

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. II, No. 11

July, 1931

News of the Month.

Metropolitan Division

Warringah Shire Council has recently completed the work of tar-surfacing a further half mile of Pittwater-road (No. 162) from St. Ives Showground in an easterly direction.

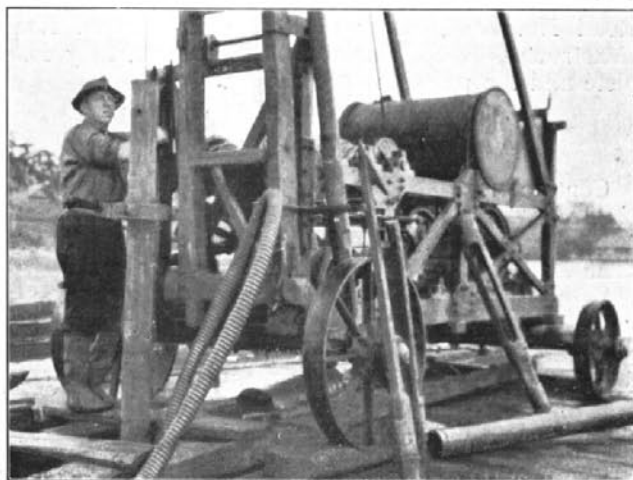
Nepean Shire Council has recently completed a further length of tar-surfacing on the Narellan-Luddenham road (No. 154), and, additionally, the blinding with gravel of rough macadam sections as far north as Bringelly.

Alexandria and Redfern Councils have recently completed a penetration macadam pavement in Wyndham-street and Gibbons-street (Secondary Road No. 2011), between Wells-street and Henderson-road (Main Road No. 193).

Baulkham Hills Shire Council has completed the tar-surfacing of Showground-road (No. 157) from the Baulkham Hills-Dural road (No. 160) to the length of the former road already tar-surfaced in the vicinity of Baulkham Hills Showground. In the same shire the Great North secondary road (No. 2015) between Glenorie and Maroota is at present being improved by grader work.

The Board has now acquired the whole of the land needed for the construction of the proposed new 100-foot wide road from the end of the northern approach of the Harbour bridge at Junction-street to the existing highway at North Sydney Post Office. Most of the area has been cleared of buildings and improvements, and regrading and drainage works have been put in hand at the two ends to afford access to new buildings which have been constructed to take the place of others about to be demolished.

The Board is at present engaged in making the survey and taking the borings for the new bridge which is to be built across the Parramatta River between



Boring plant at work on the site of the Uhr's Point-Ryde Bridge.

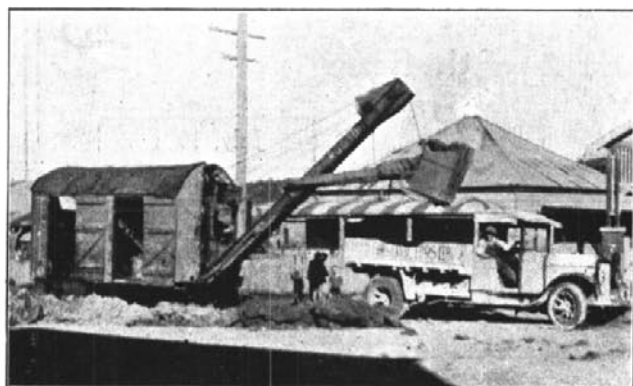
Church-street, Ryde, and Uhr's Point, Concord, under the Parramatta River (Ryde to Concord) Bridge Act, 1931.

Outer Metropolitan Division.

Extensive repairs are being effected by Contractor T. S. Brown to Washpool bridge over the Karuah River, on the Dungog-Stroud road (No 205), in the Shire of Stroud. The bridge consists of a 90-foot timber truss span and three timber beam approach

spans. Approximately seventeen new piles, ten new girders in the approach spans, twelve new stringers in the truss span, and 1,300 lineal feet of decking, together with a proportion of the walings and kerbing, are being renewed. Although the bridge is forty years old, no new timber is required in the trusses. The repairs are aimed at extending the life of the bridge a further ten years and will be carried out without closing the bridge to traffic.

At Omega, on the Prince's Highway, where the pavement is occasionally submerged by high floods, indicator posts are being erected to define the edges of the roadway at times when it is submerged by flood waters.



Excavating for concrete pavement, Glebe-road, Adamstown.

Good progress is being made in the reconstruction in cement concrete of Glebe-road, Adamstown (Main Road No. 188), under contract with Messrs. Road Constructors Ltd. The excavation is practically complete and the paving is proceeding.

Upper Northern Division.

Contractors Bugden and Bugden have built two single 30-foot span timber beam bridges over Black's Camp Creek, on the Sandilands-Bonalbo developmental road (No. 1050) in the Shire of Kyogle.

In the Shire of Terania, on the Cawongla-Kunghur developmental road (No. 1088), a grant of £4,000 for the relief of unemployment has been expended on clearing, forming and the construction of 1 mile 3,720 feet of waterbound macadam pavement, together with the necessary pipe culverts.

Contractors O'Connor and McDonald have completed 3,400 feet of waterbound macadam pavement on the Nimbin-Kyogle road (No. 141) in the Shire of Terania.

The State Monier Pipe and Reinforced Concrete Works has completed 2 miles 2,051.5 feet of cement concrete pavement on the Pacific Highway between Swan Creek and Ulmarra, in the Municipality of Ulmarra.

The reconstruction in bituminous penetration macadam of a length of 2 miles 3,240 feet on the Pacific Highway between Maclean and Harwood ferry, in the Shire of Harwood, has been completed by Contractor O'Meara.

Lower Northern Division.

Considerable improvement has recently been made to the Great Northern Highway at Cropper's Hill, north of Wallabadah, in the Shire of Tamarang. Previously the surface was high-crowned, narrow and without super-elevation. These defects have been corrected and now the short length of steep grade may be negotiated safely in top gear. This work is part of a series of such improvements which have been carried out in this shire in the past two years.

Economical maintenance of earth and gravelled sections of the Great Northern Highway north of Armidale, in the Shire of Dumaresq, is being effected by means of a California type planer drag. This tool has two adjustable blades and was made in Armidale at a cost of £25. When being transported, the drag runs on its own wheels, which are on movable axles. The cutting edges are made from the steel rims of old solid rubber tyres. The rubber is chipped and burnt off, then the rims are straightened out and cut into lengths. The drag is tractor-drawn and is very effective in removing corrugations.

In the Shire of Bellingen, on the Bellingen-Dorrigo road (No. 119), a worn-out single-span timber bridge $7\frac{1}{2}$ miles from Bellingen, is being replaced by a new structure. The alignment is being considerably improved by erecting the new bridge further up stream, and widening and regrading the approach curves. Three other bridges on the same road between Bellingen and Thora have also been repaired or renewed during the past year; one, an old single-span timber bridge, 2 miles from Bellingen, having been replaced by a new structure, and two over Boggy Creek having been redecked and strengthened, respectively.

As a result of heavy rains at the end of May and in the first week of June, the surfaces of many of the roads paved with the softer gravels and shales have been considerably cut about or punched into holes by traffic, particularly in the Tamworth district, where shales have been largely used. These materials dry out very quickly, and unless the rutted surfaces are graded at the right time, hard ridges remain. By means of an 8-foot grader drawn behind a motor lorry at 6 m.p.h., the Cockburn Shire Council, in four days, brought the 17 miles of the Tamworth-Manilla trunk road (No. 63) within its boundary, which had been reduced by rain and traffic to a most unsatisfactory state, into splendid order.

Central Western Division.

Contractor Puckeridge has completed and opened to traffic the whole of his contract for the construction of 3 miles 1,270 feet of gravel pavement, with culverts, on the Peak Hill-Dubbo trunk road (No. 56) in the Municipality of Peak Hill. This work, which extends through the greater part of the main street and terminates at the northern municipal boundary, represents a substantial improvement upon previous conditions.

A further length of $3\frac{3}{4}$ miles of decomposed granite pavement has been constructed by Contractors Griffiths Bros. through black soil country between 10 and $13\frac{3}{4}$ miles on the Eugowra-Grenfell developmental road (No. 1104) in Jemalong Shire. The entire length of the road from Eugowra to $13\frac{3}{4}$ miles is now either formed or gravelled.

Southern Division.

Three miles of the Burbong-Queanbeyan trunk road (No. 51) have been reconstructed in gravel. The work was financed by the Unemployment Relief Council and executed under the direct control of the Board.

The reconstruction in gravel of a section of the Federal Highway between Yarra and Collector, which is being effected by the Mulwaree Shire Council, has been delayed by heavy rains. As the road traverses low flats, it is impracticable to provide side-tracks, and traffic has been diverted temporarily through Breadalbane.

Riverina Division.

Several concrete culverts, with gravelled approaches, are being built at the worst of the water crossings on a recently formed length of the Wagga-Lockhart trunk road (No. 59) between Bullenbung Plain and Lockhart, in the Shire of Lockhart.

The Board's plant has recently completed the re-conditioning of a section of the Monaro Highway between 21 miles and 24½ miles in Kyeamba Shire. Although very heavy rainfalls were experienced during the progress of the work, a good running surface has resulted.

An extensive maintenance programme has resulted in notable improvement to the Mulwala-Tocumwal-Deniliquin road (No. 212) and the Jerilderie-Tocumwal road (No. 229) in the Shire of Berrigan. The earth formations, notwithstanding the exceptionally wet season have, for the most part, presented a very good running surface.

Contractor N. White has completed 1 mile of re-forming and gravelling, including a causeway 100 feet long, over heavy black soil near Marsden, on the Mid-western Highway in the Shire of Bland. There is now a continuous length of road trafficable in all weathers (floods excepted) from Wyalong to the Bland Shire boundary at Marsden.

Expenditure from 1st July, 1930, to 31st May, 1931.

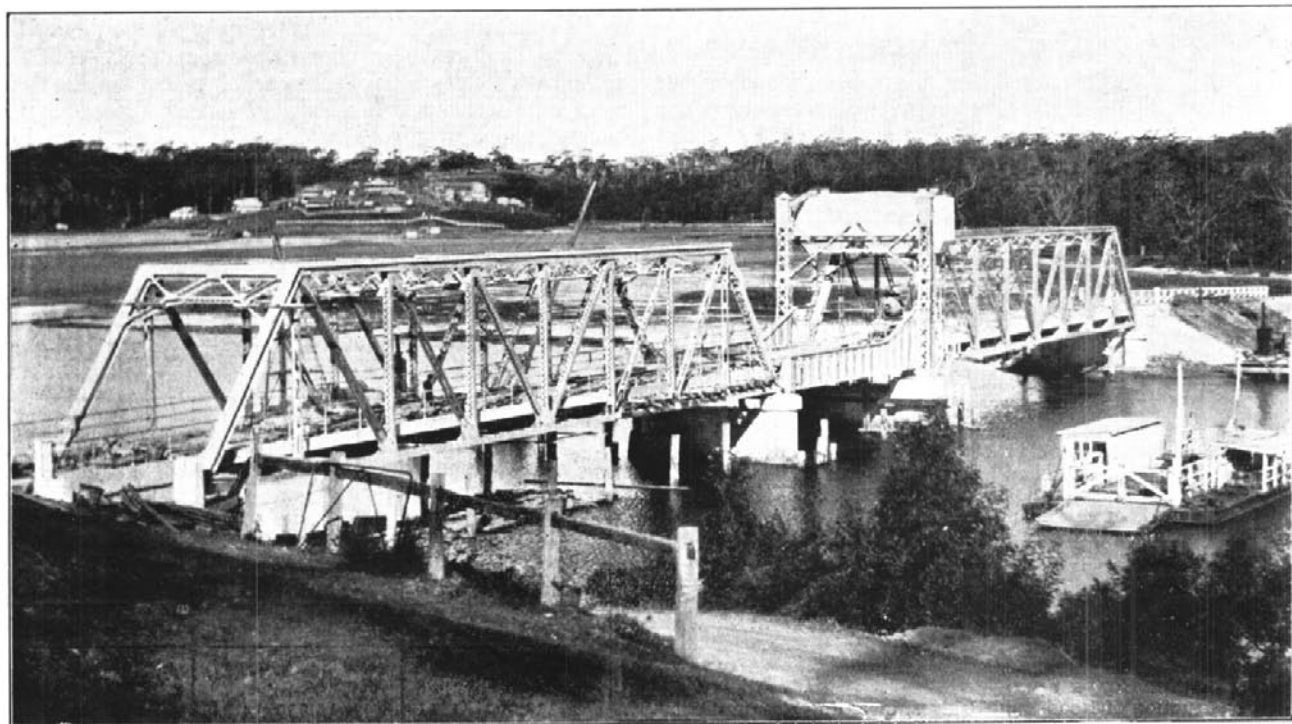
	Expenditure from 1st July, 1930, to 30th April, 1931.	Expenditure for month of May, 1931.	Total Expenditure to 31st May, 1931.
	£ s. d.	£ s. d.	£ s. d.
COUNTY OF CUMBERLAND MAIN ROADS FUND—			
Construction of Roads and Bridges	213,184 16 3	5,284 15 9	218,469 12 0
Cost of Land Resumptions	99,147 0 7	6,392 0 11	105,539 1 6
Maintenance of Roads and Bridges	145,050 5 1	10,013 13 8	155,063 18 9
Repayment of Loans	150,192 9 11	14,412 17 0	164,605 6 11
Survey, Design, Supervision and Administration	45,714 17 3	Cr. 1,647 15 7	44,067 1 8
Miscellaneous	27,291 17 1	1,222 17 2	28,514 14 3
Totals	680,581 6 2	35,678 8 11	716,259 15 1
COUNTRY MAIN ROADS FUND—			
Construction of Roads and Bridges, including Resumptions	332,762 1 11	15,939 14 8	348,701 16 7
Maintenance of Roads and Bridges	574,134 4 10	38,338 10 2	612,472 15 0
Repayment of Loans	36,824 8 9	.....	36,824 8 9
Survey, Design, Supervision and Administration	86,911 0 11	12,936 0 5	99,847 1 4
Miscellaneous	22,427 0 3	2,374 11 10	24,801 12 1
Totals	1,053,058 16 8	69,588 17 1	1,122,647 13 9
FEDERAL AID ROADS FUND—			
Construction of Roads and Bridges, including Resumptions	555,828 16 0	66,716 4 11	622,545 0 11
Miscellaneous	17,086 0 9	1,006 14 5	18,092 15 2
Totals	572,914 16 9	67,722 19 4	640,637 16 1
DEVELOPMENTAL ROADS FUND—			
Construction of Roads and Bridges	164,027 17 1	5,533 10 10	169,561 7 11
Survey, Design, Supervision and Administration	8,560 8 2	1,136 4 11	9,696 13 1
Miscellaneous	10,708 16 4	16 0 5	10,724 16 9
Totals	183,297 1 7	6,685 16 2	189,982 17 9
SUMMARY ALL FUNDS—			
Construction of Roads and Bridges, including Resumptions	1,364,950 11 10	99,866 7 1	1,464,816 18 11
Maintenance of Roads and Bridges	719,184 9 11	48,352 3 10	767,536 13 9
Repayment of Loans	187,016 18 8	14,412 17 0	201,429 15 8
Survey, Design, Supervision and Administration	141,186 6 4	12,424 9 9	153,610 16 1
Miscellaneous	77,513 14 5	4,620 3 10	82,133 18 3
GRAND TOTALS	2,489,852 1 2	179,676 1 6	2,669,528 2 8

Wagonga Inlet Bridge, Narooma.

ON 20th June, 1931, the new steel and concrete bridge over Wagonga Inlet at Narooma was officially opened to traffic by Mr. H. J. Bate, M.L.A., on behalf of the Eurobodalla Shire Council. In striking evidence of the interest which the event created, both locally and throughout the whole length of the highway which it serves, over 1,000 persons were present, some coming from the metropolis and others from as far south as Eden.

Morison and Bearby, of Newcastle, and the whole of the remainder of the work by the State Monier Pipe and Reinforced Concrete Works.

The bascule span, which is of a unique type so far as New South Wales is concerned, having been adopted on account of the lesser cost as compared with other types, and of the infrequency of the openings which will need to be made for shipping purposes, was a matter of special interest. No difficulty was found in



The new Wagonga Inlet bridge shortly before the opening ceremony. The former ferry is shown on the right. Pile dolphins to protect the centre piers from vessels using the opening span have yet to be constructed.

An account of the steps taken in connection with the substitution of a bridge for the ferry then in use was given in the September, 1929, issue of *Main Roads*. Since then the work has proceeded without incident and has been completed within the allotted time. The rock upon which the cylinders for the two main piers is founded was found to be at the level previously ascertained by borings, and shown on the contract plans, but, on exposure under compressed air, was ascertained to be somewhat shattered, necessitating sinking the northern and southern piers a further 5 and 8 feet respectively, in order to secure solid foundations.

The total cost of the work has amounted to £12,267 7s. 6d. for the manufacture and supply of the steelwork, and £30,000 (approximately) for the construction of the foundations and approaches, the erection of the steelwork, and the completion of the bridge, or a total of £42,267 7s. 6d., as compared with the original contract total of £41,762 19s. 1d. The manufacture and supply of the steelwork was carried out by Messrs.

securing satisfactory balance after erection by adjusting the weight of the counterweight. The moving weights (*i.e.*, the bascule span and the counterweight) aggregate more than 200 tons, but the bridge can be opened by hand by one man in twelve minutes. It has, therefore, fulfilled all expectations.

The bulk of the material used in the bridge was of Australian manufacture, except the large steel plates in the bascule span and the cross-girders, and the two nickel steel shafts and the ball and roller bearings for the bascule operating mechanism, which had to be imported from overseas.

The contrast between the new bridge and the ferry which it has replaced is well shown in the accompanying illustration.

Prince's Highway, Nowra-Eden.

The widening and reforming of the Prince's Highway between Nowra and Bodalla and between Eden and Pambula has been suspended, consequent upon the curtailment of Federal Aid funds.

The Development of Lane Cove Road (Pacific Highway) in the Municipality of Ku-ring-gai.

BY LIONEL J. PRICE, M.C., B.E., A.M.I.E. AUST.

Municipal Engineer.

TO the average citizen a road is simply an open way left for his convenience in travelling from point to point. Whether or not it is constructed and the type of construction depend very much on the municipality or shire in which it is situated, the amount of residential occupation adjacent to the road, and its own relationship as a means of transport between adjoining districts. If it is sufficiently important in this last respect, then it is eligible for proclamation as a main road and, after proclamation, for assistance from one or other of the funds administered by the Main Roads Board. The appearance of its footways, while dependent on the first two factors, also reveals the character of the adjoining resident. More often than otherwise, however, his interest is concerned with the smoothness of the running surface of the carriage-way and top-gear car performance; it is something which soaks up his annual rates to the council, but beyond that, the road means nothing to him. To the engineer, roads frequently mean much more, and many a road has a history which is worth recording—others have histories which are better left unwritten or buried in oblivion.

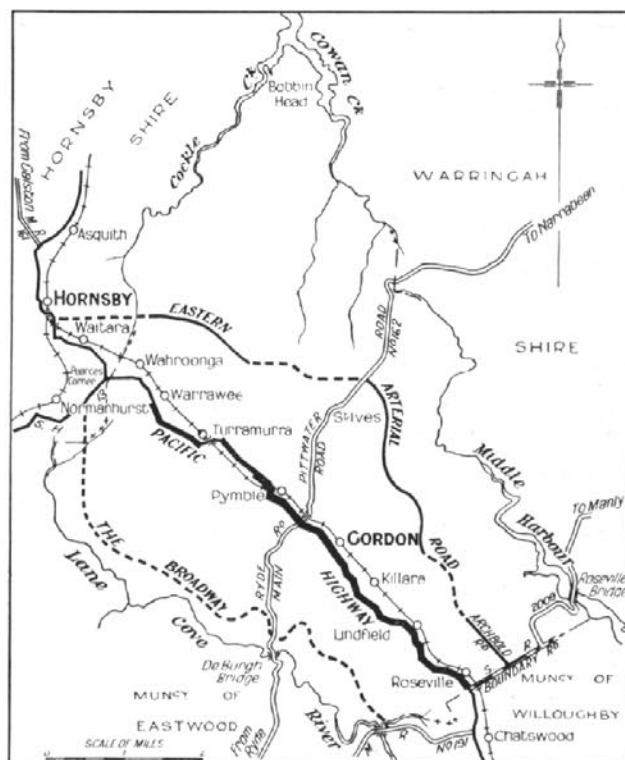
The Lane Cove road, forming now part of the Pacific Highway, was, in the early twenties of this century, well in the latter class and had a reputation equal to, if not blacker than, the notorious Parramatta-road at that time; since then it has been making history which is possibly worth recording, and it is with this objective that this paper has been written.

Those familiar with the northern suburbs will know the general locus. The highway swings—or soon will swing—from the northern end of the Harbour bridge, through the Municipalities of North Sydney, Willoughby and Ku-ring-gai to Hornsby Shire at Pearce's Corner, where it collects the Sydney-Newcastle traffic approaching from the western suburbs. This paper deals particularly with that section within what was prior to 1928 the Shire and is now the Municipality of Ku-ring-gai—a length of $6\frac{3}{4}$ miles.

It will be seen from the locality sketch on this page that the Lane Cove road runs closely parallel to the Milson's Point-Hornsby railway line and passes through the suburbs of Roseville, Lindfield, Killara, Gordon, Pymble, Turramurra, Warrawee, and Wahroonga. Midway along its length it is crossed by the Ryde-Pittwater road (Main Road No. 162), carrying traffic from the western suburbs to Narrabeen on the coast. Secondary Road No. 2009 leaves it at the Willoughby boundary (Roseville) and running east carries traffic across Middle Harbour at Roseville bridge to the coast at Brookvale.

History up to 1922.—Of the original location and design little can be said. Obviously its general position was fixed by nature along the watershed between

Middle Harbour and the Lane Cove River, the steep gullies running off at each side confining it to definite limitations for the greater portion of its length. Had the first bullock team or settler's cart been driven with a little more care, a few of the ninety bends now existent in the $6\frac{3}{4}$ miles might have been avoided. Evidently super-elevation was not at that time a serious consideration unless accidentally caused by a fallen log or a hidden stump! In this, as in other respects, the story of the Lane Cove road is similar to hundreds of other roads.



Sketch map showing existing and possible future main roads in the Municipality of Ku-ring-gai.

The Pacific Highway is shown widened on one or both sides, and the approximate location of future roads is shown dotted.

Early construction was of local ironstone gravel from the St. Ives district, succeeded in the northern section by white metal (metamorphosed sandstone) hewn principally from the quarries which have more recently provided the foundation for the work now in progress, the metal being then hand broken and now crushed by machinery. The southern or Roseville end was partly sheeted with white metal and partly with South Coast blue metal (basalt)—each successive treatment increasing the convexity. By 1915 the motor-car had commenced to take toll on a road which had hitherto been

maintained in reasonable order by Government grant augmented by council's funds. Maintenance expenditure at that time averaged £4,000 per annum, and was increasing rapidly in proportion to the increase of motor traffic. This brought about the first attempt at comprehensive reconstruction, for which a scheme was put forward, involving an expenditure of £15,000 from loan funds at $4\frac{1}{2}$ per cent., to recondition with blue metal and to tar seal the surface in shopping centres "as an experiment." This form of construction with continuous tar surface treatment would have maintained the road in good order for the traffic of that time. However, after a bitterly-fought contest at a subsequent poll, the loan proposal was defeated by one vote, the objectors drawing harrowing pictures of a bankrupt shire.

Subsequently, by dint of the unsatisfactory practice of purchasing blue metal on three or four years terms, the road was in part resurfaced as far as funds permitted. In this respect, the shire report of 1915 has an



Lane Cove road at Isis-street. The left foreground shows differing levels of kerb and the 1923 roadwork, which constituted the chief problem in widening the carriageway. The right background shows property boundaries moved back to the ultimate roadway width of 84 feet.

interesting comment: "The work now being carried out is permanent and will not require renewing for some years." It is said, "Without vision, the people perish," and surely the vision of 1915 was sadly limited, for within eight years every ton of metal laid as "permanent" was torn up—at least such metal as still remained—and an asphaltic concrete pavement laid from end to end! The great development in methods of road construction and the altered outlook of the general public towards roads which has taken place since that time is well exemplified in this road which, begrudged the comparatively small sum of £15,000 in 1915, was furnished with a new coat on the central 18-foot strip in 1923 at a cost of £66,250, and is now receiving the balance of its suit of roadway, kerbing and paving at a cost of about £120,000, the asset created in 1923 being still in excellent order. From £15,000 to £180,000 capital expenditure! From £4,000

per annum to practically nothing in maintenance expenditure! Surely such a revolution is worth recording!

1922-1925.—But such a change was not wrought without another storm in the teacup. If space permitted, it would be interesting to refresh the minds of those engineers, who at the time were interested in an attempt to construct the longest single length undertaken by a local government body using what was then (for Australia) an entirely new form of construction, viz., asphaltic concrete, by tracing through the immense amount of technical evidence taken during the twelve-day local government inquiry which was held on the council's proposal to borrow £60,000 for the work of reconstruction. The Commissioner appointed to conduct the inquiry, Mr. H. H. Newell, M.Inst.C.E., is now a member of the Main Roads Board. The proceedings opened at 10 a.m. on Wednesday, 15th November, and were concluded at 1 p.m. on Saturday, 2nd December, 1922, Dr. Brissenden, K.C., appearing for the council of the Kuring-gai Shire, other King's Counsel who appeared for interested parties being Messrs. E. J. Loxton, Richard Windeyer, and S. Mack. The report of the investigation into the proposal is a valuable treatise not only on this particular road but on asphaltic concrete construction generally. Published by the council in January, 1923, its forty-eight pages of technical report are available to anyone interested. For this reason the careful study of mixtures, types, and methods are not dealt with in this paper.

The proposal in 1923 was to recondition the road for $6\frac{3}{4}$ miles on a width of 18 feet, alternative tenders being invited for cement concrete, asphaltic concrete, and combinations of the two types. By virtue of the assumed strength of the existing foundation—initially somewhat over-estimated—the asphaltic concrete, taking into account first cost, interest on outlay and maintenance, proved the cheaper, and was adopted as the basis for the contract. The original proposal to reshape the existing base, adding blue metal at quantities estimated from 3,000 to 10,000 tons, was amended on the recommendation of a board of experts consisting of the late Professor Warren (then Dean of the Faculty of Engineering at the University of Sydney) and Mr. James Vicars, M.E., M.Inst.C.E., Consulting Engineer, to whom the contract was referred by the council, so as to provide for a minimum depth of 6 inches of water-bound macadam, and thereon to lay a 3-inch asphalt macadam base consisting of $1\frac{1}{2}$ -inch blue metal coated with not more than 10 per cent. (!) of bitumen in the mixer. Undoubtedly the provision of this black base kept the first five years' maintenance down to a very low figure, and permits the road now—i.e., after eight years—to be maintained at less than 6d. per square yard per annum.

The maintenance application for the year 1931-32 in respect of 156,000 square yards of asphaltic concrete laid under the original contract and subsequent widening of the pavement is based on an average rate of 2d. per square yard per annum, a rate which was found to be adequate for the 1930-31 grant.

Much disputation occurred at the inquiry as to the relative values of coarse-graded asphaltic concrete (as Warrenite) and Topeka with $\frac{1}{2}$ inch maximum stone,

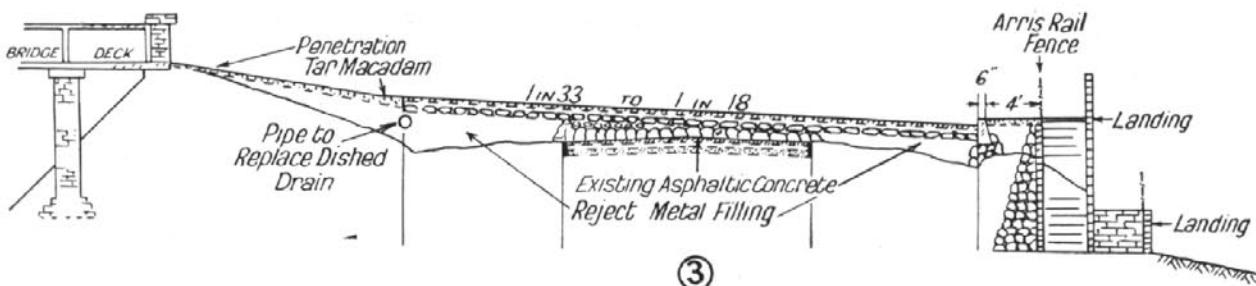
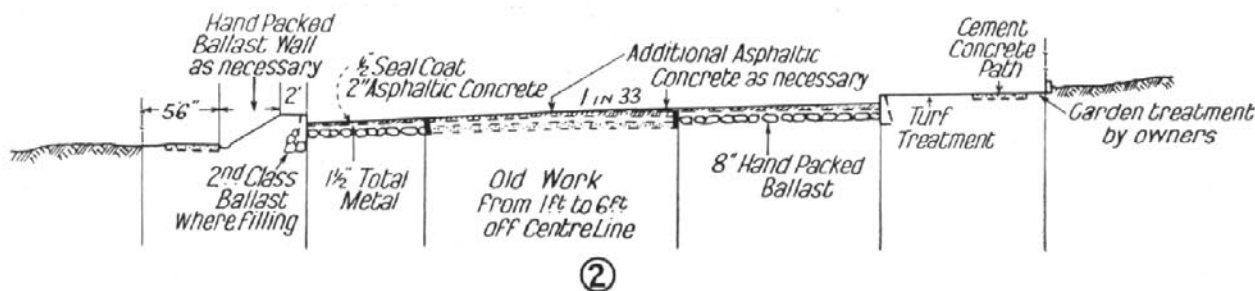
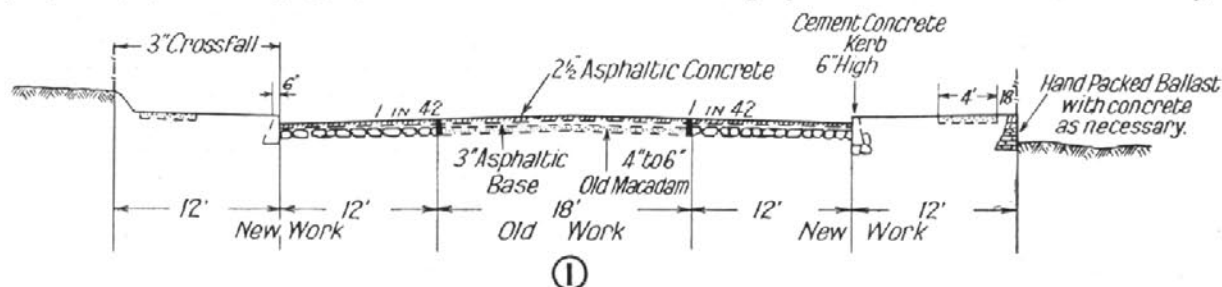
the relative values due to additional possible mechanical bond being quoted as 100 : 80, but finally a coarse-graded aggregate type (1 inch downwards) was adopted, sealed with a 90/100 bitumen squeegee coat and covered with 5/16th inch blue metal screenings.

The design problem in 1923 presented two alternatives—

- (i) To utilise the existing foundation, and
- (ii) To lift the metal in the base and use it for shoulders, the levels being set down to accommodate existing footpath levels as far as practicable.

At first glance, proposal (i) appears the more economical, particularly if widening to 42 feet was not in the immediate vision; permanent construction supports proposal (ii). Actually (i) (which was the

of the contemplated levels to the ultimate full width construction were unfortunately not given as serious consideration as the position justified. Had this been done originally, many of the difficulties of the present work might have been lessened or have become non-existent. It came somewhat as a surprise to those actively engaged in the contract to see the effect of the reduction of convexity from the existing 6-10 inches (in 18 feet) to the proposed 1½-2 inches. Either the crown had to be cut down, with reduction in foundation strength, or the outer edges built up, necessitating in turn additional material outside the asphaltic concrete pavement itself. Construction developed into striking the mean between the two alternatives, and left the cocking up of the shoulders and, incidentally,



1. A normal cross-section of the new work, showing the original pavement and the treatment of properties above and below the new path levels.
2. A super-elevated cross-section, showing treatment of abnormally low properties on the inside of the curve.
3. Special treatment at Pymble, where the original pavement was abandoned to secure suitable grading to an overhead railway bridge, and properties were considerably below road level.

course adopted) has involved an expenditure of £66,250, plus the cost of lifting levels in conjunction with the present widening—a total of approximately £75,000. The lowest tender for a reconstructed base works out, for pavement alone, at £88,322, giving a total of approximately £95,000, so that the proposition as adopted, while leaving many difficulties to the future, was reasonably sound. Despite the extended argument on the above features, *inter alia*, the effect of the proposed construction on the existing foundations and convexity and—more important still—the relationship

the lifting of the footpaths as a future problem. Provision of super-elevation at the sharper curves at least would have assisted the ultimate design. Fortunately, in the more recent work, the facility with which new asphaltic concrete can be placed over old work made super-elevation practicable without pulling up the original pavement.

The Sunday afternoon or kerbside specialists in road construction—of whom Ku-ring-gai has its full quota—condemned the work from the start, and the slightest surface ripple was heralded as the

destructive corrugation preparatory to the end. The condition of the central 18-foot strip after seven years of punching by traffic is, however, just one more instance of the wisdom of entrusting engineering work to engineers and relying upon the



Upper, footway pavement, kerb and ballast base course under construction.

Lower, footway, kerb and widened base course complete, with similar work proceeding on the opposite side of the road.

sound judgment of experts rather than on the casual criticism of the ill-informed. The contractor's plant—a standard Cummer—proved anathema to the local lovers of virgin bush and rose gardens, who were

unable to see in the mass of steel junk and dirty bricks a potential moneymaker, and against its noise, smoke and dust legal injunctions arose. Of these I will say nothing. All combined to lift Kuring-gai out of the rut—literally—and, its main spinal column restored to effective service, the whole body began to feel the impulse of a new life.

Some detailed particulars of the contract may be of interest. Undertaken by council from loan funds prior to the Main Roads Act, work was commenced by W. B. Carr Construction Company, in April, 1923, under the supervision of the Shire Engineer, Mr. T. H. Kirkpatrick, M.Inst.C.E., and completed in May, 1924. The contract included scarifying the existing foundation and reshaping, except where the convexity was so great as to render such treatment impracticable, and laying 75,705 square yards of pavement over black base. The work was completed in the contract time of forty-three weeks at a total cost of £66,250 14s. 5d. Approximately 11,000 tons of metal were used through the mixing plant in preparing the black base, and 5,000 tons of dry metal in shoulders and foundation.

The total cost per square yard of pavement laid was as under:—

	Per sq. yd.
Excavation, including scarifying and reshaping	0.54s.
Shoulder metalling, &c.	2.25s.
Black base	4.18s.
Wearing surface	10.00s.
Incidentals	0.53s.
Total	17.5s.

For comparison of the above figures with later works on this road or similar works elsewhere, it should be stated that labourers' wages were £4 13s. 6d. per week, and blue metal of 1½-inch, ¾-inch, and 5-16th inch gauges, cost 12s. 6d., 13s. and 14s., respectively, f.o.r., railway sidings.

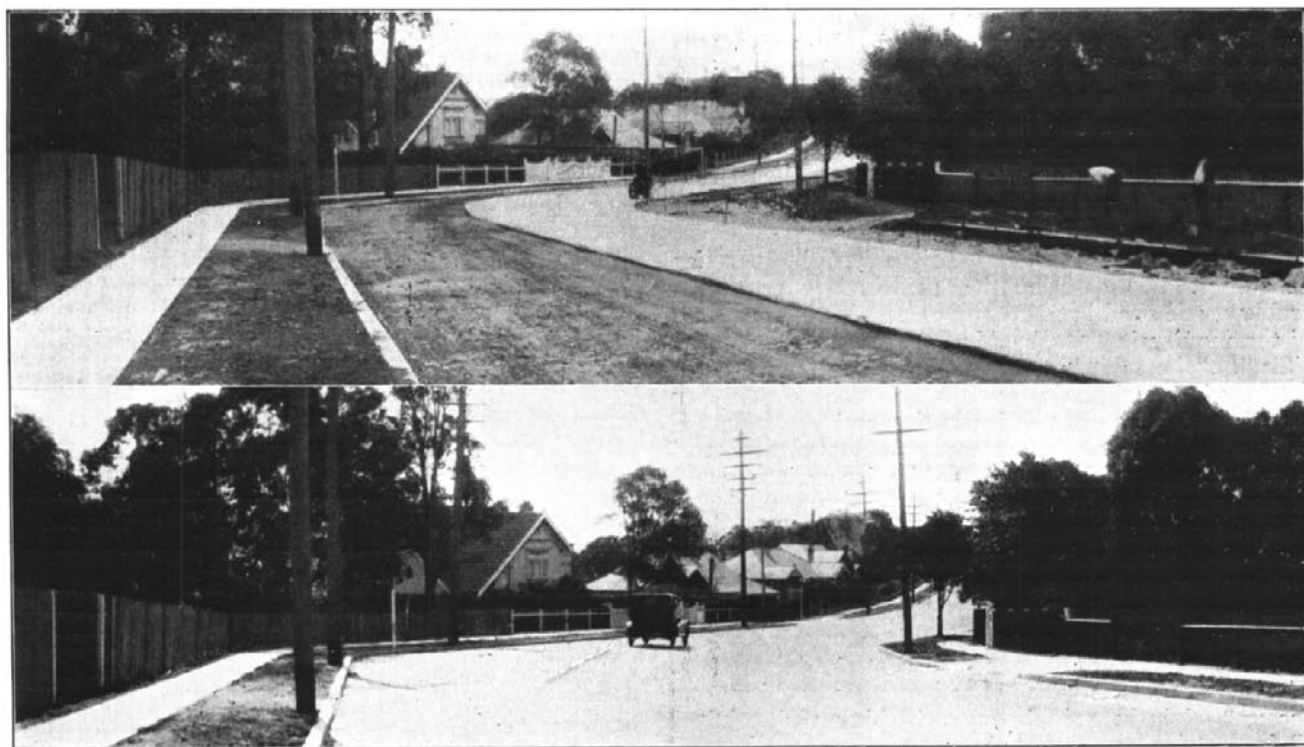
1925 et seq.—As forecasted by the board of experts who recommended initial construction to 27 feet, the 18-foot constructed carriageway soon proved too narrow. The increase of week-end tourist traffic which followed the completion of the contract, together with the construction of the Sydney Harbour Bridge and the decision by the Main Roads Board to complete the Sydney-Newcastle road (of which the Lane Cove road forms a part), within a few years made it imperative that a wider pavement should be provided and the deep unsafe watertables, shown in the illustration on page 174, obliterated in order to cope with the actual and anticipated increase in both daily and week-end traffic. Accordingly, in 1927, the Main Roads Board approved of a proposal submitted by council to complete the asphaltic concrete construction for the full width of 42 feet, concrete kerbing being run continuously and a concrete footpath 4 feet wide being laid in lieu of the old tar-paving which had been destroyed by traffic during the 1923 contract. The council undertook to carry out the work in its entirety, inclusive of the asphaltic surface, to a predetermined time schedule. For the purpose of manufacturing and laying the surface, council erected a modern plant, the details of which have been already fully described by the author.*

* See paper, *Ku-ring-gai Municipal Works Depot*, published in *The Australasian Engineer*, vol. 29, No. 152, 28th February, 1929.

The time schedule, which involved a programme of four years, evoked some criticism. Few motorists could see any reason why ballast laid to-day should not be treated with a wearing surface of asphaltic concrete next day for their week-end convenience. Compaction by traffic of the ballast foundation was, however, determined upon as an important feature to secure an open mosaic surface for pavement bonding, to further test the stability of the work over old watertables and to permit of complete settlement over excavations for the removal of mains. The programme further gave the Board opportunity to gradually acquire essential properties to permit of immediate improvements at bends and ultimate widening to 84 feet, with which, in view of the great prospective traffic and business development along this route, it had by this time also decided to proceed as occasion offered.

The construction of the footpaths calls for little comment. Levels were raised as necessary, dry rubble walls constructed to prevent pressure against front fences, driveways, and paths adjusted to suit, and a 4-foot strip of concrete footpath laid for the full length of the roadworks. A width of 18 inches has been left between the footway slab and fences for garden treatment, and the remaining 6 feet between slab and kerb is gradually being developed by residents as a continuous lawn, with very pleasing results. Kerbing is laid continuously and is capable of being lifted and reset when the road is widened to 84 feet. The gutter is of asphaltic concrete, laid as part of the carriageway.

The road pavement work comprised the widening of the existing asphaltic concrete to a total width of 42 feet by adding 12 feet on each side, together with



A corner near Roseville. Upper, ballast and white metal on the widened portion of the roadway ready to receive the surface course, with the original pavement in the centre, and kerbing and footway paving proceeding. Lower, the completed work.

The major problem of design in 1927 proved to be—

- (i) The accommodation of the existing pavement, not always rigidly true to levels and convexity and with scars of four years' wear, with rigid kerblines.
- (ii) The fixing of these kerb levels within the limits of M.R.B. crossfalls so as to bury existing properties as little as possible, and minimise the cost of alterations to properties and consequent objections of ratepayers.
- (iii) The provision of super-elevation where necessary without re-sheeting the outer half of the existing strip.
- (iv) The necessity for the immediate work to conform to the ultimate levels for an 84-foot road.

The cost of the road pavement, the expenditure on alterations to properties and the complete absence of legal difficulty are sufficient evidences of the mutual consideration and adjustment which have been achieved.

its extension to a total width of 60 feet wherever the Board has been able to acquire the land for the ultimate width of road aimed at. The foundation consisted of hand-packed spalls, hewn at council's quarry, $1\frac{1}{2}$ miles from the centre of construction, and sheeted with white metal crushed at the same quarry. After consolidation by rolling, traffic completed the tightening process and roughened the surface to permit of the maximum mechanical bond between pavement and foundation. Asphaltic concrete consisted of coarse graded aggregate ($1\frac{1}{4}$ inch downwards), sealed with sheet asphalt laid at a rate of 40-50 lb. per square yard. The first year's work (undertaken in 1927) utilised South Coast basalt, and the balance Nepean crushed gravel. The details of the mixture and plant operation

have already been described by the author,* and are accordingly not further discussed. The average weight of pavement laid is 6.64 square yards per ton.

As the result of experimental work carried out in conjunction with main road work, a comparatively new type of hot mix pavement has been developed for use on residential streets, which is possibly adaptable to main roads. With a view to minimising the quantity of imported material necessary, a heavy grade horizontal retort tar from B.H.P. Byproducts Pty. Ltd., Newcastle, has been substituted for the bitumen in the coarse graded section of the road, the sheet asphalt being laid slightly heavier than hitherto and using 60-70 or 80-100 penetration. By plant manipulation and adjustment in laying the material, the necessary increase of temperature in the fine aggregate is obtained as the sheet asphalt is being prepared. A temporary thinning agent was also used to facilitate mixing at temperatures slightly below those normally used for sheet asphalt, and proved very successful. In appearance the road is no different from sheet asphalt. It is a class of road of which several thousand square yards have already been laid in Kuring-gai, and can be recommended as a practical means of increasing tar consumption, reducing imports for black top roads and incidentally cheapening the actual cost of the work without unduly sacrificing efficiency.

Construction, as well as design, had its peculiar difficulties. To describe the principal construction problem, one need but quote an extract from the report of the inquiry in 1923 by Mr. Newell: "Much of the difficulty," he said, "is attributable to the treacherous nature of the subgrade which is liable to give one, by its appearance, a sense of security entirely false. I believe that if a section were reconstructed now and closed altogether to traffic, wave-like depressions would in a comparatively brief space of time become evident." This defective subgrade, intersected by heavy cuts for removal of watermain, &c., proved a rather harassing problem, especially when the traffic, which might have been useful for finally compacting and testing the shoulders before the wearing surface was laid, very naturally adhered to the excellent central 18-foot strip. The inability to secure effective cross rolling, on account of locking in between kerbing and original 18-foot strips, necessitated recourse to a diagonal rolling action possible only with expert handling of a tandem quick reverse roller.

At the present time, full width construction from Roseville to the northern connection with Pittwater-road, *via* Telegraph-road, is complete, and one side only is widened to Pearce's Corner, completion of this side being scheduled for 1931. The year 1932 will, it is hoped, see the opposite side ballasted, with kerbing and paving and the hot mix surface laid in 1933, when the impulse of the Harbour Bridge traffic, and that caused by improved economic conditions generally, may reasonably be anticipated.

In conjunction with road construction to 66 feet alignments, the Board has acquired from time to time, from vacant or slightly improved properties, an 18-foot strip to secure the ultimate 84 feet objective, and, as finances permit, is tackling urgent widenings for faci-

tating traffic movement within the present alignments. Some idea of the progress made and the problems still remaining may be gathered from the illustrations.

No descriptive paper would be complete without some information as to progress and costs. The laying of asphaltic concrete on the main road was interspersed with similar work on the council's other roadways.

The following costs are taken to 22nd November, 1930, and cover 68,000 square yards out of a total of approximately 100,000 to be laid.

Description.	Quantity.	Rate.	Cost.
		s.	£ s. d.
Excavation ...	81,377 sq. yds.	2.64	10,775 9 10
Ballast ...	32,964 tons	10.99	18,118 12 3
Filling under kerb ...	1,463 "	4.66	341 0 9
Asphaltic concrete ...	67,916 sq. yds.	6.99	23,755 9 9
Rolling and blinding ..	68,315 "	0.68	2,307 11 2
White metal ...	8,537 tons	14.27	6,091 10 6
Concrete kerbing ...	16,140 l. yds.	8.88	7,161 5 4
Concrete paving ...	22,327 sq. yds.	8.55	9,549 2 3
Filling on paths ...	8,951 tons	2.18	975 9 4
Sumps ...	22	82.9	91 5 10
Street crossings ...	41	297.4	609 15 8
Alteration to levels ...	17	172.3	146 9 3
Subsidiary water tables.	413 yds.	2.57	53 2 0
P.M.G. conduits ...	59	154.8	456 14 2
Retaining walls ...	Lump sum	...	1,238 7 3
Alterations to private properties.	"	...	2,593 19 0
Holidays and insurance.	"	...	1,203 5 6
Contingencies ...	.....	...	1,076 18 9
Total ...	...	...	£ 86,545 8 7

To the lay reader these costs are of more interest expressed in terms of so much per square or per lineal yard of the various main groups of work. Doing this, the following result is—

Nature of Work.	Item.	Unit Cost.	Total Cost.
Roadwork—		s.	
Foundation ...	Excavation	2.64	.....
	Ballast ...	4.45	.....
	White metal	1.48	.....
	Rolling and blinding.	0.40	8.97s. per sq. yd. of road.
Surface ...	Asphaltic concrete.	6.99	.....
	Rolling asphaltic concrete.	0.28	7.27s. per sq. yd. of road.
Footpath—			
Kerbing ...	Filling ...	0.41	.....
	Concrete kerb.	8.88	9.29s. per lin. yd.
Paving ...	Filling on paths.	0.29	.....
	Concrete paving.	8.55	8.84s. per sq. yd. of paving.
Miscellaneous—			
Drainage, sumps, &c.	.....	0.35	.....
Adjustments to intersecting streets.	.....	0.18	.....
Alterations to P.M.G. and City Council conduits.	.....	0.11	.....
Retaining walls ...	.....	0.34	.....
Alterations to private properties.	.....	0.64	.....
Holidays and insurance.	.....	0.29	.....
Contingencies ...	.....	0.26	2.17s. per sq. yd. of road.

* See paper entitled *Asphaltic Concrete Road Construction*, published in *The Australasian Engineer*, vol. 30, No. 169, 7th July, 1930.

The proportion of wages, stores, &c., to total costs is as follows:—

	Per cent.
Wages (including proportion of ballast but excluding those involved in asphaltic concrete)	42
Wages (including proportion of ballast and asphaltic concrete)	50
Asphaltic concrete (including plant and labour)...	23½
Plant charges (excluding asphaltic concrete) ...	14½
Stores and materials	13
Holidays and insurance	4
Miscellaneous charges	2

Figures relative to average output have been given in a previous paper, but the following one day's run may be of interest:—

Location.—Pymble Hill, east side, adjacent to Telegraph-road.

Mixer.—800 lb. batch.

Output (8½ hours).—145 tons 5 cwt. 3 qrs.

Area laid.—1,001 sq. yds.

Weight per sq. yd.—6·81 sq. yds. per ton.

Distance from mixer.—0·9 mile.

Haulage (2 lorries).—1s. 2d. per ton mile (1·726d. per sq. yd.).

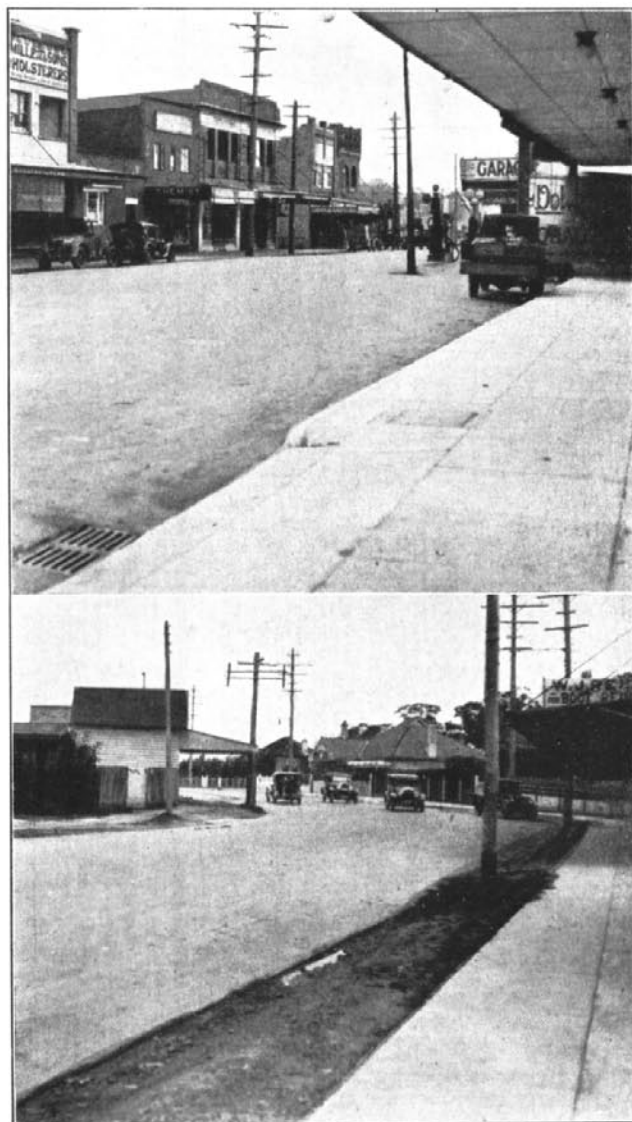
Rolling.—1·23d. per sq. yd.

Labour.—1s. 3d. ton (2·102d. per sq. yd.).

This large construction job—one of the largest in point of area and value authorised by the Main Roads Board to be undertaken by a council by day labour—shows how it is possible for the Board and a council to co-operate to mutual advantage. The Board has been able successively and profitably to increase and amend the areas for construction and the design included in the original plans, as negotiations with adjacent owners became finalised, without any complications by reason of contract adjustments. The cost of the asphaltic concrete and other works indicate that nothing has been lost under day labour control—rather a good road has been secured well below ruling contract rates. The figures of cost given for the central 18 feet and the recent widening provide further interesting comparisons, after making due allowance for the different classes of foundation work. The council has also benefited by the fact that the volume of work under this job, added to the council's works programme, has rendered possible the establishment of its works depot as an economic unit; it permitted the development of its white metal quarry, on an annual output of about 70,000 tons, to a point where ultimate working will render it possible to handle even larger construction works with greater facility. The absorption of a large proportion of labour, despite the use of all possible machinery, provided employment to labourers from this and adjoining municipalities.

As a matter of general economics, particularly in view of the present national position, this road is also of special interest. Due to the use of local materials, less than 18 per cent. of the total cost is represented by materials purchased outside the municipality, of which approximately 5 per cent. is imported in the form of bitumen and 13 per cent. is blue metal, sand, and cement for the road pavement, kerbing and guttering, and paving. The price paid for imported material (including all taxes, duty, cartage, &c.) represents approximately 1s. 3d. per square yard of pavement laid—a relatively small total. Further development of types of roadway which will economically absorb a high percentage of labour, a large proportion of

materials obtainable in close proximity to the work and a minimum of other materials which necessitate importing, would appear to be one of the local government engineers' most important present studies.

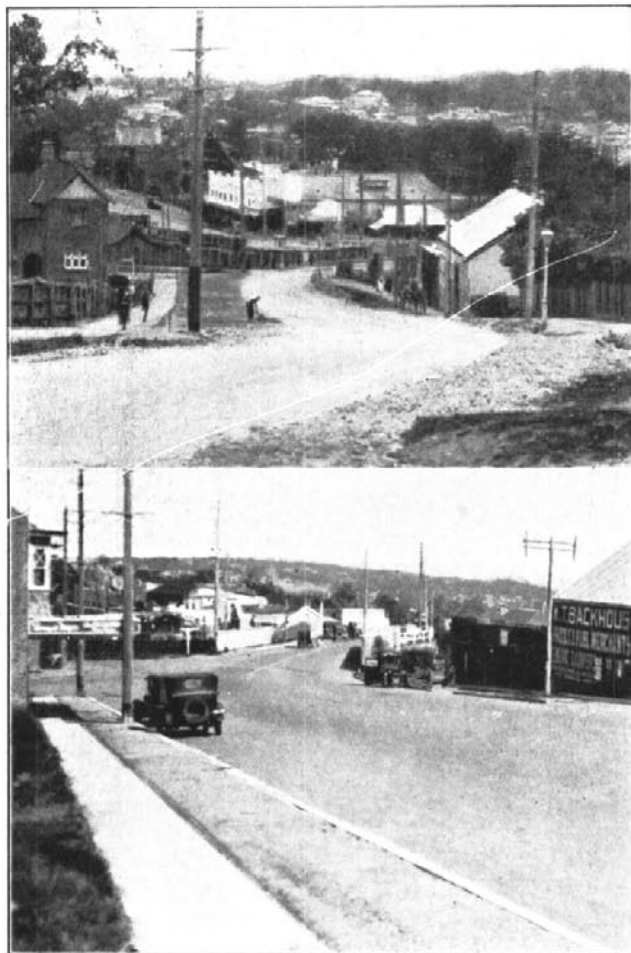


The Pacific Highway in Lindfield.

Upper, the shops on the right are built to the widened alignment (84 feet), those immediately to the north being still on the old alignment (66 feet). When they are rebuilt, the widening will be extended northwards. Lower, from the same point as the upper view, but looking south. The weatherboard structures are soon to be demolished and the road widened on the inside of this bend.

The Future.—To relieve further the future traffic on the highway, new roadways are being planned, in collaboration with the Main Roads Board and neighbouring councils, as part of a supplementary through system from Hornsby to the Sydney Harbour Bridge. On the western side, the "Broadway"—a scenic route 120 feet in width—follows the valley of the Lane Cove River, crosses Ryde-road (Main Road No. 162) near De Burgh's bridge and enters Willoughby municipality at the eastern end of Fuller's bridge. On the east a

similar route passes through North Turramurra, crosses Pittwater-road (Main Road No. 162) at St. Ives, and thence along the foreshores of Middle Harbour to and through other municipalities to the bridge (see locality sketch on page 173). Land for both routes is now almost wholly acquired, important connecting sections have been constructed and the completion will follow as the years demand.



Pymble Hill and Pymble Bridge.

Upper, the original construction, 18 feet wide.

Lower, the carriageway after construction to a width of 42 feet between kerbs.

Finale.—This then, in brief, is the story of the development of the Lane Cove road in the Municipality of Ku-ring-gai from a bush track along which our pioneers pushed out towards the north from the first settlement at Sydney Cove to the great national highway of which it now forms a part, connecting the two chief centres of population in New South Wales (Sydney and Newcastle) and the capitals of two States (Sydney and Brisbane). Possibly other engineers have roads with a history in their areas. Too often, through pressure of other duties, we neglect to write the history which the road is making. In so doing we fail in our duty to our fellow engineers and to posterity, and this paper is written—while partly technical—essentially to stir up interest in the Romance of the Road.

The Federal Highway.

A COMPREHENSIVE review of the selection of the route and the construction of the Federal Highway—the principal avenue of approach to Canberra from the north—was given in January, 1930,* when the bulk of the necessary work between Collector and the Federal Capital, both in New South Wales and the Federal Capital Territory, was either complete or in progress. Since that date, the whole of the projected work in both areas has been finished—the section in New South Wales having been opened to through traffic on 20th November, 1930, and that in the Federal Capital Territory shortly after, on 24th February, 1931.

The table on page 181 sets out the particulars of the work done in New South Wales, commencing from Collector and proceeding continuously towards Canberra.

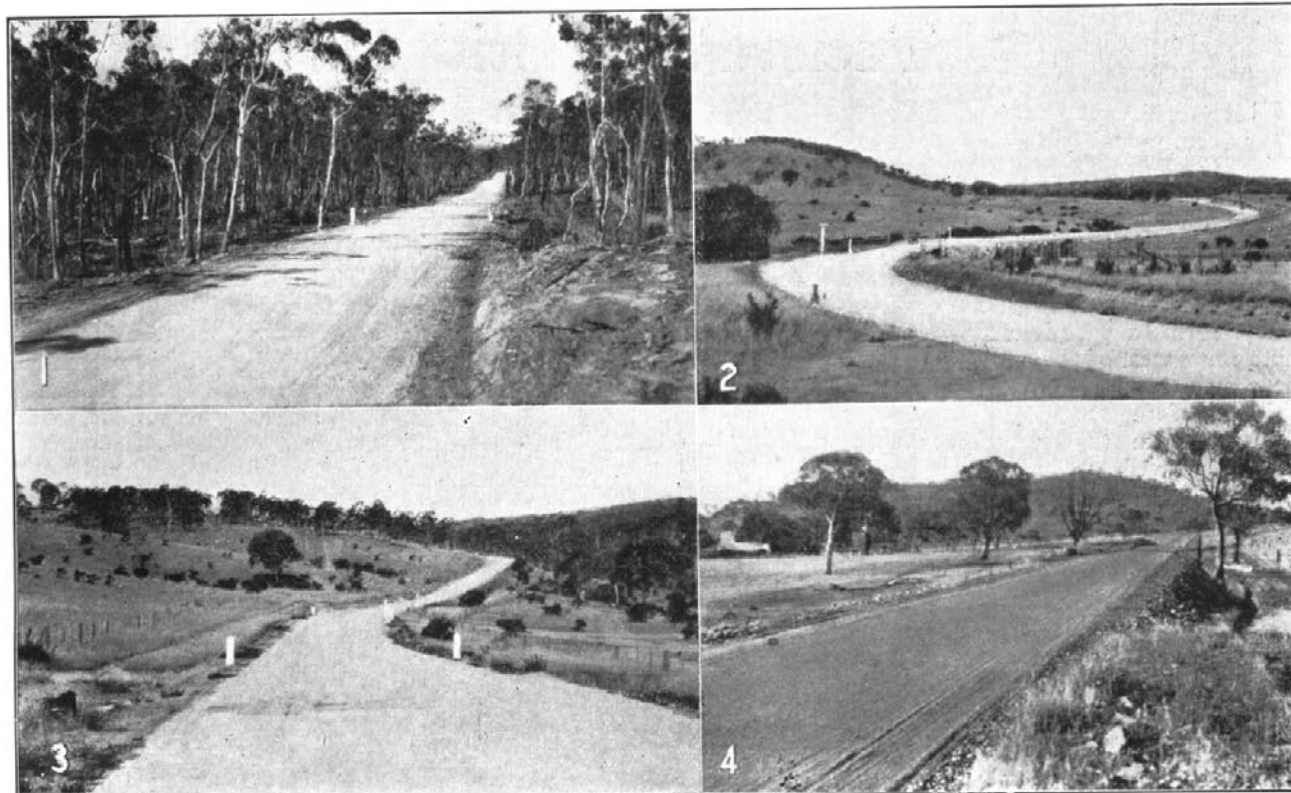
The varying costs per mile for the four main sections into which the road work was divided reflect the variations in the amount of earthworks involved and the relative difficulties in securing material for construction. Thus for section 2 for which a similar class of pavement (bitumen penetration) was adopted as for section 3, earthworks were much lighter, and gravel for base course more readily procurable. In addition, price levels fell appreciably between February, 1928, when the contract for section 3 was let, and August, 1929, when section 2 was commenced. Similarly on the two gravelled sections—Nos. 5 and 7—the earthworks on the former were lighter than on the latter, while gravel for both was obtained from sites close to the road. The use of bitumen penetration on the first two sections was made necessary by the absence of suitable local gravels for the surface course at an economic rate. It will be noted, however, that throughout, to the greatest degree practicable, local materials were utilised. This, besides keeping the first cost down to a minimum, has, in the case of the two sections where gravel has been used for the surface course, made it possible to maintain the road very cheaply by means of graders and drags. At a later stage, when the traffic develops to such a degree as to warrant the use of a higher class of pavement, this can be added on top of the gravel without discarding the asset already created, and thus by a policy of "stage construction" the road can be progressively improved.

In the Federal Capital Territory, suitable gravel was not available; the Commonwealth Department of Works and Railways has therefore constructed and surfaced its section with mixed-in-place tar macadam.

It will also be noted from the table that the bulk of the work has been undertaken under a special agreement with the Commonwealth Government, by which the Commonwealth, apart altogether from the Federal Aid Roads agreement, undertook to contribute two-thirds of a total of £200,000 for the work, on condition that the State contributed the remaining third.

Between Yarra—the point at which the Federal Highway junctions with the Hume Highway—and Collector, a length of 3 miles 900 feet, commencing 3 miles 700 feet south-west of Yarra, traverses a low flat in swampy country. The reconstruction in gravel of this section was commenced by the Mulwaree Shire Council on behalf of the Board in March, 1931, as a

*See *Main Roads*, Vol. I No. 4, January, 1930, page 86.



1. and 3. Gravel pavement between the Yass River and Geary's Gap (Lake George).
2. Looking towards Goulburn over the Yass River bridge. 4. Mixed-in-place tar macadam within the Federal Territory.

Section.			Class of Work.	Contractor's Name.	Cost to 31st May, 1931.	Source of Funds.	Cost per Mile.
No.	Limits.	Length.					
		m. ft.			£ s. d.		£
1	0 m. to 3 m. 3,800 ft. ...	3 3,800	Maintenance of existing gravel only proposed.	.....	.....	.....	...
2	3 m. 3,800 ft. to 6 m. 3,800 ft. (shown on design plans as 0 m. to 3 m.).	3 0	Bituminous penetration surface course, 3 in. thick; gravel base course, 6 in. thick.	Messrs. John Fowler (Aust.), Ltd.	12,598 8 10	Federal Aid Roads Fund.	4,200
3	6 m. 3,800 ft. to 12 m. 2,020 (shown on design plans, 0 m. to 5 m. 3,500 ft.).	5 3,500	Bituminous penetration surface course, 3 in. thick; gravel base course, 6 in. thick.	Mr. W. D. McDonald.	54,615 2 7	£200,000 Special Funds.	9,650
4	Brook's Creek Bridge, at 16 m. 370 ft. (shown on design plans as 9 m. 1,850 ft.).	0 109	Three-span reinforced concrete bridge.	McLean Construction Co.	4,842 11 9	£200,000 Special Funds.	...
5	12 m. 2,020 ft. to 17 m. 5,100 ft. (shown on design plans as 5 m. 3,500 ft. to 11 m. 1,300 ft.).	5 3,080	Earthworks and culverts	Mr. W. D. McDonald.	29,759 4 7	£200,000 Special Funds.	5,330*
6	Yass Creek Bridge, at 22 m. 3,320 ft. (shown on design plans as 15 m. 4,800 ft.).	0 110	Five-span reinforced concrete bridge.	McLean Construction Co.	3,260 6 5	£200,000 Special Funds.	...
7	17 m. 5,100 ft. to 27 m. 4,160 ft. (shown on design plans, 11 m. 1,300 ft. to 21 m. 360 ft.).	9 4,340	Earthworks and culverts	Messrs. Farley and Lewers.	37,244 3 11	£200,000 Special Funds.	3,800*
5 & 7	5 m. 3,500 ft. to 21 m. 360 ft.	...	Gravelling ...	Mr. J. Dunn	16,388 0 10	£200,000 Special Funds.	1,065*
	Total Length	27 4,160		Total Cost	164,716 18 11†		

* Total costs (formation and gravelling,) Sections 5 and 7, £6,395 and £4,865, respectively, per mile. † Total cost per mile, Sections 2-7, inclusive, including bridges, £6,850 per mile.

day-labour work under the Federal Aid Roads agreement, but, owing to the suspension of payment by the Commonwealth of Federal Aid funds to New South

Wales, this work has had to be temporarily curtailed and is being finished off to a point 5 miles 150 feet south-west of Yarra.

Tuena River Bridge.

THE bridge illustrated on this page has been recently constructed and opened to traffic on the Goulburn-Tuena-Bathurst trunk road (No. 54), in the Shire of Crookwell. It is situated a quarter of a mile upstream from the junction of the Abercrombie and Tuena Rivers, and is distant approximately 40 miles and 50 miles from Crookwell and Bathurst respectively. The trunk road of which the bridge forms a part is a link in the principal north-south route west of the coastal ranges, and therefore is of importance to through as well as local traffic.

The former bridge over the Tuena River, constructed about fifty years ago, was situated about 40 feet downstream from the new structure, and consisted of a timber truss span of 76 feet and two timber beam side spans of 34 feet. By 1927 its principal timbers had reached such a condition that comprehensive repairs were no longer practicable, but minor emergency repairs enabled it to be maintained safely for loads up to 2 tons pending the provision of a new structure.

The outstanding characteristic of the bridge site is its remoteness from sources of supply of timber and steel, since it is more than 30 miles, over hilly roads,

bridge. The isolation of the site, together with the ready availability of suitable fine and coarse aggregates, limited the choice of materials for a new structure to concrete. For safety, such a structure had necessarily to be placed above flood level, but the latter being due to backwater indicated that the dangers associated with submergence would not carry the usual weight in the selection of the type of structure. Flood level, *i.e.*, including the backwater effect,

is approximately 40 feet above the bed of the stream.

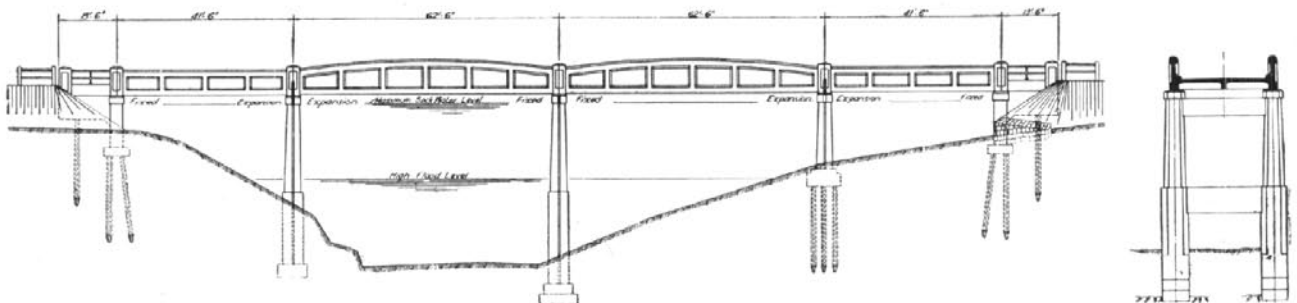
The unusual conditions resulted in a design which is unique for this State. The new bridge consists of four simply supported reinforced concrete through girder spans, the two centre spans and the side spans being 62 feet 6 inches and 41 feet 6 inches long respectively. The width of carriage-way is 20 feet.

The superstructure

is clear of backwater, the deck level being approximately 10 feet higher than that of the former bridge. The approach on the Abercrombie side is through a short cutting, but on the Crookwell side considerable filling was necessary, and an embankment about 600 feet long, and of maximum depth 10 feet, will ultimately be required to give access to the bridge at all



The new Tuena River bridge.



Elevation and cross-section of the new bridge.

from the nearest railway station. A further unusual circumstance is the nature of the flood conditions. Both the Abercrombie and Tuena Rivers are fast-flowing streams, with rocky beds and precipitous banks, traversing hilly country. A normal flood in the Tuena does not reach the deck level of the former bridge, but, should both rivers be in flood, the backwater in the Tuena held up by the Abercrombie may reach a level about 7 feet above the deck of the old

stages of the two rivers. The economy of the selected type of bridge lies mainly in the small difference possible between flood level and deck level, which reduces the quantity of material required in the approaches.

The piers of the bridge consist of pairs of reinforced concrete columns. The first and second piers from the Crookwell side are founded upon solid blue shale. The third pier and both abutments rest upon reinforced

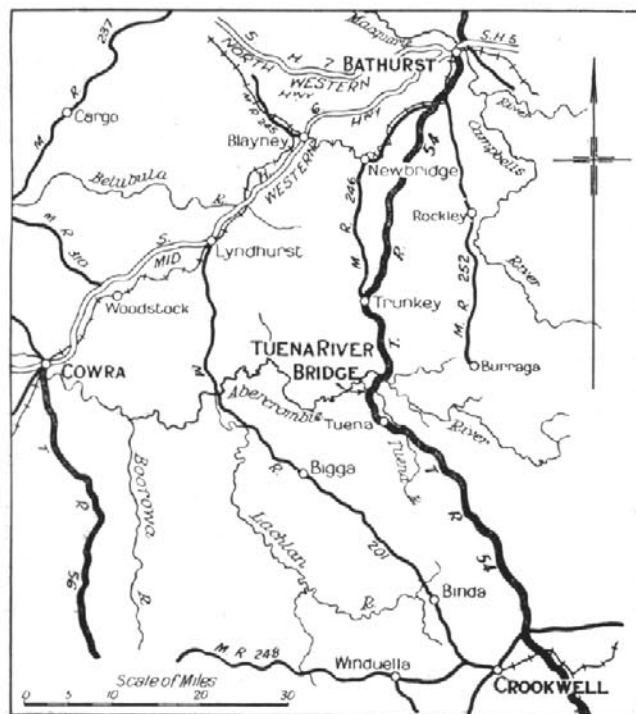
concrete piles. The abutments are of concrete also, consisting of a U-shaped retaining wall, depending largely for stability upon ties anchored to a slab buried about 12 feet beneath the approaches.

The superstructure is fixed at either abutment and at the second pier. At the first and third piers both spans are supported on cast steel rockers, which work within a recess completely filled with bitumen.

Eleven tenders were received in April, 1930, for the construction of the bridge and approaches, the lowest, which was accepted, being that of Messrs. J. A. Jackson and Sons, in the sum of £8,013 5s. 4d.

All the concrete aggregates were obtained within a few hundred yards of the bridge. Washed natural

is on a curve of 250 feet radius, which has been substituted for one of less than 100 feet radius on the original location. The Crookwell approach is straight, and has not been regraded apart from the embankment necessary to reach the deck level of the bridge. At present the lowest point on this side is about 7 feet below backwater, and consequently a short length of the approach will, for the time being, be submerged for a few hours on rare occasions. Until, however, other points on the same road can be relocated above flood level, the expense involved in raising this embankment to provide uninterrupted access to the bridge would not be warranted.



Locality sketch showing Tuena River bridge and relation of Tuena and Abercrombie Rivers.

river gravel proved to be too smooth for the production of strong concrete, but similar material, when crushed, gave satisfactory results. The gravel was a mixture in which basalt, quartz, diorite, and granite predominated. Disintegrated or partially decomposed material was picked out and rejected. The contractors' crushing and mixing plant was established on the high ground on the Abercrombie side of the river. The concrete for the piers and the Crookwell abutment was placed by means of a cableway carrying a $\frac{1}{2}$ cubic yard bottom dump bucket, while that for the Abercrombie abutment was chuted into place from the elevated mixer. Concrete for the superstructure was carried to position in barrows.

The work in the approaches consisted of 3,000 cubic yards of earthwork and 3,400 square yards of ridge gravel pavement 6 inches thick consolidated and 18 feet wide. There is a 3 feet diameter pipe culvert through the embankment on the Crookwell side, with the usual fencing, and a short length of tar-surfacing at either end of the bridge. The Abercrombie approach

The Treatment of Road Surfaces by the Semi-Penetration Method.

DIFFICULTY is often experienced in consolidating a waterbound macadam road during very hot and dry periods, or in obtaining sufficient water for this purpose at reasonable cost. Under these conditions, consolidation is an unduly protracted and costly process. In constructing a pavement which it is intended to surface with tar, it is sometimes found that serious disintegration by traffic occurs during the period the pavement has to be left open to traffic prior to being tar-surfaced. This also occurs when a considerable length of pavement has to be available before surfacing with tar, delivered in railway tank waggons in consignments of 6,000 to 8,000 gallons, can be started. Considerable success has been achieved in the County of Cumberland in reconditioning waterbound macadam pavements by applying a light tar penetration coat instead of attempting to consolidate the surface as waterbound macadam.

The procedure adopted is to reshape the existing pavement and apply up to about 2 to 2½ inches (consolidated) of 1½-inch and ¾-inch metal in the proportions of about 70 per cent. and 30 per cent., respectively. The surface is rolled without watering until the metal is packed as tightly as possible in its dry state, and tar (No. 2 Board's specification) is then applied at the rate of approximately ½-gallon per square yard and covered with metal of ¾-inch gauge or finer, which is well rolled in. The pavement is then opened to traffic, but after, say, some six months of wear it is generally necessary to apply a seal coat of either tar or bitumen.

The lengths of road in the County of Cumberland treated by this semi-penetration process have shown satisfactory results to date. One section of the Castle-reagh-Bringelly-road (Main Road No. 154), extending over a length of about ½ mile, which, prior to treatment, was badly rutted, was reshaped and about 4 tons of metal per chain of road (18 feet wide) was added. Since treatment as described above, no attention has been required in the way of maintenance for two years. Another section, about a mile in length, on the Castlereagh-road (Main Road No. 155), which was treated in 1929 and sealed with bitumen after six months' wear, is still in excellent condition. An extension of this pavement, which called for complete resheeting with 12 tons of metal (1½ inch to ¾ inch

gauge) per chain, was given $\frac{1}{2}$ gallon of 80-100 penetration bitumen per square yard. This surface was sealed with bitumen after about six months, and after twelve months further wear is still in good condition. The abovementioned work was carried out at a cost of between £10 to £18 per chain, 18 feet wide.

Re-sheeting with Pre-mixed Macadam in the County of Cumberland.

THE pavements of many of the roads leading out from Sydney constructed prior to the Board's inception consisted of a sandstone foundation with a wearing course of bitumen-surfaced water bound macadam, or bituminous penetration macadam. Besides periodical resurfacing of these pavements (referred to in last month's notes), special treatment has been required on certain lengths to remedy the unevenness or "waving" of the pavement which results from slight local

subsidence of the foundation and impact of traffic. Resheeting with a thin layer of premixed bituminous macadam has been found to be an economical means of effecting this reconditioning. The irregularities of the surface are smoothed out and at the same time the road crust is strengthened. It has been found that a carefully-graded and proportioned mixture will withstand the impact of traffic, even when laid in sheets of less than $\frac{3}{4}$ -inch average thickness. A considerable area of such work has been carried out by the metropolitan maintenance branch, the most recently-treated sections being the Hume Highway between Lansdowne bridge and the Cross Roads, the Prince's Highway in Rockdale and Kogarah, and the Great Western Highway at Springwood. Altogether some 220,000 square yards of reconditioning of this nature have been carried out since 1st July, 1930, 11,000 tons of materials, mixed either at the Board's depots or obtained from councils' mixing plants, having been laid.

Tenders and Quotations Accepted.

The acceptance by the respective Councils of the following Tenders has been approved by the Board during the month of May, 1931:—

Work.			Name of Recommended Tenderer.	Amount of Recommended Tender.
Shire or Municipality.	Road No.	Description.		
Bellingen	119	Construction of single-span timber beam bridge and approaches at 7½ m. from Bellingen.	M. Hanly	£ 522 s. 18 d.
Patrick Plains	1052	Formation and gravelling, 3,273 lin.ft., in three sections...	Sullivan and West	281 18 0
Booolooroo	12	Gravel construction, 70 chains, between 18 m. 14 chs. and 19 m. 4 chs.	Petrie Davis and Sons	375 8 6
Wallarobba	1128	Formation, with culverts and fencing, 4,075 lin. ft.	B. G. Perrin, jun.	1,072 9 0

Quotations.

The following Quotations were accepted by the Board during the month of May, 1931.

No. of Quotation.	Description of Article.	Name of Successful Tenderer.	Amount of Accepted Quotation.
28	Bridge timber—16 in. dia., 120 ft.; 6 in. x 6 in. — 48 ft.; 5 ft. 3 in. x 6 in. x 4 in.—105 sup. ft.; 12 ft. x 4 in. x 4 in.—128 sup. ft.; 12 ft. x 4 in. x 3 in.—96 sup. ft.; 8 in.—10 in. wide, 5 in. thick, 17 ft. lengths—2,040 sup. ft.	Ison & Company	£ 34 s. 6 d.
33	Bridge timber—7 in.—9 in. wide, 3 in. thick, 13 ft. 6 in. lengths — 1,620 sup. ft.; 9 in.—10 in. wide, 4 in. thick, 26 ft. lengths, — 1,360 sup. ft.; 9 in.—10 in. wide, 4 in. thick, 20 ft. 3 in. lengths—244 sup. ft.	Hargense and Sweeney	50 0 0
38	Sand—1,600 tons	Cancelled.	
39	Blue metal— $1\frac{1}{2}$ in., 500 tons	Emu and Prospect Gravel and Road Metal Co.	175 0 0
40	Blue metal— $\frac{3}{4}$ in. 500 tons	N.S.W. Associated B.M.Q.	175 0 0
40	Bridge timber—15 in. dia. — 41 ft.; 12 in. x 12 in. — 17 ft.; 6 ft. x 6 in. x 6 in. — 228 sup. ft.; 7 in.—10 in. wide, 4 in. thick, 16 ft. 3 in. lengths — 384 sup. ft.; 7 in.—10 in. wide, 4 in. thick, 15 ft. lengths — 336 sup. ft.	Hargense and Sweeney	35 1 9
41	Reinforced concrete pipes—18 in. dia., 40 ft. 6 in.	State Monier Pipe Works	18 18 0
43	Maintainer blades—3 sets of 15 each	Sydney Steel Co.	£7 per set.
44	Steel transfer cabinet, one only	Forster's Bedsteads Ltd.	15 10 0
45	Tar—No. 3, 1,344 gals.	Australian Gas Light Co.	49 0 0
46	Bridge timber—7 in.—10 in. wide, 4 in. thick, 26 ft. lengths—8,000 sup. ft.	Northern Trading Co.	106 0 0
47	Chain wire fencing—24 in. x 100 ft. x 2 in. x No. 8 gauge, 500 ft.	Rylands Bros. (Aust.) Ltd.	8 6 8
49	Bridge timber—8 in. x 8 in.—304 sup. ft.	Allen Taylor & Co. Ltd.	5 18 7