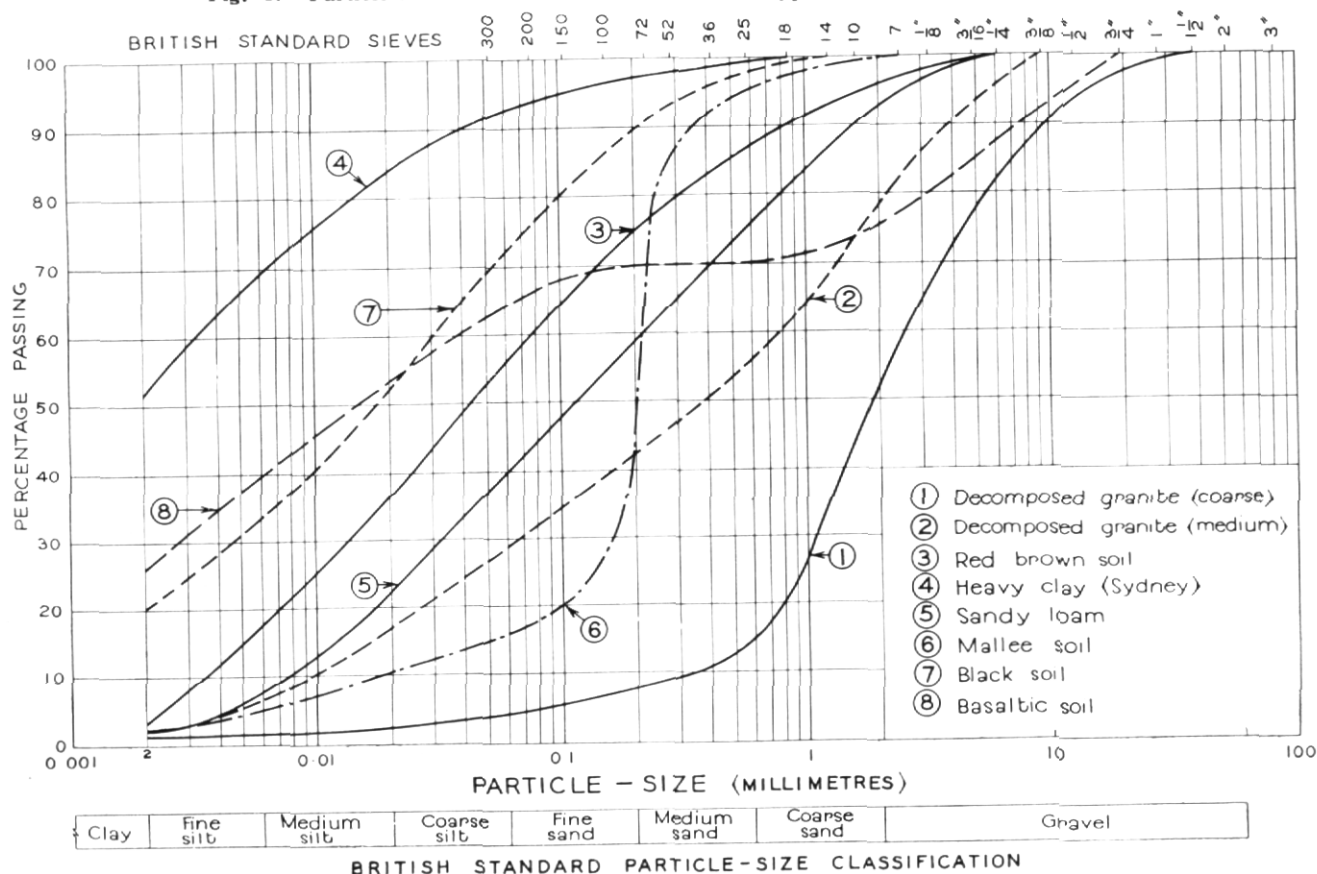
The samples on which the tests were made include in most cases material from more than one horizon.

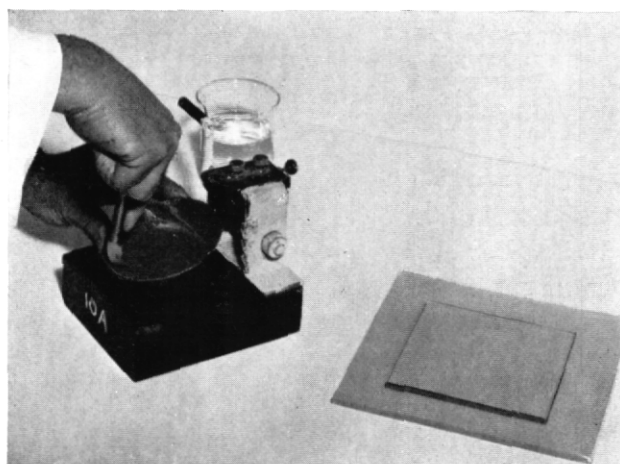
In addition to the figures for the various tests used by the Department for pavement design an indication

is given in each case of the theoretical thickness of flexible pavement required over the soil to support normal traffic loading. This figure is calculated from the formulae and methods described in "Main Roads", Volume 13, March, 1948. The thickness required for *heavy* traffic (as described therein) would be about 25 per cent. greater than the figure quoted in any particular case.

It will be noted that there is considerable variation in the test results and the estimated effective cover for the different soils both within and between types. It is not intended that the theoretical pavement thicknesses quoted be adopted on the basis of type and location: on the contrary, the figures show what a wide range of results can be obtained from soils which can be loosely grouped under one common name, e.g., decomposed granite is so variable that the calculated thickness of pavement may range from nil to 10 inches or more. A red-brown earth from Jerilderie is quoted as requiring 3 inches of pavement and one from Yanco as requiring 9 inches, but samples could be obtained from these two districts which would require 10 inches

Fig. 1. Particle-size distribution curves for some typical New South Wales soils.





Liquid Limit Test.—Soil sample being cut with grooving tool.

or more at Jerilderie and nil at Yanco. Wide variation in bearing value found within a certain soil type may be due to the samples having been taken from different horizons, e.g., the "A" horizon of a podsolised soil may be satisfactory as a pavement without additional gravel whereas the "B" horizon may require 15 inches cover or more, depending on the type of clay minerals present. Some idea of the range of particle size and variability of grading of soils is evident from the curves shown in Figure 1. These curves represent soils chosen at random from the schedule of test results hereunder. When soil surveys are being made it is necessary to keep in mind that some poor soils can be readily improved in bearing capacity by mixing them with other local materials or by stabilising them with cement or other means, either to serve as a base course for bitumen surfacing or as a sub-base material. The extent

to which this can be done is determined largely by the economic considerations in each particular case.

The various tests used by the Department of Main Roads in flexible pavement design were discussed briefly in Part I of this series of articles. Details are available from the Department's "Materials" Manual, M.R. Form No. 76, "Instructions for Design of Non-Rigid Pavements", "Main Roads", March, 1948; and in a paper by A. T. Britton, "Flexible Pavements—Design and Selection of Materials", published in Highway Research Board Proceedings, 1947, United States of America.

Test Results of the Principal Soils of New South Wales.

Common Name: Decomposed granite.

Pedological Name: Podsol.

Geographical Distribution: At or near Tenterfield, Armidale, Glen Innes, Bendemeer, Tabulam, Hungerford, Brewarrina, Wyalong, Junee, Young, Wagga Wagga, Tumbarumba, Albury, Berrigan, Gulgong, Bathurst, Hartley, Cowra, Grenfell, Blayney, Moruya, Marulan, Canberra, Braidwood, Bombala, Bega.

Description of Typical Soil Profile: The "A" horizon is grey, due to the accumulation of organic matter, often passing to very pale grey or white at a depth of about 4 inches. Textures in the "A" horizon are generally sand or sandy loam. The subsoil is yellow or red decomposing granite with a heavier texture than the surface. Podsoils are leached acid soils easily differentiated into horizons by colour and texture; they are chemically poor in plant nutrients and have bad natural drainage, due to the low permeability of the subsoil. The term "decomposed granite" embraces soils varying from A1 (requiring no cover) to those requiring an effective cover of 10 inches or more; this

Test Results. Decomposed Granite.

Location of Sample.	% Gravel (R).	Mech. Analysis of Portion Pass No. 7 B.S. Sieve.			L.L.	P.L.	P.I.	L.S.	Density (lb./c. ft.) Standard Proctor compaction.	P.R.A. Group.	Cover for Normal Loading.
		— 36 B.S.	— 200 B.S.	— .0135 mm.							
Bendemeer	17	60	38	15	14	NP	...	...	...	A1 ...	0
Uralla	8	56	31	11	17	NP	...	...	...	A1 ...	0
Albury	23	55	23	11	22	17	5	...	...	A1 ...	0
Tenterfield	12	54	27	11	21	NP	...	0	129	A2NP	3
Savernake	6	80	28	10	19	18	1	0	128	A2NP	3
Michelago	19	75	58	33	22	17	5	3	122	A4 ...	4
Gunning	40	19	8	4	28	23	5	1	116	A3 ...	6
Young	20	58	33	19	35	NP	...	3	125	A2NP	7
Bendemeer	6	71	51	38	54	16	38	7	109	A6 ...	8
Berrigan	3	95	80	54	38	18	20	10	106	A4-7 ...	10

Abbreviations used for all tests.

% Gravel (R) = R is the % by weight of material retained on No. 7 B.S. Sieve.

L.L. = Liquid Limit.

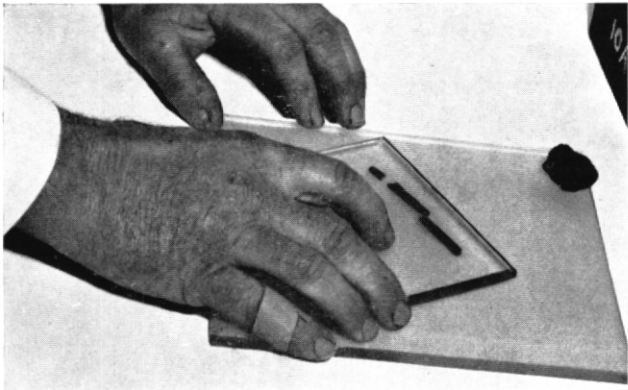
P.L. = Plastic Limit.

P.I. = Plasticity Index.

L.S. = Linear Shrinkage.

P.R.A. Group = For basis of this classification, see Fig. 2 of Part I of article, p. 115 Main Roads, June, 1950.

variation is due mainly to the amount and grading of the soil mortar but mica may also have an important effect, e.g., the difference in Liquid Limit in the Tenterfield and Young samples quoted below is mainly accounted for by the presence of mica in the latter.



Plastic Limit Test.—Rolling soil sample between glass plates.

Common Name: Red-brown soil.

Pedological Name: Red-brown earth.

Geographical Distribution: Wheat belt of south-eastern Australia, including Narrabri, Coonamble, Coonabarabran, Trangie, Dubbo, Parkes, Bathurst Plains, Condobolin, Grenfell, Wyalong, Cootamundra, Narrandera, Wagga Wagga, Corowa.

Description of Typical Soil Profile: The "A" horizon is a brown to red-brown, fine sandy loam, organic matter being concentrated very markedly in the surface layer, showing a weak crumb structure under virgin conditions; this passes sharply at about 9 to 12 inches to a deep red-brown more heavily textured "B" horizon, the structure of which changes with increasing depth from strongly prismatic to nutty. The "C" horizon consists of a sandier yellow, brown or grey decomposing parent material of diverse character. Limestone is encountered either as streaks or concretions at various depths, depending on topography and the

Test Results. Red-brown Soil.



Proctor Compaction Test.—Soil being tamped in mould with standard Proctor rammer.

Location of Sample.	% Gravel (R).	Mech. Analysis of Portion Pass No. 7 B.S. Sieve.			L.L.	P.L.	P.I.	L.S.	Density (lb./c. ft.) Standard Proctor compaction.	P.R.A. Group.	Cover for Normal Loading.
		— 36 B.S.	— 200 B.S.	— .0135 mm.							
Mathoura	4	67	36	15	22	17	5	1	127	A2P ...	inches, 2
Jerilderie	0	85	43	19	13	NP	0	0	130	A2NP ...	3
Gunnedah	3	67	29	19	30	13	17	2	125	A2P ...	3
Dubbo	8	49	24	8	17	11	6	1	110	A2P ...	3
Coonabarabran	0	71	25	7	15	NP	0	0	122	A2NP ...	4
Deniliquin	3	87	63	31	19	14	5	2	120	A4 ...	5
Narranderra	2	88	26	12	15	NP	0	1	120	A2NP ...	5
Gilgandra	14	66	43	30	47	17	30	8	115	A2-6 ...	6
Leeton	2	93	74	40	26	15	11	4	114	A4 ...	7
Finley	3	77	55	24	45	17	28	11	113	A4-6 ...	7
Yanco	4	97	82	58	35	17	18	10	110	A4-6 ...	9
Corowa	0	95	70	50	40	19	21	14	100	A7 ...	11

Common Name: Western suburbs heavy clay soil (Sydney).

Pedological Name: Grey-brown podsolc soils.

Geographical Distribution: North Shore, districts of Sydney, Eastwood, Pennant Hills, Blacktown, Kingswood, Western suburbs, Liverpool, Luddenham, Camden.

Description of Typical Soil Profile: The "A" horizon is generally a pale yellow, grey or grey-brown sand or sandy loam, slightly darkened in the A1 portion to a

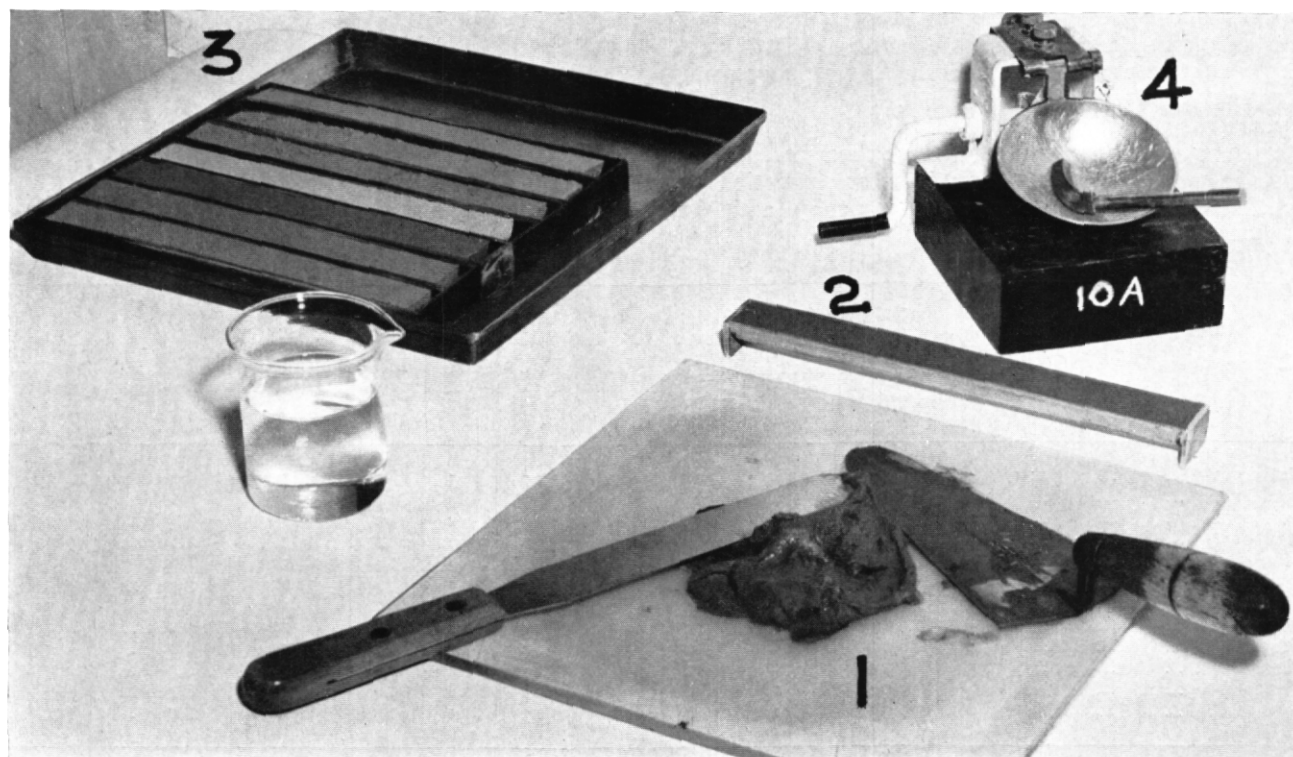
depth of 3 or 4 inches by organic matter. The "B" horizon is generally a brown to yellow-brown clay of nutty to blocky structure, and often mottled with some red, grey or grey-brown, particularly in the lower portion, due to the frequency of temporarily restricted drainage at times of heavy rainfall. The "C" horizon consists of grey to brown decomposing shale with some aluvial material. In Sydney this profile has developed on Wianamatta Shale, the rainfall being great enough to permit strong leaching of clay, sesquioxides and organic matter down the profile.

Test Results. Western suburbs heavy clay soil (Sydney).

Location of Sample.	% Gravel (R).	Mech. Analysis of Portion Pass No. 7 B.S. Sieve.			L.L.	P.L.	P.I.	L.S.	Density (lb./c. ft.) Standard Proctor compaction.	P.R.A. Group.	Cover for Normal Loading.
		— 36 B.S.	— 200 B.S.	— .0135 mm.							
Guildford ...	1	96	81	44	35	19	16	10	105	A4-7 ...	9
Rydalmere ...	3	98	93	63	53	16	37	14	112	A6 ...	10
Wiley Park ...	3	99	89	55	49	19	30	14	102	A6 ...	11
Parramatta ...	8	98	96	76	55	21	34	15	103	A6-7 ...	12
Villawood ...	36	93	89	78	62	22	40	15	99	A6-7 ...	13
Bankstown ...	0	98	96	82	74	20	54	16	105	A6 ...	14
Strathfield ...	5	97	95	78	67	22	45	18	94	A6 ...	14
Beverly Hills ...	4	99	96	82	82	25	57	19	93	A6 ...	15

Some items of apparatus for soil testing.

1. Tools for preparation of sample.
2. Linear shrinkage specimen, freshly prepared.
3. Linear shrinkage specimen dried. Note shrinkage away from end of each mound.
4. Liquid limit apparatus.



Common Name: Sandy loam.

Pedological Name: Prior Stream sands and loams.

Geographical Distribution: At or near Narrandera, Leeton, Griffith, Booligal, Hay, Jerilderie, Savernake, Berrigan, Tocumwal, Finley, Conargo, Deniliquin, Mathoura, Moama, Barham, Wakool and Moulamein; also in Coonamble and Narrabri districts.

Description of Typical Soil Profile: The natural sandy loams and gravels which occur throughout the Riverina Plains have not been deposited by the present river system, but are the last of a series of alluvial systems deposited during the Pleistocene Period from streams running westwards from mountains which then existed to the east of the area. These Prior stream, gravel-sand clays can now be followed by means of

their characteristic vegetation—pine, needlewood and spear grass. The sediments are coarsest (a) in the eastern sections of the old streams courses, and (b) in the wider streams. In places deep channels of coarse sand are overlain by fine alluvium sometimes feet thick, deposited since the Pleistocene by the Murray-Murrumbidgee river systems; a characteristic of such cases is the occurrence of yellow box above such sand, even though buried. A feature of many of these non-plastic sands is their satisfactory dry, compressive strength. A prior stream system of comparable age has more recently been located in the plains on the north-west; here, however, although some channels yield A1 material (e.g., those at Coonamble, Gulargambone and Bugilbone), their sediments appear to be generally finer than those in the south-west.

Test Results. Sandy Loam.

Location of Sample.	% Gravel (R).	Mech. Analysis of Portion Pass No. 7 B.S. Sieve.			L.L.	P.L.	P.I.	L.S.	Density (lb./cu. ft.) Standard Proctor Compaction.
		— 36 B.S.	— 200 B.S.	— .0135 mm.					
Coonamble	0	91	44	22	17	NP	...	...	No linear shrinkage or density results shown because these samples were tested as gravels only and where necessary they were subsequently stabilised with other natural material to produce a gravel suitable for bituminous surfacing. Consequently it was not necessary to do the linear shrinkage and density determinations.
Blighty	0	86	64	45	39	18	21	...	
Combara	0	82	38	17	18	12	6	...	
Quambone	0	78	46	24	23	9	14	...	
Hay	0	75	29	14	15	NP	...	...	
Finley	5	71	48	18	17	14	3	...	
Mathoura	4	69	44	27	21	16	5	...	
Finley	7	63	37	10	23	NP	...	...	
Gulargambone	0	62	36	16	24	11	13	...	
Savernake	9	60	29	19	26	16	10	...	
Moama	3	58	33	8	17	NP	...	...	
Blighty	2	56	35	19	31	21	10	...	
Pilliga	0	54	11	3	13	NP	...	...	
Bugilbone	12	52	17	10	15	NP	...	...	
Blighty	17	52	7	3	20	NP	...	...	
Coonamble	1	44	25	17	34	14	20	...	
Mathoura	7	37	26	13	18	13	5	...	
Berrigan	10	36	16	6	32	NP	...	...	
Deniliquin	25	35	18	14	26	14	12	...	
Finley	12	33	6	3	19	NP	...	...	
Coonamble	0	31	4	3	11	NP	...	...	
Mathoura	10	21	10	6	20	15	5	...	

Common Name: Mallee Soils.

Pedological Name: Solonised Brown Soils.

Geographical Distribution: Wyalong, Griffith, Hillston, Balranald.

Description of Typical Soil Profile: A brown to red brown light loamy surface showing a slight increase in clay and a marked increase in CaCO_3 down the profile—so much so that in south-western New South Wales and the Lower Murray the horizon of carbonate (travertine) is so completely cemented as to restrict the penetration of water. The soils are essentially derived from this travertine which was, in turn, formed from the redistribution of calcareous shell sands exposed on the South Australian coast during the Pleistocene glaci-

ations, but the characteristic immediate surface configuration of a moderately undulating succession of relatively short east-west rises and depressions, seldom with more than 50 feet between extreme levels, is due to wind action in recent times. The type of profile varies according to its relative topographical position. The upper slopes of the sandhills comprise deep dull brown sandy soils overlying some limestone rubble; the lower slopes and depressions comprise shallow brown or grey loam 1 to 2 feet deep overlying a heavier accumulation of lime, and accompanied by some clay.

The Mallee growth forms the dominant tree type. These soils generally form only in areas with less than 14 inches annual rainfall, this being insufficient to leach sodium out of the profile.

Test Results. Mallee Soils.

Location of Sample.	% Gravel (R).	Mech. Analysis of Portion Pass No. 7 B.S. Sieve.			L.L.	P.L.	P.I.	L.S.	Density (lb./c. ft.) Standard Proctor compaction.	P.R.A. Group.	Cover for Normal Loading.
		— 36 B.S.	— 200 B.S.	— .0135 m.m.							
Gol Gol	0	53	19	9	17	14	3	1	133	A2P ...	inches. 2
Gol Gol	0	60	11	4	11	NP	0	0	116	A2-3 ...	4
Buronga	40	90	44	26	24	17	7	4	116	A2-4 ...	5
Euston	12	87	53	37	27	15	12	4	119	A4 ...	5
Buronga	0	94	27	12	19	NP	0	1	115	A2NP	6
Euston	0	97	14	5	15	NP	0	0	110	A3 ...	7
Gol Gol	14	93	41	23	29	21	8	5	109	A2X	8

Common Name: Black Soil (plains).

Pedological Name: Grey and brown soils of heavy texture. Includes sierozems (grey desert soils) and chernozem-like soils.

Geographical Distribution: Intermittently inundated plains of the north-western, western and south-western rivers, e.g., Moree, Walgett, Bourke, Menindee, Hay, Deniliquin, Wentworth. Chernozem-like soils occur on the Liverpool Plains, the Hunter Valley north of Maitland and on the Monaro Plateau.

Description of Typical Soil Profile: These soils show no textural contrast down the profile. The A horizon is shallow, consisting of grey to chestnut clay loam or clay with a strongly developed crumb structure; the organic matter content is high and the surface looks black when wet. The B1 horizon consists of some depth of grey or brown clay, of massive or blocky

structure, and the B2 horizon of much the same material but with small amounts of secondary limestone concretions and/or gypsum, and frequently showing slight mottling in dull colours. The C horizons are variable but consist mainly of weathered parent Pleistocene alluvium which may be of considerable depth. The whole soil profile is widely cracked when dry, particularly in the case of the grey soils, and gilgais are often formed. The brown soils are found on slightly better drained portions of alluvial plains than the grey. Black soil owes its origin to fine textured material deposited during periodic floodings, there being insufficient leaching to remove limestone and gypsum but sufficient to remove sodium from the profile. The soil forms where the annual rainfall is about 15 inches to 30 inches. As the rainfall falls below 20 inches chernozems (which do not contain gypsum) give way to the gypseous form (sierozems).

Test Results. Black Soil (plains).

Location of Sample.	% Gravel (R).	Mech. Analysis of Portion Pass No. 7 B.S. Sieve.			L.L.	P.L.	P.I.	L.S.	Density (lb./c. ft.) Standard Proctor compaction.	P.R.A. Group.	Cover for Normal Loading.
		— 36 B.S.	— 200 B.S.	— .0135 mm.							
Gol Gol	0	93	54	37	28	13	15	8	114	A4 ...	inches. 6
Wentworth	0	98	43	28	22	18	4	6	112	A2P ...	7
Hay	0	91	58	43	33	16	17	7	107	A4-6 ...	8
Buronga	0	100	82	54	42	15	27	13	112	A4-6 ...	9
Bourke	6	98	68	46	42	18	24	10	102	A6 ...	9
Burren Junction	0	92	76	46	37	18	19	13	107	A4-7 ...	10
Moree	6	91	74	52	52	22	30	11	103	A7 ...	10
Menindee	0	96	87	68	49	14	35	15	106	A6 ...	11
Brewarrina	0	98	81	30	62	14	48	15	103	A6 ...	11
Deniliquin	0	97	86	64	55	17	38	16	99	A6 ...	12
Mungindi	0	96	91	76	47	18	29	15	101	A6 ...	13
Walgett	2	99	87	61	62	23	39	16	95	A7 ...	13
Boggabilla	0	99	80	69	73	21	52	19	92	A6 ...	14
Coonamble	0	96	84	65	62	28	34	15	88	A7 ...	15
Breeza	1	97	88	54	51	19	32	16	86	A6 ...	15

Common Name: Basaltic Red Loam.

Pedological Name: Krasnozems.

Geographical Distribution: Robertson, Comboyne, Lismore-Ballina Tablelands, Ben Lomond, Mount Canobolas, Mount Wilson, Mount Darragh.

Description of Typical Soil Profile: The top 6 inches to 10 inches layer consists of a friable, porous, dark red to brown clay loam with a distinct crumb structure; this merges gradually into a friable, well-structured but more compact, dull crimson clay, which extends (with some fading of the colour) into the decomposing

basalt at a depth, commonly of 2 to 5 feet but sometimes much greater. Though rich in clay the surface soil has the tilth of a loam because of its high organic matter content, the accumulation of the sesquioxides of iron and aluminium (giving the red colour) and the removal by drainage waters of most of the other constituents. Krasnozems are permeable yet coherent. In New South Wales they have been derived mainly from basalt under the strong leaching conditions due to a wet climate and high elevation, as in the dissected plateau between Lismore and Ballina. The Dorrigo samples included in the accompanying schedule represent transitional krasnozems.

Test Results. Basaltic Red Loam.

Location of Sample.	% Gravel (R).	Mech. Analysis of Portion Pass No. 7 B.S. Sieve.			L.L.	P.L.	P.I.	L.S.	Density (lb./c. ft.) Standard Proctor compaction.	P.R.A. Group.	Cover for Normal Loading.
		— 36 B.S.	— 200 B.S.	— .0135 mm.							
Dorrigo	26	Failed to disperse ...			33	25	8	7	113	A4 ...	9
Dorrigo	36	"	"	"	33	28	5	6	109	A4-5 ...	10
Dorrigo	9	"	"	"	38	31	7	8	106	A5 ...	11
Mullumbimby	27	"	"	"	41	28	13	8	98	A5 ...	12
Dorrigo	4	"	"	"	43	38	5	12	105	A5 ...	13
Dorrigo	2	"	"	"	42	NP	0	8	102	A5 ...	13
Bangalow	13	"	"	"	49	34	15	4	90	A5 ...	14
Mullumbimby	6	"	"	"	52	29	23	12	91	A7 ...	15
Lismore	7	"	"	"	65	38	37	14	85	A6 ...	16
Lismore	0	"	"	"	64	37	27	11	84	A5 ...	17
Newrybar	5	"	"	"	57	34	23	16	83	A5-8 ...	18
Robertson	27	65	30	10	56	48	8	2	73	A2-8 ...	19
Newrybar	1	Failed to disperse ...			78	40	38	20	82	A7 ...	20
Alstonville	0	"	"	"	87	43	44	20	77	A7 ...	21

Common Name: Basaltic soil.

Pedological Name: Chocolate basalt soils.

Geographical Distribution: On Monaro Plateau west and south-west of Cooma, tablelands east of Bathurst, and in the vicinity of Glen Innes, Guyra, Merriwa, Blayney, Orange and Molong.

Description of Typical Soil Profile: This soil forms on basalt under conditions of relatively low temperature and moderate rainfall where leaching has not continued long enough to produce krasnozems. The soil is a chocolate to dark brown clay loam on the surface, going down to orange-brown mottled with grey and red flecks as the parent material is approached. The

Test Results. Basaltic Soil.

Location of Sample.	% Gravel (R).	Mech. Analysis of Portion Pass No. 7 B.S. Sieve.			L.L.	P.L.	P.I.	L.S.	Density (lb./c. ft.) Standard Proctor compaction.	P.R.A. Group.	Cover for Normal Loading.
		— 36 B.S.	— 200 B.S.	— .0135 m.m.							
Merriwa	8	98	79	40	50	24	26	12	100	A7 ...	12
Black Mountain (Guyra)	20	60	45	22	44	35	9	2	96	A2X-5 ...	12
Merriwa	20	72	51	29	51	29	22	6	92	A7 ...	13
Nimmitabel	33	82	57	24	62	42	20	12	102	A5 ...	14
Cassilis	21	91	83	50	65	29	36	15	95	A7 ...	15
Coraki	0	Failed to disperse ...			74	28	46	17	88	A7 ...	16
Kyogle	0	"	"	"	111	28	83	21	82	A6 ...	18
Cassilis	5	"	"	"	87	30	57	20	82	A7 ...	18
Glen Innes	0	"	"	"	102	26	76	21	76	A6 ...	19

soil is of fairly good surface structure, but not so well aggregated as krasnozems and with a distinctly stickier clay. They commonly carry throughout the profile floaters of basalt ranging in size from pebbles to large

rocks. These basalt soils are usually very fertile and intensely farmed. They cover relatively large areas in New South Wales, but do not fit into any of the internationally accepted soil classifications.

(To be continued.)

New Bridge over Cope's Creek at Tingha.

A new bridge over Cope's Creek at Tingha, New South Wales, was opened by the President of the Guyra Shire Council, Councillor L. T. Starr, on 2nd June, 1956.

The bridge is situated on the Guyra-Inverell Road (Main Road No. 135), about 16 miles south-east of Inverell, and replaces a timber beam bridge built in 1883.

The new bridge is a reinforced concrete structure, 220 feet in length, and has a carriageway 22 feet wide and a 5-foot footway. As originally designed the bridge would have been 180 feet long in four spans, with short cantilever extensions at each abutment, but following severe floods and extensive scouring of the stream channel during construction it was decided to add an additional 40-foot span.

A contract was let for the work but after some work had been carried out the contractor asked to be relieved of his contract and the work was taken over and carried

to completion by the Department of Main Roads by day labour.

Construction was considerably interfered with by floods during November, 1954, when the falsework and formwork of one span was destroyed and other damage caused. In February of the following year further floods caused great damage, including loss of steel reinforcement assembled in position on one span, formwork and falsework elsewhere, and the filling up of excavations. During this flood the old bridge, which was still in use, was lifted from its foundations and deposited a quarter of a mile downstream. A "causeway" type crossing was then provided to serve traffic until the new bridge became available. Later floods occurred which further delayed work on the new bridge and on two occasions the causeway was partially washed away.

The bridge was completed in May, 1956, the final cost being approximately £38,000. The Guyra Shire Council will provide one-quarter of the cost and the Department of Main Roads the balance.

Bridge over Cope's Creek, Tingha.





Hauling a 25-ton condenser section to Bunnerong Power Station in 1927.

Weight of Load Regulation

A BRIEF HISTORY

Throughout history the character of roads has been conditioned by the vehicles passing over them and the loads they carried. When man discovered that the easiest way to move a heavy load was to use some form of rolling body it was probably only a short step to the invention of a rude cart mounted on wheels. As man began to extend his carrying capacity by the improvement of the vehicles, the road began to take on a special form and to become what it is to-day, a most highly developed contrivance for enabling the passage of people and the transport of goods from one point to another with a minimum of delay and inconvenience.

The Roman Era.

There is evidence to support the belief that two-wheeled carts were in use in the Bronze Age and the Early Iron Age. The ancient Britons are known to have used carts for the conveyance of Cornish tin to the ports for barter with the Phoenician traders, and when Julius Caesar landed in Britain, war chariots were used by the Britons in their efforts to repel the invaders. Roman vehicles ranged from light two-wheeled carts to heavy baggage waggons and included a variety of types used for special purposes, of which the "rheda", a four-wheeled vehicle, corresponded to the stage coach of later days.

The first known regulation of the weights to be carried on vehicles was made by the Romans. They divided traffic into two classes, an express service and

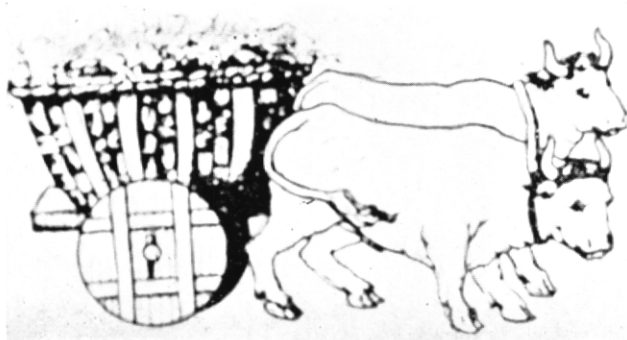
a freight service. Permissible loads were limited by law, the lighter fast vehicles being required to be drawn by eight horses in summer and ten in winter, the maximum load permitted being 718 English pounds. The freight waggons were limited to a load of 718 pounds on each of their four wheels but the number of draught animals, usually oxen, was not regulated.

England.

With the decay of the Roman roads in England, pack horses largely superseded wheeled traffic but some wheeled vehicles were always retained. In 1168, for instance, when Thomas A'Beckett went on a mission to France, he had with him eight carts, each drawn by five horses, as well as pack horses. These carts were, for the most part, little more than square boxes of planks carried on an axle between two crude wheels.

In 1418 the Town Council of Beverley in the north of England, sought to preserve their streets from damage by prohibiting their use to waggons. This they did by invoking an earlier regulation of 1367, which ordered that "no cart shod with iron" should enter the town and which required that "porters, creelmen, and other common carriers" should carry on horses and in creels and sacks, all goods that could conveniently and safely be carried in them and not in sleds. The penalty for an infringement of the regulation was a fine of 3s. 4d.

The poor state of the English roads between the Reformation and the Civil War of 1688 was due partly

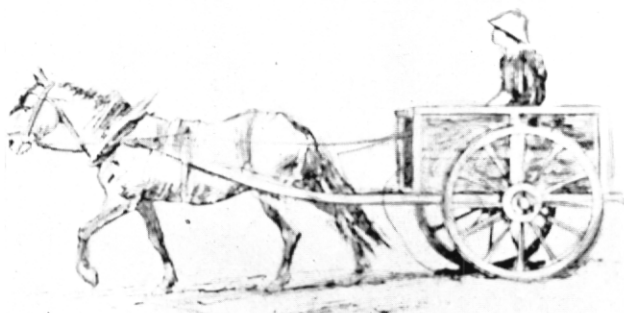


A Roman two-wheeled vehicle—"Plaustrum"—used in rural areas in ancient Britain.

to neglect but chiefly to the increase of traffic and especially the growing use of wheeled traffic. Vehicular traffic showed a marked expansion from the beginning of the 17th century at which time the roads were ill adapted to the traffic that rapidly developed. In 1605 the first passenger coach started from London and soon regular services of stage coaches and waggons were in operation over a large part of England. It is recorded that a regular service by the London carriers was commenced in 1634 but that waggons had been in regular use since the end of the 16th century is shown by an ordinance adopted by the town of Ipswich on the 6th December, 1599, which ordered that "waggons travelling to London Tewesday and Friday" and not reaching the town until "the Lord's Day" should not enter the town on the Sabbath "upon pain of forfeiture of 20 shillings for every offence, to the use of the poor of this town, and imprisonment till the same shall be paid."

The introduction of regular services of heavy wheeled vehicles soon had a most serious effect on the roads. In 1618 a proclamation was issued forbidding the use of the roads by heavy waggons and for nearly two centuries Parliament endeavoured by innumerable regulations to safeguard the roads from undue damage by traffic. Act after Act was passed to limit the use of wheeled vehicles, to regulate their construction, the nature and shape of their wheels, the weight of loads and the number of draught animals that might be attached to them.

In 1621 King James I forbade the use of any four-wheeled waggon or carriage weighing more than one

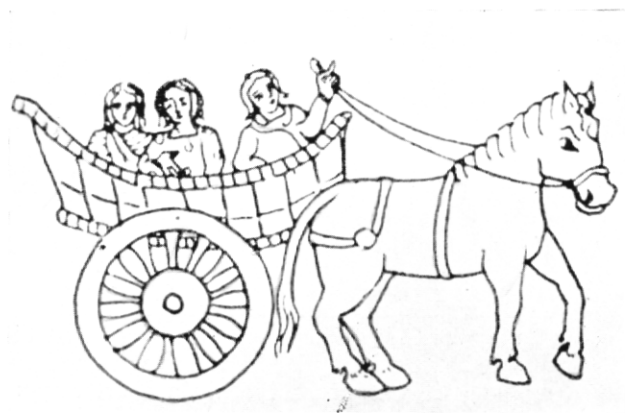


A peasant cart in use during the Roman era.

ton because "excessive loads so galled the highways and the very foundations of bridges that they were public nuisances." Later, about 1629, King Charles I issued a proclamation commanding that "no carrier or other person whatsoever, shall travel with any waine, cart or carriage with more than two wheels, nor with above the weight of twenty hundred, nor shall draw any waine, cart or carriage with more than five horses at once."

Ordinances for "repairing the highways, preserving them and preventing the inconveniences arising by carriages, especially in and about London" were prepared by the Recorder of London on the order of the Council of State in January, 1654. In these, drastic provision was made against heavy waggons and the ordinances provided also that if a cart was drawn by more than five horses, or more than six oxen and one horse, in contravention of the regulations, the draught animals were to be seized and detained until a fine of twenty shillings was paid for each of them.

By an Act of Parliament of 1662, wheels were required to be not less than four inches wide and maximum loads were limited to one ton from October to



An 8th century two-wheeled cart.

April. Enforcement of this regulation proved to be difficult as "in many places the ruts cannot receive wheels of that breadth and all waggons and carts could not at once be furnished with new wheels so that intercourse would be stayed." In view of this difficulty the part of the Act that specified the width of wheels was suspended.

In 1669 a Bill was introduced into Parliament for the repair of the highways and during the debate the suggestion was made that smaller two-wheeled carts only should be used and the weight they carried strictly limited. One of the speakers, a Colonel Birch, strongly deprecated this scheme. Two wheels, he said, spoil the ways more than four since the weight was less distributed. He proposed that any restriction that was made should apply to the number of animals that drew the waggons as then the load would have to be proportionate to their drawing capacity. It was finally decided that four-wheeled waggons should be allowed but that they might be drawn by not more than five horses.

Some curious reasons were given in support of a proposal that stage coaches be completely suppressed. In 1673, one John Evesott of Charterhouse, in a

memorial to Parliament urged that "the coaches were destroying the breed of good horses, rendering the public effeminate and idle, were bad for business as people used less clothes than when they had to travel on horseback or on foot, they were bad for the health of their passengers because of the long stages and late arrivals and that they promoted fraud as the innkeepers conspired with the coachmen to cheat their guests."

During Queen Anne's reign (1702-1714) an Act prohibited the use of more than six horses or oxen to a waggon, except uphill, under penalty of confiscation of the animals.

From 1741 onwards many Acts were passed with the object of protecting the roads from heavy wheeled traffic. Coach construction improved and coaches became lighter and less unwieldy but waggons and carts for the transport of goods continued to increase in size and weight. An Act of 1745 attempted to counteract this tendency by limiting the number of draught animals to four horses for a waggon and three for a cart but this proved insufficient and an alternative scheme was adopted for the erection of weighing machines at toll gates and the imposition of prohibitive tolls for excessive weights.



A packhorse convoy in the Middle Ages.

By an Act of 1751 no cart or waggon having wheels with rims less than nine inches wide was allowed on the turnpike roads under penalty of a fine of £5 or imprisonment for one month, and an Act of 1753 allowed vehicles with nine-inch tyres to go free through the turnpikes and increased the tolls payable by vehicles with narrower tyres.

Several efforts were made from 1754 onwards to discourage the use of narrow wheels and double rates had to be paid by vehicles with wheels less than nine inches in width.

In 1773 an Act of Parliament allowed waggons with sixteen-inch tyres to be free of tolls for one year and in 1774 another Act provided for the free period being extended to five years with half tolls payable thereafter. These Acts did not, however, achieve their purpose as the wheelwrights bevelled the edges of the tyres and so caused greater damage than that for which the narrower flat wheels were held responsible.

The operation in 1801 of a railed trackway within a roadway for the transport of goods and the develop-



A 16th century stage waggon.

ment of railways as such from about 1825 onwards for passenger as well as freight traffic took away from the roads most, if not all, of the traffic that had necessitated the restrictive legislation of the previous two or three centuries.

The Position in New South Wales.

Although the toll system was introduced into Australia comparatively soon after the foundation of the colony the purpose of the tolls, at first, was to provide funds for the betterment of the roads and did not have the intention of restricting their use by any particular type of vehicle. Later, the system was employed to discourage the use of vehicles considered to have a damaging effect on the roads. In 1832, the Legislative Council passed an Act to regularise the tolls in use and to specify those payable by various classes of traffic, but following the establishment of separate States legislation was from time to time enacted to deal with the local situation in a State.



A 16th century stage coach.



A carrier's waggon of the early 19th century.

In New South Wales, the Act of 1832 continued in effect until 1857 when an amending Act was passed in the first session of the State Parliament following the introduction of responsible government. This was an Act to encourage the use of broad wheels on vehicles and it provided that "upon and after the first day of January, 1859, every cart, dray, wain, waggon or other such carriage, both or all of the wheels whereof shall be less than five inches wide in the tyre shall become and be liable to be charged double tolls."

In introducing this measure, a member, Mr. Oxley, said its object was to "encourage the use of wide wheels so that our roads may not be cut so rudely as they are by the narrow wheels now in vogue." Carts on springs drawn by one horse or other animal and all vehicles used exclusively for the carriage of passengers or mails were exempted from the provisions of the Act.

The Act did not prove effective and agitation arose for its repeal or amendment. In 1860, Captain Martin-dale who had been commissioned by the Government to report upon the internal communications of New South Wales, pressed upon the attention of the Government the condition of the main roads. He said: "It is obvious that, with the most favourable weather, the progress of improvement upon roads must . . . be very slow:

but when such rains as have lately visited this Colony fall upon an earthen road, or upon a road in a transition state from an earthen to a macadamised road, bearing at the same time a heavy traffic, it inevitably follows that, at the least, improvement is stopped and much dissatisfaction prevails. Even were the road macadamised, its maintenance in such weather under the now very heavy loads placed upon two wheels with narrow tires, would be extremely costly; no macadamised road would stand in such circumstances."

The Act was amended in 1861 by the repeal of the sections which imposed double toll on vehicles with wheels less than five inches in width. The amendment provided instead that vehicles with wheels not less than five inches wide should be charged with only half the toll that would otherwise be charged. It contained the provision, however, that the reduced toll would not be allowed unless in addition to the vehicle being provided with wheels five inches or more in width, they were so fixed as to ensure that when the wheels were on a flat or level surface the whole width of the wheel should bear equally.



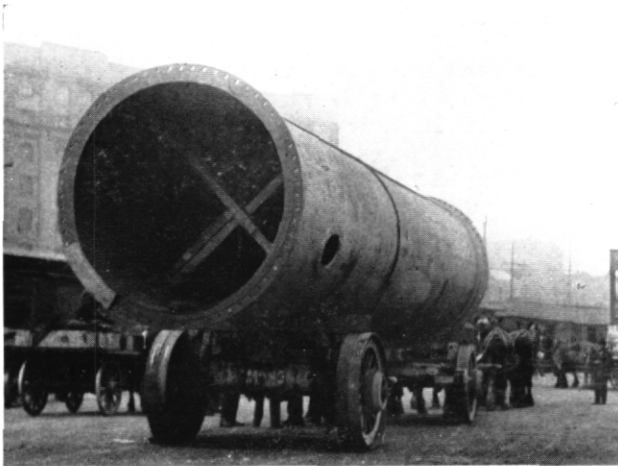
Solid-tyred motor vehicle, 1927.

When this Bill was debated in Parliament it was stated that the earlier measure "had been found to work very badly throughout the whole of the Colony." The speaker said that the tolls were unjust in the mode of their collection because they operated whether a cart was loaded or unloaded and whether it proposed to travel ten yards or ten miles. Other speakers claimed that broad wheels were totally inapplicable to the traffic of the interior and would not, under any circumstances, be adopted.

The amending Act did not, apparently, have the effect its sponsors expected for in March, 1865, the Commissioner and Engineer for Roads, Mr. W. C. Bennett, reported to Parliament that "the most important point connected with the road management in this country is, now, the question as to how the weights carried can be restricted and the mode of carrying improved. Every improvement on the road has been followed by a corresponding increase in the weights carried; from 1 ton to 1½ ton was formerly the average load for each dray in ordinary seasons; now the loads are seldom less than



Horse-drawn lorry with iron-shod wheels—early 1920's.



Jinker-type vehicle hauling heavy load, 1927. Note widened steel tyres on rear wheels.

2½ tons, and range up even to 5 tons on a pair of wheels and 6½ tons on four-wheeled waggons, and notwithstanding the differential tolls, narrow tires are still in general use."

The Commissioner pointed out that the extent of the injury caused by the "enormous weight" carried on narrow wheeled vehicles following in the same track and "making no attempt to avoid a soft place, until by turning and dragging out, a small rut is enlarged into a dangerous bog" could not be estimated. He stated that no crust could withstand such treatment and that if it was the intention of the Government to keep up and

extend macadamised roads "some means must be adopted to restrict the weight of loads and improve the mode of carriage." He said there were only two means of doing this, one was to impose cumulative tolls on the number of horses drawing the vehicles, and the other, to adjust the tolls to the weight carried. The first method was not recommended as, it was pointed out, the toll would be evaded by taking off the leading horses. The second method was suggested and it was proposed that toll bars and weighbridges be established and that differential tolls be charged for narrow-wheel vehicles, the tolls to be cumulative for all weights over 17½ cwt. per wheel in summer and 15 cwt. in winter, with a reduction of 25 per cent. for waggons "driven from the perch, with reins, and fitted with breaks."

It would appear that the Government at first relied upon the carriers making an effort to reduce their loads and to improve their methods of loading, but in the Commissioner's next report, dated February, 1871, he said "nothing having been done in reference to the prevention of excessive weights, the Government were absolutely compelled to avail themselves of the powers given to put cumulative tolls on weights carried and to establish weighbridges on all the main roads." Although, said Mr. Bennett, "this will to some extent prevent the injury . . . as the law only allows of those rates being charged on the three main roads (the Great Western Road, the Great Southern Road, and the Great Northern Road), the measure is rendered to some extent inoperative by the carriers diverging from the roads to avoid the toll bars, or taking a different route."



Oversize load (54 feet long by 10 feet 6 inches wide) being transported from Newcastle, to the South Coast of New South Wales via the Pacific Highway—1955.

A Bill had been drafted in 1866 to provide for the levying of tolls on all the roads but had not been brought before Parliament. The Commissioner, however, expressed the view that "a better and less expensive arrangement would be to prohibit, under severe penalties, the carrying of certain weights on certain widths of tyre" as was already being done in South Australia.

Tolls on all roads throughout the State were abolished by the Government in 1877 but the legislation relating to the widths of wheel was not repealed until the passage of the Local Government Act of 1906. Although, by the passage of that Act, responsibility for the care and upkeep of the roads was placed upon the local authorities, no power was given them to regulate the widths of tyres or the weight of loads that might be carried.

Provision was made in the Local Government Act of 1919 to give councils power to control and regulate the weight of load that might be carried upon any road or bridge and the Main Roads Act of 1924 empowered the making of Ordinances under the Local Government Act regulating the weight of vehicles using the main roads and the loads carried.

These powers were acted upon in 1934 by the proclamation of Ordinances No. 30C governing the weight of loads on vehicles on the main roads and No. 30D the weight of loads on vehicles on other than main roads. The present provisions of these ordinances were dealt with in an article published in "Main Roads", Vol. 16, No. 1, September, 1950.

As civilisation has advanced, there has been an inevitable demand for better and swifter communications and the passage of heavier loads. Such demands can only be met by the provision of roads of as high a standard of strength as is possible in all the circumstances of the period. Where limitations on the weight of loads on roads have been imposed, their purpose has been to ensure that the roads, with which the prosperity of the people is so strongly linked, should not be reduced in efficiency by unduly destructive use.

Acknowledgments.

Material for this article has been obtained from:—

The Mitchell Library, Sydney.
The Public Library of N.S.W.
"The Story of the Road," J. W. Gregory.
"The Story of the Roads," C. W. Hartman.

PAYMENTS FROM THE ROAD FUNDS.

For period 1st JULY, 1955 to 30th JUNE, 1956.

	Amount Paid.
COUNTY OF CUMBERLAND MAIN ROADS FUND :	£
Construction and Reconstruction of Roads and Bridges	1,851,948
Acquisition of Land and Buildings for Road Widening	278,257
Maintenance and Minor Improvements of Roads and Bridges	1,015,280
Other Expenditure	347,632
Total :	£3,493,117
COUNTRY MAIN ROADS FUND :	
Construction and Reconstruction of Roads and Bridges	4,681,932
Acquisition of Land and Buildings for Road Widening	42,882
Maintenance and Minor Improvements of Roads and Bridges	4,831,922
Interest, Exchange and Repayment of Loans	187,951
Purchase and Repair of Plant, Motor Vehicles and Other Assets	835,764
Other Expenditure	605,107
Total :	£11,185,558
DEVELOPMENTAL ROADS FUND :	
Construction and Reconstruction of Roads and Bridges	339,289
SUMMARY ALL FUNDS :	
Construction and Reconstruction of Roads and Bridges	6,873,169
Acquisition of Land and Buildings for Road Widening	321,139
Maintenance and Minor Improvements of Roads and Bridges	5,847,202
Interest, Exchange and Repayment of Loans	187,951
Purchase and Repair of Plant, Motor Vehicles and Other Assets	835,764
Other Expenditure	952,739
Total :	£15,017,964

New Aggregate Handling and Asphalt Mixing Plant at Metropolitan Maintenance Depot Granville

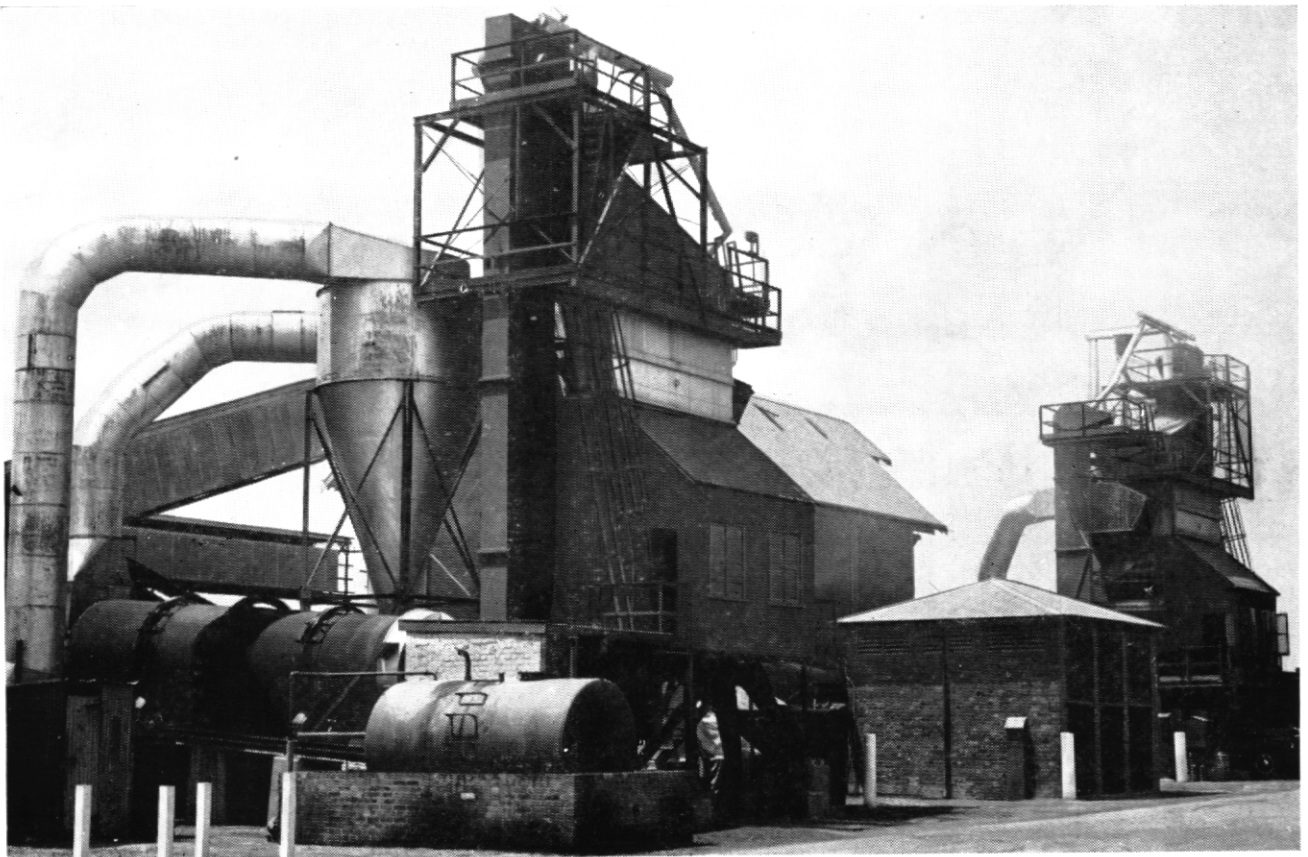
DURING 1955, the Department of Main Roads put into operation at its Metropolitan Maintenance Depot, Granville, a modern plant for production of dense-graded bituminous mixes, including ancilliary plant to handle crushed aggregate, sands, bitumen and other materials. This installation replaced an older central mixing plant established in 1933, shortly after the introduction of the drag resheeting process by the Department. The original plant comprised two machines capable of a combined output of 140 to 180 tons of mix daily. Only one machine was suitable for the production of dense-graded mix. This equipment served reasonably for about twenty years, when the age of the plant and the need for greater output, especially of dense-graded mixtures, made it necessary to consider the provision of new equipment. It was decided

to instal an aggregate handling plant and new mixers to provide at least 500 tons of mix per day. The plant now installed has a capacity of 600 to 700 tons per day. It comprises four main units, being an aggregate handling plant; two hot-mixing units; bitumen storage and heating tanks; and an electrical substation. A further unit yet to be installed will permit limestone dust (used as filler in dense mixes) to be handled in bulk by pneumatic methods.

The principal sections of each plant was driven by separate electric motors, and an electrical interlocking system automatically stops the whole plant in the event of interruption or mishap at any part.

Aggregate Handling Plant.

Crushed aggregates and sands from commercial sources are delivered by road to two large hoppers below



General view of the mixers, bitumen storage, heating unit and dust extractors.

ground level, from which belt conveyors lead to ten elevated weatherproof steel storage bins, each of 200 tons capacity. Alternatively, materials can be taken direct from the delivery hoppers by bucket elevator to a screening plant, where two triple deck vibrating screens discharge the various sizes of screened material to eight smaller holding bins. Material from the holding bins is discharged as necessary to the main belt conveyor, which delivers to the main storage bins. Delivery to the selected bin is made by suitably placing a travelling tripper, which scalps material from the conveyor. Two bins are allocated to each of the aggregate sizes in use, namely $\frac{3}{4}$ inch, $\frac{3}{8}$ inch, $\frac{3}{16}$ inch, and mixed sands, while the remaining two are reserved respectively for oversize aggregate and the future storage of limestone dust filler in bulk. The aggregate plant has an output of 100 tons per hour. If necessary, aggregate and sands can be supplied to the mixers at a still higher rate because of ample reserve capacity of the reciprocating feeders metering the output from the storage bins; if the higher mixing rates were maintained for any length of time it would be necessary to work extra time to keep up supply to the storage bins.

The storage is arranged in two rows, each of five bins, while four parallel belt conveyors, two beneath each row, receive aggregates and sands from the bins. Each bin can discharge on to the appropriate pair of conveyors by reciprocating plate feeders, which accurately control the rate of delivery from any bin to

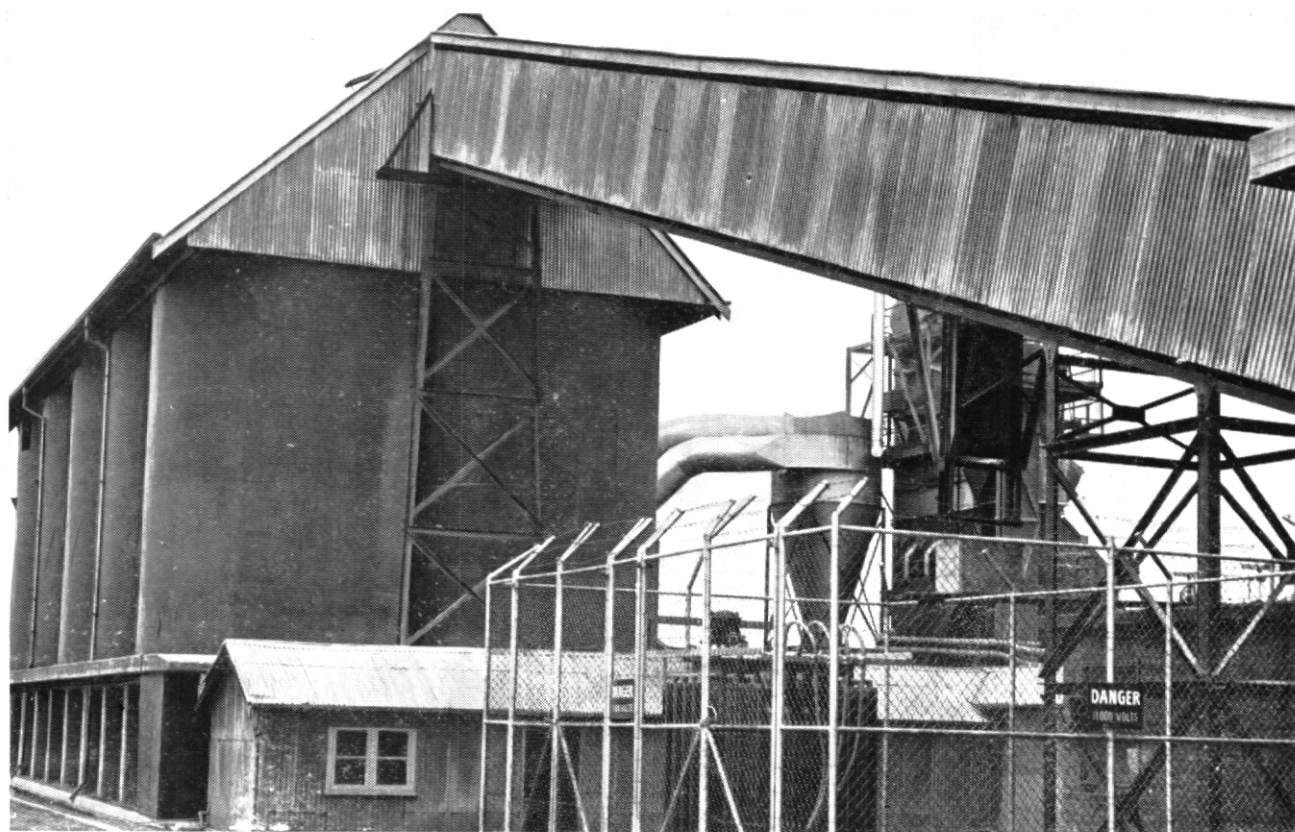
either of the two mixers. The arrangement is extremely flexible, and the designed output of 34 tons per hour from each feeder has proved ample.

Sand in use is a mixture of fine grained pit sand from Glenfield with a coarser material (standard Nepean sand) in the ratio of one part to two. Preliminary mixing of fine and coarse sand is carried out in stockpiles, as the former tends to flow unevenly when handled alone in the aggregate plant.

With a total bin storage capacity of 2,000 tons of aggregate only, and with an output which has reached 3,267 tons of mixed material in a week, it is necessary to stockpile large quantities of material to obviate interruption of output through shortage of any one grading of stone. To date the stockpiles of crushed metal and sand have amounted to 5,000 tons, but experience indicates the desirability of increasing the stockpiled quantities, particularly in the smaller sizes.

Mixing Plant.

The two batch-type Armstrong-Holland model RB hot-mix plants were manufactured in Australia under licence from the Standard Steel Corporation, U.S.A. Each machine has a rated output of 45 to 70 tons per hour, depending upon grading of the mix and moisture content of the constituents, particularly sands. Normal output of asphaltic concrete is 50 tons per hour from each machine, or about 700 tons daily from the whole plant.



Covered steel bins (storage 2,000 tons). Electric Supply Authority's transformer in foreground.

Unloading bitumen from road tankers to storage and heating unit.



Each unit comprises:—

- (a) *Cold materials conveyor*, which delivers aggregates and sands from the aggregate handling plant to the rotary dryer-heater at rates up to 70 tons per hour.
- (b) *Rotary dryer-heater*, which is a steel cylinder (or "drum") 24 feet long and 6 feet diameter, rotating at the unusually low speed of 8 r.p.m. to ensure efficient drying and heating of aggregates. The slow speed of rotation is offset by the large capacity of the cylinder. Rated capacity is 45 tons per hour with aggregate (of all gauges plus sand) containing $4\frac{1}{2}$ per cent. moisture by weight.

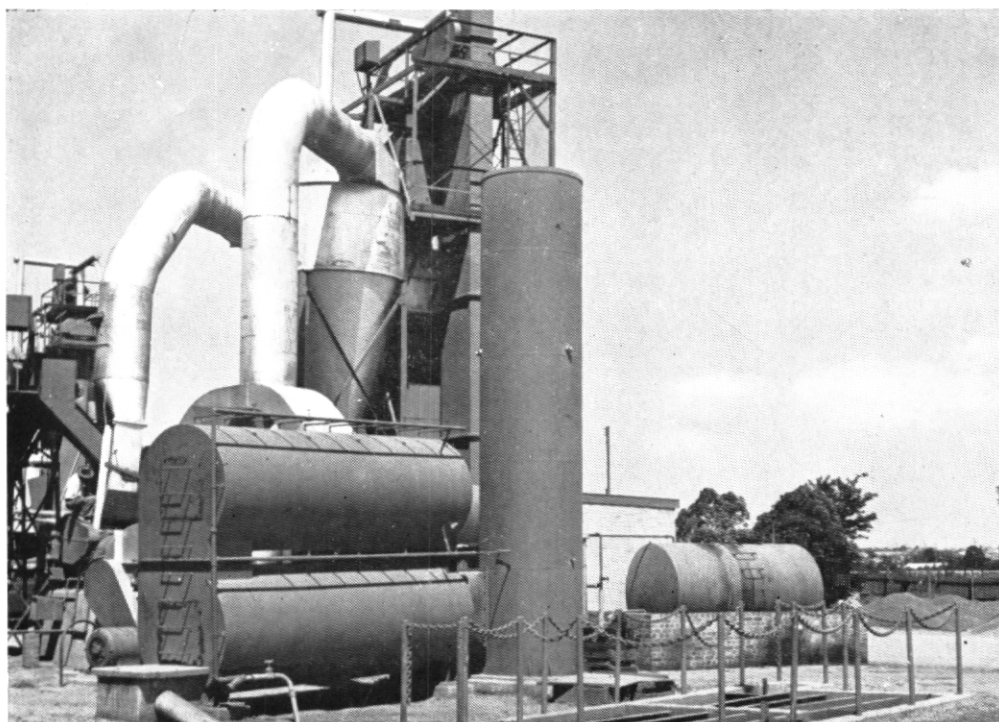
The dryer cylinder is driven by a 40 h.p. electric motor. At the discharge end a stationary combustion chamber, 42 inches interval diameter, 84 inches long and lined with 6 inch firebricks, contains the oil burners.

- (c) *Oil burners*.—Three burners each consuming up to 60 gallons of oil per hour, are controlled by a Cambridge automatic indicating controller. A thermocouple in the discharge chute from the dryer is responsive to temperature of the hot aggregate, and actuates small motors which cut off air and fuel supplies to one or more burners as necessary to maintain a constant aggregate temperature (normally 340 deg. F.). Ignition is by a pilot burner which operates at all times, and air supply to the burners is from a 20 h.p. blower motor. A fall in temperature of about 25 deg. F. occurs during the passage of aggregate from dryer-heater to the pugmill mixer, which delivers mix at about 315 deg. F. Any interruption

in the passage of aggregate through the drum could permit excessive temperature rise, and this is prevented by an over-riding control consisting of a thermostat controlled from the exhaust flue. The burners are stopped when exhaust gases reach a temperature of 400 deg. F.

Normal fuel consumption of the dryer-heater is about $1\frac{1}{2}$ gallons per ton of mix produced, or about 80 gallons per hour for each mixing plant.

- (d) *Exhaust and dust collecting system*.—An exhaust fan on each plant has a capacity of 20,000 to 25,000 c. ft. of air per minute when running at 700 r.p.m., and is driven by a 45 h.p. electric motor. The fan draws hot gases from the drum and burners via a cyclone-type dust collector 10 feet diameter and 21 feet high. Dust from various parts of the plant is also drawn through a number of conduits into the same system, this feature greatly reducing dust nuisance in and about the plant, and making an important contribution towards improved working conditions. The vibrating screens above the mixers are totally enclosed, and are connected to the exhaust system by special heat resisting flexible material. Dust collected from the cyclone is fed back into the hot materials elevator, thus reducing loss of fine materials from the mix. Some dust, consisting of very fine particles, does not settle in the cyclone, and is carried by the hot gases to a twin tank washer, where the gas passes through a series of water sprays, thence into the atmosphere.



Dust Extractor.

Effluent from the washer discharges into settling tanks, where sludge forms at the rate of some 3 to 4 tons per week for each machine. Waste water from the settling tanks runs away to a nearby creek.

- (c) *Hot-materials elevator.*—This unit raises hot materials from the dryer-heater to the elevated vibrating mixer screens. It is fitted with malleable iron buckets, and has a rated capacity of 70 tons per hour. Drive is by a separate 12½ h.p. electric motor.
- (f) *Mixer screens.*—These are of the double-deck vibrating type, 12 feet long and 5 feet wide, and are fitted with meshes of nominal openings, 1½ inch, ¾ inch, ⅜ inch and ⅛ inch. The screen are actuated by multi-vee belts from a 10 h.p. electric motor.
- (g) *Aggregate and filler storage bins.*—The hot materials from the screening unit are delivered into four bins immediately underneath. The first three are each of 11 tons capacity, and take materials passing ⅜ inch, ⅝ inch and ¾ inch, respectively, while the fourth could hold 7 tons of aggregate passing 1½ inch mesh (this size aggregate is not used at present). Limestone dust filler, in accordance with normal practice, does not pass through the dryer-heater, but is delivered cold by a separate elevator of 25 tons per hour capacity to a filler bin having a capacity of 6½ tons (based on material weighing 75 lb. per cubic foot). Overflow chutes are fitted to each bin compartment and converge into a 3 cubic yards overflow hopper which is emptied into a truck as necessary and taken to stockpiles.

- (h) *Weigh batching equipment.*—Aggregates from the hot storage bins are dropped into a weigh hopper by four single clam valves, and filler is conveyed from storage to the same weigh hopper by a 6-inch diameter screw, operated by a 5 h.p. totally enclosed electric motor with solenoid brake for quick cut-off. Weights are shown on a 36-inch diameter dial recording in 10-lb. increments up to 6,000 lb. Adjustable points are attached to the periphery of the dial for the operator's guidance in weighing out successive quantities of material from the various hot bins. Dry materials from the weigh hopper are released into the pugmill by a 42-inch x 8-inch radial clam gate.

The bitumen weigh bucket is of 55 gallons capacity, and in lieu of the more usual tilting arrangement, is discharged from the bottom by a poppet valve. Bitumen is distributed over the length of the paddle mixer by a perforated tube 8 inches in diameter. Bitumen weight is recorded on separate scales having a dial 24 inches in diameter calibrated in 5-lb. increments to 600 lb.

- (i) *Mixer.*—The pugmill or paddle mixer is of 5,000 lb. capacity and includes two sets of intermeshing paddles on twin shafts rotating at the unusually high speed of 78 r.p.m., thus reducing mixing time to a minimum. Power is supplied by a 100-h.p. electric motor through multi-vee belts. Paddle tips, which are subject to severe wear, were originally of manganese steel, but were later replaced with

harder material; white iron is now being tried in an attempt to improve the working life of the tips. The body of the paddle box is lined with 1-inch renewable manganese steel bars.

- (j) *Controls.*—All gates, doors, valves, etc., in each mixing plant are operated pneumatically, compressed air being supplied from a four-cylinder compressor driven by a 10-h.p. electric motor and rated at 30 cubic feet per minute capacity. Nine controls for bitumen, aggregates, filler, and mixed material are centred in a steel desk on the operating platform. Thermometer dials register temperatures in the four hot aggregate bins and the bitumen line.
- (k) *Fuel oil system.*—Economy in heating aggregate is effected by the use of heavy fuel oil (bunker oil) rather than the lighter and more expensive diesel oil. The heavy oil cannot be handled at normal temperatures and is therefore pre-heated in a 2,000-gallon storage tank fitted with 2 k.w. heating elements, and circulated through a return line heated by a 36-k.w. line heater capable of heating 200 gallons of oil per hour from 70 degrees F. to 180 degrees F. Thermostatic control is provided. A 1-h.p. vane pump can circulate oil at a rate of 600 gallons per hour.
- (l) *Precautions for safe operation of plant.*—As indicated earlier, all components of the plant are operated by individual electric motors. Failure of the hot materials elevator could cause serious choking of the dryer drum, and failure of any other conveyor would cause the piling up of aggregate at the discharge of the preceding conveyor. Each mixing unit has its separate line of conveyors from the bins. All components have been interlocked by relays so that the stoppage of a conveyor would bring to rest all other conveyors on the same feed line, the burners of the machine being fed would be cut out (other than the pilot burner), and the reciprocating feeders would stop. The dryer-heater drum and exhaust fan would not be stopped by failure of conveyors, but a breakdown of either dryer or exhaust fan would stop all conveyors. The incoming feeders and conveyors to the storage bins are likewise interlocked so that all components stop when one stops. Individual parallel switches are fitted to permit testing of burners or each conveyor separately.

Army type telephones have been placed throughout the installation to provide ready intercommunication between employees supervising the feeding, conveyance and discharging of the aggregate.

Bitumen Storage and Heating Plant.

Bitumen is received hot from the suppliers and is stored in a bank of three electric heaters each of 2,500 gallons capacity. Space has been left for the installation

of a fourth heater should this be found necessary. The heaters are in the form of straight-sided steel tanks, on the front face of which are mounted the electrical controls comprising main circuit breaker, element switches, thermostat dial and time clock for off-peak operation if desired.

The heating elements, each of 3 k.w. rating, are arranged in five banks of three, and each bank is controlled by a separate on/off switch; a master switch is also fitted. The elements slide into steel tubes protruding into the base of the tank, and each element may be withdrawn by undoing four retaining screws. The complete set of elements can be withdrawn when the tank is empty, together with covering tubes and connection box. Temperature control is made fully automatic by means of an indicating temperature controller having a range from 150 degrees to 500 degrees, and the temperature is controlled within plus or minus 5 degrees F. of the desired point. A depth gauge of float and rope type incorporates a trip switch to operate when the bitumen in the tank falls below a predetermined level. Each heater is fitted with its own 6 h.p. electrically driven submerged pump capable of delivering 2,500 gallons per hour.

While normally used for receiving hot bitumen, solid bitumen can be loaded through manhole covers. Agitators of positive displacement type driven by 7.5 h.p. motors are fitted to each tank. The heaters are set on a concrete base and surrounded with 6 inches of slag wool insulation held in place by a brick surrounding wall on which a roof is mounted. The tops of the tanks are lagged with 6 inches of slag wool under a



Control room for weigh batching.



Delivering hot-mixed material to motor vehicles.

timber flooring. Slag wool insulation has also been placed under the heaters.

It is not possible to use the submerged type pumps for oil flushing the bitumen lines at cessation of work, and in lieu of installing a separate pump for flushing purposes, it was decided to equip the bitumen lines with electric strip heaters placed under the lagging, and to blow out the lines with air from one or other of the compressors fitted to the mixing plants. This process has proved satisfactory and economical, as it eliminates wastage of oil otherwise required for flushing. The 320 lineal feet of strip heater has been installed in ten lengths with a combined rating of 12 k.w.

Electrical Sub-station.

The sub-station comprises an outdoor wired enclosure with provision for two 500 kVA. transformers (only one of which has so far been installed), and a brick switch room 24 feet x 10 feet. The power supply is brought in by underground cable from adjacent supply authority overhead lines to the transformer, and from

the transformer to the sub-station also by underground cable. The main switch-board comprises six panels, of which two are for the Electric Supply Authority, one panel for main switch and connecting links, one panel for supply to Metropolitan Maintenance Depot (excluding aggregate and mixing plant) plus the Department's Central Workshop, one panel for one mixing unit (No. 14) and aggregate heating and storage plant, and one panel for the other mixing unit (No. 15) and the bitumen heating and storage tanks. Space is available for another panel should this be required at some future date.

Space has been provided also in the switch room for power factor correction equipment, the requirements for which are being determined from actual operation of the plant. All outgoing cables are taken underground to distribution boards erected in appropriate positions, and again by underground cable from the distribution boards to the various motors and heaters.

Australian Standard Glossary of Names For Earthmoving and Constructional Plant

IN order to promote uniformity in the nomenclature of earth-moving and constructional plant, the Standards Association of Australia has now published a new Australian Standard Glossary of Names for Earthmoving and Constructional Plant (No. A79.1955).

Preparation of this standard was undertaken at the request of the Conference of State Road Authorities of Australia and its object is to have plant items and equipment designated uniformly, particularly in catalogues and lists. To have a standard reference work such as this will be of great benefit to all firms and

government or local authorities who buy, sell, or use any one of the wide range of units comprising earth-moving plant.

The standard includes definitions of some 300 terms arranged in twenty sections, together with a comprehensive index of standard and common names.

Copies of the publication may be obtained from the Headquarters of the Association, Science House, 157 Gloucester-street, Sydney, and from branch offices in Capital cities in the Commonwealth and at Newcastle.

New Bridge at Bobbin Head

A NEW prestressed concrete bridge has recently been constructed by the Department of Main Roads over Cockle Creek at Bobbin Head. Cockle Creek is a tributary of Cowan Creek which flows into Broken Bay near the estuary of the Hawkesbury River.

The new bridge consists of three spans, each 64 feet in length, supported on reinforced concrete piers and abutments, and comprises a carriageway 24 feet in width and two footways each 5 feet wide.

The bridge replaces a timber beam bridge built in 1928 which was destroyed as a result of a flood in 1942. As a temporary measure a light suspension bridge was built by the Department of Main Roads for the use of pedestrians and a military type "Steele" bridge was later provided for vehicular traffic.

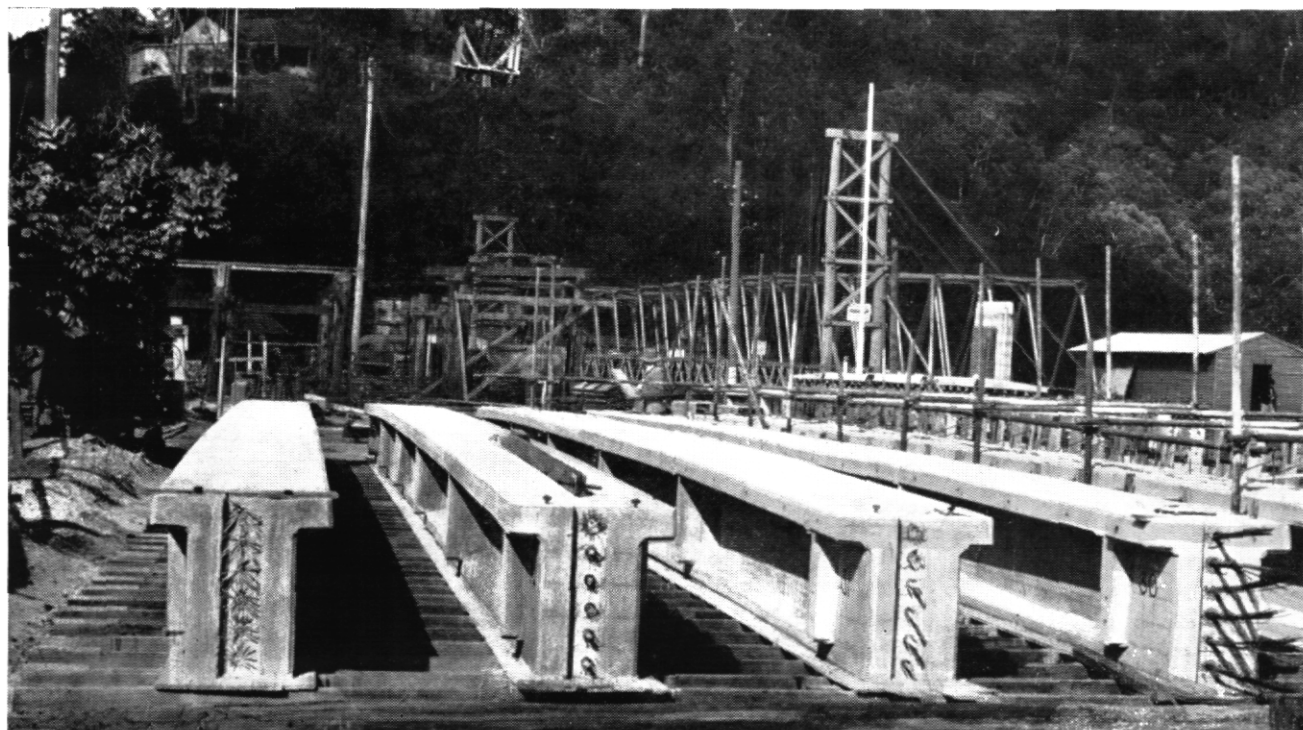
No unusual or novel features are associated with the design and construction of the piers and abutments of the new bridge but the superstructure of prestressed concrete is the first of its kind to be designed and built by the Department of Main Roads. The site at Bobbin Head, which is within 20 miles of Sydney, was selected for the first of such projects so as to enable close control of the technical aspects of the job.

The new bridge is located on Main Road No. 366 which, for part of its length, passes through the Kuring-gai Chase, a national park of more than 35,000

acres. The bridge site adjoins a pleasant recreational area, which is only slightly higher than high water level. The use of prestressed concrete permitted a more slender structure than would have been possible had ordinary reinforced concrete been used and enabled the deck level to be placed about 4 feet lower than would otherwise have been the case. The general "lightness" of the structure and the reduced height of the approach embankments made possible by the lower deck level fit well into the surroundings.

Basically the bridge superstructure consists of thirteen girders in each span designed on the "Freyssinet" system, each girder being prestressed by six cables of twelve wires each of 0.2 inches diameter. The wires have a safe working strength of 60 tons per square inch and the prestressing load applied in each cable was therefore 22.6 tons or a total of 136 tons. Creep in steel and concrete under sustained load, and shrinkage were allowed for at a total of 15 per cent. of 115 tons prestressing force. The increase in stress in cables caused by live load is materially less than the reduction due to creep, etc., so that the prestressing stress is the greatest which the wires will be called upon to carry. The girders are laid side by side and tied together by cross tensioning at intervals of 3 feet with twenty-two cables of twelve wires in each span. The effect is, therefore, that the girders act as a ribbed slab.

Pre-stressed main girders. (Note girder at right not yet pre-stressed). Temporary "Steele" bridge in background.



The concrete takes an initial compressive stress of 2,000 lb. per square inch. In view of this high figure, good quality concrete was essential. Batching of aggregates was by weight, using a water-cement ratio of 0.35—0.40, and all concrete was vibrated in the forms. In spite of these precautions there were at first considerable variations in the strength of the concrete. Some were found to be due to variations in quality of cement, other to pollution of fine aggregate following floods, others to a rather dense mix difficult to place. By using cement from one source only and varying the mix to improve workability, much greater uniformity was obtained in the rest of the work. The mix as used contained eight bags of cement per cubic yard of concrete and strengths averaging 5,700 lb. per square inch (cylinder strength) at twenty-eight days were obtained. As the work proceeded and in the light of the experience gained, strengths ranging up to 7,300 lb. per square inch were obtained.

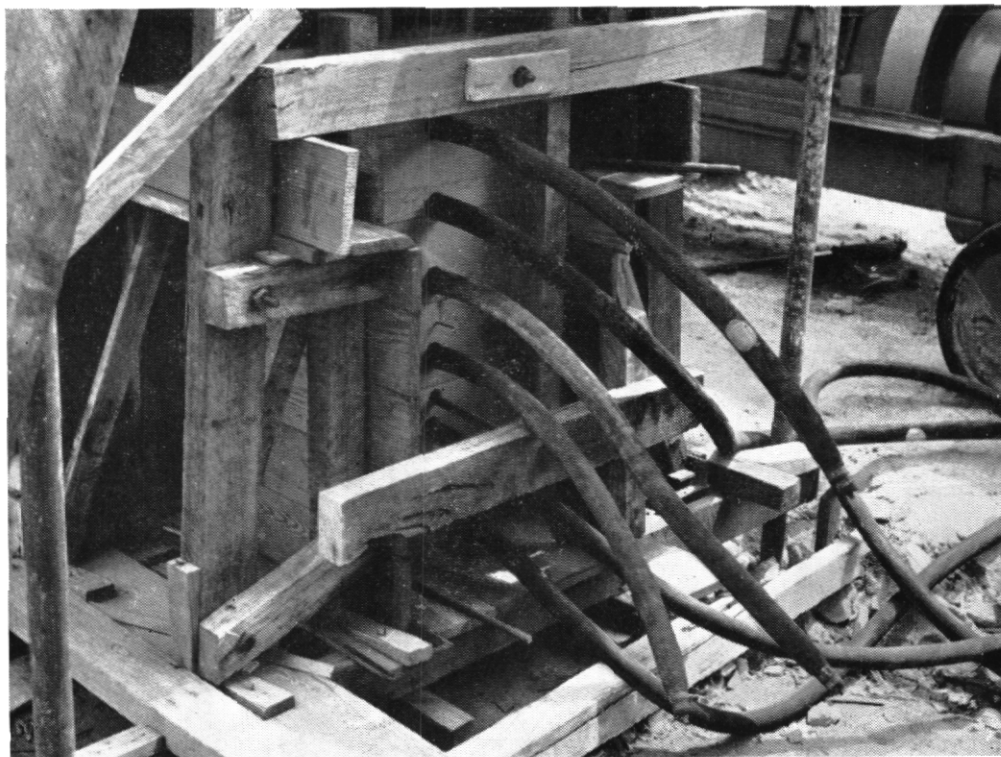
For tensioning the cables, Freyssinet jacks were hired from the Prestressed Concrete Pty. Ltd. (Australia), which also supplied the equipment for grouting up the ducts after tensioning of cables. In the initial stages of the work trials were made of suitable grouting mixture and it was found that a grout of neat cement and water was the most satisfactory. The neat cement grout, however, contracted on setting, leaving a small cavity along the top of each duct, but the addition of a small quantity of aluminium powder overcame this shrinkage, and cavities no longer appeared. Another improvement adopted was to set the anchor cones in precast short end section of girder, thus facilitating the setting up of the cables. The original girder design incorporated a thin web section between flanges, which made it

difficult to insert the vibrators for packing the concrete past the cables. The design was amended slightly by thickening the webs, and increasing the slope of the bottom flange to 45 degrees making it easier to place and compact the concrete. A further improvement effected during construction was to give a slight taper to the short cross girders which are cast with the main girders themselves, thus facilitating the removal of the forms.

Timber forms were used throughout. Although substantially built the maximum use to which the forms could be put averaged only three occasions and some repairs were necessary after each use. Lining of web forms with galvanised iron sheet instead of plywood improved the position materially since the vibrators did not affect the metal sheathing and the timber was protected from moisture and grout. The loss of grout through joints in the forms was also reduced and this, in an already dry mix, was a considerable advantage. It was also found advisable, where metal lining was not necessary, to use plank boarding rather than plywood sheets to make up the forms.

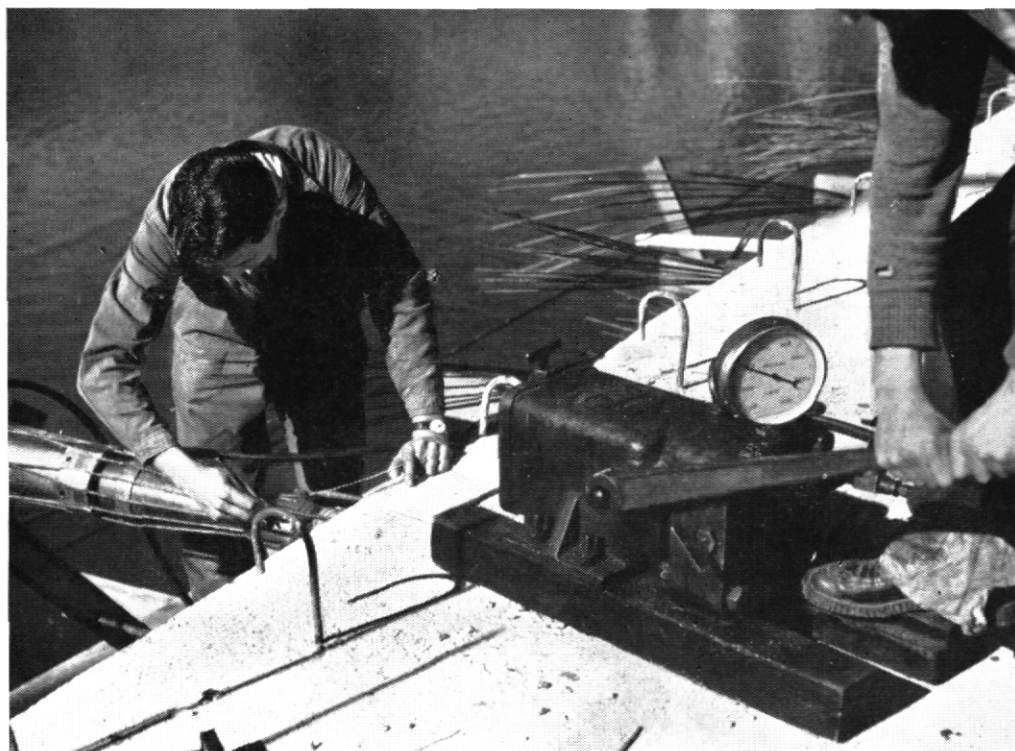
The proper use of the vibrators in packing the thin sections with dry concrete mix had to be learnt by the personnel employed on the work. External vibration was not used extensively, but where used produced a good surface finish.

For the first girders rubber tubes were used to form the channels for the prestressing wires. Some difficulty was experienced both in placing and withdrawing these. It was later decided to use permanent sheathing left in place, and this proved satisfactory when used in conjunction with precast end blocks, thus obtaining a



Inflated tubing used during the construction of the first pre-stressed girder.

Stressing of transverse cables. Checking wire extension against jack pressure.



grout-proof connection. The permanent sheathing is in the form of a spirally wound interlocked casing similar to that used to surround speedometer cables but measuring about $1\frac{1}{8}$ inch in diameter. However, rubber tubes were again used when the transverse holes of the deck were completed, the holes in this case being much shorter.

To assist in placing the girders a flying fox of 10 tons capacity was used to haul one end of each girder to its seat, the other end being brought into position by means of a mobile crane.

The bridge was officially opened to traffic by the Commissioner for Main Roads, Mr. H. M. Sherrard, on 1st September, 1956.

Tenders Accepted by the Department

The following Tenders (exceeding £3,000) were accepted by the Department during the months of April, May and June, 1956:—

Council or Division.	Road No.	Work or Service.	Name of Accepted Tenderer.	Amount.
Gundagai S. ...	2	Construction of deviation across flat between South Gundagai and Jessop's Cutting.	Hume Road Construction and Earth Moving Co.	£ 21,259 s. 7 d. 0
Hornsby S. ...	139	Construction of Beecroft Road between Copeland Street and State Highway No. 13, comprising cement concrete pavement generally 42-ft. wide, together with channelised intersection, underground drainage, kerbs and all subsidiary works.	Road Constructors Pty. Ltd.	96,640 5 0
Kempsey M. ...	10	Construction of bridge over Macleay River, at Kempsey. Contract No. 2, construction of piers, abutments, deck; erection of steelwork and final completion.	Hornibrook, McKenzie Clark Pty. Ltd.	282,720 13 0
Lower Hunter S. ...	...	Sandblasting and metal spraying of R.S.J's., cross girders and bearings for bridge over Hunter River at Ash Island.	Metal Coatings Pty. Ltd.	4,596 0 0
Manning S. ...	10	Reconstruction of 8.92 m. of roadway from 4 m. south to 5 m. north of Main Road No. 111 (Tuncurry Road).	Tarjan Construction Co. Pty. Ltd.	84,958 0 0
Muswellbrook S.	209	Construction of approaches to bridge over Hunter River, at Denman.	Messrs. Beavis Bros. Construction Pty. Ltd.	6,953 0 0
„	209	Reconstruction of washed-out spans of bridge over Goulburn River, at Yarrawa.	N. H. Bowers, Pty. Ltd.	71,725 7 2
Stroud S. ...	10	Construction of 90 ft. reinforced concrete bridge over Fry's Creek, 1.80m. north of Bulahdelah.	H. Mueller and Co. ...	10,056 10 0

Tenders Accepted by Councils.

The following Tenders (exceeding £3,000) were accepted by the respective Councils during the months of April, May and June, 1956:—

Council or Division.	Road No.	Work.	Name of Accepted Tenderer.	Amount.
				£ s. d.
Abercrombie S. ...	3085	Construction of timber beam bridge over Evans Plains Creek.	Central Construction Co.	9,333 13 9
Berrigan S. ...	...	Supply and delivery 14,748 c. yds. gravel for Main and Trunk Roads Maintenance and Improvement Programme, 1956.	J. G. McMillan ...	6,437 14 0
Bingara S. ...	63	Supply and delivery 3,070 c. yds. aggregate for section 19m. 4.118 ft., Barraba Shire Boundary to 36 m. 1.384ft.	Messrs Peterson and Rae	3,070 0 0
Bland S. ...	57	Supply, delivery, spreading and rolling of 11,840 c. yds. gravel between 25.60 m. and 40.40 m.	A. G. Neal ...	4,127 13 4
" ...	57	Supply, delivery, spreading and rolling of 9,840 c. yds. gravel between 11.40 m. and 13.50 m., and 18.40 m. and 28.60 m.	I. N. Miller ...	3,488 0 0
Camden M. ...	154	Reconstruction and partial deviation of existing road between 2 m. 2,540 ft. and 5 m. 2,500 ft. from the intersection of State Highway No. 2, at Narellan, including $\frac{3}{4}$ -in. flush bituminous seal.	R. G. Furney ...	67,518 1 7
Carrathool S. ...	321	Supply and delivery of 7,450 c. yds. of gravel ...	C. G. Staines and F. L. Gundy.	3,818 2 6
Gilgandra S. ...	205	Construction of bridge over Uargon Creek ...	Central Construction Co.	10,933 3 0
Goobang S. ...	61	Construction of box culvert 11.22 m. east of Parkes ...	" ...	3,051 5 0
Guyra S. ...	135	Strengthening and surfacing section 3.12 m. to 7.82 m. east of Guyra.	Messrs. "Emoleum, Limited	4,435 16 2
Holbrook S. ...	1231	Supply and delivery of 9,200 c. yds. gravel between 1.72 m. and 7.42 m.	F. A. Carstens and Son	3,365 0 0
Liverpool M. ...	154	Strengthening of pavement between 7.6 m. and 11.3 m. from Narellan. Supply and laying bituminous concrete.	Bituminous Pavements Pty. Ltd.	26,237 0 4
Macintyre S. ...	187	Construction of 3/25 ft. span timber beam bridge over Spencer's Gully at 5.06 m. north of Inverell.	L. G. Rixon ...	5,867 7 8
Manly M. ...	164	Paving of western shoulder from Sydney Road to Cross Street. Supply of ready mixed concrete up to 850 tons, at 82s. per ton.	Dee Why Ready Mixed Concrete Pty. Ltd.	3,485 0 0
Marrickville M. ...	2018	Alterations to properties, Old Canterbury Road...	Stanmore Construction Co.	4,026 3 9
" ...	167	New Canterbury Road, Trafalgar Street and Crystal Street. Supply, delivery and laying of Hotmix bituminous material following removal of tram tracks.	Bituminous Pavements Pty. Ltd.	10,317 6 3
Port Stephens S. ...	167	Construction of six reinforced box culverts between Trunk Road No. 90 and Karuah.	H. Mueller and Co. ...	11,221 2 0
Shoalhaven S. ...	293	Reconstruction and widening, 1 m. 20 ft. to 2 m. 2,547 ft. from State Highway No. 1. Cement stabilisation of 6-in. gravel pavement and priming of 15,000 sq. yds.	Stabilizers Ltd. ...	5,375 0 0
Waradgery S. ...	14	Supply and delivery to stock-piles of 687 c. yds. aggregate	R. Stevenson ...	3,331 19 0
Weddin S. ...	6	Construction of bridge over Barbingal Creek ...	Central Construction Co.	18,496 0 0
Yallaroi S. ...	3079	Construction of bridge over Ottley's Creek, on Booraba-Blue Nobby Road at the boundary of Ashford Shire.	J. Jurd ...	4,046 13 0

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 } Specimen drawings, country road design.
- A 478A } Specimen drawing, flat country road design.
- A 478C } Specimen drawings, urban road design.
- A 478B } Stadia reduction diagram.
- A 1645 Design of two-lane rural highways. (Instruction.)
- 355 Design of urban roads. (Instruction.)
- 369 Design of intersections. (Instruction.) (1952.)
- 288 Design of acceleration and deceleration lanes. (Instruction.)
- 402 Design of kerb-lines and splays at corners. (Instruction.) (1952.)
- A 499 Widening at points of "A" sight distance.
- A 83 Earthwork quantity diagram.
- A 1640 Manual No. 2—Survey and design for main road works
- Mould for permanent mark block.
- 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 (1947) 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); 4 ft. (A 1014); 5 ft. (A 1015); 6 ft. (A 1016); 7 ft. (A 1017); 8 ft. (A 1018); 9 ft. (A 1019); 10 ft. (A 1020); 11 ft. (A 1020A); 12 ft. (A 1020B).
- A 1021-29 Two cell, reinforced concrete box culvert: 6 in. to 1 ft. 3 in. (A 1021); 1 ft. 4 in. to 3 ft. (A 1022); 4 ft. (A 1023); 5 ft. (A 1024); 6 ft. (A 1025); 7 ft. (A 1026); 8 ft. (A 1027); 9 ft. (A 1028); 10 ft. (A 1029);
- A 1031-36 Three cell, reinforced concrete box culvert: 6 in. to 1 ft. 3 in. (A 1031); 1 ft. 4 in. to 3 ft. (A 1032); 4 ft. (A 1033); 5 ft. (A 1034); 6 ft. (A 1035); 7 ft. (A 1036); 8 ft. (A 1038); 9 ft. (A 1040).
- 25 Pipe culverts and headwalls, and drawings: single rows of pipes: 15 in. to 21 in. dia. (A 143); 2 ft. to 3 ft. dia. (A 139); 3 ft. 6 in. dia. (A 172); 4 ft. dia. (A 173); 4 ft. 6 in. dia. (A 174); 5 ft. dia. (A 175); 6 ft. dia. (A 177); Double rows of pipes: 15 in. to 21 in. dia. (A 211); 2 ft. to 3 ft. dia. (A 203); 3 ft. 6 in. dia. (A 215); 4 ft. dia. (A 208); 4 ft. 6 in. dia. (A 207); 5 ft. dia. (A 206); 6 ft. dia. (A 213). Treble rows of pipes: 15 in. to 21 in. dia. (A 210); 2 ft. to 3 ft. dia. (A 216). Straight headwalls for pipe culverts: 15 in. to 24 in. dia. (A 1153).
- 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 Low level timber bridge, for 12 ft. and 20 ft. between kerb. (Instruction.) (1949.)
- A 3471 Running planks.
- A 1216 Reinforced concrete pile—25 tons. (1945.)
- A 1207 Reinforced concrete pile—35 tons. (1945.)
- A 1208 Reflector strip for bridges.
- A 1621 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 reseat. (Instruction and chart.)
- A 1635 Fluxing chart for bitumen road-mix reseat.
- 167 Resheeting with plant-mixed bituminous macadam by drag spreader. (1951.)

FENCING AND GRIDS.

- 141 Post and wire fencing (1947) and drawings: plain (A 491); 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 Tree guards, Types A, B, C, D, E, F, and G.
- A 1452-5 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 tyre caravan.
- A 2828 Multi-wheeled pneumatic tyre roller.
- A 2976 Fantail aggregate spreader.
- A 3530 Benders for steel reinforcement.
- A 3547 Steel bar cutter.

CONTRACTS.

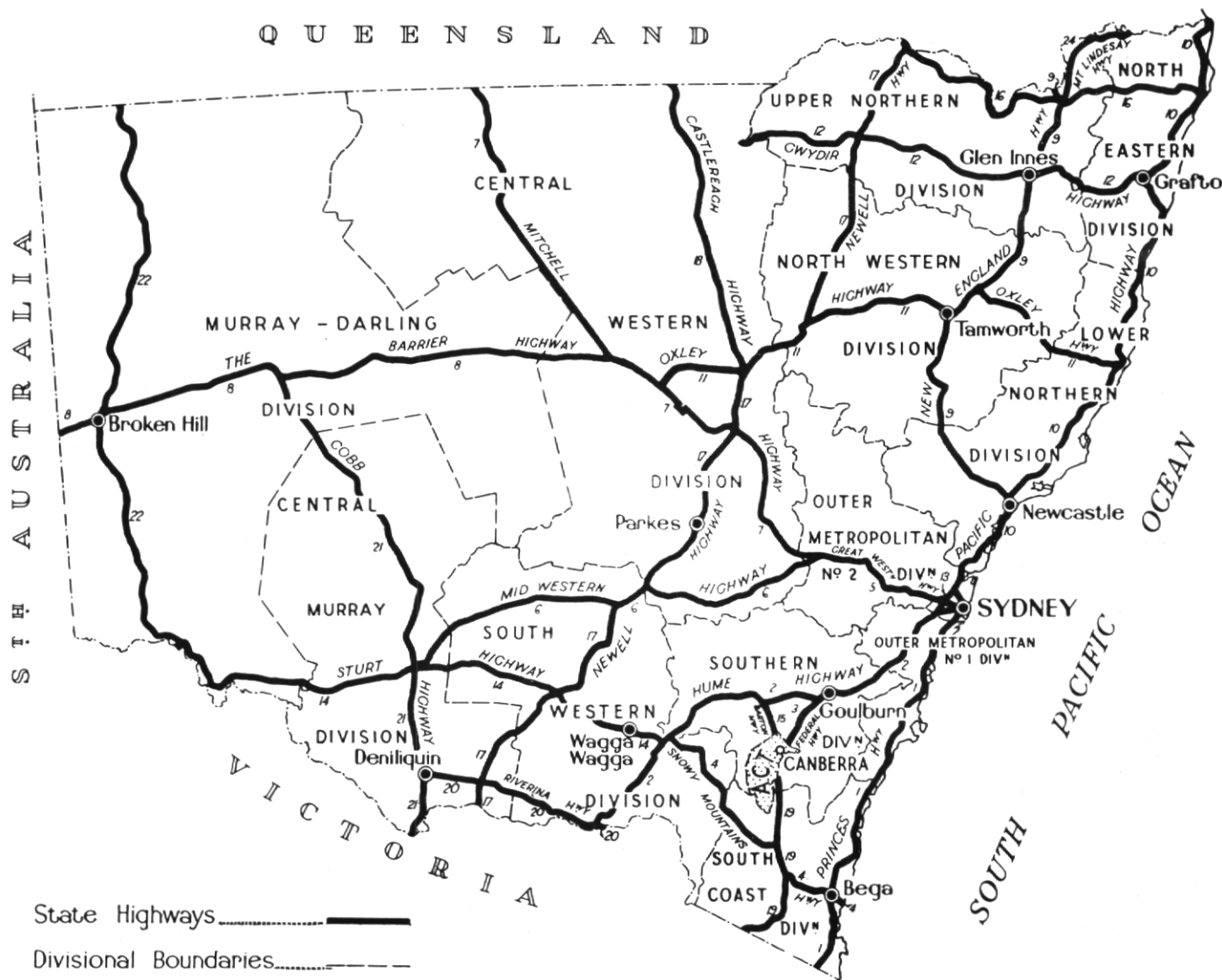
- 248 General conditions of contract, Council contract. (1956.)
- 342 Cover sheet for specifications, Council contract. (1950.)
- 64 Schedule of quantities form.
- 39 Bulk sum tender form, Council contract. (1946.)
- 38 Bulk sum contract form, Council contract.
- 193 Duties of superintending officer. (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 being free to Councils.

Sydney: A. H. Pettifer, Government Printer—1956.

State Highway System of the State of New South Wales

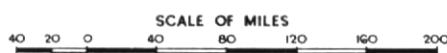
QUEENSLAND



State Highways.....

Divisional Boundaries.....

Divisional Offices.....



Area of New South Wales, 309,433 square miles.

Length of public roads within New South Wales, 125,879 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

TOTAL 28,424