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

December, 1929

The Use of the Road.

DURING the next few weeks and months, the traffic on the roads will be at its maximum for the year. With all the happiness and pleasure that this involves, it is depressing to recollect the numbers of accidents, both minor and serious, that are continually being reported, and which may be expected to occur unless precautions are taken.

Accidents occur from one of three broad causes:

(1) The neglect of proper precautions in the use of the road by either drivers or pedestrians.

(2) The loss of control of the vehicle, either by unskilful driving, or breakdown of the car.

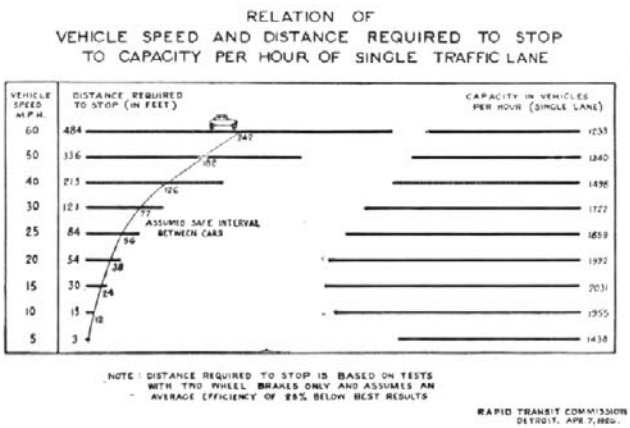
(3) Misadventure due to the condition of the road.

By far the greatest proportion are the result of (1), and are, therefore, preventable. Accidents due to (2), except for the frailty of human endeavour, might also be classed as preventable. It is the duty of the road authority to reduce the possibilities of accidents due to (3) to a minimum, and in general, it succeeds in this. It is also the business of the road authority to so design the road as regards alignment, visibility, grade, and contour, as to ensure that if the road is used by travellers in the manner contemplated by the designer, no danger can arise. Many accidents occur because of attempts to use the road in manners other than those intended by the designer. It is, therefore, important that those features of design which should determine the manner of use of the road should be generally recognised.

First of all, the road is designed on the basis of providing for one or more streams of traffic—generally two. The width adopted for each stream is dependent upon the actual width of the widest vehicles in common use on the road (this is limited to a maximum of 8 feet under the Motor Traffic Act Regulations), and the speed at which they pass. The width of the stream —which is sometimes described as the "virtual width" of the vehicle—varies from 10 feet on heavily trafficked roads to 9 feet or 8 feet on less trafficked roads. Consequently on the ordinary two-stream road, the pavement is 20 feet, 18 feet or 16 feet respectively. Vehicles easily pass each other at high speed on a 20 feet pavement, but on an 18 feet pavement, although there is room for them to do similarly, it is found that many drivers, in an endeavour to give a passing vehicle as wide a berth as possible, move out on to the shoulders of the road. This considerably increases the cost of maintenance of the road, and it would make for greater safety and lower costs of maintenance, if drivers kept wholly on the pavement, and reduced speed when passing other vehicles; also if, except when passing, drivers kept wholly within the width of the road

*35278—A

allotted to the stream in which they are driving. Obviously, if they do not do so, they must be continually moving in and out of their stream as other vehicles pass or overtake them, and this variation from the designed course does not make for safety. On lightly trafficked country roads, the width of pavement adopted is sometimes 12 feet. This is more than sufficient for one stream and not enough for two. It contemplates that passing will not be frequent, and that drivers shall move generally along the middle of the road, or slightly to the left of this, and move out on to the shoulders when passing other vehicles.



On roads which warrant provision for more than two streams, the desirable width is some even multiple of ten, *i.e.*, 40, 60, &c., feet. The common 66 feet road has a carriageway width between kerbs of 42 feet, of which the outside foot on either side may be regarded as of use to traffic only when it is standing, or in emergencies. Where such roads are widened by the Board, a carriageway of 60 feet is provided, *i.e.*, six streams of 10 feet, the two central streams being occupied (possibly) by trams, and the two outer streams on either side being exclusively used by road vehicles. Clearly, if a widened road is to function in the manner designed and to give the greatest service to traffic, standing vehicles must be reduced to a minimum. Except when the traffic is so dense as to more or less completely occupy both stream widths on either side, moving vehicles should keep to the stream width adjacent to the kerb, only using the adjoining width for passing purposes. The common practice on the part of drivers of travelling half and half in each stream, or wholly in the stream farthest from the kerb, is entirely contrary to the basis upon which the design of the road has contemplated it will be used, and greatly restricts its traffic capacity. It follows that if traffic is to keep consistently as far over to the left as is possible, entry of new traffic from side streets must be carefully made. The neglect of this important requirement is one of the most prolific causes of accident.

A proper and intelligent use of the width of the road will, in many cases, postpone for a long while the need for widening roads which will otherwise be necessary. The rules for safety in use, economy in road maintenance, and greatest traffic capacity of the road are, therefore: For the traffic in the road—"*Keep in your stream, and, except when overtaking, to the stream farthest to the left!*"; for the traffic coming into the road from side streets—"*Join the main stream carefully.*"

There is a further matter which very greatly affects the traffic capacity of any road, viz., the speed at which vehicles travel along it. This, of course, will be regarded as almost a self-evident truth. It is not generally recognised, however, that there is a definite limit to individual vehicle speeds for maximum traffic movement when traffic is dense. At first thought, it would appear that the faster vehicles attempt to move, the quicker will the general movement be. This is not, however, the case, if due regard be paid to safety, as may be demonstrated as follows:—

If L = the actual length of the vehicle,
V = its speed in feet per second,
S = the stopping distance at a speed V,
f = the retardation due to brake action, friction, &c.
M = the total mass of the vehicle and load,
g = the acceleration due to gravity,

then, by the laws governing energy and motion—

$$\tfrac{1}{2}\,M\,V^2 = Mgf S$$

$$\text{or} \quad S = \frac{V^2}{2gf}$$

The "virtual length" of the vehicle, or the length of the road which must be allotted to it for safe movement in the event of the vehicle in front suddenly stopping, is L + S.

$$i.e.,\ L + \frac{V^2}{2gf}$$

The time (T) taken to traverse this distance is $\dfrac{L + \frac{V^2}{2gf}}{V}$

For the greatest number of vehicles to pass any point in a given time, this quantity must be a minimum—

$$i.e.,\ \frac{dT}{dV} \text{ or } -\frac{L}{V^2} + \frac{1}{2gf} \text{ must} = 0$$

$$i.e.,\ \frac{V^2}{2gf} = L$$

In other words, the maximum track capacity for a given type of vehicle is obtained when the velocity and

braking are such that the virtual length of the vehicle equals twice its actual length, *i.e.*, the speed must be so adjusted that in case of emergency the vehicle can draw up in its own length. This may be more clearly understood by explaining that for a definite type of vehicle, the greater the speed the greater must be the interval between it and the vehicle immediately ahead, if due regard be paid to safety. The speed may become so great that the interval between vehicles must be disproportionately large. A relatively high speed may actually reduce the carrying capacity of a track just as much as a relatively slow speed. This applies to all forms of road and rail traffic and is illustrated for road vehicles by the diagram opposite, which has been taken from a report of the Rapid Transit Commission of Detroit, U.S.A. (kindly lent to the Board by Dr. J. J. C. Bradfield). From the point of view of road occupation, there is then an economic limit of speed for varying types of vehicles. For the average motor vehicle under good road conditions, this does not exceed 15 to 18 miles per hour, and after rain, when the road is slippery, will be considerably less.

It must be clearly understood that these figures refer to a condition when traffic is densely packed. It does not mean that when traffic is sparse, the speed should be kept to these limits. The greater the interval between vehicles, the greater can be the speed, but if it is a matter of getting the largest number of vehicles over the road in any given time, then the speed must be adjusted to the figures mentioned.

The above calculation presumes that vehicles remain in their stream. If they are continually moving in and out of this, the traffic capacity will be very much reduced, since the general rate of movement of the mass will be lowered. Hence on congested highways, the rule for the safe and rapid movement of the traffic is "*Keep in line, keep to your stream, and keep at such a distance from the vehicle immediately ahead as will enable you to draw up without hitting it, if on any account it should suddenly stop.*" The big thing to realise when travelling along a densely trafficked road is that the driver who is always endeavouring to pass the vehicle in front actually slows down the general traffic movement, and at the same time enormously increases the risk. Patience and discipline in the use of the road will make for more speedy travel, and increase its enjoyment and safety. *Keep in line!*

News of the Month.

METROPOLITAN DIVISION.

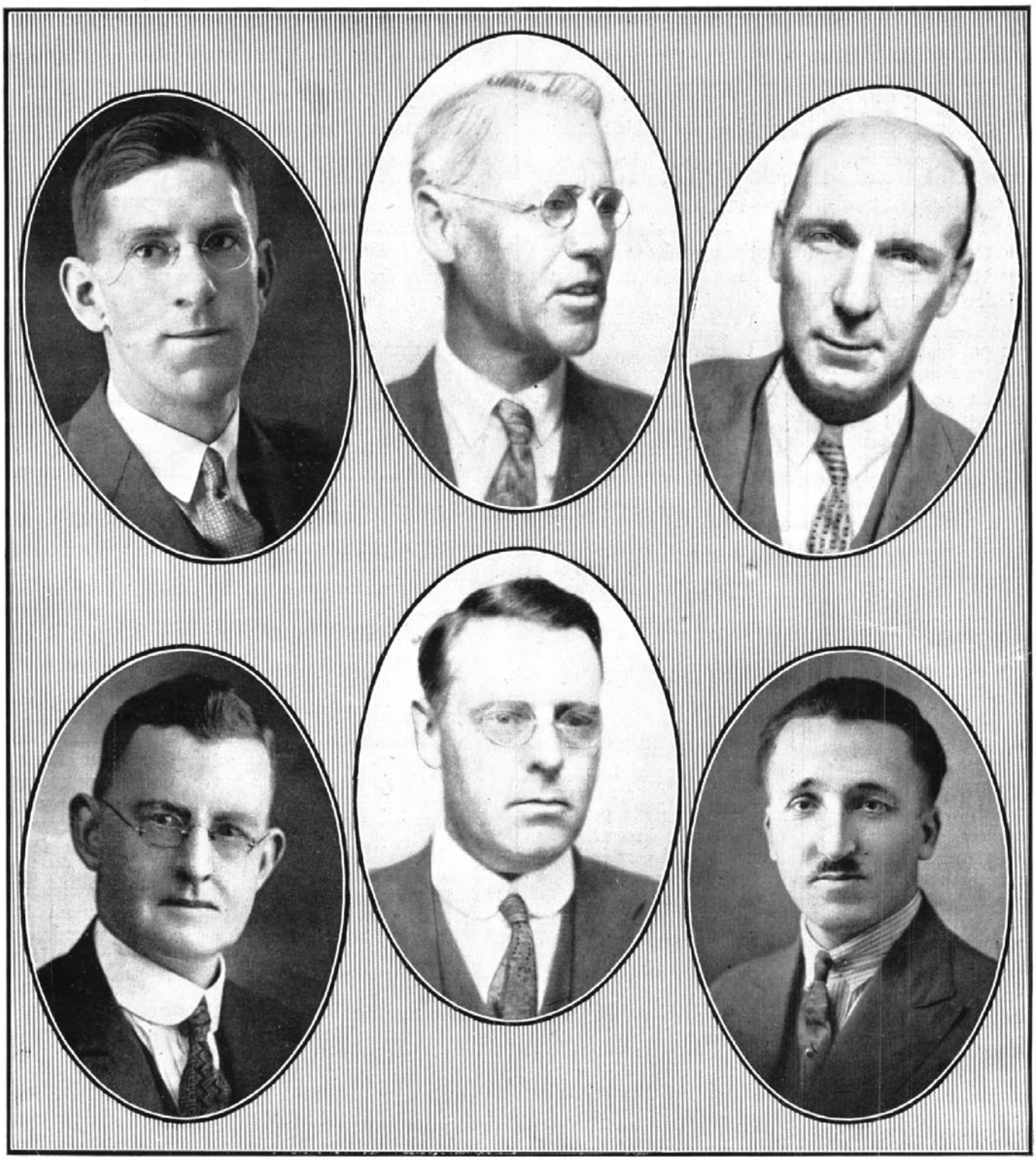
THE deviation of the Great Western Highway between Emu Plains and the foot of Lapstone Hill, which was constructed last year and surfaced with gravel as a temporary measure pending the proper consolidation of the embankments, has now been closed in preparation for surfacing in bituminous penetration macadam. The work is being carried out by the Board by day labour, and it is anticipated that with favourable weather, it will be re-opened to traffic by mid-December.

The reinforced concrete deck has now been placed on the mass concrete piers of the new King's Falls Bridge, which is to take the place of the old timber structure near Appin, on the Bulli-Appin road. Contractor De la Torre is turning the whole of his attention to the completion of the approaches, and the Wollondilly Shire Council which is administering the contract, hopes to have the bridge and approaches open before the Christmas holidays. The steep and difficult approach to the old bridge led to many accidents and the improvement of the grades and alignment of the approaches in conjunction with the construction of the new bridge will be welcomed by travellers.

The steam-driven ferry, recently in service at Tom Ugly's Point, George's River, has been overhauled and is now in commission at the Parramatta River crossing at Ryde. This ferry has a capacity of fifteen average vehicles, i.e., practically double that of the ferry recently in operation at this point, and should serve to substantially reduce the delay to traffic at the ferry at peak hours. As before, the service will be continuous as required, and at peak hours at approximately fifteen minutes interval. Motorists are advised that the ferry will be laid off for general overhaul purposes on the second Tuesday in each month from 10 p.m. until 6 a.m. the following morning.

The construction of the Cabramatta-Mulgoa road, Developmental Road No. 1087, between Cabramatta railway station and Cowpasture-road, a distance of approximately 4½ miles, is now complete. The pavement is waterbound macadam on a ballast base course between Bull's-road and Cowpasture-road, and between the former and Cabramatta Station, the old existing macadam was reshaped and utilised. During the work in wet weather, the red clay made a difficult subgrade upon which to place metal, but a very sound compaction and good surface was finally obtained.

Country Divisional Engineers.



UPPER NORTHERN, Mr. A. L. Horniman, A.M.I.E.Aust.
LOWER NORTHERN, Mr. J. A. L. Shaw, B.E., A.M.I.E.,Aust. CENTRAL WESTERN, Mr. H. M. Baker.
OUTER METROPOLITAN, Mr. D. H. Ingram, A.M.I.E.,Aust.
SOUTHERN, Mr. A. T. Donaldson, M.M.Cy.E., A.M.I.E.,Aust. RIVERINA, Mr. V. J. G. Harding, B.E., A.M.I.Ae.E.

On the 5th November, a start was made with the re-construction in cement concrete of Burns Bay road, between Longueville-road and Fig Tree Bridge (Lane Cove), and Joubert-street and Gladesville-road (Hunter's Hill), which are at present missing links in the chain of concrete between Lane Cove road and Great North road. The State Monier Pipe and Reinforced Concrete Works, under contract to the Board, is carrying out the work, which is expected to be completed in about five months. The pavement will be laid and opened section by section, with the minimum of inconvenience to motorists. On the section of Burns Bay road between View-street and Fig Tree Bridge, a quick-hardening cement will be used which requires only seven days curing before traffic is allowed on it, instead of the twenty-one days for ordinary cement. On other sections, ordinary cement is to be used, as provision can readily be made to carry traffic while the work is in progress.

The reconstruction in concrete of Pittwater-road between Dee Why and Collaroy, now being carried out by Messrs. Lane and Peters under contract to the Board, is making rapid progress. It is hoped to have the whole length open for the Christmas and New Year holidays, notwithstanding the delays which have occurred in the reconstruction of the bridge over Dee Why Lagoon as a result of washaways during the heavy rains in October.

A deviation of the Great Western Highway, ⅝ of a mile in length, immediately on the Sydney side of Valley Heights Railway Station and on the northern side of the railway, was opened for traffic on the 30th October. The earthworks were carried out by the Board's staff some eighteen months ago, and a year was allowed for settlement of the banks. A 3-inch bituminous penetration surface course on a 6-inch broken stone base course has now been laid upon it under contract to Mr. F. H. Stewart, in conjunction with the reconstruction of the Western Highway between Blaxland and Springwood. The use of the deviation will eliminate dangerous corners at the Valley Heights Railway Overbridge, and at the subway between Valley Heights and Warrimoo.

OUTER METROPOLITAN DIVISION.

Tenders have been called for the tar surfacing of 10½ miles of the Great Western Highway from the Victoria Pass to Old Bowenfels.

A section of the Hume Highway, north of Pioneer-street, Mittagong, was recently reconstructed in bituminous macadam by the Nattai Shire Council, on behalf of the Board. Further arrangements have been completed with the same council to continue the reconstruction from Pioneer-street to the southern municipal boundary, and a commencement has been made.

Good progress is being made by the Blaxland Shire Council with the reconditioning of the Lithgow-Mudgee road (Trunk Road No. 55). The Council recently purchased a tractor and scarifier grader, and this additional plant is assisting greatly in the progress of the work.

The Mittagong and Bowral Municipal Councils have the work of reconditioning and tar surfacing the road between Mittagong and Bowral (No. 260) well in hand.

The Wingecarribee Shire Council, on behalf of the Board, has commenced the laying of a bituminous pavement on the Deviation of the Hume Highway between Berwick Orchard and Paddy's River.

The reconstruction of the Prince's Highway between Shellharbour Platform and Minnamurra Bridge, has been completed by the Board by day labour, and the new pavement opened to traffic.

Arrangements have been completed with the Colo Shire Council for maintenance works on the Wiseman's Ferry-Mount Manning Road (No. 181), and it is anticipated that the work will be completed by Christmas.

UPPER NORTHERN DIVISION.

A two-span reinforced concrete bridge over Bluff Creek, on the Great Northern Highway, in the Shire of Tenterfield, has been completed and opened to traffic.

Three miles of gravel construction across Hickey's Plains on the Inverell-Yetman road (No. 187), in the Shire of Ashford, have been completed. An all-weather road is now provided from Wallangra to Inverell.

The construction of the portion of the road from Inverell *via* Kings Plains, to Glen Innes (Developmental Road No. 1,002), within the Municipality of Inverell, has been commenced. The work will be completed early in 1930.

Contracts for 4,732 lin. ft. and 3,897 lin. ft. of waterbound macadam construction on Developmental Road No. 1,050 between the Tenterfield-Casino road near Mallanganee, and Bonalbo, in the Shire of Kyogle, have been completed.

The construction of 4,607 lin. ft. of gravel pavement and a timber beam bridge at Roseberry Creek, on the Kyogle-Woodenbong road (No. 140), has been completed and opened to traffic. Contracts for further sections, amounting to 8,184 lin. ft. of a similar class of construction, are in progress.

LOWER NORTHERN DIVISION.

The first section of a deviation in the Shire of Barraba on the road Barraba to Bundarra (No. 132) at Wood's Reef, is nearing completion. This section is 4,530 feet long and eliminates a very rough bush track over which a considerable amount of wool traffic passes. Good progress has also been made on the second section, the length of which is 1 mile 1,975 feet, and it is expected that both sections will be open to traffic before Christmas. The work is being carried out by Contractor J. White under the supervision of the Shire Engineer.

Work has been commenced on the bridge at "McGoldricks" on the Aberdeen-Rouchel road (Developmental Road No. 1,105), in the Shire of Upper Hunter. The bridge is of high-level type and consists of one 100 feet composite truss span with two 35-feet timber beam approach spans, and will provide an all-weather crossing in lieu of the existing ford. The contractor is Mr. L. J. C. Mansfield.

The last gate on the Great Northern Highway, apart from those at railway level crossings, has just been removed. This was in the Shire of Nundle at the boundary of the Goonoo Goonoo Estate. There were eight gates across the road passing through the estate, and during the year these have been removed one by one as fencing progressed.

The construction of a two-span low-level timber beam bridge in place of an open crossing over the Castlereagh River on the Coonabarabran-Quirindi road (No. 129), in the Shire of Coonabarabran, has been completed by Contractor McMahon. The bridge is on driven piles and has a collapsible iron handrail.

The Cockburn Shire Council is replacing twenty "V" gutters by small culverts on the Great Northern Highway and a contract has just been let for the construction of sixteen additional culverts. The elimination of these thirty-six "V" gutters will greatly improve the drainage and riding qualities of the road.

The Board has practically completed 3 miles of reconstruction on the North Coast Highway between the foot of Cheer's Hill and Kempsey, in the Shire of Macleay. The roadway has been widened and raised above the surrounding low-lying country and has a waterbound macadam pavement, which will shortly be surfaced with road oil and bitumen.

Three power grader units controlled by the Board are at work on the North Coast Highway in the Shire of Hastings, between John's River and the Wauchope turnoff. This section of road is above flood level, but was very rough and worn. The power graders are scarifying and reshaping the existing pavement, which will then be strengthened where necessary and rolled.

CENTRAL WESTERN DIVISION.

Work has been commenced by the Contractor (Mr. Jamieson) on the construction of a six-span reinforced concrete bridge 210 feet long over Mandagery Creek at Manildra, on the Manildra-Orange road (No. 224), in the Shire of Boree. It is anticipated that the present tortuous route to the temporary crossing (which was established after the old bridge was washed away) will be abandoned by the end of April, 1930.

A further section of 1¾ miles of gravel pavement, including concrete box and pipe culverts, has just been completed by the Shire of Amaroo on the Cumnock-Eurimbla Developmental Road (No. 1,009). A good pavement now extends for about 4½ miles out from Cumnock, whilst a reinforced concrete bridge has been erected over Hillan's Creek.

The construction of a three-span timber beam bridge over Humbug Creek on the Condobolin-Wyalong Road (Trunk Road No. 57) has just been completed by the Shire of Lachlan. Previously there was no bridge at this crossing, and the old crossing was washed away during 1925.

The Shire of Amaroo has completed about 7 miles of reconditioning of the North-Western Highway between the 188 and 195½ mile posts. The sections treated were old and raw macadam, which was scarified and reshecled with gravel, producing a much improved surface.

The construction of 342¼ chains of gravel pavement (with culverts where required) on the Eugowra-Collett's Crossing road (Developmental Road No. 1,104), in the Shire of Boree, has just been completed. Portion of the work was done by Contractor Kiss, and the remainder by Contractor Wilson. The entire length of this developmental road within the shire has now been constructed.

Two hundred and seven and three-quarter chains of macadam with gravel blinding have been constructed between the 7 and 11 mile posts in the Shire of Boree, on the Eugowra-Canowindra road (No. 238), with concrete causeways where required. This work, which was carried out by contract, completes the construction of this road, the surface of which is now generally good.

Twelve miles of clearing and grubbing on the Armatree end of the Armatree-Tooraweenah Developmental Road (No. 1,080), in the Shire of Gilgandra, have been completed, of which a length of 9,500 feet has been formed and loamed and causeways constructed, and a further 4,000 feet formed only.

SOUTHERN DIVISION.

The contractors, Messrs. Concrete and General Constructions Ltd., have completed the erection of a three-span concrete bridge over Uringalla Creek, on the Hume Highway, at the boundary of the Shires of Mulwaree and Wingecarribee, near Marulan.

The construction of a length of 12,400 feet of formation and gravel pavement within the Shire of Murrungal, on the road Wattamondara to Reid's Flat, via Mount Collins (Developmental Road No. 1,058), has been commenced.

The contractors for the erection of the Wagonga Inlet bridge at Narooma (the State Monier Pipe and Reinforced Concrete Works), have commenced pile driving for the southern abutment, and the cutting edges of the cylinders for the first pier have been lowered into position.

A contract for the regrading and reconstruction of three-quarters of a mile of the Prince's Highway near Kiah, in the Shire of Imlay, is nearing completion.

The Queanbeyan Municipal Council has commenced the construction of 1 mile of bitumen penetration macadam in Crawford-street (Trunk Road No. 51).

Reconditioning of the Goulburn-Taraga-Bungendore road (No. 268), within the Shire of Mulwaree, has been completed by the Shire Council. Pending the completion of the new Federal Highway, this forms the principal road of access to Canberra for traffic from the north. Reconditioning on the section from the Mulwaree boundary to Bungendore, in the Shire of Yarrowlumla, is in progress.

RIVERINA DIVISION.

The Chas. Hardy Contracting Co. Ltd. has almost completed a further length of gravel construction on Brookong Plain, on the Lockhart-Urana road (Trunk Road No. 59), in the Shire of Lockhart. The new roadway will be open to traffic at an early date. The construction of a further 2 miles of the same road on the Bullenbong Plain, in the Shire of Mitchell, will shortly be undertaken.

The Young-Grenfell road (No. 239), in the Shire of Burrangong, has been greatly improved by means of progressive maintenance and the widening and superelevation of curves.

The four-span timber bridge over Houlaghan's Creek, in the Shire of Illabo, on the Wagga-Temora road (Trunk Road No. 57) is nearing completion, and will be opened for traffic at an early date.

A commencement has been made with the construction of a reinforced concrete bridge over Tumbarumba Creek on the Tumut-Tumbarumba road (No. 278), in the Shire of Tumbarumba.

The control of the bridge over the Murrumbidgee River at Carrathool, on the Gunbar-Carrathool road (No. 244), in the Shires of Carrathool and Murrumbidgee, has now been transferred to the Board from the Public Works Department.

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

	Expenditure to 30th September, 1929.	Expenditure for Month of October.	Total Expenditure to 31st October, 1929.
County of Cumberland Main Roads Fund—	£ s. d.	£ s. d.	£ s. d.
Construction of roads and bridges	138,667 1 7	40,691 1 3	179,658 2 10
Cost of land resumptions	39,800 10 3	40,228 13 9	80,029 4 0
Maintenance of roads and bridges	63,241 0 7	34,569 10 8	97,810 11 3
Repayment of Loans	67,328 7 6	8,619 9 8	75,947 17 2
Survey, design, supervision, and administration	24,462 10 4	12,540 2 10	37,002 13 2
Purchase of stock and assets	3,148 7 9	6,397 1 11	9,545 9 8
Miscellaneous	905 6 3	3,994 19 1	4,900 5 4
Totals	£ 337,853 4 3	147,940 19 2	484,894 3 5
Country Main Roads Fund—			
Construction of roads and bridges, including resumptions	226,308 6 9	120,927 3 2	347,235 9 11
Maintenance of roads and bridges	247,954 12 9	134,980 18 11	382,935 11 8
Repayment of Loans	.....	13,902 10 11	13,902 10 11
Survey, design, supervision, and administration	20,832 0 3	10,844 5 10	31,676 6 1
Purchase of stock and assets	7,938 3 10*	5,622 12 5	2,315 11 5*
Miscellaneous	4,003 1 11	10,390 0 0	14,393 1 11
Totals	£ 491,159 17 10	296,667 11 3	787,827 9 1
Federal Aid Roads Fund—			
Construction of roads and bridges, including resumptions	237,582 9 9	57,267 4 7	294,849 14 4
Purchase of stock and assets	5,307 14 2	6,319 5 10	11,627 0 0
Miscellaneous	2,831 6 2	1,521 18 10	4,353 5 0
Totals	£ 245,721 10 1	65,108 9 3	310,829 19 4
Developmental Roads Fund—			
Construction of roads and bridges	75,178 1 5	33,137 12 2	108,315 13 7
Miscellaneous	160 3 3*	6,426 6 8	6,266 3 5
Totals	£ 75,017 18 2	39,563 18 10	114,581 17 0
GRAND TOTALS	£ 1,149,752 10 4	548,380 18 6	1,698,133 8 10
Summary All Funds—			
Construction of roads and bridges, including resumptions	717,836 9 9	292,251 14 11	1,010,088 4 8
Maintenance of roads and bridges	311,195 13 4	169,550 9 7	480,746 2 11
Repayment of Loans	67,328 7 6	22,522 0 7	89,850 8 1
Survey, design, supervision, and administration	45,294 10 7	23,384 8 8	68,678 19 3
Purchase of stock and assets	517 18 1	18,339 0 2	18,856 18 3
Miscellaneous	7,579 11 1	22,333 4 7	29,912 15 8
GRAND TOTALS	£ 1,149,752 10 4	548,380 18 6	1,698,133 8 10

* Credit.

The Metropolitan Main Road System.

Adapted from an address delivered to the Annual Conference of the Local Government Association on 26th September, 1929.

By H. H. Newell, M.Inst.C.E., M.I.E.,Aust.,

Deputy President.

WHAT is a main road? Is it any heavily trafficked road of considerable length, or is it any road that serves more than merely local needs and leads from one district to another? Or is it a road that has been carefully selected from the general system of roads, and specially promoted to the rank of Main Road? Everybody knows that the cost of main roads in the county of Cumberland is borne by the funds of the Main Roads Board. Are, then, all the roads that one sometimes hears referred to as main roads, the responsibility of the Main Roads Board, or does some more specialised group of roads constitute the Main Roads system?

The Main Roads Act defines a main road as "any public road proclaimed by the Governor on the recommendation of the Board to be a main road." In recommending any metropolitan main road to the Governor, the Board is required to take into account—

(*a*) any representations made by the councils through whose areas the road passes (or will pass) or whose areas the road serves (or will serve);

(*b*) the funds which are or will be available for the construction and for the regular maintenance of metropolitan main roads;

(*c*) whether the road is or will be a main trunk route for traffic between the business centres of the metropolitan area and the other parts of the county of Cumberland;

(*d*) whether the road is or will be a main trunk route for traffic between one part of the said county and another;

(*e*) whether the traffic along the road is mainly local, that is arising or terminating within the area in which the road is situated, or whether it is or will be mainly through traffic;

(*f*) whether the road is or will be a tourist road to develop tourist traffic; and

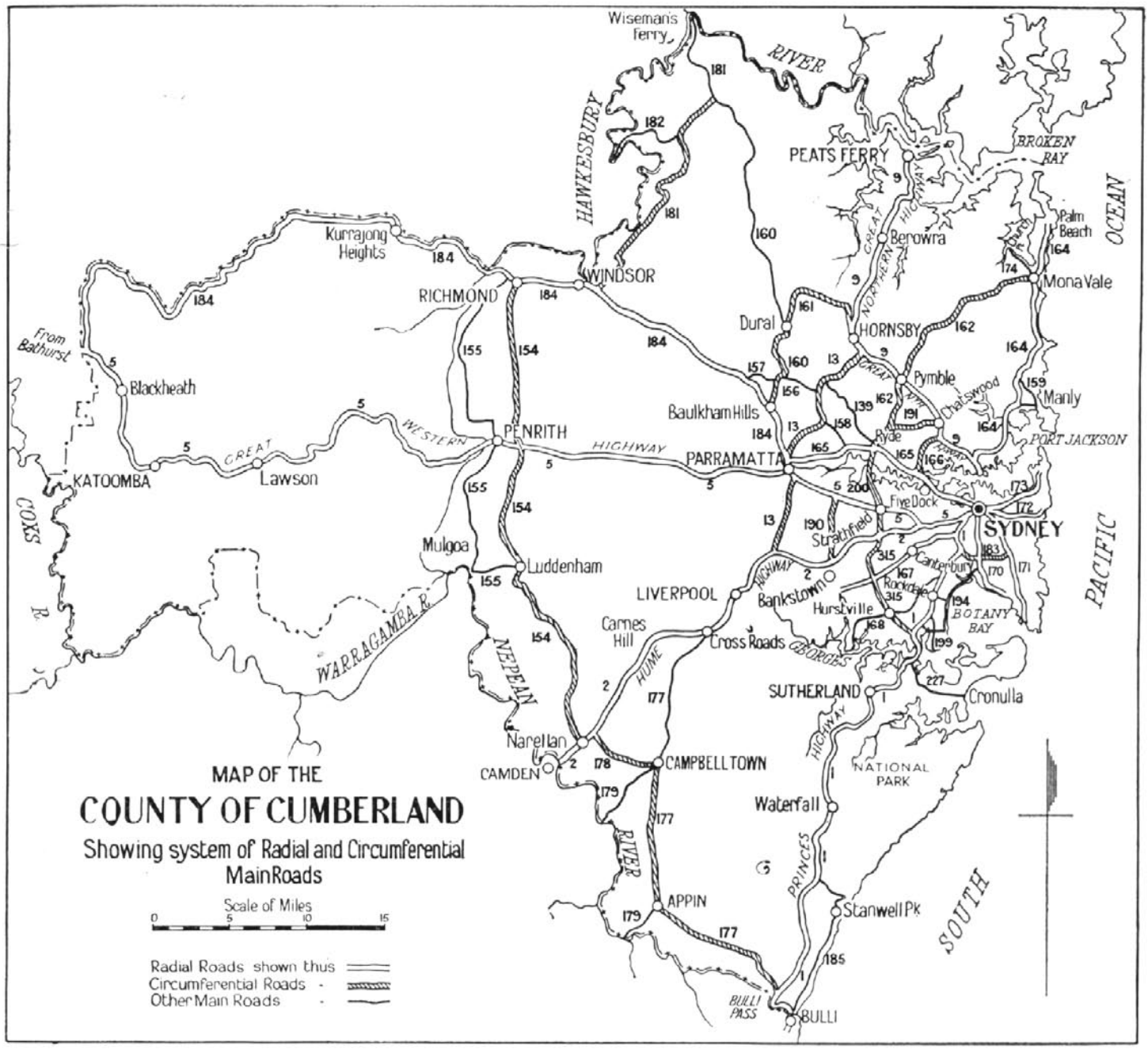
(*g*) the value of the proposed route from a defence point of view.

Altogether there are at present 599¼ miles of main roads in the county of Cumberland. Of these, 504½ miles had been proclaimed as main roads prior to the commencement of the operations of the Main Roads Act (1st January, 1925). The remainder have been added since that date in replacement of 17¼ miles which were also main roads at 1st January, 1925, and have since, with the concurrence of the Councils concerned, been deproclaimed as main roads. In addition, 42¾ miles of road have been declared "secondary roads," which is really a second and lower class of main road.

A glance at the map opposite—which is a map of the present main roads system in the county of Cumberland—will show that the system of roads divides itself, broadly, into radiating roads running out from the metropolis into the country, and cross roads connecting these and the various centres of business, pleasure, or residence. This arrangement of radial and circumferential roads is characteristic of the main lines of any metropolitan road system. It is a natural and inevitable growth. A little group of settlers takes up its abode on the shore of a river or bay. In course of time, the settlement grows into a town and perhaps ultimately into a great city. At first their food supplies are produced locally. As the settlement expands, its centre becomes devoted to commerce and the cultivation of its food supplies is transferred to the fringes. So the process goes on—the town reaching out into the country, and the roads following suit. The radial road is thus the earliest part of the main road system. As these move away from the centre, the distances between them increase, and a secondary system becomes necessary to connect across them and thus reduce the delays and losses which would result to traffic if only the radial system existed. These are the circumferential roads. Some of the radial and circumferential roads have a greater importance than others. These are the roads which are described in popular parlance as main roads.

If the process described represents the natural evolution of the main road system, the selection of the roads which should be assisted from the fund which is set aside by Parliament for the benefit of the metropolitan main road system (the county of Cumberland Main Roads Fund) should, it appears to the Board, be determined upon somewhat similar principles. This is the basis upon which the Board has added to and subtracted from the main road system which it inherited.

In some cases, the roads which, if they were in good condition, would form the natural lines of traffic in any area, do not now function in this manner, and other parallel roads perform this duty for them. On the score of traffic carried, these other roads would have



a superior claim to those for which they are acting. It appears to the Board, however, important to arrange for the system to function in a natural and healthy manner, as, to allow traffic to proceed in the more convenient way, will serve to eliminate congestion. Greater emphasis is therefore placed in the selection of new main roads on the development of a sound system than on the traffic at present borne by any road. The latter consideration does, however, receive full regard.

The greater proportion of the radial roads shown on the map were, except for slight extensions made since the inception of the Board, proclaimed main roads before the Board took office. Compared with cross roads, the metropolitan area was fairly well served. It lacked, however, an efficient system of circumferential roads. There was in the large triangular area between the Parramatta-road and the Prince's Highway not a single main cross road. After consultation with the councils affected, the Board has had added to the list Main Road No. 190 connecting Lidcombe and Bankstown—a road capable of easy extension southerly when the time warrants to Canterbury-road (Main Road No. 167). A still larger addition has been Main Road No. 315 between Concord and Kogarah, passing through Enfield, Canterbury, and Hurstville. Lyons-road, Drummoyne, was also declared a secondary road, and a conference was held last September with the

various councils interested, at which practical agreement was reached for the extension of this route through Ashfield, Enfield, Canterbury and Bexley to junction with Bay-street, Rockdale, an already proclaimed main road. On the north side of the harbour, the road connecting Roseville and Dee Why, which is one section of the grand circumferential sweep of which Main Road No. 315 previously referred to is part, has been declared a secondary road. Most of the other roads which have been added have been roads which relieve existing main roads. On the north side of the harbour, the revolution in traffic movement which will be brought about by the opening of the Sydney Harbour Bridge has rendered it inadvisable to add new roads to the list, which, with the opening of the bridge, will no longer function as the major traffic routes. At the same time strenuous attempts are in progress to fit those roads which are already main roads to cope with the situation which will arise when the bridge is opened. A new length of road, 100 feet wide, costing in the vicinity of £100,000 for resumptions alone, is, after consultation and agreement with the North Sydney Council, to be cut through the block bounded by Blue-street, Miller-street, Mount-street, and Walker-street. Lane Cove road has been widened between Mount-street and Falcon-street, and from St. Leonards Railway Station to Broughton-road, and also for considerable lengths in the Municipality of Kuring-gai. At the present time, an investigation is in progress to determine the best means of dealing with the traffic which will proceed to and come from the east of the bridge on the south side of the harbour. In the eastern suburbs, Fitzgerald-avenue and its extension westwards have been made a main road to give access to Maroubra Bay, and the construction of a cement concrete pavement thereon is about to commence. All these changes and additions have been decided upon after full consultation with the local governing bodies concerned, and with only one minor exception, in which there was a difference of opinion between two councils, entirely in accordance with the councils' wishes. As a matter of fact, the Board has received a considerable number of applications for new main roads during the past four years, and it has detailed a special officer to examine and report on these. It is from the information so obtained, as well as from personal observation and conference with councils, that it has made selections.

Some months ago, the Metropolitan Sub-committee of the Executive of the Local Government Association, under the chairmanship of Alderman G. J. Baker, of Randwick, suggested there should be established "A body, on which the councils would be represented, which could carefully study the traffic requirements and make a selection of what roads should be main roads, and provide for both radial and circumferential roads." Under the Main Roads Act, this responsibility has devolved upon the Board in consultation with the councils. I think it will be seen from the foregoing that the Board has carried out its obligations in the matter in a scientific manner and in the spirit of the Act, and whatever the Board's funds have permitted to be done in this respect has, I believe, given general satisfaction. From the Board's experience of this problem, it is, however, of the opinion that something more than the present legislation is required in order to deal with the matter fully. It is necessary not only to proclaim, so far as funds permit, those roads which are of present benefit to the community as main roads, but also to preserve the possibilities of securing additional roads of this character which will be required in the future. In large undeveloped areas such as Warringah and the outer suburbs, it is necessary to survey and preserve what will some day become the main roads in these areas. Subdivision is proceeding rapidly, and unless some guiding eye sees to it, through routes will not be provided. What is needed is the establishment of future traffic routes to which new subdivisions should comply. The Board proposes, therefore, as opportunity permits, to discuss this matter with the various councils to see what can be done.

It will be of interest to mention that by the passage of the Main Roads (Amendment) Act last session, the area of the County of Cumberland was for main road purposes enlarged so as to include the "Devil's Elbow" of the Bulli Pass road, and the road from Richmond via Kurrajong and Mount Tomah to Mount Victoria. These two pieces of road are primarily of metropolitan interest, the former being a short length of the Princes Highway outside the strict boundaries of the County of Cumberland, and the latter being the alternative route to the Blue Mountains from the city. Under the rate of assistance which could have been given to the second road had it remained in the country, viz., 30s., by the Board to 20s. by the council, it would not have been possible to place or keep it in suitable order such as is required by metropolitan traffic.

The Surface Treatment of Roads.

THE Board desires to direct attention to an important paper, under the above title, contributed by Mr. A. C. Tregoning, M.C.E., A.M.I.E., Aust., to the September number of the Journal of the Institution of Engineers, Australia.

The paper deals with the subject of the surface treatment of roads to assist them in withstanding the stresses caused by modern traffic. The binders used in surface treatments, and the mineral aggregates used with the bituminous binders are described in detail. The methods of applying surface treatments are given, with a discussion on costs and traffic-carrying capacity. The final section of the paper is devoted to a description of the plant used in the various methods.

Mr. Tregoning's paper covers fourteen pages of the Journal of the Institution, and sets out a wealth of closely reasoned and fully detailed information, emphasizing the importance to highway engineers of a full understanding of the problem, and indicating very clearly that treatment includes more than "tarring" a road, and "blinding" with any readily available material. Successful treatment depends on the proper preparation of the roadway, the selection of suitable priming and binding agents and their correct application, and the thorough incorporation of graded mineral aggregate selected to meet the requirements of each particular case.

The Reorganisation of the Great Western Highway Between Old Bowenfels and Bathurst.

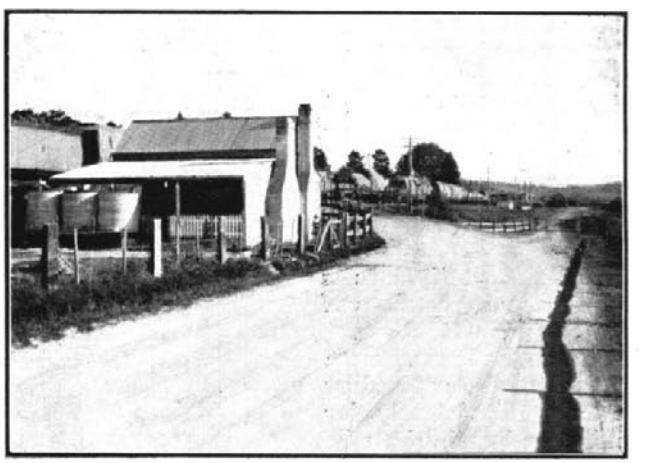
THE task which confronted the early pioneers in the crossing of the Blue Mountains and the manner in which it was overcome are matters of history and constitute one of the most interesting stories of our early colonial development. The problem of the route to the west was not, however, confined to ascending and descending these mountains,

Marangaroo Creek Bridge, old crossing on right.

for the greater part of the country between Mount Victoria and Bathurst was of a hilly and difficult character, and when the land was covered with trees, as it was at that time, instead of being comparatively clear as it now is, the finding and making of a road through was

Cement Penetration Pavement, Cox's River Deviation.

a formidable undertaking. Evidence of this is shown in the steep grades and tortuous alignment of much of the length of the old Great Western road, and may be gathered to some extent by those familiar with maps, from an examination of the plan on pages 60-61. Numerous references to the unnecessary "up and down" character of the road had been made prior to the inception of the Board, and were confirmed by an examination of the route by the Board early in 1925. From this inspection, it was clear that the old road from Old



Dangerous Railway Level Crossing at Rydal, on the Old Western road.

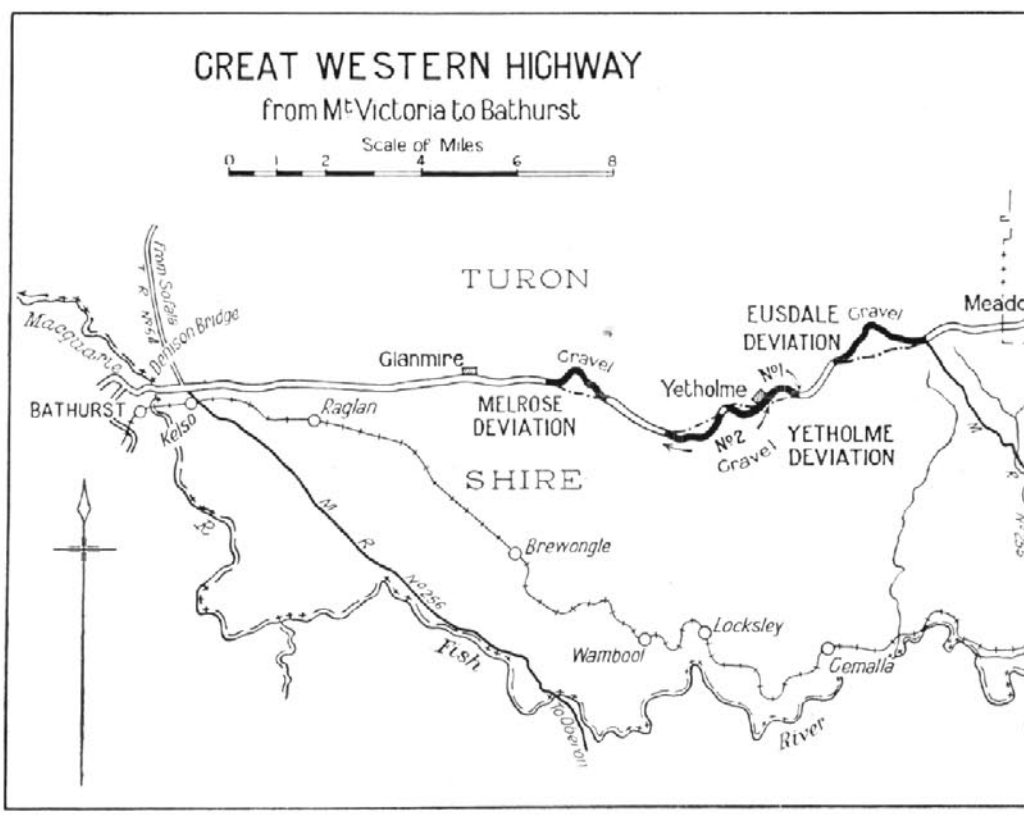
Bowenfels westwards was generally quite unsuited to modern traffic requirements, and that, if it was at all practicable, some improvement on the descent of Mount Victoria would also be desirable. Accordingly, as soon as opportunity offered, surveyors were set to work to

Cox's River Deviation, Gravel Pavement near Meadow Flat. The old road is shown at the left.

examine the old road and to see what departures from or alterations to it were necessary to reorganise it in keeping with present-day conditions. While these investigations, and any construction works which might

be authorised following on them, were proceeding, the Board was prepared to subsidise the Councils concerned for maintenance works on the old road at the general rates prevailing, viz., £ for £ until 30th June, 1926; £2 by the Board to £1 by the Councils from 1st July, 1927, to 30th June, 1928, and the whole cost by the Board after 1st July, 1928. The earlier rates of subsidy were found to be entirely inadequate to the needs of the road, as by adhering to them, the amount the Board could contribute was limited by the capacities of the various Councils to provide their quotas. Difficulties of this kind and similar difficulties on other important main roads led ultimately to the classification of the main roads into three groups and transference to the Board on 1st July, 1928, of the full financial responsibility for those classed as State highways. The Great Western road was one of these. As a result of this change, the whole length of the road between Mount Victoria (the boundary of the country area) and Bathurst is now in good order.

The first part of the road investigated in detail was that between Old Bowenfels and Bathurst. Here the old road (proceeding westerly) dips steeply for 2 miles—a length of 1 mile of grade averaging one in ten—to the crossing of Cox's River. It then climbs for 2 miles on a heavy grade—1 mile of one in eleven—and tortuous alignment from the river to Rydal, where it crosses the railway by a level crossing which had for long been regarded as particularly dangerous for heavy traffic. Past Rydal, the road runs to the north, then leaving the railway on the right hand, proceeds westwards through Meadow Flat. It continues to climb, reaching its highest point, 3,840 feet above sea level, near Yetholme. Steep pinches and winding alignment are met with for several miles on either side of Yetholme, and then the road converges on the railway as it approaches Bathurst. The last 4 miles of the route cover undulating country, until, crossing the Macquarie River at Denison Bridge, it reaches Bathurst at a distance of some 125 miles from Sydney.

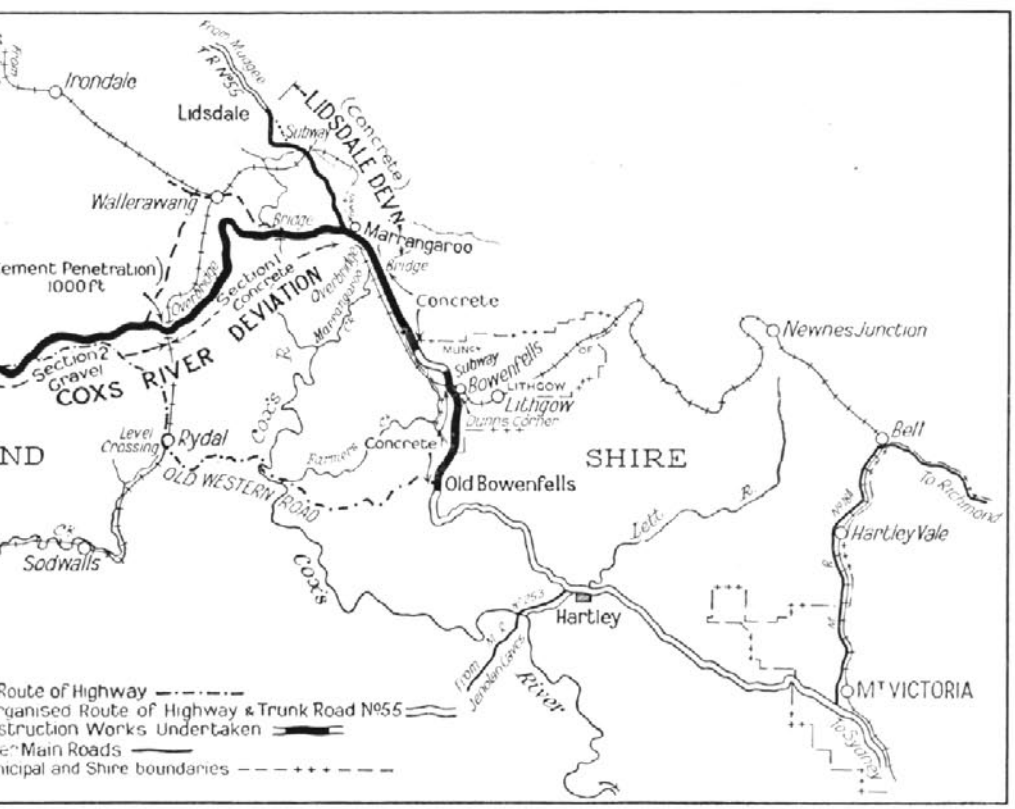


As a result of the surveys, it became apparent that the most suitable means of improving the portion of the road between Old Bowenfels and Meadow Flat was to substitute for it a new road leading from the Lithgow-Mudgee road immediately north of Marrangaroo Station towards Meadow Flat. Consequently, the improvement of the Great Western road became bound up with that of the Mudgee road between Old Bowenfels and Lidsdale. This latter road proceeded northwards from Bowenfels by an easy route in undulating country, and crossed the Western railway by a level crossing at Bowenfels Station. It ran parallel with the railway to Marangaroo Creek, then crossing the railway by an overbridge, commenced a steep climb of more than a mile, with dangerous turns. The descent towards Lidsdale, for the next mile, was almost equally steep and winding, leading to a subway under the railway, whence the remaining 1½ miles to Lidsdale traversed somewhat easier country. Apart from the necessity of replacing the level-crossing at Bowenfels by a subway, the alteration required to the route of this road was confined to a length of ¾ mile between the overbridge previously mentioned and Lidsdale.

The essential works to establish these alterations were two: the Lidsdale deviation and the Cox's River deviation, the limits of which are shown on the plan. The former required the replacement of a ford over Marrangaroo Creek by a bridge. The latter, which passed through the Lidsdale State Forest, necessitated the construction of two bridges—one 180 feet long over Cox's River and the other over the Great Western railway. When, therefore, in 1926, the Board was asked to suggest road works suitable for the relief of unemployment, these two deviations were put

in hand. The whole of the works covered by them, including pavement, have now been completed, and the last section in the vicinity of Cox's River Bridge will be opened to traffic early in December. On the length between Old Bowenfels and Marrangaroo Creek, the substitution of a subway for the level crossing at Bowenfels is now in progress, the bridge having been completed by the Railway Commissioners with whom the Board is sharing the cost, while the remainder of the length, except for a short section of 2,000 feet immediately north of the subway, where the road has been tarred and is in good order, is being formed and paved with cement concrete by Messrs. Court and Braithwaite under contract to the Board.

Between Meadow Flat and Bathurst, it was found to be practicable to adhere to and suitably improve the existing road, except at four points where four deviations, which are marked on the plan as Eusdale deviation, Yetholme deviation No. 1, Yetholme Deviation No. 2, and Melrose deviation, were adopted. The construction of these deviations was commenced in November, 1928, again to assist in the relief of unemployment, special funds being provided for the purpose by the Government. The earthworks are now practically complete. The first and last deviation, being in granite country, will be opened to traffic without waiting for a pavement to be added, but the two Yetholme deviations cannot be satisfactorily connected to the present road until the abandonment of the latter as a through route, and will not, therefore, be available to traffic until paved. Arrangements for the construction of a gravel pavement are in hand, and will be proceeded with as soon as sufficient time has elapsed for the consolidation of the new formation.

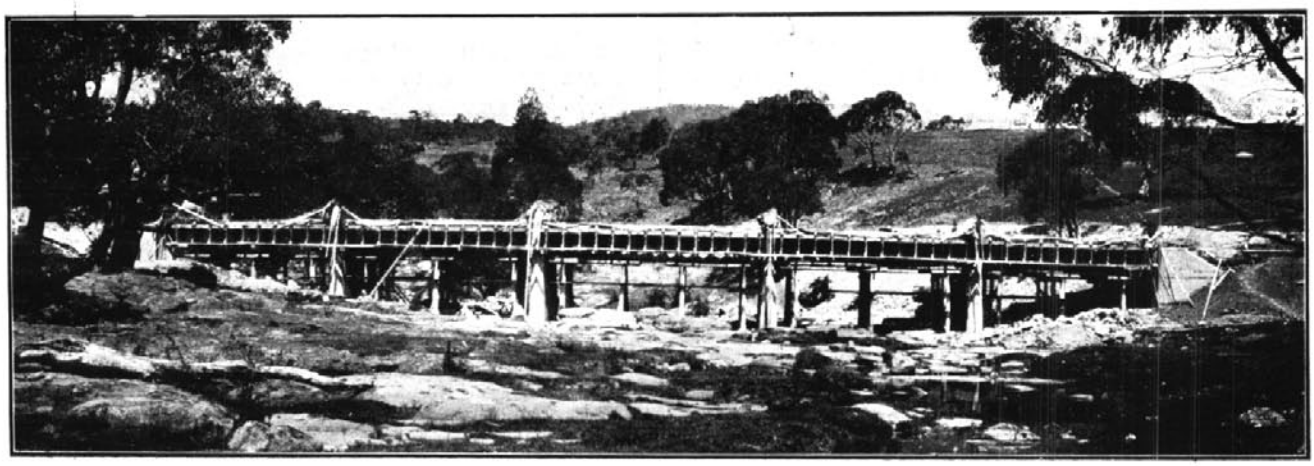


Systematic maintenance of those sections of the old road between the western end of Cox's River deviation and Bathurst, which are included in the reorganised highway, has been undertaken. The pavement consists of gravel, wih a short length of tar surfacing near Bathurst, and has been brought to its present smooth-running condition at comparatively low cost.

A comparison of the ruling grades, minimum curvatures, &c., which have been obtained on the various deviations and those which appertain on the old road is given in the following table:—

Section of work.	Ruling grade.		Minimum radius of curvature.	Length.				Height reached above sea level.	
	Old Road.	New Road.	New Road.	Old Road.		New Road.		Old Road.	New Road.
	per cent.	per cent.	feet.	M.	ft.	M.	ft.	feet.	feet.
Old Bowenfels to end of Cox's River Deviation (near Meadow Flat)	10	5·5	250	14	2,700	18	2,000	3,820	3,790, also reduces rise and fall.
Marangaroo Creek to Lidsdale ...	9	6·8	150	4	100	4	1,080	3,215	3,210, also reduces rise and fall.
Eusdale Deviation	9·8	6·1	250	1	784		4,488	3,801	3,768.
Yetholme Deviation (No. 1) ...	8·9	5	300	1	365	1	1,345	3,763	3,763, also reduces rise and fall.
Yetholme Deviation (No. 2) ...	8·9	5·5	400	1	3,233	1	3,573	3,439	3,402.
Melrose Deviation...	6·8	6	300	1	1,301	1	2,786	3,011	2,956.

The types of pavement which have been laid or are being laid are also shown on the map. These are cement-concrete from Old Bowenfels to Lidsdale and the bridge over the western railway north of Rydal, and gravel from this bridge to Meadow Flat, except that, about half a mile west of the bridge, a length of 1,000 feet of cement penetration pavement has been laid. In each case, the road has been formed to a width of 28 feet (increased at curves) and the pavement is 20 feet wide. On the Lidsdale deviation, and on the Old Bowenfels-Marrangaroo Creek section, the concrete pavement is or will be 6½ inches thick at the centre and 9 inches at the outer edges, the mixture being 1 : 2 : 3½. On the Cox's River deviation, the pavement is similar to that on the Lidsdale deviation, except that for the first mile from the Mudgee road junction the mixture is 1 : 2 : 4, and for the remaining distance the pavement is 6 inches thick at the centre and the mixture 1 : 2 : 3½. The gravel pavement has been laid to a total consolidated thickness of 7 inches, the material being obtained from a quarry opened by the Board at Mount Lambie. The cement penetration pavement is of an experimental character, and was laid by first constructing a foundation course of macadam 3½ inches thick, then laying on top of this a 2-inch covering of cement mortar (1 cement to 2 of sand) and finally adding, while the mortar was wet, 2½ inches of metal, and then rolling the whole until the mortar completely penetrated both courses of metal. The pavement has not been down for a sufficient length of time to give any indication as to the merits of this class of construction, but it will be carefully watched and compared with the other concrete work in the vicinity.

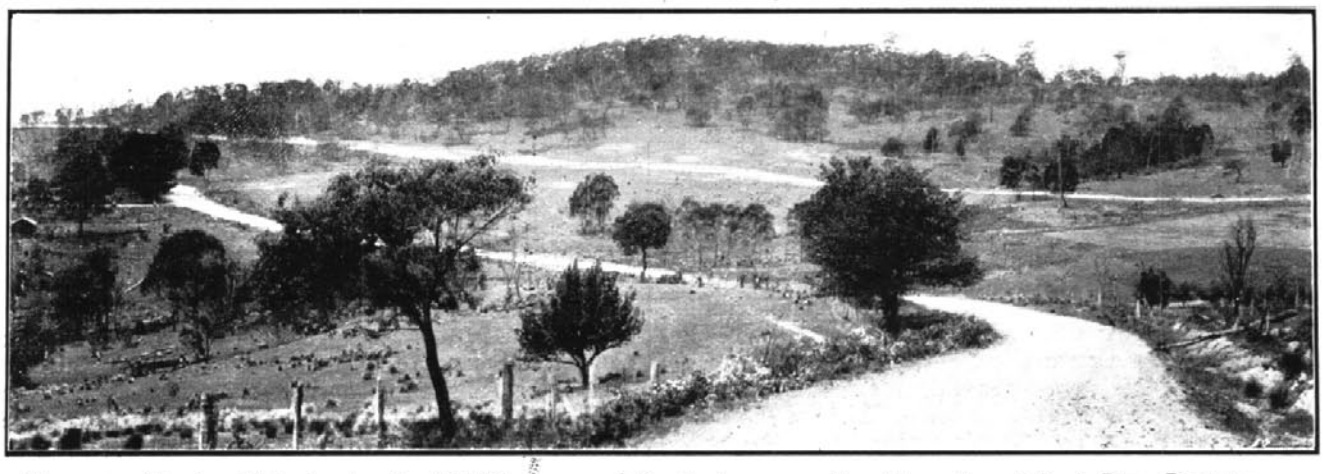


Cox's River Bridge, During Construction.

The following table sets out particulars of the work done:

Section of work.	Class of Construction.	Length of work.	Cost to 30th Oct. 1929.	Period of work.	State of work.
		M. ft.	£		
Old Bowenfels to Marangaroo Creek.	Formation and cement concrete pavement.	4 1,461	20,000	Commenced March, 1929	50 per cent. complete.
Bowenfels Sub-way and approaches.	Steel and concrete bridge ...	2,882	1,000	Commenced March, 1929	Bridge 90%, approaches 30% complete.
Lidsdale Deviation ...	Formation and cement concrete pavement.	4 1,980	91,400	Oct., 1926, to May, 1929	Complete.
Marangaroo Creek Bridge ...	Reinforced concrete	126	3,600	May, 1928, to May, 1929	Complete.
Cox's River Deviation (Section 1).	Formation and cement concrete pavement.	5 5,050	119,600	Jan., 1927, to May, 1929	Complete.
Cox's River Bridge ...	Reinforced concrete	180	6,600	Aug., 1928, to Nov., 1929	Complete.
Cox's River Deviation (Section 2).	Formation and gravel and cement penetration pavement.	6 1,430	42,000	July, 1927, to Nov., 1929	Complete.
Bridge over railway, north of Rydal.	Steel and concrete	745	1,800	Aug., 1928, to April, 1929	Complete.
Eusdale Deviation	Formation	4,488	30,000	Nov., 1928, to Nov., 1929	90% complete.
Yetholme Deviation (No. 1)	Formation	1 1,345		,, ,,	Complete.
Yetholme Deviation (No. 2)	Formation	1 3,573		,, ,,	Complete.
Melrose Deviation	Formation	1 2,786		,, ,,	Complete.
	Total	20 4,220	£316,000		

The use of a cement concrete pavement in this vicinity has been subjected to some criticism. The Board's policy in this matter was to endeavour to foster the use of local materials. It took regard of the fact that there were established at no great distance, large cement works at Portland and Kandos, which, if a more advantageous rate for cement could be obtained, would, when consideration was paid to both



View near Meadow Flat, showing the Old Western road (in the foreground), with portion of Cox's River Deviation (in the background), and illustrating the reduction in rise and fall on the new road.

first cost and maintenance, enable this form of construction to compete favourably with other classes of pavement. It recognised that at the then ruling rates for cement, it would not be practicable to employ cement concrete except as an experiment. It hoped that by the authorisation of a fairly long length of such pavement from Marrangaroo Creek to Lidsdale, and from Marrangaroo to Cox's River, it would encourage a substantial drop in the price of cement. That this would be advantageous to the State if it would enable cement concrete to compete with other forms of construction in the country will be admitted, since it would mean that the whole of the materials would be obtained within the State. While the Board's desires in this respect have been achieved to some degree, the result has not been all that was hoped for. However, the policy was partly successful in connection with the work between Old Bowenfels and Marrangaroo Creek. For this length, alternative tenders were called for a bituminous pavement consisting of a 3-inch penetration wearing course upon a 6-inch waterbound broken stone base course, and a cement concrete pavement of 9:6½:9 section and 1:2:3½ mixture. The cement manufacturers, desiring to ensure that the cement concrete pavement could compete with the bituminous work, lowered the price of cement to tenderers with the result that, although the lowest tender for the bituminous pavement was higher than the lowest tender for the cement concrete, the latter was the cheaper proposition when regard was paid to subsequent maintenance costs, and was, therefore, preferred.

There was a further advantage in carrying out a considerable instead of a short length of cement concrete, viz., that while a good deal of this class of work had been done in the metropolitan area, only comparatively small amounts had been laid in the country. It was difficult to get suitable men to do the work in the country, and, if the experience to be gained of what standard of work could be expected in the country was to be of any value, a sufficient length would have to be done to enable the men on the job to become skilled. This has been exemplified in the work, which has progressively improved as the laid length of concrete increased.

A preliminary investigation has also been made to ascertain whether it is practicable to improve the descent from Mount Victoria, but the work involved would be so great that the Board does not consider it is warranted in proceeding further with the matter at this stage.

Melrose Deviation, looking towards Sydney.

The Crossing of the Hawkesbury River on the Great Northern Highway.

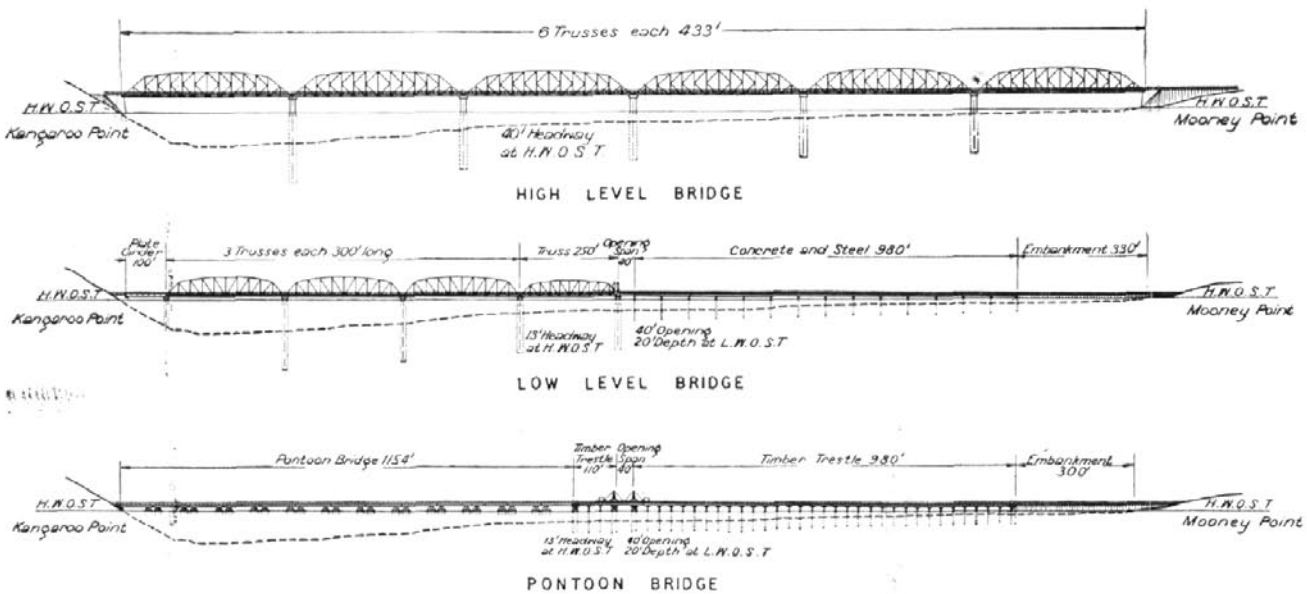
By F. Laws, B.E.

Assistant Designing Engineer.

(Historical information kindly supplied by Frank Walker, F.R.A.H.S.).

THE broad waters of the Hawkesbury River and the rugged sandstone ranges on either side have for 133 years constituted formidable obstacles to the establishment of direct road connection between the two principal cities of the State—Sydney and Newcastle. Four years ago, however, the Board undertook the task of establishing that connection, and within a few months from the present time a direct road will be in use. Some conception of the size of the task may be gauged from the quantities of rock and earth which have been moved in the construction of the new formation between Hookham's Corner and Gosford, a distance of 36½ miles, viz., 715,000 cubic yards. Six and a half of the 14¾ miles of concrete pavement to be laid between Hookham's Corner and the river on its southern side have been completed, while on the northern side of the Hawkesbury, 18 miles of a total of 21¾ miles of gravel, or gravel and sandstone, pavement have been laid. The erection of the superstructure of the bridge, 214 feet long, over Mooney Creek on the already completed foundation is now in progress, and there remains only the crossing of the Hawkesbury River itself, for which there is no visible sign at the site as to what is projected.

Obviously there are, broadly, two possible solutions to this crossing—a bridge or a ferry. From side to side, the river has a width of 2,600 feet at its narrowest point. The bed of the river shelves gradually from the northern bank until it reaches a depth of 38 feet (L.W.O.S.T.) at a distance of 1,700 feet from the shore, after which it deepens rapidly to 74 feet, until at a distance of 250 feet from the southern bank it again commences to rise sharply. The general course of the river hugs the southern shore at this point, flowing at the rate of 2.4 knots. The range of the tide is normally 5 feet, with a maximum of 8 feet.



From the point of view of general convenience, a bridge would be much superior to a ferry. It would be available for use at any hour of the day or night without causing any delay to traffic—clearly a very important consideration on a road which is destined to carry heavy traffic—but it would be very costly. A ferry would be cheaper to install, but it would give intermittent instead of continuous service and might be interrupted at times. The determination of the form of crossing to be adopted was, therefore, a matter of weighing the pros and cons of the various possibilities and of selecting the proposal most fitted to the

need. Further, rival forms of bridge and of ferry had to be considered.

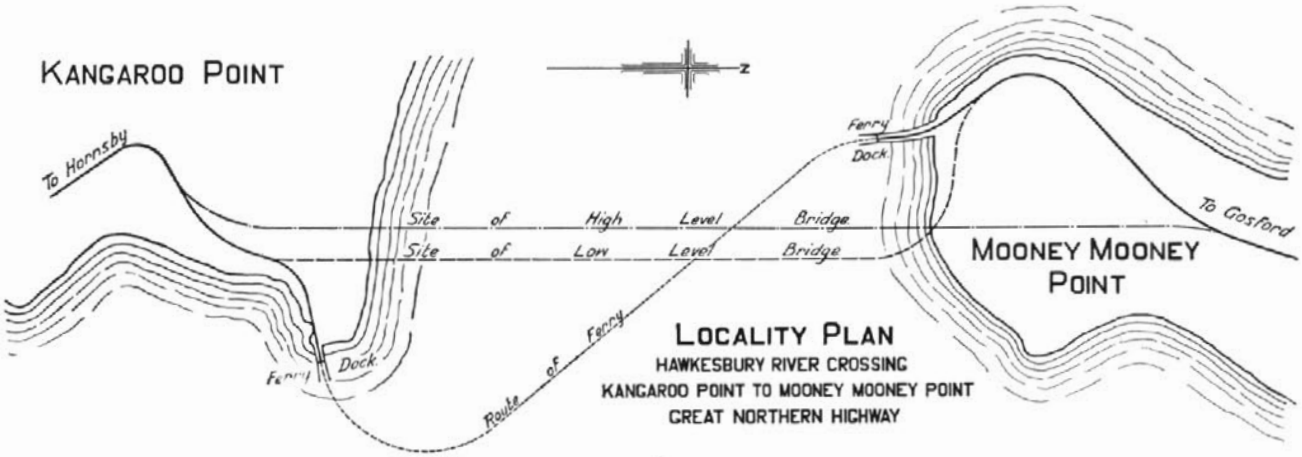
Three types of bridge were possible:—

(1) A high-level steel bridge, at such an elevation that river craft could pass beneath;

(2) A low-level steel bridge, with an opening span for vessels to pass through;

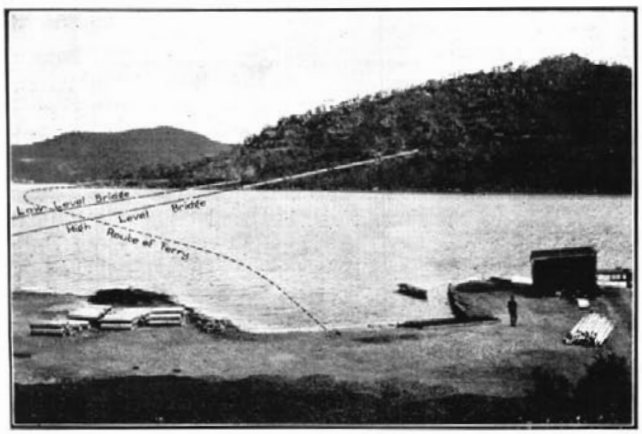
(3) A composite viaduct and floating bridge, the viaduct being used in the shallower depths and the floating bridge where the depth was great.

available for this purpose on the southern side of the river, and the rounded crest of Mooney Point on the north. Borings were taken of the river bed disclosing conditions closely analogous to those which pertained at the railway bridge, 1½ miles farther down stream. The lowest foundations of this bridge are 154 feet below water level (L.W.O.S.T.), and were at the time the bridge was erected (1886-89) the deepest bridge foundations in the world. An approximate estimate of constructing the most suitable steel bridge under such conditions was between £900,000 and £1,000,000. The

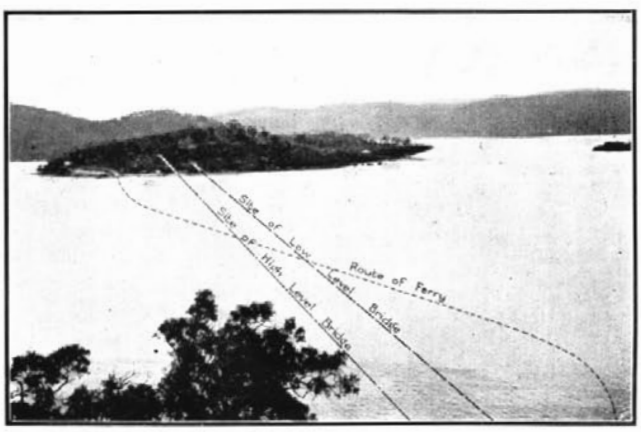


These are illustrated on the diagram on page 64. Number 2 was found to be almost as costly as Number 1, and was attended with the inconvenience, both to road and river traffic, of the opening. It was therefore abandoned. Number 3 was cheaper than No. 1, but not sufficiently so to warrant its adoption, even as a temporary expedient, in preference to No. 1, when the disadvantages of the short life of the timber piles on which it was proposed to found the viaduct, and

average annual cost of maintenance of this structure was estimated at £5,700, so that the capitalised cost of establishing such a bridge would be £1,150,000. From the high initial outlay required for the erection of this bridge—which could only be financed by a loan—and from the difficult financial position prevailing, it was evident that the construction of such a work was not practicable at present. A high-level bridge might be required ultimately, but for the time being some



Kangaroo Point.



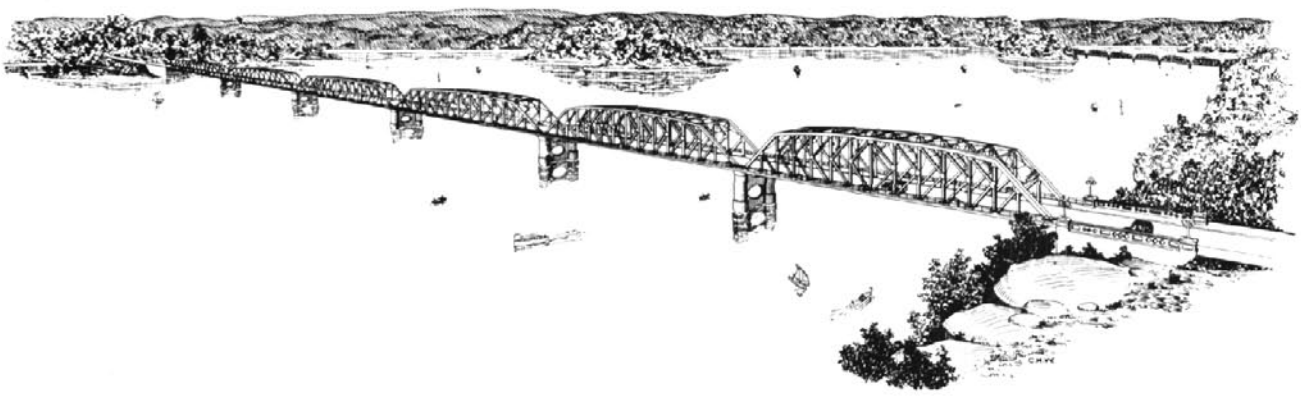
Mooney Point.

the difficulties of maintaining the floating portion under rough weather conditions and fast-running tides were considered. A high-level bridge was therefore determined upon as the only suitable bridge proposal. The take-off for such a bridge on either bank was ideal—the flank of a spur leading to Kangaroo Point being

expedient involving a lesser capital outlay would have to be adopted. This expedient was found in a ferry service.

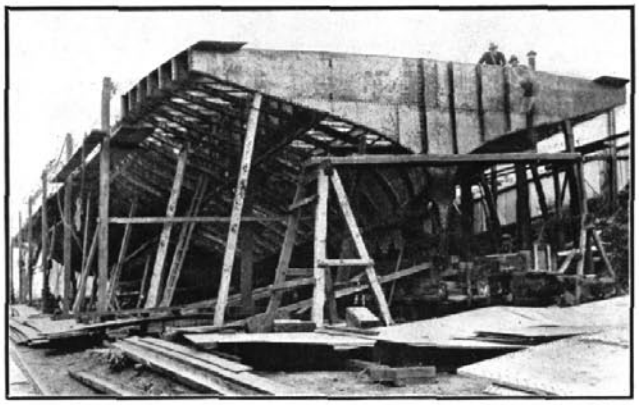
Consequently, tenders were called for the construction of two Diesel-engined ferry vessels, capable of carrying thirty-two road vehicles each, together with

passengers, and of manoeuvring without the aid of guide ropes. The lowest tender, that of Messrs. Poole and Steel, of Balmain, amounting to £72,500, was accepted. The first boat is due for delivery during March, 1930, and the second some thirteen weeks later. The ferries will be capable of a speed of 10 knots, and should make the crossing in five minutes. With the aid of the two boats, therefore, it is anticipated that it will be practicable to run a twenty-minutes service when necessary. As the traffic develops further ferries can be installed if needed.



The Ultimate Crossing.

Tenders for the ferry docks, which will be used for embarking and disembarking vehicles on either side, have also been let—the manufacture, supply, and delivery of the steelwork to the Australian Iron and Steel Company for £1,700, and the construction of the docks to the State Monier Pipe and Reinforced Concrete Works for £16,025. The docks will be located in such a way as not to interfere with the construction of the bridge when this becomes necessary.



One of the Vessels for the Hawkesbury Ferry in Course of Construction.

It will be of interest to record that the ferry will be established practically on the line of that which was inaugurated by Mr. George Peat shortly after 1840, and we of a later day are, by the adoption of this site, paying a just tribute to the judgment of an early pioneer who, venturing into the unknown, selected, with true intuition, the best position that Nature has provided for the crossing over the Hawkesbury of a road between Sydney and the north.

George Peat was born in Sydney in 1792. At an early age, he was apprenticed to the shipbuilding trade at the Government Dockyards, Sydney. After completing his apprenticeship, he made a brief visit to India, and then, returning to Sydney, commenced his trade as a shipbuilder, taking up residence in Kent-street. On 4th January, 1836, he obtained a grant of 50 acres of land situated at the head of a creek flowing into the Hawkesbury River at its confluence with Berowra Creek. Here, at a part now known as Peat's Bight, he erected huts for his men and for his own use on his periodical visits to the site, and engaged in cattle-raising and farming. On 16th March, 1840, he obtained a further grant of 60 acres on the northern side of the river at Mooney Point. This was evidently part of a definite policy of developing his farming interests, for within the year he built a substantial two-storey house on his new land for use as a country residence. Thereafter he divided his time between his town house at Kent-street and his new country home. With the acquisition and putting to use of the land on the northern side of the Hawkesbury, it became necessary to have some means of transporting cattle across the river to bring them to the Sydney market. He thereupon turned his training and business as a shipbuilder to account, and ventured on the establishment of a ferry across the river between Mooney Point and Kangaroo Point. This was intended not only to serve his own immediate needs, but also to be of similar use to the settlers still farther to the north. Shipwrights and boat-builders were accordingly brought from his yards, suitable timbers felled upon the banks of the river, and the craft fashioned and launched. It was a two-masted sailing lugger, worked by sweeps, and was operated at first either by assigned servants or hired labour. Transport with its aid was somewhat slow, for it is recorded that on one occasion a whole day was occupied in getting thirty-four horses across. The crossing at this point for such a vessel was by no means an easy one, subject as the locality is to stiff breezes and fast currents, and the man in charge needed to be an experienced sailor.

The ferry soon caused an increase in traffic along the track which led to Pearces' Corner (Wahroonga), with the result that from 1848 and onwards, steps were taken by the Government to make this into a road and to extend it to the north to connect with the existing northern road at Wollombi. Work was carried out on both sides of the river, either by means of small contracts or by road gangs, but chiefly on the southern side. By 1852 the punt dues amounted to about £50 per annum, and the road had become sufficiently established to warrant the purchase of the ferry by the Government. It was then leased on the basis of the ferrymen retaining the tolls, and, in addition, receiving an annual subsidy of £50. With the completion of the railway bridge further downstream and the opening of the railway between Sydney and Newcastle in 1889, the subsidy and the ferry service ceased; the little settlement at Kangaroo Point, with its church and school transferred to Brooklyn, a wayside hostelry known as "The Traveller's Rest," which had been established near the northern landing place, faded away, and the track to the north reverted to its natural state.

George Peat died on 9th August, 1870, at the age of 78, without seeing the full realisation of his ambition for the establishment of a permanent road via Kangaroo Point and Mooney Point to the north. It remained for the new age of motor transport to bring his project once again into prominence. When the works now in hand have been completed, his ideal will have been attained. It is, therefore, just and proper that his name should continue to be associated with the ferry service he was the first to inaugurate, and it is proposed to do this by naming the two vessels now under construction after his wife and himself, viz., the "Frances Peat" and the "George Peat."

New Main and Developmental Roads Proclaimed.

The following new Main Roads have been proclaimed:—

Main Road No. 267.—The route of this road was amended by deproclaiming the section between Turpentine and Nowra, and proclaiming the section between Turpentine and the Prince's Highway in the Clyde Shire as portion of Main Road No. 267.

Main Roads Nos. 6 and 58.—The section of the Mid-Western Highway (Main Road No. 6) between Gunbar, Booligal, Oxley and Balranald, and a section of Main Road No. 58 between Hay and Oxley have been deproclaimed, and the road from Gunbar, via Hay, to Balranald, has been proclaimed as part of the Mid-Western Highway (Main Road No. 6).

The following new Developmental Road has been proclaimed:—

Developmental Road No. 1,142.—The road from Sedgefield to Merannie, between 18 miles and 25½ miles from Singleton, within the Patrick Plains Shire.

Kerbside Petrol Pumps.

Towards the end of 1928, the Minister of Transport of Great Britain issued to Local Authorities a circular on the subject of petrol pumps on highways.

Reference was made to a previous Circular No. 191 (Roads) dated the 25th August, 1923, in which it was explained that Local Authorities had no power to sanction or even to acquiesce in the erection of petrol pumps or similar installations on lands dedicated to a public highway, and the Minister urged that where petrol pumps were necessary, they should be erected on private property adjacent to the highway in such a manner as to enable vehicles to draw up to the pump without causing obstruction either in the carriageway or on the footway. The circular then continued:—

> "While during the past five years, many Local Authorities have adopted the policy recommended by Colonel Ashley, there are unfortunately others who have not only permitted existing pumps to remain on the highways, but have also allowed further installations to be erected.
>
> "I am to point out that, owing to the constant increase of traffic, very large sums are being spent annually on the widening of roads in order that more space may be available for vehicles and foot passengers. In carrying out these widenings, the aid of the Ministry is almost invariably invoked, and a substantial share of the cost is commonly provided by the Road Fund, from which contributions are also made towards the maintenance of the roads in question. It is clearly not in the public interest that, while local and national funds are thus being spent in widening highways and removing encroachments unwisely tolerated in the past, certain Local Authorities should now permit a new form of obstruction, standing, sometimes, on the very land which has been acquired for widening the road.
>
> "I am accordingly to state that where land dedicated as part of the public highway is allowed to be obstructed by petrol pumps or other similar installations, the grants from the Roads Fund towards the maintenance and improvement of the roads concerned will be jeopardised."

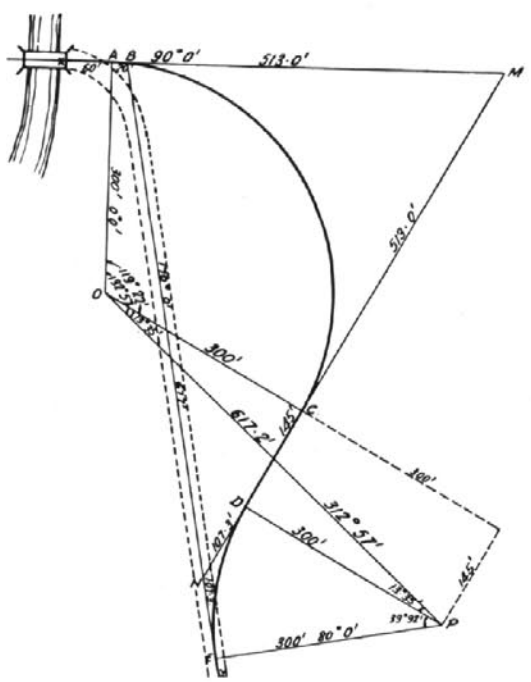
The remarks of this British circular may well be applied to conditions around the metropolis of Sydney and other leading cities of the State, such as Newcastle, Goulburn, Bathurst, &c. So far as the main roads of the county of Cumberland and the State highways in the country are concerned, no new kerbside petrol pumps may be erected on the roads without the Board's concurrence. A Bulletin (No. 8) setting out the manner in which the Board desires any applications for new kerbside petrol pumps should be dealt with, will shortly be issued to all Councils. The objective of the requirements explained therein is to encourage the establishment of drive-in, drive-out service stations off the road, instead of kerbside petrol pumps. As a result of this policy, which was initiated in 1927, there has been a marked development in the desired direction on metropolitan main roads, and, in addition, on a number of the more important of these, Councils have notified the owners of garages with kerbside petrol pumps that by the end of 1931 all such erections must be removed.

The Setting Out of Alignment Improvements.

By N. E. Dowden.
Engineer, Murrungal Shire Council.

IN the September issue of *Main Roads* there was shown in an article on "The Principles of Road Location" a sketch of an improved alignment in a bridge approach. I had a similar case recently, and as it took me some time to solve it, I thought it might assist other shire engineers to publish my solution.

The problem is to set out a reversed curve ACDE between the bridge alignment XB and the alignment of the existing road BY. So that the deviation may be as short as possible, the curves should be of the minimum radius 300 feet, with transition lengths 60 feet, and 25 feet of normal cross-section on the common tangent CD between transition points. Thus the tangent point A will be 60 feet from the bridge abutment when a



300-feet curve is used. The solution applies to curves of any radius, the problem being to commence at a given tangent point A in a fixed line XB, and by means of two curves of given radii, but reversed direction, and a given length CD of tangent between them, to finish on another fixed line BY at a tangent.

O and P are the centres of the curves.

CD = the sum of the transition lengths + 25 ft.

$$\text{Tan COP} = \frac{\text{CD}}{\text{OC} + \text{DP}}, \text{ and OP} = (\text{OC} + \text{DP}) \sec \text{COP}.$$

Whence we have the angle COP and the length OP.

Then in the surround OABEPO, we have the length and bearing of OA, AB, and EP, the length of OP and the bearing of BE.

Whence we can find the length of BE and the bearing of OP, which gives us the angles OAP and OPE.

Then angle AOC = AOP − COP and DPE = OPE − COP

AM = OA tan ½ OAC and NE = PD tan ½ DPE.

Whence we have M and N, the points of intersection of the tangents, from which we can set out the curves.

For example, suppose the centre line of the bridge has a bearing of 90°, and is intersected at B, 80 feet from the bridge abutment X, by the centre line of the existing road, which has a bearing of 170°, and that curves of minimum radius 300 feet, with transition lengths 60 feet, are to be used. The tangent point A being 60 feet from X, AB = 20 feet and CD = 60 + 60 + 25 = 145 feet.

$$\text{Tan COP} = \frac{145}{600} = \cdot 24166, \text{ so COP} = 13°35'.$$

OP = 600 sec 13°35′ = 600 × 1·02877 = 617·2 ft.

To find the length of BE and bearing of OP, call the line BE of unknown length due south, so that it will have latitude without departure, *i.e.*, add 10 degrees to each bearing.

Line.	Bearing.	Length.	N.	S.	E.	W.
OA	N. 10° E.	300	295·4	...	52·1	...
AB	S. 80° E.	20	...	3·1	19·8	...
BE	S	?	...	...	...	...
EP	E	300	...	...	300	...
PO	N. ? W.	617·2	...	...	...	...
			295·4	3·1	371·9	...

To balance the closure, the departure of PO must be 371·9 W. and $\frac{617 \cdot 2}{371 \cdot 9}$ = cosec bearing of PO west of north = cosec 37°3′.

Latitude of PO = 617·2 cos 37°3′ = 492·5 N.

Thus the total northings are 295·4 + 492·5 = 787·9 ft. which must equal the total southings; so that the latitude BE must be 787·9 − 3·1 = 784·8 ft. which is also the length of BE.

The bearing of PO is N. 37°3′ W. = 322°57′ when BE is due south, or 312°57′ when BE is 170°.

Thus angle AOP = 132°57′ and AOC = 132°57′ − 13°35′ = 119°22′ and angle OPE = 52°57′ and DPE = 52°57′ − 13°35′ = 39°22′.

$$\text{AM} = 300 \tan \frac{119°22'}{2} = 300 \times 1 \cdot 7101 = 513 \text{ ft.}$$

$$\text{NE} = 300 \tan \frac{39°22'}{2} = 300 \times \cdot 3577 = 107 \cdot 3 \text{ ft.}$$

BN = BE − NE.
= 784·8 − 107·3 = 677·5 ft.

Thus we have M and N the intersection points, from which we can peg out the curves.

The above method can, of course, be used to set out two reversed curves between any two tangent lines with a given length of common tangent between them.

What is a Developmental Road?

By C. Binns,

Engineer.

A DEVELOPMENTAL road is defined in the Main Roads Act as "any road which in the opinion of the Board—

(a) will serve to develop or further develop any district or part of a district; or

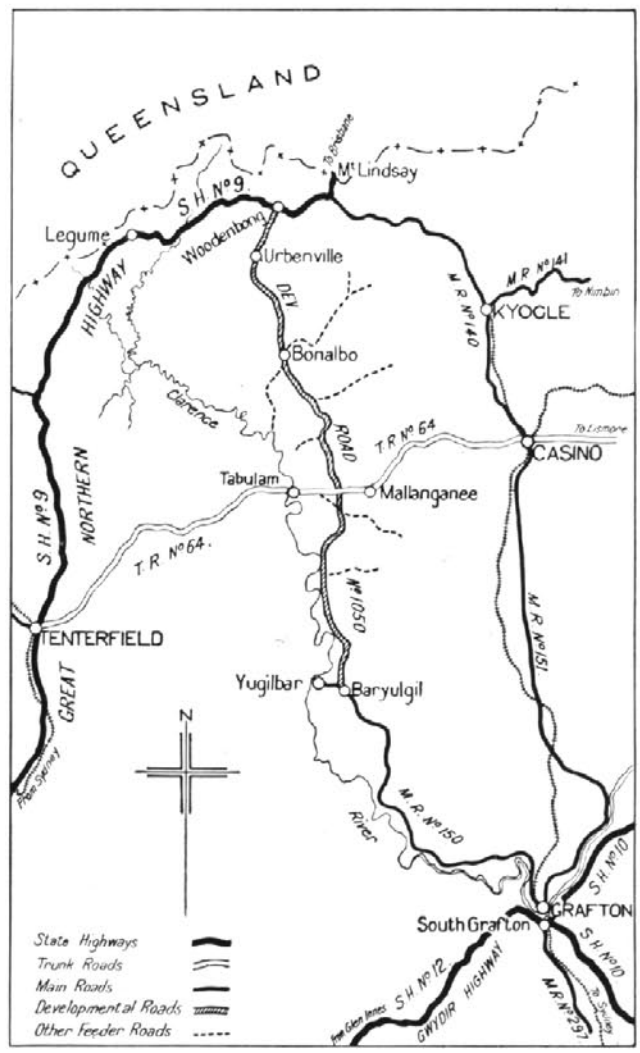
(b) will serve to develop any area of Crown or private land by providing access to a railway station or a shipping wharf or to a road leading to a railway station or a shipping wharf,"

and which, on the recommendation of the Board, has been proclaimed by the Governor as developmental. (In the original 1924 Act, proclaimed main roads were definitely excluded from being proclaimed also as development roads, but this was removed by a 1927 amendment.) This definition is a wide one; it may cover both existing roads and new roads, so long as their construction results in development. What then are the broad divisions into which developmental roads may be grouped?

A Typical Feeder road in a North Coast Dairying District—Before Improvement.

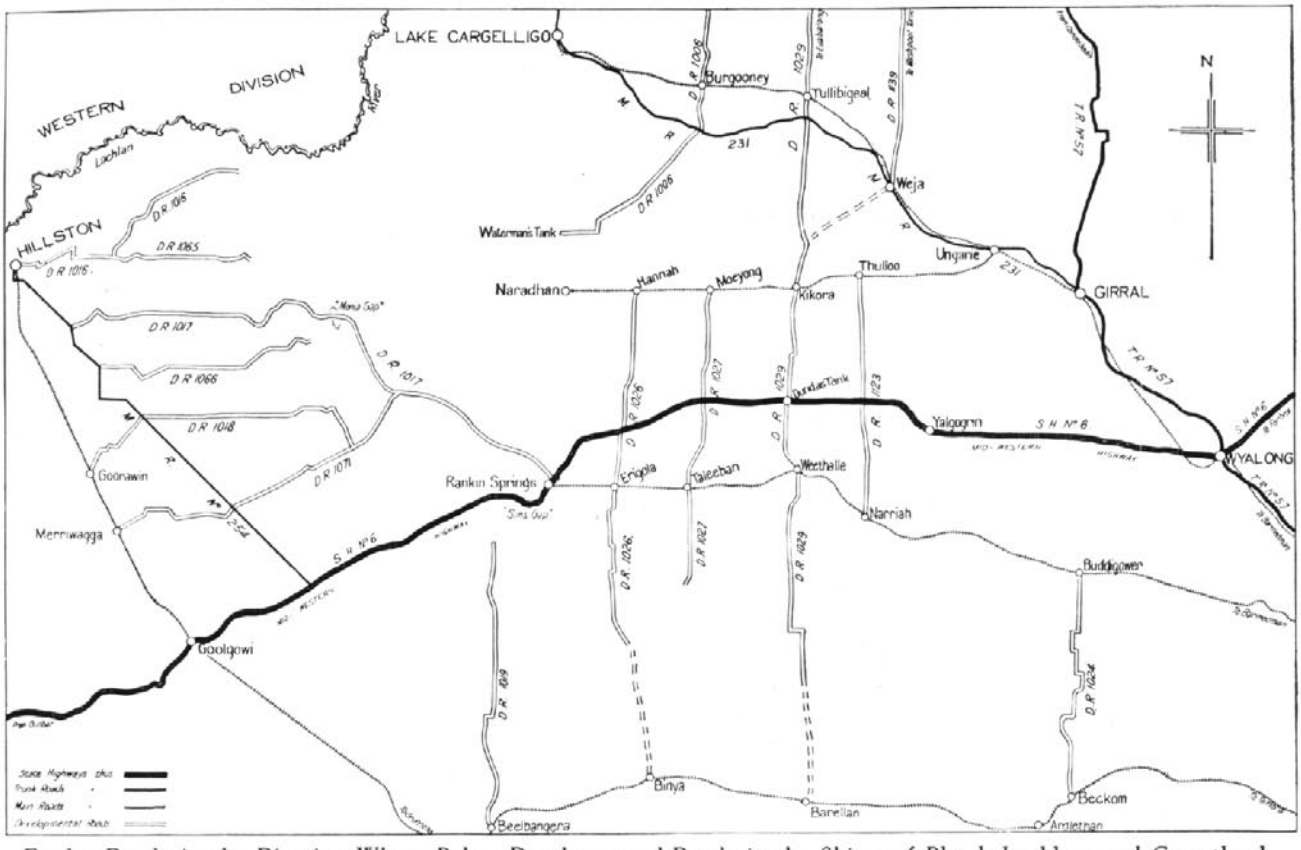
First of all, it should be stated that the type of development contemplated by the Act is that of primary production. The satisfactory development of any area for this purpose is dependent largely upon the means provided to transport products quickly and economically to the consumer. It is therefore essential, when contemplating the subdivision of land, to first give consideration to this question. Prior to the development of motor transport, if the area to be dealt with was of large proportions, it was usually found economical to provide a railway line which would facilitate the transportation of goods and produce over long distances with a minimum of delay. Under present-day conditions, it is frequently better to provide a road first instead of a railway, and to allow settlement to develop until it is sufficient to warrant the construction of a railway.

The provision of a railway and its profitable operation involve the establishment of a system of roads which will enable the produce to be brought to the railway for transportation. These roads will be more or less at right angles to the railway and act as its feeders. Thus we have the "Feeder" road.



The Clarence Valley Developmental Road (No. 1,050) in the Shires of Kyogle and Copmanhurst.

This type is naturally short in length, as each class of farming can only be profitably pursued while the value of the commodity produced annually is greater than the cost of transportation, plus production costs, during the same period. This will be more readily appreciated by mentioning that in the wheat belt of this State, where the value of land is in the vicinity of £7



Feeder Roads in the Riverina Wheat Belt. Developmental Roads in the Shires of Bland, Lachlan, and Carrathool.

to £8 per acre, the economic distance from a railway siding at which grain can be produced is generally regarded as 15 miles.

In some areas, the presence of a navigable stream provides a natural substitute for the railway line, and the "Feeder" roads will then be those leading to the wharves.

Where the area is not sufficiently large, or where development has not reached a stage to warrant the construction of a railway line, the main facility for transport will, as previously stated, be provided by a road. Such a road will commence from an established centre or market, and traverse, in as direct a manner as possible, the heart of the area being dealt with. It will collect the traffic from minor branch roads leading on to it, the junctions with which will form the picking up places. Here we have the two broad types of developmental road illustrated—the feeder road, and the road which carries the concentrated traffic of feeder roads, providing the means to transport the produce to the consumer.

In the foregoing, the ideal developmental road has been presented, but owing to the manner in which settlement has taken place in the State of New South Wales, such instances as these, where considerable areas of land are available for settlement—are rare. Generally, it is found that land has been alienated in piecemeal fashion, although in the Riverina, where research and experimentation in the growing of wheat has produced a drought and moisture resisting grain, large areas are now in process of development or are about to be made available for closer settlement.

The position to-day is that while in some instances Councils in whose areas such roads are located have been able to provide adequate means of transport, there are others where settlement has progressed so rapidly that the finances have been insufficient to meet the demand. In such cases the land is rarely being used to its maximum capacity, due largely to the fact of the farmers being unable to transport their produce to market under adverse weather conditions. Especially is this the case where the produce is of a perishable nature, and in that connection may be mentioned the dairying industry.

It is generally recognised that the districts best adapted to dairying are those where the rainfall is heavy, the country undulating to hilly with numerous streams, and the soil of rich quality. All these features tend to make roads costly to construct and maintain, it being generally admitted that the better the country, the poorer are the roads. Without an assurance that he will be able to get his cream and other products to his market town, the farmer cannot afford to put his land to full use. With such assurance he will employ more labour to develop each acre and bring it to full productivity. Faced with the possibility of being unable to market his produce, he employs fewer men, restricts his herd, and cultivates smaller areas. He is not prepared to take the risk of loss due to the fact that the state of the roads will not permit transport of his produce under bad weather conditions. In such circumstances, he is not encouraged to strive beyond making a bare living for himself and family. On the other hand, given an all-weather road, he would be

prepared to employ more labour, increase his herds, cultivate larger areas, and in thus improving his own position, would be benefiting the community as a whole.

Full development towards which we should continually strive, can only be attained by the provision of good roads of access, suitably located, properly constructed and efficiently maintained. Roads of this character constitute a distinct type of developmental road—roads that will lead to increased production on areas that have already been alienated. It will be apparent that the assistance to be given to such roads from the Developmental Roads Fund should, for national and economic reasons, be determined by the extent of the anticipated increase in production.

Similarly, there is the case where only portion of the area served is settled, and the possibility of additional settlement taking place is doubtful on account of the lack of adequate access. Here again, the construction of the road should lead to increased settlement and increased production.

There is yet another case, perhaps met with less frequently, where development has reached its maximum, but on account of bad roads and the consequent high cost of transport, the farmers are only able to obtain a bare living and are gradually being compelled to abandon their farms. It may be possible to provide a more direct access, or, failing that, the construction of an existing road may reduce the cost of transport sufficiently to re-establish the settlement.

There are, therefore, two broad types of developmental road, viz.:

(1) The feeder road.

(2) The road serving as the main route of transport for primary produce.

These may include—

(a) Roads, the construction of which will result in increased production without increased settlement;

(b) Roads, the construction of which will result in increased settlement and therefore increased production;

(c) Roads, the construction of which will re-establish a settlement where industries are languishing.

Tenders and Quotations Accepted.

The following is a list of the Tenders and Quotations accepted by the Board during the month of October, 1929:—

TENDERS.

Work or Article.			Name of Successful Tenderer.	Amount of Accepted Tender.
Municipality or Shire.	Road No.	Description.		
Hunter's Hill and Lane Cove.	166	Reconstruction of Gladesville-road and Joubert-street, and portions of Burns Bay road, between Mary-street and Longueville-road in cement concrete pavement.	State Monier Pipe and Reinforced Concrete Works.	£ s. d. 28,784 15 10
Yass	56	Construction of 1 mile of earthworks, gravel pavement, &c.	W. D. McDonald ...	2,436 1 9
Tenterfield (Shire) ...	9	Construction of two span timber beam bridge over Hoffman's Creek.	M. R. Hornibrook, Ltd.	1,252 14 6
Do ...	9	Construction of three span timber beam bridge over Little Oakey Creek.	W. G. Bamberry ...	1,797 5 0
Macleay	10	Construction of three span reinforced concrete bridge at Piper's Creek.	Balgue Construction Co.	3,509 0 0
Hornsby	9	Supply and delivery f.o.r. Hawkesbury River of steelwork and machinery for construction of Ferry Docks at Peat's Ferry.	Australian Iron & Steel, Ltd.	1,700 0 0
Campbelltown ...	177	Haulage of 725 tons gravel from Campbelltown railway station to overbridge at Morgan's Gate.	W. J. Donovan ...	@ 2s. per ton.
Randwick	317	Haulage of approximately 10,600 tons of material from Botany railway station to Fitzgerald-avenue, Randwick.	C. H. Nicholson ...	@ 2s. per ton.
Do	317	Hire of up to twelve 2-ton motor trucks with power-operated tipping gear.	P. L. Miller	3 @ 7s. 3d.
			C. C. Goodman ...	1 @ 7s. 6d.
			R. H. Chappell ...	2 @ 8s.
			J. T. Staples & Co. ...	1 @ 8s.
			S. Moore	1 @ 8s.
			W. J. Donovan ...	4 @ 8s.
Blue Mountains ...	6	Haulage of approximately 1,060 tons of materials from Emu Plains railway station to Board's dumps along road at Emu Plains deviation.	W. J. Donovan ...	1st mile @ 2s., additional miles @ 1s. per ton.
		Great Northern Highway—Bridge Caretaking—		
Lake Macquarie ...	9	Swansea Bridge over entrance to Lake Macquarie ...	J. Watkins	£78 per annum.
Erina	9	Wyong Creek Bridge	Mrs. Cremen	£12 per annum.
West Maitland ...	9	Long Bridge	J. Nelligan	£20 per annum.
Patrick Plains ...	9	Dunolly Bridge	G. Grainger	£26 per annum.

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

Work.			Name of Recommended Tenderer.	Amount of Recommended Tender.
Municipality or Shire.	Road No.	Description.		£ s. d.
Tumbarumba ...	278	Construction of bridge over Tumbarumba Creek	J. S. and H. Gamble ...	1,850 10 0
Do ...	278	Construction of culvert at 5 miles 3,430 ft.	J. McLurg	200 0 0
Bland...	1,029	Formation and gravelling	P. Donovan	319 0 0
Stroud	110	5,280 lin. ft. road construction and culverts	L. Lord	5,930 0 0
Lachlan	1,139	Clearing and grubbing	A. Buchanan	168 0 0
Turon	54	Small deviation at 27½ miles...	C. M. Cole	144 2 6
Patrick Plains ...	1,124	Construction from 0 ft. to 6,429 ft.	C. A. Leahey	1,398 19 0
Namoi	126	Construction of bridge over Cox's Creek	J. McMahon	2,938 0 0
Urana	131	Construction from 9 miles 2,000 ft. to 10 miles 2,251 ft. ...	Connelly and Son ...	863 3 2
Culcairn	210	Gravel construction and culvert	W. J. Stores	942 10 0
Hillston	1,016	Gravelling, 5,441 lin. ft.	E. O'Kane	1,678 0 0
Bland...	1,027	Clearing and formation	W. Harpley	484 13 0
Mitchell	58	Scarifying, gravelling, rolling, &c.	D. Glascott	599 8 9
Do	58	Construction of culvert	Charles Hardy Contracting Co.	490 0 0
Do	58	Scarifying and gravelling	J. Ovington	203 17 3
Do	210	Forming, boxing, gravelling, and culverts	J. Glascott	149 8 0
Do	57	Gravelling	L. Reinecher	90 0 0
Do	57	do	H. Reberger	43 15 0

QUOTATIONS.

No. of Quotation.	Description of Article.	Name of Successful Tenderer.	Amount of Accepted Quotation.
			£ s. d.
626	6 doz. hexagon barrier lamps	Kavanagh and English	32 9 5
631	100 tons 60–70 penetration bitumen	Shell Co. of Australasia	750 0 0
635	Timber decking, 136 ft. x 6 in. x 4 in., 58 ft. x 7 in. x 4 in., 39 ft. x 8 in. x 4 in., 116 ft. x 9 in. x 4 in.	W. D. Wood, Ltd.	15 7 9
644	525 tons Teralba gravel (2nd class)	D. Robertson	105 0 0
645	200 tons decomposed granite gravel	Sodwalls Gravel Co.	116 13 4
		Wilson's Gravel Co.	116 13 4
646	1 set parts for power tipping gear	Noyes Bros., Ltd.	43 5 0
648	Galvanised chain wire gates, 1¼-in. mesh: 1, 10 ft. 1 in. x 4 ft.; 1, 5 ft. 7 in. x 4 ft.; 1, 5 ft. 5 in. x 4 ft.; 1, 4 ft. 6 in. x 4 ft.; 2, 3 ft. 10 in. x 4 ft.	H. Clarke and Sons	7 7 8
655	Deformed metallic jointing, 13,360 lin. ft.	F. G. Kerr & Co.	233 2 9
656	⅜-in. mastic jointing: 514 sq. ft., type A; 1,406 sq. ft., type B; 938 sq. ft., type C.	Stuart and Sons	57 3 2
658	Reinforced concrete pipes, 1,246 ft. x 18 in. dia., 237 ft. x 21 in. dia.	Richard Taylor, Ltd.	311 19 7
659	Reinforced concrete pipes, 60 ft. x 21 in. dia.	State Monier Pipe Works	18 0 0
547	8-ft. power grader and front scarifier	British Standard Machinery Co., Ltd. ...	875 0 0
651	Double-action steam pump	D. H. Berghouse	22 10 0
652	2,700 tons Nepean sand, f.o.r., Botany	Nepean Sand and Gravel Co.	1,131 1 8
653	Blue metal, 50 tons ⅝ in., 768 tons 2½ in., 200 tons ¾ in.... ...	Nepean Sand and Gravel Co.	518 1 2
654	Blue metal, 2,270 tons 1½ in., 2,270 tons ¾ in.	Nepean Sand and Gravel Co.	1,418 15 0
657	50 tons bitumen, 90–100 penetration	Shell Co. of Australasia	387 10 0
664	Bridge timber, 24,000 sup. ft. decking, 4 in. x 6 in. to 10 in., 1,600 lin. ft. kerbing, 8 in. x 8 in.	W. D. Wood, Ltd.	698 2 6
582	Pumping outfit	Cameron, Sutherland, and Seward Pty., Ltd.	46 7 0
633	Hardwood timber, 1,150 ft. x 9 in. x 5 in.	C. W. Elliott	77 12 9
639	Blue metal, 600 tons, 1½ in., 600 tons ⅝ in.	State Metal Quarries	355 0 0
660	Concrete mixer, 7 cub. ft. capacity	Moffat-Virtue, Ltd.	165 0 0
666	Blue metal, 2,962 tons 1½ in., 2,962 tons ¾ in.	Bowral Blue Metal Quarries	1,629 2 0
685	200 tons bitumen, 60-70 penetration	Shell Co. of Australasia	1,425 0 0

Nymboida River Bridge.

TENDERS have been invited, and will close on 20th December, 1929, for the supply and delivery of steelwork for a bridge over the Nymboida River, at Nymboida. The bridge consists of three 100-feet steel truss spans, with timber deck, founded upon concrete piers, and nine 35-feet and one 30-feet timber beam spans. The width between kerbs throughout is 20 feet. Tenders will shortly be called for the erection of the steelwork and the completion of the bridge and approaches. The bridge site is at a point 27 miles out from Grafton, on the Armidale-Grafton road (No. 121).

Sydney: Alfred James Kent, I.S.O., Government Printer—1929.