MAIN ROADS

A month to month account of the activities of

THE MAIN ROADS BOARD OF NEW SOUTH WALES

Issued by and with the authority of the Board

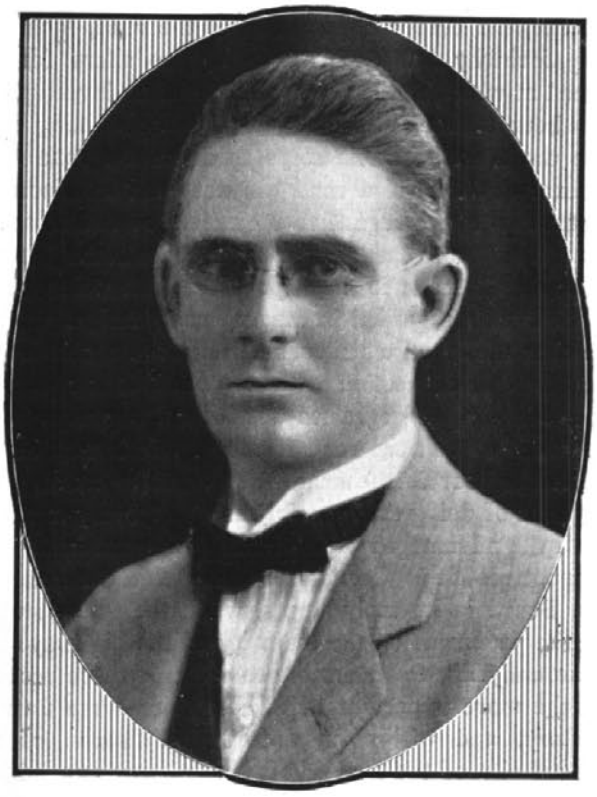
Vol. I, No. 5

February, 1930

Foreword.

By Councillor J. B. Macdonald, M.I.A.,

I HAVE read with great interest the issues of *Main Roads* already published, and I desire, as President of the Local Government Association, to extend my welcome to it. Ruskin has written, "All civilization begins with a road." To attempt to consider local government without concentrating upon roads would be much worse than trying to stage "Hamlet" and omitting any reference to the Prince of Denmark. The first test of the local government machine is whether it succeeds in giving the community good roads. The roads carry our traffic and provide houseroom for our public utilities such as water, light and sewers; and, incidentally, it is the road that absorbs most of our revenues. Since the passing of the Main Roads Act in 1924, the councils have taken into the business of road construction a most effective and powerful partner in the Main Roads Board. Before it commenced operations, the main roads of New South Wales were in a state that was a disgrace to any community that called itself civilised. Since the advent of the Board, wonderful progress has been made, and if it is maintained, New South Wales will not only be the "Good Roads State" of Australia, but will be able to show a network of roads equal to the famous roads of England and America. The publication of this magazine will give the councils information as to the progress that the Main Roads Board is making. In addition, by becoming familiar with the details of the Board's administration, the councils should be able to obtain lessons in roadmaking, and thus draw from the experience gained by the Board valuable information that will lead to efficiency and economy in roadmaking.



Councillor J. B. Macdonald,
President, Local Government Association of New South Wales.

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Improvement *v.* Deviation.

THE problem of improving any highway system is a continually progressive one. The first objective is to remove the ruts which destroy the smooth running qualities of the road, and to take such steps as are immediately practicable to provide an all-weather road. The first result of improving the road surface is to speed up traffic, and so unsafe conditions usually arise. Curves which could be safely negotiated at a slow speed now are too sharp at the higher speed, and immediate attention has to be paid to improving them. The degree to which this can be done depends entirely on the general location of the road. When the limit has been reached in this respect, it becomes necessary, if further action is needed for the protection of traffic, to consider whether something more substantial in the way of re-location is not required. Such a situation is fast developing on the Prince's Highway. By continual attention, particularly since the road has become a State highway, the surface has been very greatly improved. As a consequence, the curves on sections of the road, including the Cockwhy Hills, are becoming too sharp for the speed at which traffic now travels, and an investigation has been authorised with a view to ascertaining what are the most desirable steps to make the road safe. Sooner or later, if a road has not been satisfactorily located with due regard to the safety of traffic, action must be taken to ensure this. Elsewhere in the journal, reference is made to the importance with which alignment is now regarded in modern road design. It will be clear then that, when considering what action should be taken in connection with any road, it is necessary to determine the degree to which local improvement is practicable to fit the road for the traffic it may be expected to bear in the near future, and to contrast the expense of doing this, possibly as a temporary measure, with the advantages of re-locating the road in its permanent position. Considerations of this character led the Board in its early stages, when the salvage value of the pavement on the majority of the highways was practically nil, to determine to relocate those sections of the more important highways which were unsatisfactory, and within an ordinary day's run of the capital city of the State, before any large expenditure had been undertaken in improving the pavements thereon. In this way, works such as the Lidsdale and Cox's River deviations on the Lithgow-Mudgee and Great Western roads near Wallerawang; the Sydney-Newcastle road and the Warland's Range deviation on the Great Northern road; the Razorback deviation and the Breadalbane-Cullerin-Gunning deviation on the Hume Highway, and the work between Bulli and Kiama on the Prince's Highway were undertaken. All of these are now complete, except in the case of the Sydney-Newcastle road, where some portions of the pavement will not be finished until 1931. Such works, however, are costly, and it is only practicable to undertake a limited number of them at any one time.

A rational programme of highway improvement must include:

(a) Progressive improvement of the road system by intensive maintenance, including the reconditioning of the road surface, the enlarging of bends and the super-elevation of curves.

(b) Progressive re-location of those sections of road which have reached, or will shortly reach, the limits of their suitability with the increasing speed and volume of traffic.

In accordance with this policy and as a result of extensive works, the greater part of the Prince's Highway from the city boundary to Kiama, a length of 72 miles, may now be considered to be in a location suited to modern traffic conditions, except possibly the Bulli Pass section, for which the cost of deviation cannot at present be considered. Similar remarks apply to the Hume Highway as far south as Marulan, a distance from Sydney of 109 miles, to the Northern Highway as far north as Scone, a distance from Sydney of 196 miles, and to the Great Western Highway out to Bathurst, a distance of 128 miles—with the possible exception of the descent towards the west from Mount Victoria, which would be very costly to alter substantially. In addition, numerous other sections of these highways have been re-located.

Simultaneously with these construction works, a progressive policy of maintenance of the remaining lengths has been pursued, with the widening and super-elevation of curves.

An interesting comment on the results which have been gained is indicated by a 2¼ days tour recently completed. Leaving Sydney on the evening of 27th December, a member of the Board proceeded to Nowra, the route taken involving a travelling distance of 105

miles. A start having been made from Nowra at 5.40 a.m. next day, the Prince's Highway was followed to Bega, thence the Monaro Highway to Tathra, back to Bega and over the Brown Mountain, through Nimmitabel and Cooma to Adaminaby, which was reached at 8 p.m., the travelling distance being 308 miles. The next day, after leaving at 5.45 a.m., the Monaro Highway was again followed through Kiandra, Talbingo, and Tumut to its junction with the Hume Highway, along which the return to Sydney was effected by 8 p.m., the day's travelling being 386 miles. Altogether 799 miles were traversed in a total travelling time of twenty-seven hours, an average speed of almost 30 miles per hour.

Corresponding to the improvement of the road alignment and surface is the replacement of fords or ferries by bridges, to secure through communication under all conditions of weather. In this respect, very substantial improvement has been made on the roads, particularly since the commencement of the operation of the Federal Aid Roads Agreement. Since 1st January, 1925, no less than seventy-five bridges on the State Highways alone have been completed or are now in progress, aggregating a length of 5,476 feet. Numbers of ferries previously worked by hand have had power installed in them, while others of small capacity have been replaced by new or transferred ferries of larger capacity.

News of the Month.

METROPOLITAN DIVISION.

On 21st December last, the remaining sections of Pittwater road between Dee Why and Collaroy were opened to traffic. The new concrete pavement, which is of a general width of 21 feet, extends for a distance of 2⅛ miles, and links up with ¾ mile of concrete from Brookvale to Dee Why, which was completed in May, 1929.

The reconstruction in cement concrete of Rocky Point road, Sans Souci, between Ramsgate-road and Taren Point, on the Rockdale side of the road, has been completed and is opened to traffic.

The surfacing in bituminous penetration macadam of the deviation between Emu Plains and the foot of Lapstone Hill has been completed and is open to traffic.

It is anticipated that the widening of Duck River bridge on Parramatta-road, in the municipalities of Auburn and Granville, which was mentioned in the January issue of this journal, will be finished about the second week in February. During January, the pier frames and deck slabs were completed.

A tender has been accepted by the Nepean Shire Council for the construction in waterbound macadam of three-quarters of a mile of the Cabramatta-Mulgoa road (Developmental Road No. 1,087), from Cowpasture-road towards Mulgoa. The successful tenderer is Mr. W. J. Donovan. Owing to the difficulty of constructing a waterbound road directly on a subgrade of red clay such as exists in this district, a subbase of 4 inches of gravel has been provided for in the contract. This length of road will link up at Cowpasture-road with the 4¼ miles recently constructed between that point and Cabramatta.

During the past three years, the road from Richmond to Penrith (No. 155) has been brought by stages into good condition. Some 3 miles were resheeted by the Board in 1927 and in 1928-29, the Penrith and Castlereagh Councils tar-surfaced several miles. During the latter part of 1929, the Board treated the 4 miles leading into Richmond at the northern end. The road now offers a good tarred surface at either end, where traffic to the railway and commercial centres of Penrith and Richmond is heaviest, the middle portion, which carries practically only through traffic, being retained in gravel.

The State Monier Pipe and Reinforced Concrete Works, which has the contract for the construction of the docks for the ferries which will link up the Great Northern Highway across the Hawkesbury River, between Kangaroo Point and Mooney Point, are actively engaged on the work, and are making good progress with the pile-driving at Mooney Point. The work is due for completion early in May, 1930.

OUTER METROPOLITAN DIVISION.

The contractor for the erection of the seven-span concrete bridge over Wallarah Creek, on the Great Northern Highway, 9 miles north of Wyong, in the Shire of Erina, has completed all the piers, and the deck over three spans.

The gravelling of the Catherine Hill Bay deviation, between Wyong and Swansea, on the Great Northern Highway, in the Shires of Erina and Lake Macquarie, has been completed over a distance of 5 miles. The reconstruction of the highway between the northern end of the deviation and Swansea has been commenced.

On the Wiseman's Ferry-Spencer road (No. 225), the earthworks and base course are practically complete for a distance of 16 miles. The timber truss bridge over Mill Creek, 4 miles east of Wiseman's Ferry, is complete, and is in use by traffic. At Gunderman Creek, 9 miles from the Ferry, pile driving has been commenced in connection with the construction of a three-span timber beam bridge. Work it at present in progress between Spencer and Greengrove.

A section of reconstruction in premixed bituminous macadam, extending over 2 miles 3,055 feet, has been commenced between Macquarie Rivulet and Oak Flats, via Telegraph-road, on the Prince's Highway.

The contractor for the reconstruction in cement concrete of the Great Western Highway between Old Bowenfels and Marangaroo Creek has completed and opened to traffic a length of 2¼ miles between Old Bowenfels and Bowenfels railway station, and a length of ¾ mile ending at Marangaroo Creek. Further sections will be opened to traffic as completed.

On the Hume Highway, in Wingecarribee Shire, the Council is constructing a premixed bituminous pavement on the deviation between Berwick Orchard and Paddy's River. The base course is practically complete, and the surface course will shortly be commenced. During the work, traffic must follow the old road, which has been put into order for this purpose.

UPPER NORTHERN DIVISION.

The construction of embanked formation is in hand from 20 miles 16 chains to 21 miles 41 chains, from 22 miles 50 chains to 24 miles 12 chains, and a length of 12 chains near the 31-mile post, on the Garah-Boonangar road (No. 232), in the Shire of Boomi.

The construction of three timber beam bridges at Gibson's, Buchanan's, and Jeffrey's, on the Wongavale to Cawongla road (Developmental Road No. 1,085), in Terania Shire, has been completed, and these works are now opened to traffic.

The reconstruction in penetration macadam of 71 chains of the North Coast Highway, within Ballina Municipality, is now in hand. This work is a continuation of the mile of bitumen penetration which was completed last year.

The construction of 40 chains of waterbound macadam has been completed on the Lismore-Woodburn road (No. 147), in the Shire of Gundurimba. This section of the road had not previously been constructed, and was impassable in wet weather. Further lengths still require construction and will be undertaken as funds are available.

The first section of Korora Deviation, on the North Coast Highway, in Dorrigo Shire, comprising 5,650 lineal feet of waterbound macadam, timber culverts and a timber beam bridge has been completed by Contractors McGrath and Range. The deviation will not be open to traffic until the second section, which is now in hand, is completed.

Several contracts for gravel construction on the Gwydir Highway between Warialda and Inverell, in the Shire of Bannockburn, have been completed, and this section of road is now in good order.

The construction of 2 miles 826 feet of gravel pavement on the Delungra-Graman road (Developmental Road No. 1,082), in the Bannockburn Shire, has been completed by Contractors McGregor and Addison.

The contractors, Messrs. Model Homes Ltd., have completed 1 mile 1,110 feet of penetration macadam on the Great Northern Highway in Glen Innes Municipality, and the road has been opened to traffic.

LOWER NORTHERN DIVISION.

The surfacing with road oil and bitumen of 1¾ miles of newly-constructed waterbound macadam road on the North Coast Highway, in the Municipality of Port Macquarie, and a 2-mile section of newly-constructed gravel road on the Oxley Highway, between its junction with the North Coast Highway and Wauchope, has been commenced. The work is being carried out by the Board by day labour.

The Tamworth Municipal Council has recently completed 104 chains of bitumen surfacing on the Tamworth-Barraba road (Trunk Road No. 63) by day labour. The council is continuously extending the length of such work on its streets, as well as on the main roads, and has obtained very satisfactory maintenance results, besides improving the appearance of the streets and eliminating the dust nuisance.

Tenders have been called for the construction of two low-level bridges over the north arm of the Bellinger River on the Thora to Brinerville road (Developmental Road No. 1,134), in the Shire of Bellingen. An alternative proposal to make a deviation to eliminate the two river crossings has been considered and rejected, as it was estimated that the two bridges will cost less than the deviation and at the same time afford improved service.

Tenders have been invited for a further length of 150 chains of construction on the Firefly Creek and Brown's Creek road (Developmental Road No. 1,044), in the Shire of Gloucester. There is no road at present, so that this construction will open up new country. On the continuation of the same road, in Manning Shire, tenders have been received for the construction of a four-span timber beam bridge over Brown's Creek. This will provide settlers with all-weather access to the local butter factory.

In Macleay Shire, work has recently been completed on several sections, totalling approximately 3 miles, on the Nulla Nulla Creek and Five Day Creek road (Developmental Road No. 1,048). The new work provides improved grades and alignment, and will assist in opening largely untouched country. On the Nulla Nulla Creek section, tenders have been invited for the construction of two low-level timber bridges over the creek at the first and second crossings, which are at present impassable during freshes in the creek.

CENTRAL WESTERN DIVISION.

The construction of 5 miles 339 feet of gravel pavement, with pipe and reinforced concrete box culverts, between 8 miles and 19½ miles, on the Cowra-Burrowa road (Trunk Road No. 56), in the Shire of Waugoola, is well in hand. Messrs. Sellen and Sellen are the contractors.

The construction of the six-span reinforced concrete bridge over Mandagery Creek at Manildra, on the Manildra-Orange road (No. 224), in the Shire of Boree, is well advanced. All the piers and abutments are complete, and the girders and deck slab of the two western spans have been cast. Considerable progress has also been made with the approaches to the bridge.

A new macadam pavement with gravel blinding has just been completed between 2 miles and 4 miles 28½ chains on the Arthurville-Geurie road (Developmental Road No. 1,007), in the Shire of Macquarie.

A gravel pavement over a length of 1 mile 3,400 feet (including causeways) has been completed on the Nubingerie Siding to Wollombi Soldiers' Settlement road (Developmental Road No. 1,135), in Talbragar Shire.

The access road to Wyangala Dam, between Woodstock and Mount McDonald, which is being constructed by the Board on behalf of the Water Conservation and Irrigation Commission, is nearing completion. The road, which is 14 miles in length, has been constructed in gravel, with about ½ a mile of bitumen surfacing at the Woodstock end. A timber beam bridge is also being constructed over Waugoola Creek.

Extensive maintenance work on the main roads within its areas has been carried out by the Goobang Shire Council in recent months. Approximately 9 miles of reshaping and resheeting with gravel have been completed, together with standard concrete pipe culverts and general repair work.

SOUTHERN DIVISION.

Messrs. Australian Roads, Ltd., the contractors for the reconstruction in penetration macadam of a section of the Hume Highway between Yass and Bowning, are opening the new road to traffic as completed, thus considerably reducing the length of sidetracks.

The contractors, Messrs. W. Sims and Son, have commenced the repairs to the old steel bridge over Bowning Creek, on the Hume Highway at Yass. A new concrete deck, 20 feet wide between kerbs, will be constructed.

The construction of ¾ mile of penetration macadam in Crawford-street, Queanbeyan (Trunk Road No. 51), has been completed by the Queanbeyan Municipal Council, and opened to traffic. The new pavement replaces a gravel surface which required constant attention.

Under the supervision of the Bibbenluke Shire Council, gravel surfacing has been completed for a distance of 9 miles on the Bombala-Bondi-Cann River road (No. 288). Upon the completion of contracts for further sections now in progress, a good gravel surface will be available to the Victorian border.

Cullerin deviation, Hume Highway, Shire of Gunning. Gravel road through abandoned railway cutting.

The bitumen surfacing of 7 miles of reconditioned road on the Hume Highway between Cullerin and Gunning has been commenced by the contractors, Messrs. John Fowler & Co. (Aust.) Ltd.

RIVERINA DIVISION.

Notable improvement has been made on the Young-Boorowa section of the Temora-Gunning road (Main Road No. 241), in Burrangong Shire, by means of progressive maintenance, and widening and super-elevating curves.

Gravel road maintenance in Holbrook Shire.

Contracts are being let for the reconditioning and resheeting of 8 miles of main roads in Wakool Shire, those chiefly concerned being the Swan Hill-Balranald road (No. 221), and the Moulamein-Balranald road

(No. 296). It is anticipated that these roads will be greatly improved with the completion of the proposed works.

The construction of 4,100 lineal feet of bituminous macadam in the main street of Murrumburrah has completed a continuous length of bitumen surfaced roadway on the Harden-Cootamundra road (No. 243) through the Municipality.

Recent heavy rains in Jindalee Shire, which, in the vicinity of Cootamundra, amounted to the record fall of 5.10 inches in about four hours, caused serious damage to the main roads in the district. The emergency was met with expedition by the Shire Council, and all main roads are again in good trafficable order.

The Griffith-Hillston road (No. 254) and the Goolgowi-Hillston road (No. 257) are now cleared throughout, and these roads are in good order, some of the worst lengths having been formed and the balance graded to make good motor tracks.

Good progress is being made by the Chas. Hardy Contracting Coy. Ltd. with the construction of a further 2 miles of gravel pavement and culverts on the Wagga-Lockhart road (Trunk Road No. 59), crossing Bullenbong Plain, in the Shire of Mitchell. Messrs. Harrington, Son and Bourke have the construction of a similar length on the Lockhart-Urana section of the same road, on Brookong Plain, in the Shire of Lockhart, well in hand.

Expenditure from 1st July to 31st December, 1929.

	Expenditure to 30th November, 1929.	Expenditure for Month of December.	Total Expenditure to 31st December, 1929.
County of Cumberland Main Roads Fund—	£ s. d.	£ s. d.	£ s. d.
Construction of Roads and Bridges	225,064 7 1	41,348 7 3	266,412 14 4
Cost of Land Resumptions	88,647 2 5	9,166 10 5	97,813 12 10
Maintenance of Roads and Bridges	121,790 8 6	30,721 17 5	152,512 5 11
Repayment of Loans	90,360 14 2	51,811 6 9	142,172 0 11
Survey, Design, Supervision and Administration	46,636 7 1	8,824 19 9	55,461 6 10
Purchase of Stock and Assets	11,477 0 4	1,044 15 2	12,521 15 6
Miscellaneous	6,069 11 10	1,863 9 11	7,933 1 9
Totals £	590,045 11 5	144,781 6 8	734,826 18 1
Country Main Roads Fund—			
Construction of Roads and Bridges, including Resumptions	411,328 8 4	66,076 2 9	477,404 11 1
Maintenance of Roads and Bridges	468,661 1 8	119,212 5 10	587,873 7 6
Repayment of Loans	13,902 10 11	4,118 2 2	18,020 13 1
Survey, Design, Supervision and Administration	37,074 13 8	8,018 19 5	45,093 13 1
Purchase of Stock and Assets	2,062 16 2	*15,676 17 7	*13,614 1 5
Miscellaneous	18,557 6 6	1,698 10 3	20,255 16 9
Totals	951,586 17 3	183,447 2 10	1,135,034 0 1
Federal Aid Roads Fund—			
Construction of Roads and Bridges, including Resumptions	393,033 7 7	127,574 14 9	520,608 2 4
Purchase of Stock and Assets	11,700 1 5	443 17 2	12,143 18 7
Miscellaneous	6,219 5 11	*152 17 11	6,066 8 0
Totals £	410,952 14 11	127,865 14 0	538,818 8 11
Developmental Roads Fund—			
Construction of Roads and Bridges	127,907 7 1	24,988 9 10	152,895 16 11
Survey, Design and Supervision	78 10 0	139 17 4	218 7 4
Miscellaneous	6,234 15 5	*131 2 4	6,103 13 1
Totals £	134,220 12 6	24,997 4 10	159,217 17 4
Summary—All Funds—			
Construction of Roads and Bridges, including Resumptions	1,245,980 12 6	269,154 5 0	1,515,134 17 6
Maintenance of Roads and Bridges	590,451 10 2	149,934 3 3	740,385 13 5
Repayment of Loans	104,263 5 1	55,929 8 11	160,192 14 0
Survey, Design, Supervision and Administration	83,789 10 9	16,983 16 6	100,773 7 3
Purchase of Stock and Assets	25,239 17 11	*14,188 5 3	11,051 12 8
Miscellaneous	37,080 19 8	3,277 19 11	40,358 19 7
Grand Totals £	**2,086,805 16 1**	**481,091 8 4**	**2,567,897 4 5**

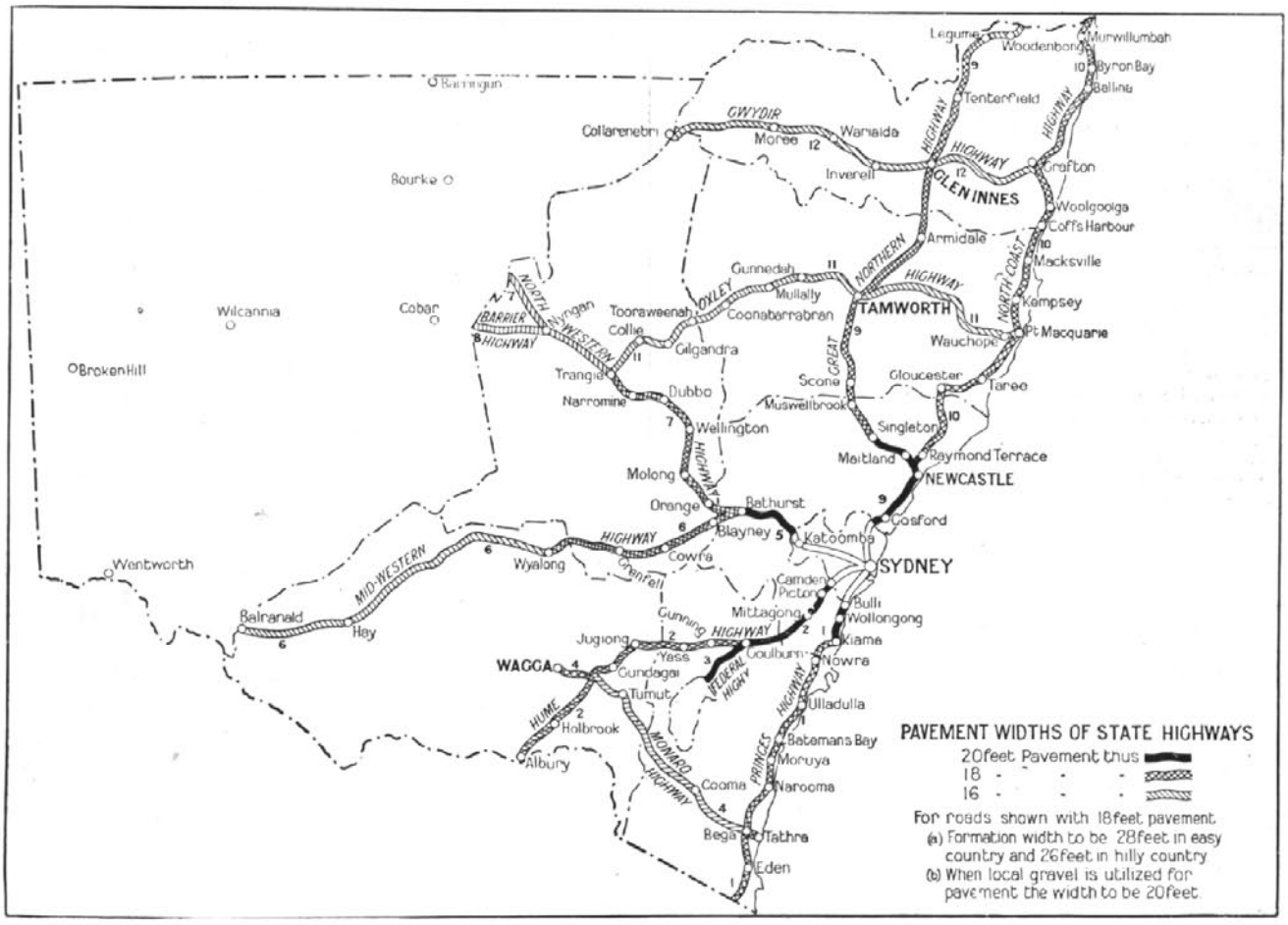
* Credits.

Formation and Pavement Widths on Country State Highways.

By D. Craig, M.Inst.C.E., M.I.E. (Aust.),
Chief Engineer.

SINCE the reclassification of the country main roads into three groups, which took effect on 1st July, 1928, an investigation has been carried out by the Board into the desirable widths of pavement and formation for use in connection with future works on these roads. Detailed reports have been obtained from the six Divisional Engineers, which have been reviewed and co-ordinated into the scheme shown on the accompanying map. In this, an endeavour has been made to take account not only of present traffic, but of the growth in the traffic which is constantly taking place on account of the improvement of the roads, and also of the connections with the Trunk Roads, which form the second most important group of main roads, and act as a system of interconnection with the State Highways.

From the map it will be seen that on the most heavily trafficked parts of the Highways—chiefly those in approach to the City of Sydney—pavement and formation widths of 20 and 28 feet respectively have been adopted. This also applies to any Highways within the business parts of municipalities generally, although not shown on the map owing to the small scale. The remainder of the Prince's, Hume, Great Northern, and North Coast Highways, and the North-western and Mid-western



Highways as far west as Trangie and Wyalong respectively, will have a pavement width of 18 feet, except where local gravel is used, when this will be increased to 20 feet. As, however, it is preferable, so far as it is practicable and not unduly expensive, to have any excavation and filling that may be done adapted to the formation width that will ultimately be desirable, any formation on these lengths will be 28 feet wide in easy country and 26 feet wide in hilly country. On the Great Northern Highway, a length of about 12 miles at the Devil's Pinch, south of the Guyra Shire boundary, will be formed to 24 feet. For the remainder of the State Highways, the pavement width will be 16 feet. On curves, the widths mentioned will be increased and superelevated in accordance with the standards that are described elsewhere in this journal.

When the Board came into existence, the general standard of width of metalling throughout the State was 15 feet, with 4 feet shoulders. Other standards were in use in other States, and with a view to the adoption, as far as practicable, of common principles and standards on main road works throughout the Commonwealth, the Commonwealth Government called, in February, 1926, a conference in Melbourne between the Main Roads Boards and authorities of various States.

At this conference, the following resolutions in regard to the widths of roads and pavements were adopted:—

(1) The width of metalling or gravelling on single track roads shall be not less than 12 feet.

(2) The width of metalling or gravelling on ordinary main roads shall be 16 feet.

(3) In special cases, and on selected roads, the width of metal or gravel construction may be increased to 18 feet.

(4) The width of metalling or gravelling on the great trunk highways shall be 20 feet.

(5) The width of shoulders outside the metalling or gravelling shall be 4 feet on each side, so that the formation widths will be as set out hereunder:—

For single track road	..	20 feet.
For 16-feet pavements	..	24 ,,
For 18-feet pavements	..	26 ,,
For 20-feet pavements	..	28 ,,

(6) The minimum width of the carriage-way of bridges in agricultural areas shall be 18 feet in the clear between kerbs; in other cases, the clear width of the roadway on a bridge shall be not less than the width of the metal or gravel construction on the road on which the structure is located.

Nos. 4 and 5 have special reference to the State Highways.

The whole of the earlier construction work carried out or authorised by the Board has been in accordance with these standards. It has been found by the various States to be impracticable to adhere entirely to the standards of width adopted by the conference, and the Board's action in reviewing these, so far as it affects the State of New South Wales, is in conformity with the actions of its neighbours.

A similar review is now being undertaken in connection with the Trunk Roads.

New Main Roads.

The following new Main Roads have been proclaimed:—

Main Road No. 127.—The existing main road from Walgett, via Pilliga, Wee Waa, and the Three Mile Bridge over the Namoi River, to Narrabri, has been extended to West Narrabri Railway Station.

The alteration of the main road system in the Murrumbidgee Irrigation Area, described fully on pages 79-80 of the January issue of "Main Roads," has been effected. The descriptions of Main Roads Nos. 58, 254, and 321, gazetted on 13th December, 1929, are as follow:—

Main Road No. 58.—From the Mid-Western Highway (Main Road No. 6) at Hay, via Waddi, Gillenbah and Mundowey, to the Monaro Highway (Main Road No. 4) at Wagga.

Main Road No. 254.—From Hillston, via Griffith, Yenda, a point 1 mile north of Whitton, Leeton, Yanko, and Narrandera to Main Road No. 58 at Gillenbah.

Main Road No. 321.—From Main Road No. 254 at Griffith, via Willbriggie and Darlington Point to the Hay-Narrandera Road (Main Road No. 58) at Waddi.

Road Progress in U.S.A.

Through the courtesy of Mr. Chas. F. Baldwin, U.S.A. Trade Commissioner, Sydney, the following information concerning the progress of road construction in the United States of America has been made available for publication.

Reports obtained by the Bureau of Public Roads, U.S. Department of Agriculture, from authorities of selected counties indicate a tendency towards a higher type of local and county road construction in the United States. With each succeeding year, the percentage of graded and drained earth roads decreases and the percentage of surfaced roads increases, says the bureau, on the basis of the reports.

The reports indicate that there was improved in 1928 in the entire United States, exclusive of State roads, a total of 45,531 miles of local and county roads, of which 29,888, or 66 per cent., were surfaced, and 15,643, or 34 per cent., were graded and drained earth roads. In 1927, the estimated mileage improved was 59,732 miles, of which 33,852, or 57 per cent., were surfaced, and 25,880 miles, or 43 per cent., were graded and drained. In 1926, the total mileage improved was 89,026, of which 36,027 miles, or 41 per cent., were surfaced, and 52,999 miles, or 59 per cent., were graded and drained.

(*Concluded on page 115.*)

The Northern Roads Leading to the Sydney Harbour Bridge.

By G. B. H. Sutherland, B.E., Assoc.M.Inst.C.E., A.M.I.E. (Aust.),

Metropolitan Designing Engineer.

THE need for connecting the northern and southern sides of Sydney Harbour, for which purpose the great arch is now under construction, has long been recognised, the first suggestion to this effect having been made as early as 1815, by Mr. F. H. Greenway, the architect of the then young colony and the designer of some of its most historic buildings, including the Sydney Supreme Court and St. James' Church. The form and location of the crossing were matters of prolonged discussion, while the high cost of either a bridge or a tunnel—the two practicable alternatives—led to a continual postponement of any decision as to what should be done As a result, the City on the one side of the Harbour, and the North Shore suburbs on the other, grew up without proper provision being made for the road connections which would be required to give access to the bridge. To secure this, it is now necessary to widen existing streets or to cut new roads across lands already built upon—both costly and difficult processes. On the southern side of the Harbour, the financial responsibility for this work, apart from the limits defined by the Sydney Harbour Bridge Act, 1922, and any local improvements not of general interest to through traffic, is that of the Sydney City Council within the City of Sydney and of the Main Roads Board outside the City boundaries, while on the northern side of the Harbour, beyond a point immediately south of the Methodist Church at the angle of Junction-street and Blue-street, the responsibility is again that of the Board. It is the purpose of this article to describe the situation on the northern shore, and what is being attempted in regard thereto.

On this side, two principal traffic arteries lead away from the bridge approaches, viz., Lane Cove road (State Highway No. 9) and Miller-street (Main Road No. 164), forming the first lengths of the Great Northern Highway, and of the road to Pittwater, respectively. The Great Northern Highway follows the Lane Cove road to Hornsby, then leads to the Hawkesbury River at Peat's Ferry, and passes through Gosford, Newcastle, Tamworth, Armidale, Glen Innes, and Tenterfield, to the Queensland border and Brisbane. The road to Pittwater branches from the Great Northern Highway at Miller-street, and follows, in turn, Miller-street, Falcon-street, Military-road, and Spit-road to The Spit; thence it continues via Condamine-street and Pittwater-road, through Brookvale, Narrabeen, Newport, and Palm Beach, to Barrenjoey and Pittwater, and so serves as the main connecting link between the Municipalities of North Sydney, Mosman, Manly, and the Shire of Warringah.

Prior to the start of the bridge works, the Highway commenced at the vehicular ferry docks at the foot of Alfred-street, and followed that street, Junction, Walker, and Mount streets to the intersection of Miller-street and Lane Cove road, where bifurcation takes place. With the commencement of the construction of the northern bridge pylon on the site of the old Milson's Point railway station, the ferry docks were moved from Alfred-street to the foot of Jeffrey-street to make room for the bridge, and the first section of the Highway now follows Fitzroy-street to Alfred-street.

The bridge approaches proper, under construction by the Public Works Department, extend to the intersection of Junction-street and Blue-street, and on the opening of the bridge, the main road system will commence at this terminal. On the bridge and its approaches, to the southern end of Junction-street, there will be provided a carriageway 57 feet wide, i.e., sufficient to carry six streams of traffic, while pedestrian traffic will be catered for by two 10-feet footways. Beyond this point to the Methodist Church, at the intersection just mentioned, the road will be 100 feet wide, providing a carriage-way of 76 feet width (i.e., sufficient for six streams of moving traffic and two lines of standing vehicles) and two 12-feet footways. A glance at the map will show that this traffic would debouch into the local road system and would have to divide, portions following Junction, Walker, and Mount streets, and Blue and Miller streets, respectively, to the intersection of Miller-street and Lane Cove road. At the latter junction it would then divide permanently, and follow the two arterial routes, of which Lane Cove road is being widened by the Board to 84 feet, Miller-street being at present 66 feet wide.

Between the terminus of the bridge approaches and the crossing of Lane Cove road and Miller-street, the routes at present available are, however, unsuited to heavy traffic. Blue-street and Mount-street are on grades of 1 in 13, while the number of right angle bends, and the presence of tram tracks in Walker and Mount streets, together with congestion from local business traffic, combine to hamper through traffic. Further, the grade at the corner of Walker-street and Mount-street, combined

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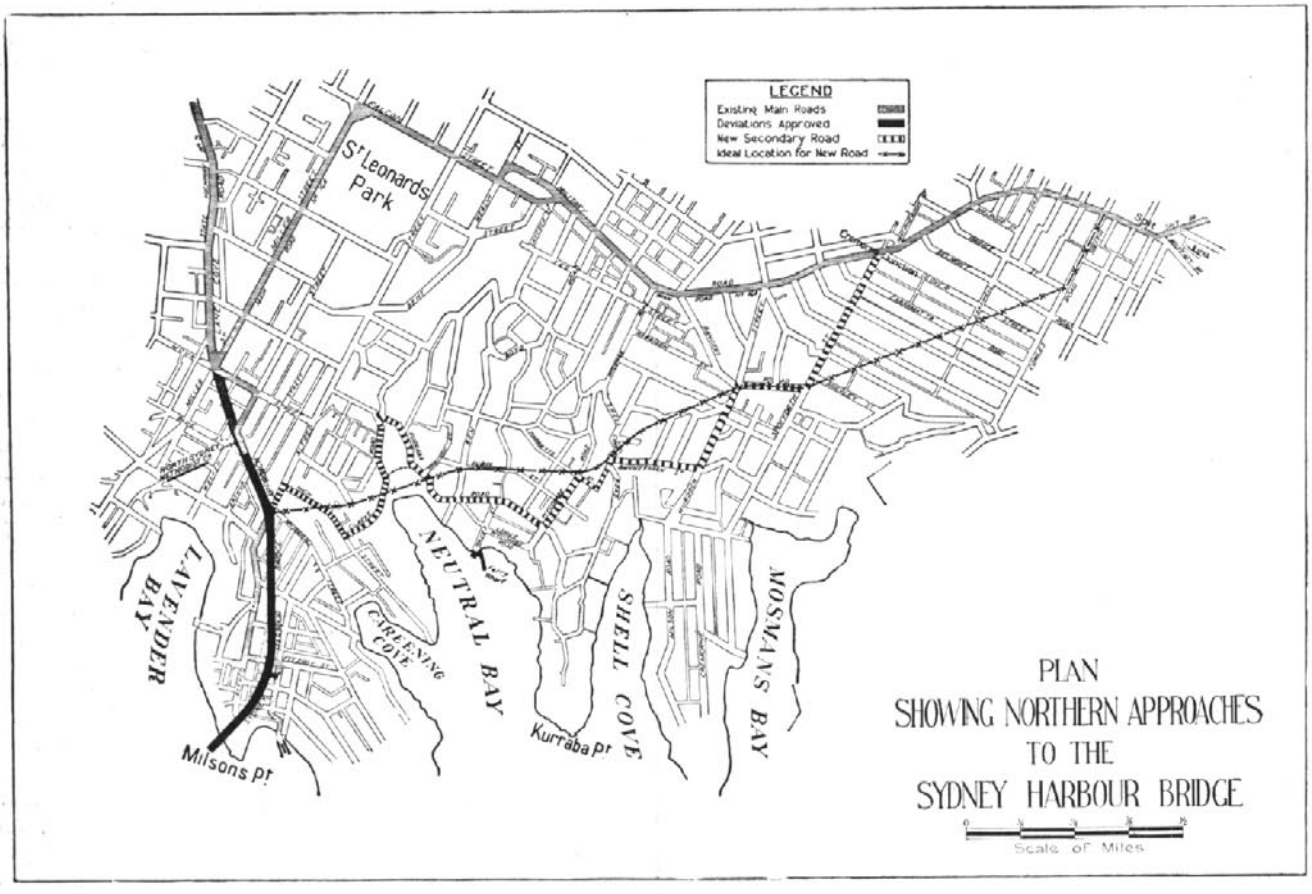
with the sharp turn, constitutes a danger point. It will therefore readily be appreciated that the increased volume of traffic which the completion of the Harbour Bridge will create called for the provision of an improved connection between the bridge terminal and the junction of Lane Cove road and Miller-street. Several alternatives were investigated for this purpose, as a result of which it was found that the only solution capable of effective service was the cutting of a new road 100 feet wide diagonally across the block bounded by Walker-street, Mount-street, Miller-street, and Blue-street. This will provide the same width of carriage-way and footpaths as on the adjacent section of the new road being available for traffic when the Harbour Bridge is opened. Action is therefore being directed to this end. The required lands have been resumed, and, up to date, an amount of £15,544 has been paid in compensation. The road pavement will consist of a portland cement concrete base course surfaced with a carpet of asphaltic concrete.

Traffic to the east is served at present principally by two roads:

(i) Main Road No. 164, following, as already mentioned, Miller-street, Falcon-street, and Military-road, with a one-way traffic loop between Merlin and Laycock streets.



bridge approach. It will also give ideal alignment and will result in a considerable improvement of grades (1 in 17 as compared with 1 in 13 on the existing route). The estimated cost of the works involved, including resumptions, is £125,000. The expenditure of this large sum on a comparatively short length of road—the length of the new cut being 990 feet—would be a serious drain on the Board's resources, and if given effect to, would seriously reduce the amount of the Board's funds available for other road improvements on the northern side of the Harbour for several years to come. Nevertheless, it appeared to the Board imperative that it should be undertaken, with a view to the

(ii) A somewhat shorter, but tortuous route (shown by dotted line on the map), containing rapid alternations of rise and fall and occasional steep pinches, via Alfred-street, High-street, Clarke-road, Kurraba-road, Wycombe-road, Harriette-street, Bannerman-street, Murdoch-street, Ranger's-road, and Spofforth-street, rejoining Main Road No. 164 at Cremorne Junction.

The former follows the principal ridge of the area, and offers the best obtainable gradients and alignment. The latter cuts across a series of lateral, steep-sided spurs, which connect with the ridge previously mentioned; this accounts for its grades and

tortuous alignment. The whole of the district to the north and east of Milson's Point between the main road and the water's edge is very broken, as is reflected in the general lay-out of the streets, and consequently any through route, other than the main road, can be established to conform to the usual standards of alignment and grade only at heavy expense.

The main road is the natural route. Owing, however, to its width (66 feet generally) and the presence of a double line of tram tracks throughout its length, its traffic is at times congested, and lighter touring vehicles often prefer alternative (ii) in spite of the disadvantages which have been mentioned. The whole of the traffic from Mosman and Manly, as well as a large part of that from North Sydney, wishing to enter the City via the present Milson's Point ferry now uses one or other of these routes. The problem then as regards providing suitable eastern access to the bridge is determined by the answers to the following questions:—

(a) Are the present eastern routes adequate and satisfactory?

(b) If not, can they be improved?

(c) What other routes are available?

(d) How can the costs of improving the present or other routes and of constructing any new ones be met?

As regards the first question, the two routes now in use are barely adequate for existing traffic during the rush periods of the day, and therefore will not be sufficient for the increased traffic which will follow the opening of the bridge. As regards the last question, the great cost of establishing the new connection from the bridge terminal to the junction of Lane Cove road and Miller-street prevents, as has already been stated, any ambitious scheme being undertaken which will involve any other large immediate expenditure from the Board's funds. Whatever is determined upon must be such that it can be achieved by yearly instalments, progressively directed to the end of the ultimate scheme. This feature has therefore dominated the Board's decision, and cannot be avoided.

The great advantages of Main Road No. 164 over any other possible route indicate that it is destined to remain the chief connection to the east. Widening is therefore clearly called for, except between Merlin-street and Laycock-street, where a one-way traffic loop has been adopted. From the intersection of Miller-street and Lane Cove road to the intersection of Merlin-street and Falcon-street, and from Laycock-street to Cremorne Junction, the road will be widened to 84 feet by the realignment method. This will provide for two streams of traffic between the tram tracks and the kerbs, and prevent the blocking of traffic due to vehicles standing alongside the kerbs. At the crossing of Falcon and Miller streets, a difficult traffic problem exists owing to the routing of the tram tracks. This creates uncertainty in the minds of road travellers unfamiliar with the situation as to what path should be followed in negotiating the crossing. An endeavour will therefore be made in connection with the general widening of the main road to reorganise the crossing by the installation of a rotary system of traffic movement, including trams. With the foregoing improvements, coupled with the opening of the new road between the bridge terminal and the junction of Lane Cove road and Miller-street, traffic conditions on Main Road No 164 will be immeasurably improved, and much of the traffic that now seeks alternative routes from the bridgehead to Military-road will then be able to follow the main road.

The most satisfactory route for any through road in closer proximity to the Harbour than Main Road No. 164 is indicated on the map thus —x—x—x. This is the line of a new road proposed by Dr. J. J. C. Bradfield, Chief Engineer, Sydney Harbour Bridge. It offers excellent alignment and grades, and is three-quarters of a mile shorter than the main road. It would involve a deviation between Alfred-street and Clarke-road, and a lofty viaduct at the head of Neutral Bay, with a deep cutting to reach Ben Boyd road; from Aubin-street to Wycombe-road and thence to Harrison-street, new ground would be broken, while a further deviation would be required to bring the route from Spofforth-street to Cowles-road; Cowles-road would be followed to Military-road. This route, while offering ideal alignment and grades, could only be effected at a great cost for resumptions, demolition of valuable properties, and construction. No detailed estimate is available, but the total cost of the compensation to property-owners and construction involved would be such as to make it impracticable for the Board to finance.

It was therefore necessary for the Board to examine whether some existing route could be adhered to, and progressively improved. The following proposals were examined on this account:—

(a) The construction of a new low-level road around the head of Neutral Bay connecting Clarke-road with Lower Wycombe road; and the widening of the narrow section of Wycombe-road between Harriette-street and Military-road.

(b) The use of Alfred-street, Bent-street, and Yeo-street, with a suitable connection to Military-road.

(c) The improvement of route (ii) previously described.

As regards (a), while a new road across the head of Neutral Bay, and leading to Lower Wycombe road, would avoid a steep section of Kurraba-road between Spruson-street and Ben Boyd road, the resumption and construction costs involved would be very heavy considering the short length involved, and traffic would still be confronted by the severe grade in Wycombe-road. Moreover, a lesser expenditure on the steep portion of Kurraba-road would improve it up to the general standard of the remainder of this route. As regards the widening

of the upper portion of Wycombe-road, this would be of substantial advantage to local traffic, as the road in sections is only 40 feet in over-all width, and the greater portion of the 24 feet width of carriage-way is occupied by a double set of tram tracks. But as this route would not relieve the main road for so great a length as (c), and had no features to commend it specially, it was rejected.

In respect of (b), it would be possible to obtain a route along that line, but any such road having suitable grades and alignment would entail the construction of three costly connecting links—Alfred-street to Bent-street, Bent-street to Yeo-street, and Yeo-street to Military-road. On account of its close proximity to the present main road, this route could not be expected to attract any traffic from the latter and it was also rejected.

There remained then route (ii), i.e., the route shown dotted on the map, together with the question as to whether it could be suitably improved. The distance between the bridge terminal and Cremorne Junction by this route is 2¼ miles, as compared with 2½ miles by the main road. Its present use by light traffic indicated that car owners were not finding its difficulties too great to discourage them.

With the incorporation of certain improvements, viz.:—

(a) The widening of the east-west portion of Harriette-street and the rounding off of its intersection with Wycombe-road.
(b) The construction of a viaduct or embankment around the head of Neutral Bay.
(c) The regrading of Kurraba-road between Spruson-street and Ben Boyd road.

the route could be greatly improved. Of these, the most urgent was the widening of Harriette-street, and the remainder, together with various minor improvements to corners and grading, could be carried out stage by stage as funds permitted. This route joins Military-road at a point nearly opposite McPherson-street, so that at a later date, if necessary, that street, with other roads, could be used as a relief route for the section of the main road east of Spofforth-street.

The Board accordingly advised the two councils of North Sydney and Mosman that it was prepared to declare the route now followed by traffic a secondary road (as it relieves the main road of a proportion of the traffic), and to share equally with the councils the cost of any approved works undertaken after declaration, until such time as the route selected by Dr. Bradfield, or any acceptable alternative is constructed, should the Government decide at any time to proceed with such a road as part of the Harbour Bridge works.

The North Sydney Council has concurred in the proposal, and the Mosman Council has had a preliminary conference with the Board on the matter. In the meantime, the Board has put in hand a detailed survey of the route with a view to the determination of the precise improvements to be made and the order in which they shall be undertaken.

To sum up, the Board proposes for the establishment of proper main road connection with the Sydney Harbour Bridge on the north side of the Harbour:

(1) The cutting through the block bounded by Walker-street, Mount-street, Miller-street, and Blue-street of a new road 100 feet wide.
(2) The widening to 84 feet by the realignment method of Main Road No. 164 from its junction with the Great Northern Highway to Cremorne.
(3) The declaration as a secondary road and progressive improvement of the route now used by light traffic between Alfred-street and Cremorne Junction.

The Development of Road Transport.

The following resolution—adopted on 27th November, 1929, by the Committee on Mechanical Transport, operating under the auspices of the Commonwealth Development and Migration Commission, indicates the great development which is taking place in road vehicles:—

"Recent development in the design of motor transport vehicles has taken the direction of greatly increasing load capacity, and by the use of multiple wheels, of reducing individual loaded wheel pressures to an extent that earth or light road formations may be traversed without undue damage to road surfaces.

The Oversea Mechanical Transport Directing Committee, London, with which the Commonwealth and State Governments are co-operating, is at present engaged upon the design of 15 and 50 ton capacity road transport units.

A Dutch firm has recently developed a tractor-trailer road train using eight-wheeled trailers automatically braked and steered, having a capacity up to 30 tons, and capable of operation on Dutch roads at speeds varying up to 25 miles per hour.

The 15-ton unit now being designed by the Oversea Mechanical Transport Directing Committee will in all probability consist of a tractor and two or more eight-wheeled trailers, the maximum wheel pressure of which will not exceed 30 cwt.

State regulations at present only permit the use of one trailer, and also provide for a maximum overall length of tractor and trailer.

These large capacity road units may appear at any time upon the Australian market, and there is little doubt that, owing to their low operating cost per ton mile, they will be largely used by cartage contractors and haulers.

To permit the free operation of these transport units, even if heavily taxed, may embarrass the administration of State railways and further complicate transportation problems in Australia.

(*Concluded on page 112.*)

The Organisation of Road Works in the Shire of Tumut.

By C. W. Williams, B.E., A.M.I.E. (Aust).

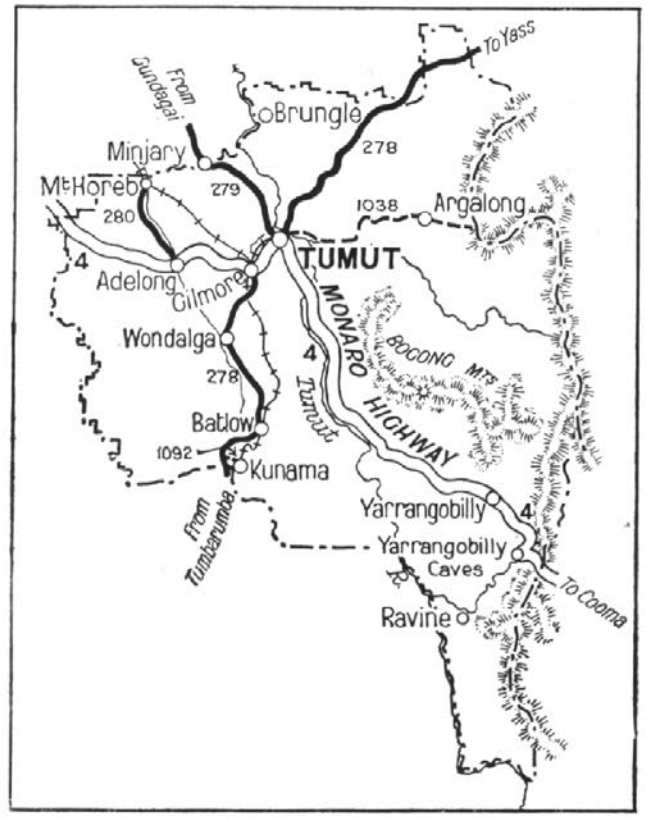
Tumut Shire Engineer.

(The problem of improving the main roads is only one part of the general problem of road improvement in the State. At least seven-eighths of the total mileage of roads are not main roads, and although many of these are side roads of interest perhaps to only one or two settlers, yet it is important that the general condition of all the roads shall be consistently made better. The allocation of shire revenue between the various groups of shire roads is the first step towards the organisation of a policy of general improvement, of which the systematisation of methods and types of work is the next. In this article, Mr. Williams sets out the general topographical and other characteristics of the Shire of Tumut, the manner in which the Council adapted its policy and equipment to the new conditions brought about by the passing of the Main Roads Act in 1924, and the principles by the application of which it is endeavouring to maintain the main roads in reasonable condition for traffic, while at the same time progressively attacking the task of permanent improvement. Such information should be of great help to Councils in formulating or reviewing their policies. The Board would, therefore, be glad to receive and publish contributions of a similar nature from other Shire Engineers. It suggests, however, that in order that comparison may be readily made between shires, such articles should be arranged somewhat along the lines adopted by Mr. Williams.—Editor.)

General Topographical and other Conditions of Shire.—The Shire of Tumut (originally Gadara Shire) covers an area of 1,400 square miles of hilly and mountainous country, a considerable portion of which to the south-east is for five months of the year frequently under snow, and therefore practically closed for road work. Its road system, as will be seen from the map, is centred on Tumut, which is also the Shire headquarters. This has been a very important factor in the development of the methods of working explained later, and makes for ready and effective control of works. The total mileage of main roads in the Shire is 150, of which 75 miles are classified as State Highway (No. 4) and the remainder as ordinary main roads. There are 600 miles of other roads within the Shire.

Except for the one outlet down the Tumut River Valley, the roads radiating from Tumut (elevation 900 feet), all lead out over mountain ranges 3,000 feet to 4,500 feet high. Geologically, every type of road making material is represented, and the haul is rarely greater than 4 miles. This advantage is, however, somewhat offset by the material being often difficult to get at, and hard to work.

The Formation of a Policy.—With the advent of the Main Roads Board in 1925, the Shire decided to concentrate on the improvement of its main roads. It was realised that the job was a big one, and would require careful forethought and planning. It was decided that no construction work, unless of an urgent nature, would be done, and that as much money as possible would be put on the main roads. It was thought better to take advantage of the Board's assistance for main roads and thereby put at least one section of the Shire roads in good order, rather than just go on in the old way and have the whole lot in bad condition.



Sketch Map, Shire of Tumut.

With funds very limited, it was imperative that the work be carried out economically. On the completion of the stocktaking survey of the main roads, asked for by the Board in 1925, it was found that most of them were in bad order and consisted of short, disconnected lengths of varying types of construction, with a good deal of bad alignment, and containing numerous sharp curves and danger spots. The maintenance question generally was carefully considered, having regard to the following factors:—

(a) Available funds.
(b) Available permanent employees.
(c) Road plant.

(a) The figure of £70 per mile per annum, including Board's subsidy, was fixed upon as the basis of possible expenditure, and was adhered to until July, 1928, when half of the 150 miles of main roads of the Shire became State Highway No. 4. The basis of expenditure for ordinary main roads was then increased to £82, and on the State Highway to £110 per mile per annum. Working to these figures, it has been found that good progressive maintenance can be realised and something more than merely making good the year's wear and tear can be done. Each year a fair proportion of permanent improvement work is carried out.

(b) About thirty permanent employees are engaged, most of whom are capable of handling gangs. Permanent hands are engaged for driving road plant, crusher feeding, quarrying and spreading. Temporary labour is engaged as the work warrants. The drivers of the road plant are local men and have been carefully chosen. Each man's work has been observed over a number of years, and it is now possible to allot the different classes of work to the men most suited to them. A good deal of time has been spent in instructing the men in the standards of work required. Every effort is made to get and keep the men interested in their work, each ganger or leading hand being given as much responsibility as possible. This gives the men an added interest in their job, and lightens the Shire Engineer's work of supervision.

(c) With the greatly increased roads expenditure resulting from the Board's subsidies, consideration was given to buying additional plant. The road plant in 1925 consisted of steam traction engine, independent 4-tyne scarifier, 5-ton lorry, portable steam engine, crusher, and 8-foot blade horse grader. It was decided to adapt the old plant to the new conditions, and get as much use out of it as possible. The crusher, however, had to be scrapped, as being inefficient. A portable crushing plant with elevator and bins, one 10-12-ton power roller, one mechanical loader, one heavy power grader, three baby graders, a power pump, and a 300-gallon tank and spray were purchased. The old portable engine was used to drive the new crushing plant. The old traction engine hauls the plant about, and also hauls the 4-tyne independent scarifier; the mechanical loader makes the running of the big 5-ton truck more economical. All the graders are used as much as possible. Additional transport in the way of motor lorries is hired as required, it being found far more economical to do this than to purchase and maintain the necessary vehicles out of Shire revenue. There is the further fact that private individuals will buy motor trucks, but will rarely consider buying graders, &c., so that the Shire prefers to expend any money available for plant on machinery other than trucks. The traction engine, scarifier, roller, one baby grader, and watering plant form a scarifying and reshaping unit. The baby grader is capable of reshaping the loosened material, and as it is worked only part time, the horses are used in the carts for carting blinding, &c. A bigger grader or a power grader as part of this unit would mean less economical work. The watering plant consists of engine and 3-inch belt-driven centrifugal pump (80 gallons per minute capacity), mounted on a small four-wheeled carriage. The watering tank is of 300-gallon capacity, of galvanised-iron, with spray attached, and was made locally for £17. This tank when used is mounted on a 30 cwt. truck hired by the day as required. The pump, engine, and tank together cost £130. In this way, a cheap and efficient road watering plant has been obtained.

The power grader, with its own scarifier, and a heavy plough, form a grader unit used for the heavier work. The 8-ft. blade, 4-horse grader, with ploughs and scoops, forms another grader unit for use on heavy work. The heavy motor truck, mechanical loader, and horses and carts form a gravelling unit. The carts are worked up to a ½-mile lead, and the lorry for any greater lead. The crushing plant is operated as required, but, generally speaking, crushing for maintenance purposes is kept down to a minimum, the existing road material being reused as much as possible and good gravel added to make up deficiencies. The small graders are used for light work, cleaning table drains, and grading in material that has just been spread.

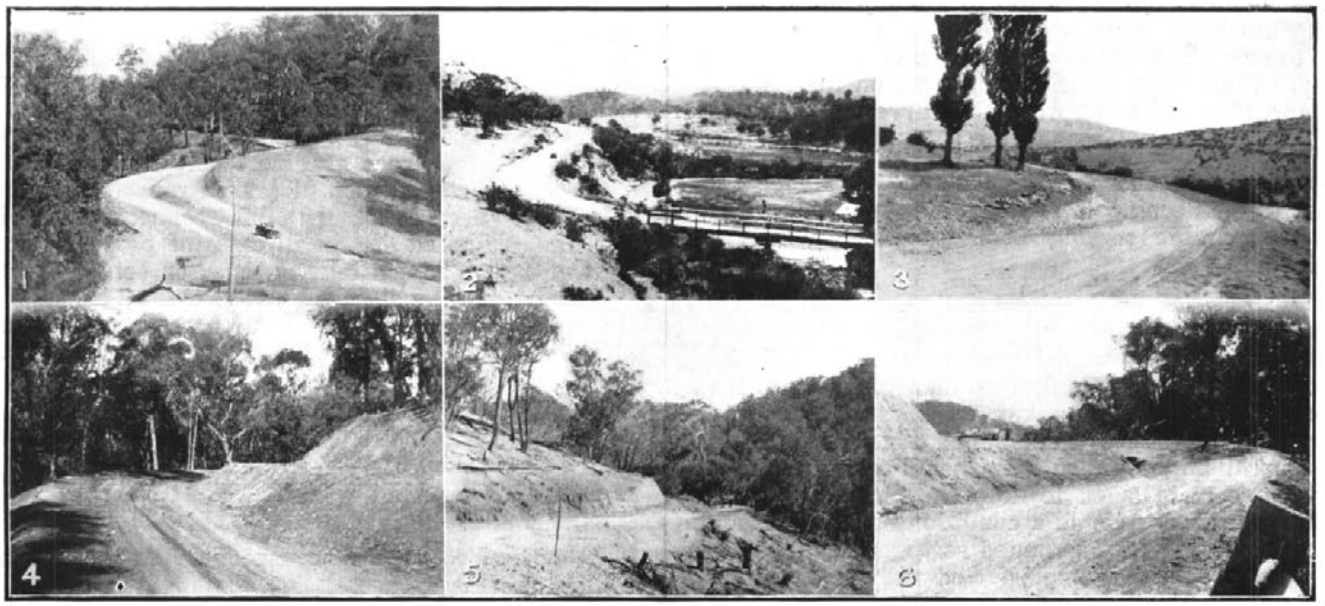
All drivers of road plant are made responsible for the upkeep of their machines and do all repairs and replacements. Every opportunity is taken of slack periods to overhaul machines, with the result that the whole plant is kept going constantly and is rarely seen in the Shire yard.

The Yearly Programme.—The organisation of each year's work commences with the preparation of the annual main roads programme. This is started about July of the preceding year, and is gradually built up as road conditions are observed over the period from July to December. The programme, complete with detailed estimates, is submitted to and approved by the Council early in December, and is then forwarded to the Board and approval obtained in time for work to start right away in the New Year. In the compilation of the programme, each item is made to cover as long a length of road as possible. Short sections that often appear comparatively good in a generally bad stretch, will, after the road is done, appear relatively bad in comparison with the reconditioned sections. Long uninterrupted lengths of work also tend to more economical work with the road plant, especially in this district of mountain roads, where turning places are few. The proportion of general maintenance or unspecified work is kept below 20 per cent. Planning the work ahead in this way gives the minimum amount of work and correspondence both to the Shire and Board, and it is found that the programme can be carried through generally with only one or two variations during the year.

The Conduct of the Work.—Once the programme has been determined upon, the economical performance of the work is determined largely by the system under which it is executed. On the roads

where work can be carried out all the year round, operations are evenly distributed over each month. For that section of State Highway No. 4 that is snowed in during winter, the work is pushed on as rapidly as possible during the three months of September, October, November, and the road is quickly put in order in time for the summer holiday traffic.

mountainous country, and as the roads near the town are in a more advanced stage of construction than those further out, they can be worked on more during the wet months. Consistent effort is made to have all main roads leading out of Tumut kept in good order, as the traffic density is greatest near the population centre, and good work done there confers the maximum benefit.



Typical views of the Monaro Highway within Tumut Shire.

1 and 4.—Talbingo-Yarrangobilly Caves Scheme.

2.—Yarrangobilly River bridge and approach.

3.—Adelong-Tumut section.

5 and 6.—Talbingo Hill.

Special care is taken to keep the time lost in shifting plant and travelling down to a minimum. With this objective, a road, once started, is worked right through. With the heavy reconditioning plant, it is found better to work from the far end back to headquarters and thus save travelling the heavy plant over the new work. On reforming and gravelling, however, the plant works its way out from headquarters, and then comes back over the work, any portions that have been knocked out of shape being touched up on the return trip.

No general preference is given to the patrol system of maintenance as compared with the gang system. The two are worked in together to suit local conditions. However, it is found that under present-day conditions of high speed motor traffic, any extensive patrol work with horse and dray is wasted effort and money, and a careful check is always kept on this type of work. It is found better to leave a length a few months until the road plant can get at it, rather than to try and patch it.

Generally, an endeavour is made to keep the road plants near Tumut during the winter months. All the main roads leading out from Tumut go over

Tar or bitumen surfacing work is done by contract, the work being let out in good size lots so as to attract contractors with the right plant and labour. Patch work on surfaced lengths is done with bitumen emulsion, which has been found both quick and economical.

Long lengths of road in this Shire run through mountainous country and are narrow, with numerous curves and steep sidlings. To widen to the full standard generally adopted in less hilly country would cost too much, but whatever work is done is executed in as economical a way as possible consistent with safe travelling conditions. There are many places where deviations are desirable. As, however, funds will probably not be available for these expensive works for many years to come, these sections are being maintained in the meantime, and the results obtained have been very satisfactory.

Where the road is narrow, but wide enough for two vehicles to pass, and the visibility is good, the road is maintained at its existing width. Where the visibility is bad, the corners are benched back, and the material obtained from the benching used

to widen and superelevate the curve and to improve the alignment. The getting and disposal of material on these mountain roads to the greatest advantage is a most important matter. The men are instructed always to get material from the points of curves and to dump it wherever it will widen or improve curves. Any work done thereby results in the maximum improvement of the road.

Curves generally are widened and superelevated. This again is too big a job to attempt all at once. The most important curves are therefore brought up to standard and the others are undertaken gradually. Whenever material is put out on the road, it is spread so as to improve the curves.

Trees and scrub are kept cut to improve visibility, and on sharp crests the road is widened so that traffic keeping to its right side will have room to pass traffic coming in the opposite direction safely.

Supervision.—With increased expenditure and higher standards of work, the task of supervision has become heavier. However, the Council has found it to be possible to keep this work within reason by carefully planning work well ahead, by training the men to understand their jobs, and by giving them as much responsibility as possible. Special care is taken to keep the Shire Engineer's transport in as reliable a condition as possible, and inspection trips are arranged so that the maximum number of jobs may be inspected with the minimum amount of travelling. A reasonably high speed of travel is also maintained. In 10,000 miles per annum, the difference in travelling time between an average speed of 20 miles per hour and 25 miles per hour is 100 hours. The office work is systematised and kept as light as possible. Certificates of expenditure indicating how the work is proceeding are rendered to the Board at regular monthly intervals. Each job has a summary card, stores and materials card, tools card, and plant hire card, from which the certificates are made up directly. Each item of road plant has also a card showing the number of days worked. Lastly, it is endeavoured to have all expenditure of grants complete within the time stated.

Hume Highway, Mittagong.

A second section of the Hume Highway is under construction in the Municipality of Mittagong, between Pioneer-street and the municipal boundary. The base course is nearing completion, and the wearing course of premixed bituminous macadam with a premixed seal coat has been commenced. The work is an extension of that completed within the Municipality some months ago, and is being carried out for the Board by the Nattai Shire Council. The Mittagong-Bowral road (No. 260), for a length of 1 mile south of Mittagong, has recently been reconditioned and surfaced with bitumen.

The Development of Road Transport.

(*Continued from page* 108.)

It is, therefore, urged by the Committee on Mechanical Transport that early action should be taken by State Governments to provide for the co-ordination of road and rail transport systems, with a view to directing the operations of large capacity road units to serve areas at present inadequately provided with transport facilities and to extend the influence of existing railways by encouraging the use of these units as feeders.

It is also desired to invite attention to the prospect that the development of these large capacity road transport units will result in such a marked decrease in the cost of road transport per ton mile as to render the construction of branch railway lines decidedly uneconomic. In this connection, it is strongly advised that in all cases of proposed construction of branch railway lines, or border extension of existing lines of less than 100 miles, full consideration should be given to the possibility of utilising properly organised road transport systems.

It is also suggested that the use of such units might, after inquiry, be considered as possible economic alternatives to the use of existing branch railway lines on which the earnings fall short of operating expenses. This suggestion is specially advanced in view of the posibility of extra expenditure being decided upon in connection with the unification of gauge proposals."

Dealing with the same subject, the Commonwealth Transport Committee, which reported to the conference of Prime Minister and State Premiers held at Canberra in May, 1929, on the Co-ordination of Transport in Australia, said:

"While it is necessary that the roads should be adjusted to the present types of vehicle in common use, it is equally important that a constant endeavour should be made to devise road vehicles capable of economic operation on the less expensive forms of road construction. During the last decade, very considerable investigation has been given to this matter, and six-wheeled and trackless types of heavy motor vehicles have been devised, which are capable of giving good service. They are, however, in only limited use—due largely, it is thought, to lack of knowledge by the public of their virtues. It is highly desirable that definite encouragement should be given to these types of vehicle, and it is recommended that the rate of vehicle taxation for them should be adjusted to be less than that appertaining to four-wheeled vehicles of similar capacity, in a similar manner to that applying between four-wheeled vehicles according to whether they have pneumatic or solid rubber tyres. The activities of such a body as the Mechanical Transport Committee, operating in a voluntary capacity under the direction of the Development and Migration Commission, in the collection and dissemination of knowledge on transport matters, are considered to be of great service. . . ."

Standards of Road Location.

By J. James, B.C.E.

Engineer.

THE ideal aimed at in road location is to secure, consistent with economy, the straightest possible road, with the least necessary change in grade. The ideals of straightness or low grade may conflict with that of economy, and that of cheapness with safety. It becomes necessary, then, to determine the factors governing road location, to assess their relative importance, and to establish standards.

As yet, there is no all-embracing treatise covering the fundamentals of road location as thoroughly as Wellington, years ago, analysed the principles of railway location. Probably there never will be, because roads are not used in the same regular manner as railways. Highways have also witnessed, since the commencement of this century, a revolution in transport, by which animal traction has been replaced by mechanical traction, and each year sees further developments in the application of mechanical transport, in the design of new types of self-propelled vehicles, and in the volume of traffic upon our roads. Thus, the science of highway location must be continually adjusted to meet the changing demands upon it, and not the least important part of a highway engineer's duty is to gauge the trend of, and, as far as possible, anticipate the demands of traffic.

The ruling factors which determine the location of a road are:—

(1) Safe alignment.
(2) Easy and suitable grading, with which is included the crossing of any obstacle without unnecessary change of level.
(3) Adequate drainage.
(4) Economy of construction, consistent with 1, 2 and 3, and the use to which the road will be put.

The relative order accorded alignment and grading is a sign of the passing of animal transport. Ten years ago, the team reigned in Australia. Proceeding at low speeds, it could negotiate sharp curves with little difficulty. Visibility was of minor importance. Grading was all important. The effort which a team could exert for more than a very short period was the same on a grade as on the level, and the 5 per cent. or 1 in 20 grade represented the maximum economical grade for this type of haulage. With the advent of the motor truck, all this was changed. The truck, by virtue of its impetus, can overcome short steep grades without changing gear, and when a longer steep grade requires increased tractive effort, meets this demand by proceeding in a lower gear, though at a reduced speed. Grade, as such, has with the increasing efficiency of motor vehicles, ceased to be all important. But whereas teams travelled at little more than 2 miles per hour, the commercial motor vehicle proceeds at speeds undreamed of in the animal transport era. Alignment has therefore taken the foremost place—curves must be wide to permit the newer vehicles to safely utilise their superior speed, and increased visibility is essential to safety.

(1.) Alignment.

Figures 1 and 2 show the basis upon which alignment standards depend. In general, the alignment will consist of straight lines, joined by curves. On the curves, following railway practice, super-elevation is used to correct the tendency of vehicles to capsize when traversing a curved path, and, aided by the friction between the pavement and the wheels of the vehicle, to prevent skidding towards the outside of the curve. The steepest possible superelevation, which will naturally be

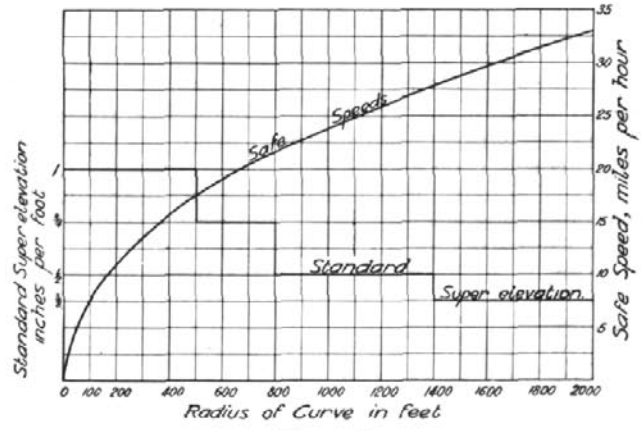


Figure 1.

applied on the sharper curves, is limited by the fact that some slow speed vehicles still traverse the roads, and some pavements will wash and scour if banked too steeply. These considerations unite in limiting super-elevation to an upper value of 1 in 12, or 1 inch per foot. Similarly, the least value, which will be used for the wider curves, is fixed by the type of pavement, and a slope not less than the flattest at which the satisfactory drainage of the pavement is assured, must be employed. This corresponds to the ordinary crossfall of the pavement on a straight road, and varies between 1 in 18 for a gravel pavement and 1 in 48 for concrete. Super-elevation is not applied to curves of radius greater than 2,000 feet. Such curves are, for all practical purposes, equivalent to a straight road. Thus, on referring to Figure 1, it will be seen that the Board's standards provide for a maximum side slope of 1 inch per foot for the sharper curves, and this is reduced at convenient intervals, reaching the minimum for curves of wide radius.

On the same figure, a line has been drawn to indicate the safe speeds for the various curves, when superelevated according to the Board's standard scale. In calculating this line, the friction between the wheels of a vehicle and the road has been taken into account. The curves shows that, if a certain vehicle is on the point of skidding at a speed of 33 miles per hour on a

A curve of 100 feet radius. The sight distance has been increased by 50 per cent. (from 90 feet to 140 feet) by the benching shown.

curve of 2,000 feet radius (which, as remarked above, corresponds almost to straight alignment) the same vehicle has an equal margin of safety on a 1,000 feet radius curve when travelling at 24 miles per hour, and so on. The safe speed drops rapidly as the radius of curvature falls below 300 feet, and reaches a very low value for curves of 100 feet radius and less. The diagram, then, illustrates the more important of the considerations which have guided the Board in fixing the minimum radius of curve for main highways at 300 feet, and for local service roads (*e.g.*, developmental roads) at 150 feet, except where very special cases necessitate departure from this standard.

The higher speeds and larger vehicles associated with modern motor transport have focussed attention on a further requirement of traffic. Vehicles occupy a greater width of the roadway when traversing a curve than when passing along a straight road, due to the rear wheels tracking inside the front wheels, and the front and rear extremities of the vehicle projecting outside the space occupied by the vehicle when travelling in a straight line. The widths occupied on curves by certain vehicles are shown graphically in the upper part of Figure 2, and may be compared with the widths occupied by the same vehicles on a straight road. This width increases rapidly as the radius of the curve decreases below 300 feet, and, in the case of a long vehicle, *e.g.*, a motor coach, or timber jinker, may reach, on a very sharp curve, a width more than 40 per cent. in excess of the width necessary to accommodate the same vehicle on a straight road.

Traffic demands a degree of safety on curves similar to that provided on a straight road. Although it is more difficult to drive a vehicle on a curve than on the straight, speeds should, for safety, be reduced on curves, as illustrated in Figure 1. It may be taken, then, that a satisfactory degree of safety can be maintained by ensuring that vehicles shall pass on a curve with not less than the clearances which obtain on a straight road. This immediately involves the widening of the roadway at curves, and the manner of arriving at a suitable widening scale is shown on the lower

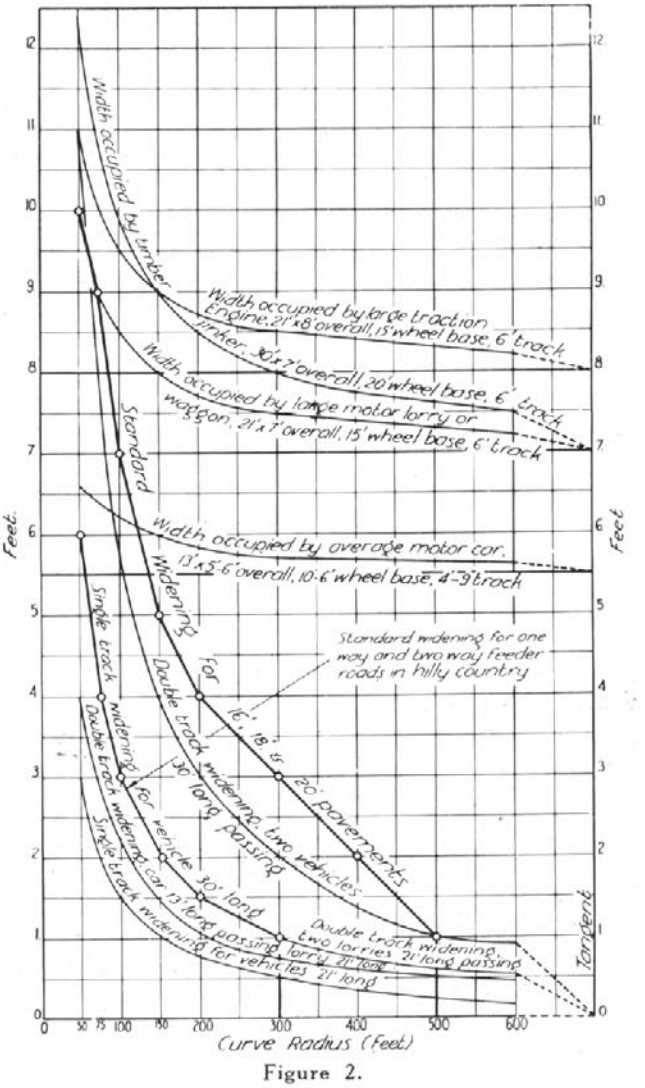


Figure 2.

part of Figure 2. For a main highway, it is necessary to contemplate the passing of large and fast vehicles, such as motor coaches. The widening scale in such a case may be derived from the increased widths on curves of two such vehicles. The widening scale adopted by the Board for main highways has been plotted on the same diagram, and follows, in steps convenient for practical application, the widening scale for two large motor coaches. For roads of lesser importance, the typical crossing may be that of a motor car and a motor truck, and, on a single track developmental road, when only one vehicle can traverse the road at a time, the necessary widening for a single vehicle will fix the widening scale. The question of a widening scale for one-way and two-way

feeder roads in hilly country was recently examined, and the scale adopted is shown in Figure 2. The typical crossing for the two-way road was assumed to be that of two ordinary motor lorries, and the vehicle assumed in the case of the one-way road was a large timber jinker. It is a coincidence that the two scales are identical, and that one line on the figure should cover both cases. The figure shows that all widening scales increase quickly as the curve radius decreases beyond 300 feet, and hence have an appreciable effect on construction costs for the sharp radius curves. The difficulties of widening the sharper curves to provide a safe sight distance, even when the expedient of benching is adopted, are obvious, and need not be further dealt with at present. These considerations lend additional weight to the adoption of the curve standards quoted in the preceding paragraph.

Visibility is measured by the distance at which two points on the road centre-line, and 5 feet above the pavement, first come within sight of each other. This distance is a measure of the time interval at which drivers proceeding in opposite directions become aware of each other, and indicates the time at their disposal for adjusting their courses to clear. It is this time interval, and not necessarily the actual visibility or sight distance, which should be uniform throughout a road, so that speed plays a part in the consideration of this aspect of the safety question. If a sight distance of 300 feet is necessary on a curve which traffic may

An example of difficult alignment on a main highway. The radius of the first curve is 150 feet, and of the second 200 feet, providing a sight distance of 180 feet.

be expected to traverse at 20 miles per hour, this distance may be reduced to 150 feet, and provide equal safety on another curve, where, by reason of the sharpness of the curve, the steepness of the grade, or other special condition, the usual speed of traffic may be only 10 miles per hour. Visibility is thus to a very great extent a relative matter. On a main highway which provides, generally, a very clear alignment, an isolated point of reduced visibility should have a sight distance of, say, 600 feet. On a mountain highway, where curves are frequent, and drivers are consequently keyed up to a greater pitch of carefulness, the sight distance need only be 300 feet to provide approximately the same degree of safety. In more difficult cases, this distance can safely be reduced to 150 feet, provided (and this is most important) that the sight distances generally are gradually reduced until the critical point is reached, when they may again be increased in the same way to whatever is the generally ruling value for the particular road.

(To be continued.)

Road Progress in U.S.A.

(Continued from page 104.)

The surfaced roads constructed in 1928, indicated as 29,888 miles, are made up of the following types of pavement:—Sand-clay and topsoil, 3,518 miles; gravel, 20,221; waterbound macadam, 3,001; bituminous macadam, 1,631; sheet asphalt, 83; bituminous concrete, 267; portland cement concrete, 1,145; and 22 miles of brick and other block pavements.

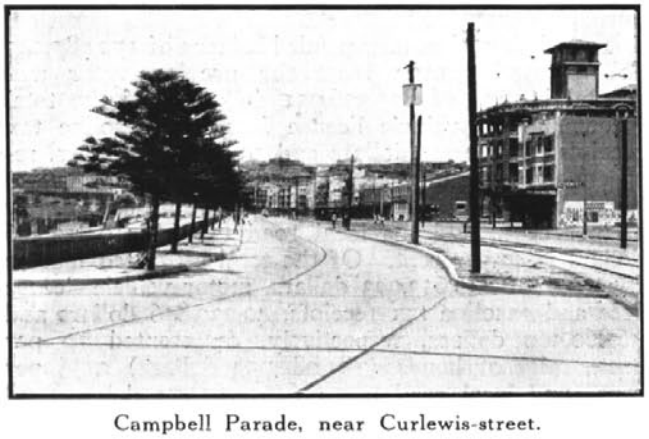
At the end of 1928, the estimated total length of county road systems was 2,709,839 miles, according to the figures given to the bureau. Of this total, 432,999 miles are surfaced, with the following types of pavement:—74,562 miles of sand-clay and topsoil, 277,797 miles of gravel, 46,454 miles of waterbound macadam, 14,953 miles of bituminous macadam, 1,472 miles of sheet asphalt, 3,763 miles of bituminous concrete, 12,317 miles of portland cement concrete, and 1,681 miles of brick and other block pavements.

The reports from the selected counties indicate a total expenditure for the entire United States in 1928 of 282,314,715 dollars for county and local road and bridge construction, 259,753,188 dollars for maintenance, 79,806,915 dollars for interest on bonds and outstanding notes, and 37,347,326 dollars for miscellaneous expense. They also indicate that the counties paid out 103,281,707 dollars in retirement of the principal of outstanding bonds and notes, and transferred 69,638,156 dollars to the States for work on State roads, making a grand total disbursement of 832,142,007 dollars and leaving an unexpended balance of 176,082,089 dollars for all counties in all States.

At the beginning of 1928, the reports indicate, the counties had an estimated total of 1,008,224,096 dollars available funds for local road and bridge construction, this consisting of an unexpended balance of 172,987,145 dollars carried over from the previous year and a total income of 835,326,951 dollars. Of the total income, motor vehicle license fees and gasoline tax receipts, 50,322,055 dollars and 53,778,852 dollars, respectively, contribute 12 per cent., receipts from local bond sales of 150,222,357 dollars represent nearly 18 per cent., and the local road tax of 416,812,566 dollars is 49 per cent. Of the total estimated income for 1927 of 840,613,923 dollars, motor vehicle license fees and gasoline tax receipts, 40,239,856 dollars and 46,860,509 dollars, respectively, represented 10 per cent., sales of bonds (181,080,953 dollars) 21½ per cent., and local road taxes (405,219,774 dollars) 48 per cent. In 1926, motor vehicle license fees and gasoline tax receipts, 37,861,018 dollars and 39,733,227 dollars, respectively, contributed 10 per cent. of the total income of 775,423,682 dollars, sales of local bonds (168,575,423 dollars) more than 21½ per cent., and local road taxes (357,263,356 dollars) 46 per cent.

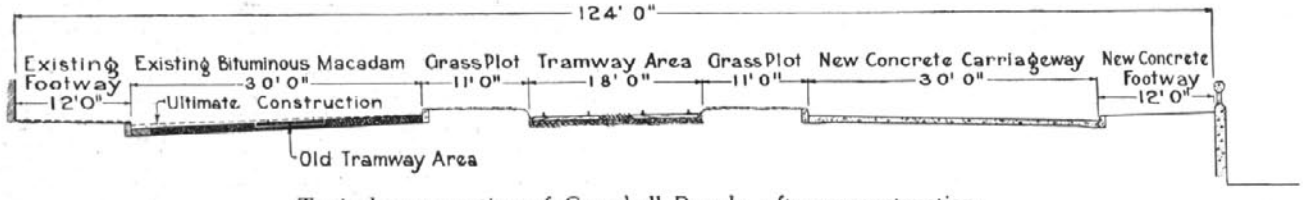
The Reorganisation of Campbell Parade, Bondi.

FOR the conception and successful carrying through of the magnificent improvements to Bondi Beach, which were officially opened on 21st December, 1929, the Waverley Council deserves the thanks of the community. These works have transformed the beach, which is now replete with the most modern conveniences, capable of accommodating the thousands of people who will use them, and constituting in the Commonwealth a new standard of bathing facilities. The Council, however, was not satisfied with merely providing improved bathing facilities, but set out to reorganise the whole of the Bondi Bay front, so that it would not only be picturesque and beautiful, as any sea promenade should be, but also would deal efficiently with the large volume of road traffic which would proceed to and depart from it. The road running parallel with the bay is known as Campbell-parade, and is portion of Main Road No. 172. It was, prior to the commencement of the improvements, from 66 feet to 80 feet wide. The southern half of its length was traversed by a double line of trams, and opposite Hall-street there was also a loop line. In February, 1928, the Council,



Campbell Parade, near Curlewis-street.

accompanied by the architect for the beach improvement scheme, Mr. G. H. Godsell, waited upon the Board, with the request that the Board should reconstruct the parade in keeping with the proposed beach improvements. The architect's design provided for the road to be widened to 124 feet, by taking in portion of the beach. This width would provide space for gardens, as well as ample room for footways, road traffic, pavements, and tramways. Realising that the harmony of the beach improvements would not be complete unless the road was constructed in keeping with them, the Board agreed to go into the matter to see what could be done to arrange the road in accordance with the Council's wishes. Between Hall-street and the northern end of Campbell-parade, the road had been reconstructed by the council prior to the commencement of the Main Roads Act, and the Board had, in accordance with section 13 of that Act, taken



Typical cross-section of Campbell Parade, after reconstruction.

Campbell Parade, view of eastern end, looking west.

over certain outstanding loan liabilities of the Council for that work which did not expire until 1st September, 1931. It would have been unsound economy to discard this asset while the liability still remained, particularly when it appeared that the existing pavement could be made to do good service for a considerable number of years to come. The Board, therefore, considered that it was advisable, if at all practicable, to retain this pavement in any reorganisation that might be adopted. It was finally decided that the 124 feet width of road should be divided up, as illustrated in the typical cross-section, to provide for two 12-feet footpaths, two 30-feet road traffic pavements,

(*Concluded on page* 118.)

Taemas Bridge.

By S. Dennis, B.E.
Bridge Engineer.

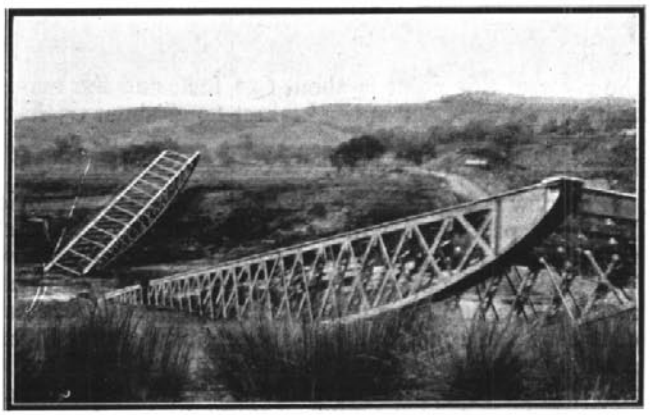
SOME bridges, like some individuals, are naturally great; others, like other men, have greatness thrust upon them. The latter experience has been the fate of Taemas Bridge. It had its humble origin in 1888, when an iron bridge 465 feet long, in three continuous lattice girder spans, was built to span the Murrumbidgee River to give connection between Yass and Tumut. When the Burrinjuck Dam was mooted, at a site 25 miles downstream from the bridge, with the consequential raising of the water level at Taemas, it became necessary to determine what should be done in regard to the bridge—whether it should be raised and lengthened, or whether it should be replaced by an entirely new bridge some distance upstream. After exhaustive enquiries, the Water Conservation and Irrigation Commission decided to maintain the river crossing at the site of the old bridge, and to

The original Taemas Bridge, with tackle erected for raising the trusses.

raise it by 15 feet. This involved extending the original bridge by 420 feet, and also considerable works on the approaches, including a six-span timber relief bridge, 180 feet long, so that when this work was completed in 1924, the bridge became a major structure 885 feet long, consisting of twelve timber approach spans, each 35 feet long, supported on concrete piers founded on timber piles, and the three original continuous truss spans, supported on the extended original piers.

The expectations of the Commission as to the highest water level at the site were surpassed by the record flood of 1925, which overtopped the Burrinjuck Reservoir by 3 feet 4 inches. The flood waters reached the deck level of the bridge at midday on 27th May, 1925, and shortly afterwards the trusses were washed from their piers. The waters continued to rise, and before midnight, had reached a level 6 feet higher than the deck of the bridge. When the flood subsided, the trusses were seen stranded in the river, 100 yards downstream from their piers, and it was noticed that the piers had been deflected from their true position. Connection between the two sides of the river was, of course, broken.

For the time being, communications were restored by the Public Works Department by means of a punt, but as the levels of the stream were continually changing, this was difficult to maintain, and, in April, 1929, the punt was, in its turn, washed away. Prior to this,



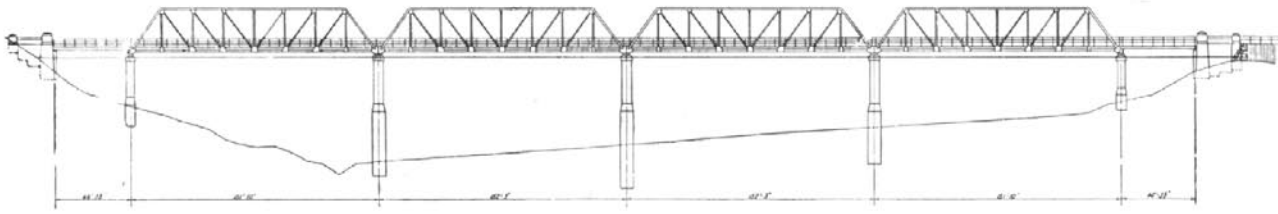
Trusses of the Taemas Bridge after the wrecking of the bridge by flood in May, 1928.

financial responsibility for the crossing was transferred to the Board on 1st July, 1928. Temporary access was then restored by the Public Works Department, after consultation with the Board, by a low level bridge. The river rose over this bridge in July, 1929, again dislocating the traffic, and a second punt was then purchased, and placed in commission during September. This will, in conjunction with the low level bridge, continue to maintain connection until the new bridge, now under construction, is available for use. This punt, carrying twenty-one bales of wool, is shown in the adjoining illustration.

Temporary punt, carrying load of wool.

Simultaneously with the adoption and installation of these temporary expedients to prevent entire dislocation of traffic, steps have been taken to provide a permanent high level bridge. The old problem of whether the bridge should be rebuilt at the original site, or at a new site up-stream, was again investigated

by the Public Works Department, and, as a result, it was decided that a new site 2 miles up-stream from the original site afforded improved assurance of permanency, as well as a shorter bridge. The width of the river at this point is about 650 feet, and the maximum depth of water in the highest flood about 65 feet. Borings indicate rock surface at from 10 to 30 feet below the bed of the river.



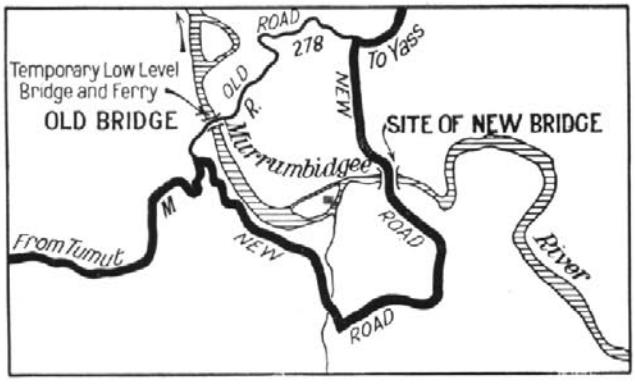
TAEMAS BRIDGE
LOOKING UP STREAM

The new bridge (which was designed by the Public Works Department) will consist of four 150 feet steel truss spans, and two 45 feet rolled steel joist spans. The deck will be of reinforced concrete, 6 inches thick at the kerbs, increasing to 8½ inches thickness at the centre of the roadway, and above this, there will be a 2-inch concrete wearing surface; the width of roadway will be 18 feet between the kerbs. The substructure consists of reinforced concrete cylinder piers sunk to rock, and semi-mass concrete U-shaped abutments.

The work has been divided into two contracts, as follows:—

(*a*) Supply of steelwork.

(*b*) Construction of piers and abutments, and erection of steelwork.



Sketch plan, Taemas Bridge site.

Eleven tenders were received for (*a*) and the lowest, that of Messrs. Tulloch's Phoenix Ironworks, Limited, in the sum of £14,857 3s. 8d., was accepted on 19th June, 1929.

For (*b*), four tenders were received, and the lowest, that of the State Monier Pipe and Reinforced Concrte Works, in the sum of £26,810 16s. 6d., was accepted on 24th June, 1929. The contract requires that the work shall be completed early in 1931.

The approaches to the new bridge necessitate the construction of 1¾ miles of new road on the northern side of the river to connect with the road to Yass, and on the southern side, the construction of about a quarter of a mile of new road and the inclusion of some 5½ miles of existing road in the route of the main road to Tumut. Plans for portions of this work have been prepared, and the remainder are in hand.

The completion of the approaches will be arranged to coincide with the completion of the bridge.

The Reorganisation of Campbell Parade, Bondi.

(*Continued from page 116.*)

two 11-feet garden strips, and a central 18 feet of tramway reserve. This would enable the eastern (seaward) 30 feet width of road pavement to be constructed and the existing bituminous pavement to be preserved. It would, however, involve the elimination of the tram loop and the placing of the tram lines in their central position.

This proposal was agreed to by the Council, which then took up with the Tramway Department the question of rearranging the tram tracks in the manner desired. Special funds were provided by the Government for this purpose, and the tram loop removed, the double line of tram tracks being laid in ballast centrally in the road. In order to disturb the western road pavement as little as possible, only the rails of the old tram tracks which previously ran along the length of Campbell-parade were lifted, the sleepers being left in position.

The eastern side of the road has been concreted to a width of 30 feet, and the necessary adjustments in the bituminous macadam have been made to the original western pavement. These works were carried out by the Waverley Council, using its own staff, in accordance with detailed plans prepared by the Board, as part of the Metropolitan Main Road Construction Programme for 1928-29. Incorporated with them is an extensive improvement of the underground drainage system of the area, which was completed at a cost of £1,789 8s. 5d. There now only remains to complete the project the construction of approximately 100 square yards of concrete pavement opposite Lamrock-avenue. This pavement was temporarily omitted by the Council pending the finalising of its own plans for improving the drainage of Lamrock-avenue, which involved laying a pipe across Campbell-parade at this point. Excluding this, the road and drainage works arranged for by the Board have been finished at a total cost of £12,709, of which £11,167 is borne by the Board and the remainder by the Council.

Tenders and Quotations Accepted.

The acceptance by the respective Councils of the following Tenders has been approved by the Board during the month of December, 1929:—

Work.			Name of Recommended Tenderer.	Amount of Recommended Tender.
Municipality or Shire.	Road No.	Description.		
				£ s. d.
Tumbarumba ...	1,143	Construction of 1 mile 3,020 l. ft. (formation, culverts, &c.)	Winnett and Sons ...	3,187 17 6
Mitchell	59	Construction of section between 2 miles and 4 miles ...	Chas. Hardy Contracting Company.	3,898 13 6
Tumbarumba ...	1,117	Gravelling, 1,150 l. ft.	B. Wolter	284 19 4
Macleay	1,048	Formation, 1,521 l. ft.	F. N. Range	614 7 0
Tumut	4	Construction of culverts at Killarney and Piper's Creeks ...	W. W. Beaven and Sons	782 13 9
Manning	110	Construction of timber culverts at 13 miles and 14 miles...	S. J. Donaldson ...	1,642 12 4
Maclean	10	Road construction, 2,982 l. ft.	Model Homes, Ltd. ...	6,127 6 1
Bland...	1,028	Forming and gravelling	McCartney & McDonald	206 2 0
Nepean	1,087	Reconstruction in water-bound macadam, 4,500 l. ft. ...	W. J. Donovan ...	4,427 12 8
Terania	141	Construction between 24¼ and 25¼ miles	O'Connor & McDonald...	3,939 5 8
Wallarobba	1,128	Construction of bridge at Kenny's Crossing. (Relet.) ...	J. Croll and Sons ...	1,977 14 0
Severn	9	Construction of 8-in. gravel pavement, together with culverts, between 10 miles and 15 miles 1,494 ft.	R. Maydon	10,875 1 7

The following Tenders and Quotations were accepted by the Board during the month of December, 1929:—

TENDERS.

Work or Article.			Name of Successful Tenderer.	Amount of Accepted Tender.
Municipality or Shire.	Road No.	Description.		
				£ s. d.
Gunning	2	Bituminous surfacing of sections of the Hume Highway between Cullerin and Gunning. Alternative tenders for (1) supply, heating, spraying; or (2) supply, heating, spraying, gritting, and rolling of bituminous surface with priming coat of tar or bituminous oil.	John Fowler & Co. (Aust.), Ltd.	2,217 11 8 (supply, heating, spraying, gritting, and rolling, using asphaltic oil.)
Tarro	9	Resurfacing with tar of 183 chs. at Hexham	Brooklyn Oil Co. ...	535 16 4
Nambucca	10	Macksville Bridge—		
		Contract No. 1: Supply and delivery of steelwork ...	A. Goninan & Co. ...	8,988 13 8
		Contract No. 2: Construction of a steel and concrete bridge.	Oxenford Contracting Co., Pty. Ltd.	26,967 0 0
Tenterfield	9	Construction of a 160-ft. span concrete arch bridge over Koreelah Creek.	W. L. Jemison ...	8,729 0 0
Hornsby	9	Berowra to Hawkesbury River—Supply and delivery of 5,000 cub. yds. of sub-base sand near Berowra ...	W. J. Donovan ...	@ 5s. 2d. per cub. yd.
Penrith	5	Haulage of approximately 6,608 tons of materials from Penrith Railway Station to the Board's depot at corner of Henry and Evans-streets.	W. J. Donovan ...	@ 1s. 5d. per ton.
Sutherland	1	Hire of up to 6 2-ton motor trucks with power-operated tipping gear, for use on the Prince's Highway between Heathcote and Waterfall.	P. L. Miller	@ 7s. 4d. per hour.
Sutherland	1	Haulage of approximately 2,355 tons of materials and 15,000 linear ft. of 5 in. x 2 in. hardwood timber from Heathcote Railway Station to the Board's dumps situated between Heathcote and Engadine.	F. C. Allman	@ 2s. per ton, broken stone; @ 3s. per ton, bit.; @ 17s. 6d. per 1,000 lin. ft., hardwood.
Camden	2	Painting of the bridge over the Nepean River	H. Smart	£105.
Nepean	2	Supply and delivery of 2,900 cub. yds. of sand (suitable for sub-base use) on the Hume Highway between Carne's Hill and Narellan.	Cleary Bros.	1,450 cub. yds., 6s. 6d. per cub. yd.
			H. Coakley	1,450 cub. yds., 6s. 6d. per cub. yd.
Penrith	5	Supply and delivery of 1,810 cub. yds. of sand (suitable for sub-base use) on the Great Western Highway between Parker-street and Castlereagh-road.	Emu and Prospect Gravel and Road Metal Co. Ltd.	@ 5s. 6d. per cub. yd.
Penrith	5	Hire of up to 14 2-ton motor trucks with power-operated tipping gear, for use on High-street, Penrith.	M. C. Cohen	1 truck @ 7s. 6d. per hour.
			A. Leach	1 truck @ 7s. 9d.
			A. C. Collins	1 truck @ 8s.
			C. Hayter	2 trucks @ 8s.
			W. J. Donovan ...	9 trucks @ 8s.

QUOTATIONS.

No. of Quotation.	Description of Article.	Name of Successful Tenderer.	Amount of Accepted Quotation. £ s. d.
669	One motor tent for utility truck	Hoseason & Co., Ltd.	9 0 0
679	Sand, 5,470 tons	Hawkesbury Sand Co.	1,777 15 0
695	Decomposed granite gravel, 68 tons	Wilson's Granite and Gravels, Ltd.	39 13 4
711	Blue metal, 3,625 tons ¼-in., 3,625 tons 1½-in.	Emu and Prospect Gravel and Road Metal Co., Ltd.	3,715 12 6
712	Blue metal, 790 tons $\frac{5}{16}$-in., 1,470 tons 1½-in.	Blue Metal Quarries, Ltd.	624 5 0
716	Road scrapers, 2 only	Armstrong, Holland, Ltd.	20 18 0
720	One library cabinet	Brien and Tompsett	7 19 6
722	Concrete pipes— 29 ft. x 15 in. dia., 57 ft. x 18 in. dia., 27 ft. x 21 in. dia., 58 ft. x 30 in. dia., 29 ft. x 42 in. dia.	State Monier Pipe Works	82 18 3
723 (in lieu of 692)	Concrete pipes— 481 ft. x 15 in. dia., 240 ft. x 18 in. dia., 58 ft. x 21 in. dia., 82 ft. x 24 in. dia.	Richard Taylor, Ltd.	219 11 10
727	Bitumen boiler, 400 gals.	W. N. Stone	137 10 0
728	Concrete pipes, 204 ft. x 12 in. dia.	State Monier Pipe Works	22 15 11
707	Bitumen— 8 tons 60–70 pen., in wooden barrels 920 gals. asphaltic road oil	Shell Co. of Aust., Ltd.	76 16 0 41 4 0
708	Bitumen— 15 tons 60–70 pen. 2,400 gals. asphaltic road oil	Shell Co. of Aust., Ltd.	112 10 0 70 0 0
724	Portable pumping unit	Moffat-Virtue, Ltd.	50 0 0
634	Strainer posts, 330–10 in. dia. x 6 ft. 9 in. long	F. Beggs & Co., Ltd.	148 10 0
709	Caravans (2)	Star Bros.	214 14 0
721	Sand, 4,420 tons	Emu and Prospect Gravel and Road Metal Co., Ltd.	1,473 6 8
729	Concrete pipes, 306 ft. x 15 in. dia.	Richard Taylor, Ltd.	52 0 5
730	Concrete pipes— 30 ft. x 18 in. dia., 71 ft. x 24 in. dia., 24 ft. x 30 in. dia., 35 ft. x 36 in. dia.	State Monier Pipe Works	72 0 0
731	Galvanised chain wire fencing	Cyclone Fence and Gate Co.	20 2 2
732	Bridge timber— 141 ft. x 14 in. x 12 in., 18 ft. x 12 in. x 12 in., 170 ft. x 18 in. (round), 32 ft. x 14 in. (round).	Oakley & Co., Ltd.	96 13 9
733	Bridge timber— 138 ft. x 18 in. dia. (round), 46 ft. x 8 in. x 8 in., 80 ft. x 10 in. x 3 in., 71 ft. x 4 in. x 4 in., 71 ft. x 4 in. x 3 in., 36 ft. x 6 in. x 4 in., 141 ft. x 10 in. x 4 in., 138 ft. x 8 in. x 4 in.	Oakley & Co., Ltd.	61 10 5
735	Bridge name-plates, 36 flat with 144 hooks, 24 curved with 96 screws.	Linder and Taylor	27 11 0
736	Pipe moulds—2 18-in. dia., 1 24-in. dia., 1 36-in. dia., 1 outer shell 18 in. dia., 1 outer shell 36 in. dia.	Armstrong, Holland, Ltd.	38 7 6
738	Galvanised jointing, 18,800 lin. ft.	F. G. Kerr & Co., Ltd.	326 9 2
740	Concrete pipes— 38 ft. x 24 in. dia., 38 ft. x 30 in. dia., 32 ft. x 36 in. dia	State Monier Pipe Works	59 10 5
713	Asphaltic road oil, 2,000 gals.	Atlantic Union Oil Co.	72 10 0
725	One 8-ft. leaning wheel road grader	British Standard Machinery Co., Ltd.	240 0 0
737	Bituminous jointing, ⅜ in. thick— 377 pieces type " A," 132 pieces type " B," 512 pieces type " D," 280 pieces type " E."	Ormonoid Roofing and Asphalts	77 2 6
739	Concrete pipes, 216 ft. x 18 in. dia.	Richard Taylor, Ltd.	41 15 3
742	Portable bitumen boiler, 400 gals. capacity	W. N. Stone	205 10 0
743	Concrete pipes—46 ft. x 24 in. dia., 29 ft. x 60 in. dia.	State Monier Pipe Works	65 12 0
744	Mild steel pile shoes, 20 only	Brown and Brown, Ltd.	7 15 0
745	Blue metal, 350 tons, ¾-in	Newcastle District Municipal Metal Quarries	312 1 8
747	Bitumen, 18½ tons 60–70 penetration, in wooden barrels	Shell Co. of Aust., Ltd.	138 15 0

Great Western Highway.

On the Great Western Highway in the Blue Mountains district, the road was tar-surfaced some 3½ years ago, and the portions not as yet reconstructed have since been maintained by patching. The treatment as a whole has proved most successful and economical. The effect of traffic on the crust of gravel and tar however, was to form shallow waves or corrugations, which became uncomfortable for travel at certain speeds. The removal of these over a large portion of the area has now been effected by means of a specially-adapted disc-harrow, which cuts off the tops of the undulations, leaving a reasonably smooth surface ready for retreatment with tar or bitumen and blue metal screenings.

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