1914.

VICTORIA.

COUNTRY ROADS BOARD.

FIRST ANNUAL REPORT.

PRESENTED TO BOTH HOUSES OF PARLIAMENT PURSUANT TO ACT No. 2415

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The Hon. F. Hagelthorn, M.L.C., Minister of Public Works.

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DIAGRAMS, MAPS, ETC.

Country Roads Board,
Melbourne,
1st September, 1914.

The Hon. F. Hagelthorn, M.L.C.,
Minister of Public Works,
Melbourne.

SIR,

As required by Section 73 of the Country Roads Act, I have the honour to submit to you the first Annual Report of the proceedings of the Board.

In addition to the information required to be furnished under the Act, the Board has thought it advisable to include as much information as possible relating to what are considered to be the most effective and economical methods of road and bridge construction and maintenance, as applicable to the roads in this State, in the hope that Municipal Councils may not only apply those principles to the main roads, but that they may also gradually apply and extend them to the subsidiary roads in their respective districts.

I have the honour to be,
Sir,
Your obedient servant,
W. CALDER,
Chairman.

COUNTRY ROADS BOARD.

FIRST ANNUAL REPORT.

In submitting the first Annual Report of the proceedings of the Board, it is considered necessary, at the outset, to explain that the Report deals not so much with the constructional work carried out during the period under review, as with the preliminary work connected with the investigation of the highways in those portions of the State that have been visited, the conditions of the roads in the districts, the existing methods of dealing with the roads by the Government and municipalities, and also the Board's proposals for giving effect to the provisions of the Country Roads Act.

The Board was appointed on the 26th day of March, last year, and held its first meeting at the office of the Minister of Public Works on the 31st idem.

Before any constructional work could be undertaken it was necessary to determine what roads should be brought under the provisions of the Act, or in other words, the roads which should be declared main roads. It was obvious that this could be done only after careful investigation of the existing road conditions throughout the State. That such an investigation was a necessary preliminary, and was recognised as such by the Government, is evident from a statement made by the Hon. H. McKenzie when introducing the Country Roads Bill into the Legislative Assembly, when he said, regarding the duties of the Board which it was proposed to appoint, that, "Its first duty will be to make a thorough investigation into existing highways, so that it may have the materials on which to exercise sound judgment."

At the outset it became apparent to the Board that, in a great many instances, municipal councils had not a clear conception of the provisions of the Country Roads Act, of the manner in which it was to be administered, or of the benefits expected to ensue from its operation; and as the Act requires that Councils are to be consulted before the declaration of any main road, it was decided to visit every municipal district, inspect the roads in each, and if possible, to interview the councillors and give a general explanation of the provisions of the Act, and the methods proposed to be adopted in giving effect thereto; and it may be here stated that this procedure has met with the unanimous approval of those councils which the Board has had the privilege of meeting. The visits of the Board to districts such as Gippsland, Cape Otway, and the North-east, where the early construction of better roads is a matter of vital importance to the welfare of the settlers, have also been much appreciated by them, as the improvement of their only means of communication appeared within measureable distance of realization.

Another matter which should be here referred to is the period over which the expenditure of the loan of £2,000,000 should extend. Section 29 of the Act makes provision for the raising of a sum of £400,000 per annum during a period of five years, and some disappointment may have been occasioned because this amount was not expended during the first year. It is therefore necessary to explain that during the first year the Board was, and for a considerable portion of the second year expects to be, fully occupied in making the investigation referred to, which necessitates almost continuous travelling, together with much negotiation with councils. The general organization of the work, the consideration of methods of surveys, the principles of construction and maintenance of roads to be adopted has also occupied much time. This, it may be stated, was also anticipated by the Government, as indicated by a statement by the Hon. the Minister of Lands in Parliament, when he said that "There is no doubt that in the first year the Board will not expend anything like £400,000."

For convenience in making the investigation, it was decided to divide the State into sections, to take the districts in the order considered to be the most necessitous, and to complete the investigation of each district before determining what roads should be main roads in any one municipality. The sections decided upon were :—

(1) *Gippsland District*, extending from Whittlesea on the west to Traralgon and Yarram on the east, and from Healesville and Narracan on the north to the coast line on the south.

(2) *East Gippsland District*, extending from Rosedale and Maffra shires on the west to Mallacoota and the New South Wales border on the east, and from Dargo and Omeo on the north to the coast line on the south.

(3) *Cape Otway District*, extending from Warrnambool and Mortlake on the west to Werribee, Corio, and Queenscliff on the east, and from Skipton and Rokewood on the north to the coast line on the south.

(4) *North-Eastern District*, embracing all the municipalities along and east of the main Sydney road, between Melbourne and Wodonga, and as far west as Nagambie and Wahgunyah, and between Yea, Alexandra, and Walhalla on the south and the Murray River on the north.

(5) *South-Western District*, from the South Australian border on the west to the shires of Mount Rouse and Belfast on the east, and from Goroke in the shire of Kowree on the north to the coast on the south.

(6) *Northern District*, from the shire of Rochester on the west to Shepparton and Yarrawonga on the east, and from the shire of Waranga on the south to the Murray River on the north.

(7) *North-western District*, from the South Australian border on the west to the shires of Bet Bet, Charlton, and Wycheproof on the east, and from the shires of Lowan, Arapiles, Wimmera, and Ararat on the south to Mildura and the Murray River on the north.

(8) *Central District*, from the shire of Mount Franklin on the west to Pyalong Shire on the east, and from Keilor and Melton on the south to Newstead and McIvor on the north.

(9) *Bendigo District*, from the Shire of Korong on the west to Strathfieldsaye on the east, and from Castlemaine and Maldon on the south to Kerang on the north.

(10) *Ballarat District*, from Stawell and Ararat on the west to Ballan on the east, and from Grenville on the south to the shires of Kara Kara and Tullaroop on the north.

It may be pointed out that this system of grouping has been adopted merely to facilitate inspection and has no other signification.

There being no interpretation in the Act as to what should constitute " main roads " other than the direction in Section 18, which states that the " Board shall . . . declare any highway which is, in the opinion of the Board, *of sufficient importance*," it was decided to consider them from the following points of view :—

1st. As to whether they were main arterial roads carrying extensive traffic, or likely to carry extensive traffic between centres of population, or from one district to another.

2nd. As to whether they were subject to considerable traffic from rural districts to the railway systems.

3rd. As to whether they were developmental in character, that is, whether their construction would be likely to lead to increased settlement or increased production.

CONDITIONS IN GIPPSLAND (GROUP No. 1).

The Board commenced its investigation in the shire of Lillydale in May of last year, and continued easterly into Gippsland, proceeding through the shires along the main Gippsland railway as far east as Traralgon, then returned westerly through the coastal and South Gippsland shires from Alberton on the east to Mornington, Frankston, and Moorabbin on the west. The inspection of this group was finished in September.

Plates 1, 2, and 3. Showing ordinary Winter conditions of roads in South Gippsland.

It will thus be seen that the inspection of the whole of the south and Central Gippsland shires was carried out during the winter months, when the roads and tracks were in their worst condition, many being quite impassable for vehicular traffic, and in consequence the greater part of the inspection had to be made on horseback.

Plate 4. Showing ordinary Winter condition of a road in South Gippsland.

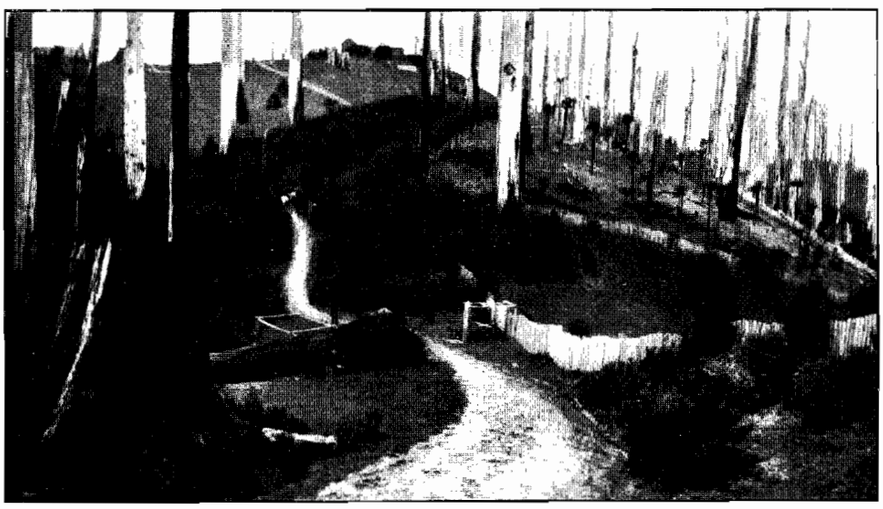
It is not considered necessary to comment on the condition of the roads in each shire in detail, as what applies to one shire, particularly in the hill and forest country, applies practically to all. It is not only in the remote hill country, however, that these conditions obtain, for the main Gippsland road between and adjacent to centres of population such as Drouin, Warragul, and Trafalgar is in a similarly impassable condition during the winter months.

Plate 5. Main Gippsland Road, near Yarragon, in Winter.

In the extensive area of this hilly country between the main Gippsland railway and the coast, from Lang Lang on the west to Carrajung on the east, the roads are of the most primitive description. Almost without exception the location of the roads, as originally surveyed, was at fault, and large sums have been expended by the Government and the municipalities, either in securing deviations through what has since become freehold and improved properties, or in the hopeless endeavour to construct roads on existing gradients which are quite unfitted for the economical haulage of agricultural produce. It is quite usual to see expensive side cuttings, some of them metalled on grades varying from 1 in 5 to 1 in 11, and in many instances these are on deviations from the original surveys, that have been acquired by the Shire Councils with their own revenue, and then constructed as stated by means of a Government grant.

In fact, it is not so much the absence of formed roads that is the greatest handicap to the Gippsland settler, as it is the hopelessness of ever being able to construct the majority of existing surveyed roads with suitable gradients.

These badly located roads appear to be the result of the system that was in force between 1870 and 1880, which permitted selection before survey, and in the absence of any scheme for financing the cost of constructing roads with suitable gradients on side cuttings, the adoption of what may be termed the natural roads following the leading features, by which a track could be secured at the cost of clearing only.

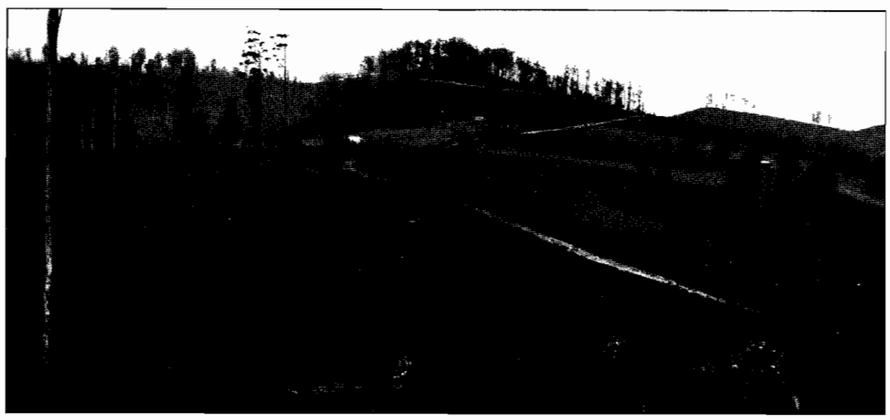


Plates 6 and 7. Showing typical location of Gippsland roads.

Had the road condition now inserted in grazing area leases, agricultural allotment licences and leases, and the survey regulations relating thereto, adopted in 1902, been in force when South Gippsland was made available for selection, much expense and trouble would have been avoided.

The condition and regulation referred to provide for the survey of the main roads with grades not steeper than 1 in 19, while for secondary roads a grade of 1 in 15 is adopted, but pending the construction of the surveyed roads, temporary road rights are reserved over such tracks as may be necessary along the ridges and leading features.

When the country became occupied by settlers, however, who required provisions and the other necessaries of life, as well as facilities for getting their produce to market, the necessity for roads on trafficable grades was realized.



Plates 8 and 9. Showing typical location of Gippsland roads.

In each of the above illustrations, the road has been surveyed, and to a certain extent constructed over the summit of the hill.

The country at this time, being unimproved and heavily timbered, was of little value from a rate-producing point of view, consequently the municipalities with their limited revenues were able to accomplish little in the way of road re-location. Assistance was granted by the Government from time to time, but such assistance was dependent upon the financial condition of the State, and this is being continued to a limited extent at the present time by means of special grants. These grants have always been provided for construction works only, no portion being permitted to be utilized in acquiring land for the re-location or deviation of roads, or for fencing new deviations. Where deviations were necessary, and it is safe to affirm that there is scarcely a road in the whole of the hill country of Gippsland that has not been deviated in some part, the necessary land had first to be bought by the municipalities. Instances have been noted where two or three deviations have been made on the same hill, and still the grades are unsatisfactory. In each instance the cost of acquiring the land for the deviation was borne by the municipality.

In this connexion one shire claims to have expended from its own revenue no less than £6,000.

Another condition attached to the granting of Government moneys was that no expenditure was allowed on grades steeper than 1 in 11 except under special circumstances. This condition had the effect of practically establishing a standard grade of 1 in 11, and even this has been departed from in many instances, and as such grades were known to be acceptable, no special efforts were made to secure better, it being realized that the cost of securing a better grade involved a greater expenditure of municipal revenue to acquire the greater area of land, as well as an increased Government grant to construct the road.

The acquisition of land from persons to whom the new deviations are of little or no benefit, especially when it has to be done compulsorily, is always regarded by councils as an uncongenial and tedious task, and consequently is avoided, if possible, in favour of the improvement of the existing road, which is more quickly accomplished and affords some earlier measure of relief to settlers from the existing intolerable conditions.

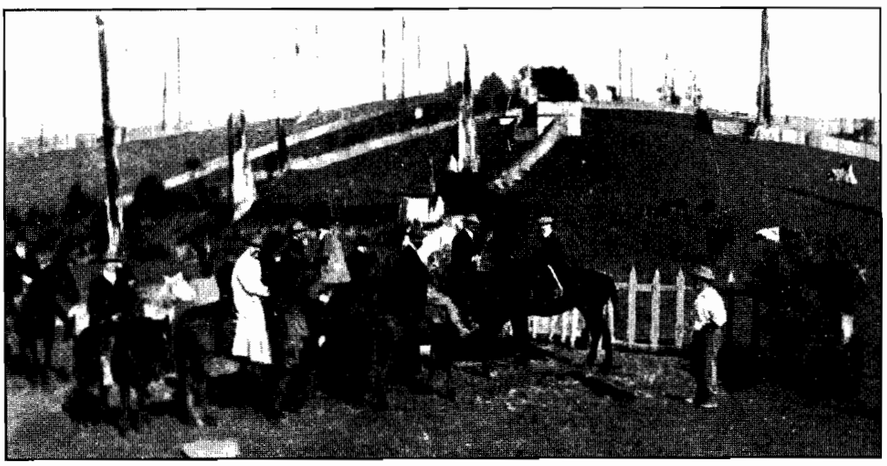
Under the system described, miles of roads have been constructed for developmental purposes at a cost of many thousands of pounds, which, owing to the steepness of the gradients, have only partially achieved their object.

Referring again to the topography of the South Gippsland country, it must be remembered that practically the whole area between the main Gippsland railway and the Great Southern line consists of ranges varying in altitude from 1,000 to over 2,000 feet. These ranges reach their highest altitude about midway between the two railway systems, the watershed being irregular owing to the broken nature of the country. This divide generally speaking forms the southern boundaries of the shires on the north,

Plates 10 and 11. Showing groups of settlers who met and accompanied the Board on its inspections South Gippsland.

and the northern boundaries of the coastal shires on the south. Consequently the settlers all along the divide, from about the terminus of the proposed Lang Lang to McDonald's track railway, through Allambee, Mirboo, Gunyah, Ryton, Bulga, and Blackwarri to Carrajung, situated as they are on the extreme boundaries of their respective municipal districts, and in the most difficult country for road construction, are truly in an unenviable position. The Board traversed this area from west to east, and again from east to west, intersecting it at intervals from north to south and *vice versâ*, and interviewed settlers all along the route. So interested were these men in the Board's proceedings that they travelled for miles through the rain and mud in order to learn whether they could hope

for improved road conditions. Some were met congregated in groups on the tracks in the day-time ; others came as deputations at night to urge that something might be done for them.



Plates 12 and 13. Showing groups of settlers who met and accompanied the Board on its inspections in South Gippsland.

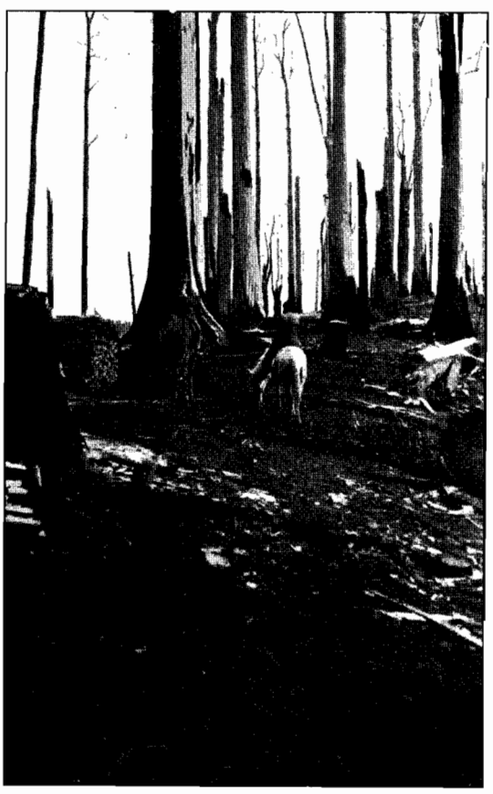
Many of them stated that although they had been in occupation for fifteen and twenty years, they had not yet had a wheeled vehicle on their holdings.

Plate 14. Showing road on which vehicular traffic is impracticable.

Their statements to the effect that the country in some parts was retrogressing, and that there is less population in these localities that there was ten or fifteen years

ago, are confirmed by the existence of numbers of deserted homes and holdings which have been abandoned for no other reason than the absence of means of communication.

It must not be thought that the roads shown in Plates 1 to 4 are exceptional cases. In fact, they illustrate the ordinary condition of the roads in the hill country of Gippsland during the winter months, and it is under such conditions as here depicted that the settlers with their wives and children live, isolated even from their neighbours. These are the roads over which the settler must convey his produce to the market, that his wife must use to reach the township, and through which the little children have to struggle to get to school.



Plates 15, 16, and 17. Showing roads on which vehicular traffic is impracticable.

Is it any wonder that a deputation of settlers' wives waited on the Board to plead for a metalled road to the township?

The proposals that have been outlined for making roads through this territory as shown on the accompanying map will no doubt effectively relieve the settlers in the vicinity of these roads, but owing to the broken nature of the country, there are

hundreds of settlers whom the main roads as laid out can never serve, while there are many more who will be unable to use them until connexions are made with the main roads from the roads or tracks on which their homes are situated.

While these connecting roads are less important than those determined upon as main roads, they are nevertheless essential to the settlers and to the development of the country, and without them, the full advantage which should result from the construction of the main roads, will not be reaped.

The Board therefore considers that it is its duty to bring this aspect of the question under the notice of the Government with a view to the consideration of the claims of the settlers so situated.

Plate 18. Deputation of wives of settlers at Bullarong, South Gippsland, who urged that a metalled road be constructed to Foster.

Apart from the great handicap such roads are to the settler in his struggle to clear his land and earn a living, they are also a serious factor in retarding the growth of country townships.

In the older settled parts of the State, it is the custom of the farmers, with their families, to visit the townships at regular intervals for the purpose of transacting their business with the local store-keepers. This, in many instances, is the only outing that the farmer's wife and daughters enjoy, and is a welcome relief from the sameness of everyday life on the farm, but even this little relaxation is denied to many of the wives of Gippsland settlers, owing to the impassable condition of the roads, with the result that the townships do not reap the full benefit of the trade from the surrounding districts.

EAST GIPPSLAND DISTRICT (GROUP No. 2).

The investigation of this group of shires was commenced with the Shires of Rosedale, Maffra, and Avon in September last. With regard to the three shires mentioned, and as relates to the level country in the vicinity of the railways, it may be said that the roads are exceedingly good. This is accounted for by the fact that there are few engineering difficulties, while there is an abundance of excellent gravel, easily accessible, and widely distributed throughout the district.

But in the case of the hill country away from the railway lines, in the direction of Willung and Gormandale to the south of Rosedale, and the Licola and Dargo country to the north of Maffra and Stratford, where the rainfall is greater and the country heavily timbered, considerable expenditure in road construction is required to induce further settlement, and to make the existing settlements successful. The Licola road has recently been partly constructed by the Government through the Public Works Department, and this work will now be carried through to completion.

With regard to the Dargo district, the conditions are such as to call for special mention. The township of Dargo, an old mining settlement, is situated on the Dargo River, 50 miles north of Stratford, and its only means of communication with the railway system is that known as the Insolvent Track from Stratford, through Stockdale and Waterford.

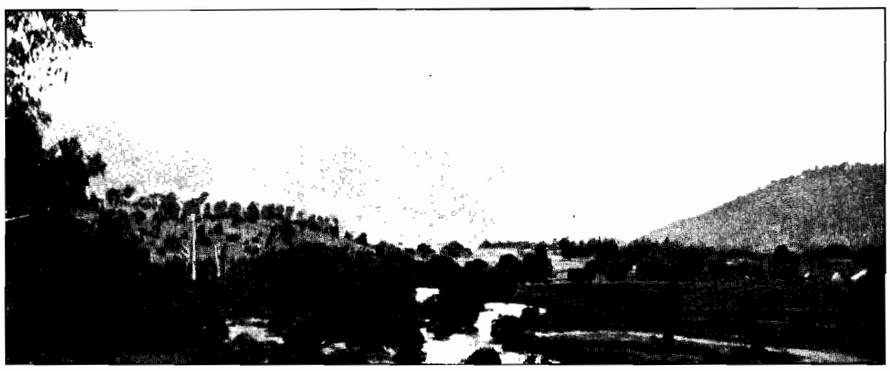
Plates 19 and 20. Showing stretches of gravelled roads in Shires of Avon and Rosedale.

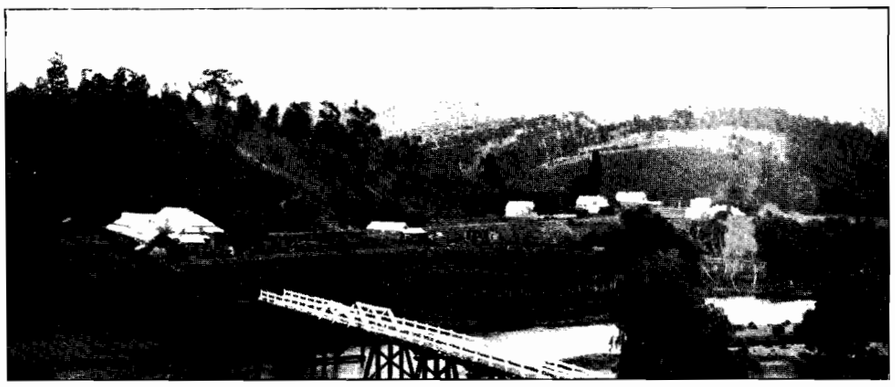
From Stratford to Stockdale, 15 miles distant, the road has very fair gradients, and is in good condition, but from that point to Dargo, a distance of 35 miles, the location of the road is extraordinary. The country is extremely precipitous, and on that account,

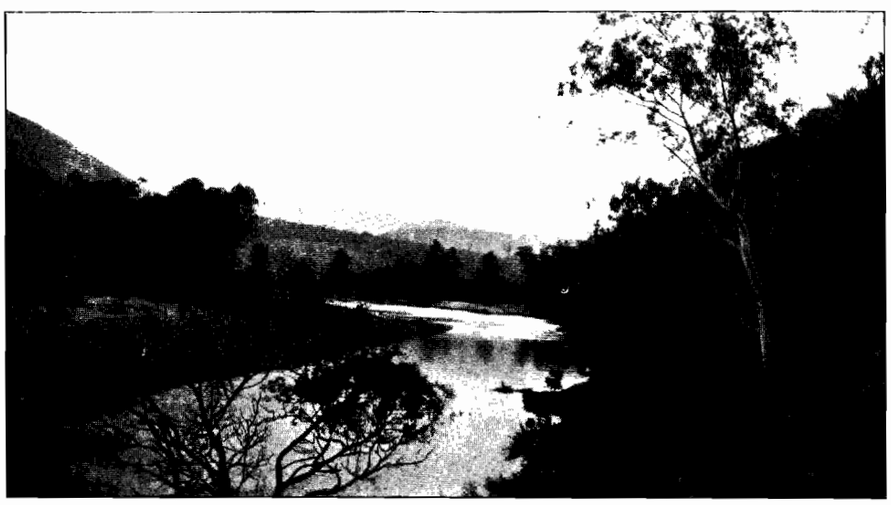
Plate 21. Showing six-horse teams on the Insolvent Track, hauling stores to Dargo.

before any construction work in the form of sideling cuttings was carried out, the traffic was forced to climb to the summit of a range of hills, and to laboriously follow the ups and downs of the leading ridge, finally to descend on the far side at Waterford. It

would appear that this route eventually became the main road. Many thousands of pounds have since been expended by the Government from time to time on side cuttings. These have consisted chiefly of short lengths here and there to avoid some excessively steep pinches, generally near the top of a hill, with the result that there is still only a badly located bush track, which inflicts on the residents of Dargo and district a freight charge of £3 10s. per ton on stores from Stratford railway station.







Plates 21A, 21B, and 21C. Showing views of the Dargo District.

If the Dargo district were only a mining settlement, without agricultural or grazing possibilities, the expenditure involved in the construction of a good road would not be justifiable, but there is some excellent land suitable for potatoes, maize, &c., in the narrow valleys of the Mitchell, Crooked, and Dargo Rivers, whilst the hillsides, once the timber is cleared, are suitable for grazing. It is impracticable, however, to convert the Insolvent Track into a road with suitable gradients at a reasonable cost.

It is, therefore, proposed to abandon the lower end of the Insolvent Track, and construct a new road from Briagolong railway terminus up the valley of the Freestone Creek for a distance of 19½ miles. This new road will reduce the distance from Dargo, Waterford, and Talbotville to the railway system by 7 miles, and at the same time will provide access to an area of 20,000 acres of Crown lands of fair grazing quality in the valley of the Freestone Creek.

Further east, in the Shires of Omeo, Bairnsdale, Tambo, and Orbost, the conditions generally are somewhat similar. The area of first-class land compared with the extent of poor land is small, and it is on the settlement of the greater area of poorer country that the progress of East Gippsland must to a large extent depend. The construction of trafficable roads, however, is a necessary preliminary, as may be gathered from the following :—

The township of Bairnsdale is one of the oldest towns in Gippsland. It has magnificent natural advantages, a good climate, generous rainfall, a fine river, and with a regular line of steamboats trading with the metropolis. Yet Bairnsdale as a town has been practically stagnant for the past twenty years, the increase in population during that period being 142. The reason for this condition, in the opinion of the Board, is that the area of first-class land which has been settled for the past 50 years is limited, and no effective effort has been made to develop the enormous area of comparatively poor land in the vicinity.

Consider, for instance, the area of country immediately to the north of Bairnsdale, in the direction of Bulumwaal and Tabberabbera. This area, particularly between Bairnsdale and Bulumwaal, is eminently suitable for fruit, maize and vegetable growing, and, being close to both rail and water carriage, should support a considerable population, while the area between Bulumwaal and Tabberabbera is suitable for grazing and dairying.

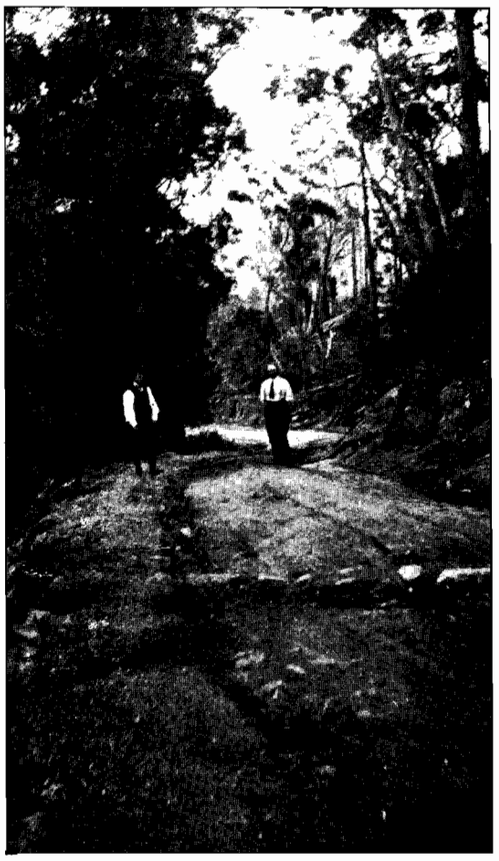
Plate 22. Section of road over Mount Taylor, between Bairnsdale and Bulumwaal.

The Government recently threw open for selection a considerable area of the country between Bulumwaal and Tabberabbera, and expended a sum of £6,000 in making a road through the area, but the result was not satisfactory for the following reasons :-

From Bairnsdale to Bulumwaal the distance is 16 miles, and from Bulumwaal to Tabberabbera another 19 miles, and it was through this last 19 miles that the road was constructed. To reach this road, however, prospective settlers would be required to traverse the road shown in the accompanying photographs with grades of 1 in 5, 1 in 7, and 1 in 9. From Bulumwaal onward, the steepest gradient on the new road is 1 in 20. As a matter of fact, the section between Bairnsdale and Bulumwaal is absolutely dangerous for vehicular traffic, and when it is remembered that the successful applicants for these areas are required to reside on their blocks, and that preference is given to married men with families, it is not surprising that men decline to take up land under such conditions.

In the Shires of Tambo and Orbost the extent of country with indifferent roads is enormous. From Bruthen, the Board travelled to Buchan, and from thence as far north as Gelantipy, along the New South Wales old stock route. At Buchan the country is very good ; there is also good land along the route as far as Gelantipy, but here again the existing road has gradients that form an obstacle to any possibility of successful settlement, consequently the country is entirely devoted to grazing.

A well-graded road from the new railway station at Nowa Nowa on the Orbost line, through Buchan to Gelantipy, should lead to considerable development both in dairying and agriculture.



Plates 23 and 24. Sections of road over Mount Taylor, between Bairnsdale and Bulumwaal.

As this road traverses good country throughout, and as it is understood that similar country extends further north, it may be considered advisable in the future to make an extension *viâ* this route to New South Wales in the direction of Delegate. This will be determined, however, by a further inspection after the regrading and construction of the lower section is completed.

The railway from Bairnsdale to Orbost, now in course of construction, will, for some time after its completion, practically throw out of use the existing rough track between those centres, except for through motor traffic or for stock, and as the most pressing need for some time in those districts is the construction of developmental roads to the new railway at centres such as Bruthen, Nowa Nowa, and Orbost, the Board considers that the large expenditure that would be required to construct a road between Bairnsdale and Orbost would not be justifiable at the present time.

In the Shire of Orbost, which embraces the whole of the county of Croajingolong and portion of the county of Tambo west of the Snowy River, owing to the fact that the land suitable for agricultural settlement is confined to comparatively narrow river valleys situated at great distances apart, and also at long distances from the new railway terminus at Orbost, the road problem is likely to be one of the most difficult that the Board will have to deal with.

From Orbost to Genoa, at the head of Mallacoota Inlet, the distance is over 80 miles, and from Genoa to Gipsy Point an additional 7 miles. Between Orbost and the Brodribb River, a distance of 6 miles, the road will require to be regraded, but from that point to Genoa, a distance of about 74 miles, an excellently located road with easy gradients has been partly constructed by the Public Works Department, but a good deal remains to be done on certain sections in the form of metalling or gravelling, to make the road trafficable for vehicles at all seasons. This road promises to become one of the most important highways in the State. It will not only carry the whole of the traffic of the settlements east of Orbost to the railway at that centre, but will be the means of making accessible to Victorian tourists the scenic beauties of Mallacoota Inlet, and will also facilitate trade and intercourse between Victoria and the south-eastern portion of New South Wales. It is essential, however, that an effective system of maintenance of the road be adopted. It is only six years since the road from the Cann River to Genoa was constructed by the Public Works Department, yet it is now almost overgrown, as shown in the accompanying photograph.

Plate 25. Showing road between Cann River and Genoa. The figure on each side shows the width originally cleared and formed six years ago.

At Genoa the Board was interviewed by representative settlers who gave a graphic description of their difficulties, which certainly are unique. The settlements in this district include that at Wangarabelle, along the valley of the Genoa River, and those in the immediate vicinity of the Mallacoota Lakes.

The uncertainty of the navigability of the entrance to Mallacoota, the absence of a road connecting Genoa with the deep water landing at Gipsy Point, combined with the fact that these settlements are over 80 miles from Orbost, practically excludes the settlers from business dealings with their own State—consequently their produce is sent to the port of Eden in New South Wales, 45 miles distant, and thence to Sydney.

From Genoa to the border of New South Wales the distance is about 7 miles, and the condition of the road or track on both sides is very bad. On the Victorian side the chief difficulty is the absence of a bridge over the Genoa River, for which plans are now in course of preparation, and the regrading of the road for the first 2 or 3 miles from Genoa.

From the border to the port of Eden, a further distance of 28 miles, the track is also very rough, except in the vicinity of Eden, while a bridge more costly than that at Genoa is required over the Kiah River in New South Wales.

At Eden the Board was favoured with an interview by a representative of the Imlay Shire Council, which has its head-quarters there. He was of opinion that if the road and bridge were constructed at Genoa, his council and the New South Wales Government would carry out the necessary works on the New South Wales side, and that it was the absence of a bridge at Genoa which had delayed the erection of a bridge over the Kiah River, as the one would be of little use without the other.

From Eden the Board travelled to Rockton, which is about 7 miles from the Victorian border, at the head of the Cann River.

From Eden to Rockton—40 miles—the road is not good, but from Rockton to Bombala there is an excellent road suitable for motor traffic. To connect Rockton with the Victorian border requires the construction of about 7 miles of road, and another councillor of the Imlay shire stated that he thought there would be no difficulty in constructing the section on the New South Wales side if the road on the Victorian side in the Cann River Valley were extended to the border.

On crossing the Victorian border, the Board travelled down the valley of the Cann River to its intersection with the main Orbost-Genoa road, a distance of 29 miles. For the first 12 miles there is only a bush track on very steep gradients, the conditions being similar to the 7 miles on the New South Wales side. Through this 12 miles on the Victorian side there is no settlement, as the land has not yet been made available for selection. The remaining 18 miles, however, are fairly well settled, and a good road has been constructed by the Public Works Department, but a bridge is required where the road crosses the Cann River, for which a contract has now been let by the Board.

Plate 26. Showing tree indicating the border line between New South Wales and Victoria on coach route between Genoa and Eden.

The whole of the Cann River Valley consists of excellent land, the extensive river flats being second only to those at Orbost. Owing, however, to the great distance from railway or port facilities, very little in the way of agricultural development has been possible, the whole valley being devoted to the raising of pigs and other stock. An instance of the difficulties that the settlers here have to contend with, even in connexion with pig raising, may be cited.

When the Board was at Hospital Creek, between Bairnsdale and Orbost, a herd of 500 pigs from the Cann River was met with. These pigs had then travelled 67 miles by road, and had still another 40 miles to travel to Bairnsdale.

A beginning has, however, been made to put the land in the Cann River valley to more profitable use. One farmer has entered upon the making of cheese, and carts his produce to Twofold Bay, a distance of over 70 miles. Other settlers with experience in tobacco culture gained in the King River district, have commenced tobacco growing, and encouraged by the success of their first venture, which realized £80 per acre, they are planting a larger area this year. They speak in the highest terms of the suitability of the soil and climate of the Cann River Valley for tobacco production, and even with the existing poor road facilities, which necessitates their paying £6 per ton for the carriage of the produce to market, they are satisfied that tobacco growing will produce handsome returns.

As previously mentioned, the distances between settlements, and between these settlements and Orbost, are very great, and to this fact, together with the bad road facilities, is due the backward condition of this part of the State.

The construction of the railway to Orbost will, no doubt, be of great advantage to the territory, but as regards the extensive area of country to the east of Orbost, including the settlements of Genoa, Cann Valley, and Murrungowar, the Board is of

opinion that in the use of mechanically propelled vehicles, such as motor waggons acting as feeders to the railway, lies the solution of the successful occupation of this area, pending the extension of the railway beyond Orbost. The roads, to a great extent, pass through clean granitic country, and could be made suitable for this form of vehicle.

The operation of such a service by the State is worthy of consideration by the Government, as, in addition to the carriage of produce, it could be also utilized for the conveyance of mails and passengers. Owing to the nature of the country and the amount of work that has already been done by the Government, the cost need not be so great as the distance to be covered would seem to indicate ; but it is evident that unless a very considerable additional area of country is made available for settlement, the revenue derived by the Orbost shire from existing scattered settlements will not be sufficient to enable the council to bear its proportion of the cost of the works, even under the liberal provisions of the Country Roads Act.

The southern portion of the shire of Omeo, between Bruthen and Omeo, was included in this group of shires, as the only means of communication between the rich country on the Benambra Plains, as well as the mining townships of Omeo, Glen Wills, and Cassilis is southerly *viâ* the Tambo Valley road to Bruthen and Bairnsdale

Plate 27. Showing peg indicating the border line between New South Wales and Victoria at head of Cann Valley.

As the proposed railway from Bruthen to Tongio within 12 miles of Omeo will relieve the Tambo Valley road of most of its heavy traffic, it is not proposed to incur the amount of expenditure on this road that would otherwise be necessary.

The first work to be undertaken therefore will be the regrading of the road over the Tongio gap between the proposed railway terminus at Tongio and Omeo, where the grade at present is as steep as 1 in 5, and then to gradually improve the worst sections between Bruthen and Tongio where required for local traffic.

At its interviews with the councils in the Gippsland and East Gippsland districts the Board stated that it was its intention to proceed with construction works as soon as the councils signified their concurrence with the proposals as regards the roads to be declared main roads. This was done in the hope that every shire in Gippsland would avail itself of the opportunity to commence work on at least one road during the first summer of the Board's operations, and thus give some of their ratepayers the benefit of a good road at the earliest possible date.

It may be stated that the majority of the councils have allowed their engineers to proceed with the necessary investigation surveys, and in a number of shires good progress has been made with works of road construction.

It is to be regretted, however, that in some shires the professional officers, who have also to attend to the secretarial and other duties of the municipality, have not been able to undertake the more important work of surveys and the preparation of the plans, &c., for new road works.

Unfortunately this has occurred in shires where the road conditions are such, that they should command the whole time of a professional officer.

Road location and survey is slow and tedious work, especially in the rough timbered country of Gippsland, and although the Board with its limited staff of professional officers has given, and is prepared to render councils every assistance in its power, it must be obvious to these councils that unless they are prepared to provide their professional officers with the necessary facilities, road works in their districts must be seriously delayed.

CAPE OTWAY DISTRICT (GROUP No. 3).

As this group includes the municipalities in the older settled districts in the vicinity of Geelong and between Geelong and Melbourne, as well as those in the Cape Otway and Heytesbury Forests, an opportunity was offered of observing the methods of road construction adopted in the early fifties and sixties and those of more recent date.

The principal roads in the Geelong district are the main Melbourne road, the Ballarat road, the roads to Barwon Heads and Queenscliff, and the main Warrnambool road, all of which would appear to have been constructed about the same time, and to a similar substantial standard, as regards width of formation, and the character of their foundations, viz., Telford pitching. The massive bluestone bridges and culverts

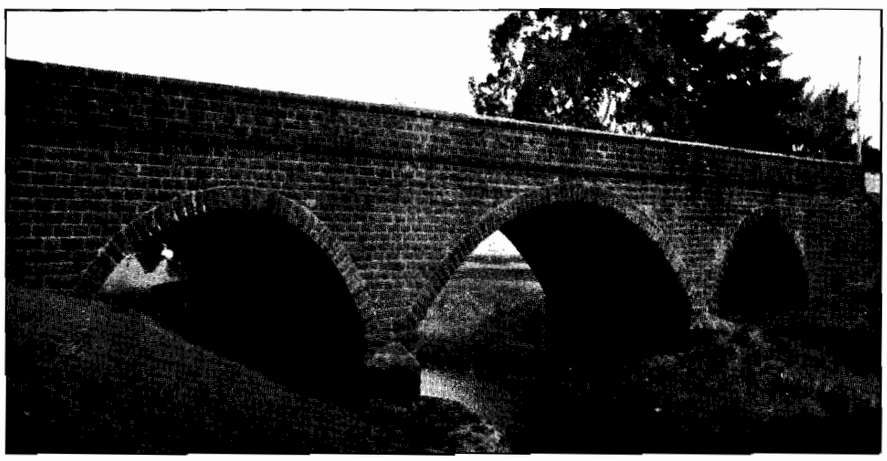
Plates 28 and 29. Showing sections of Melbourne–Geelong road, with foundations exposed through neglect of maintenance.

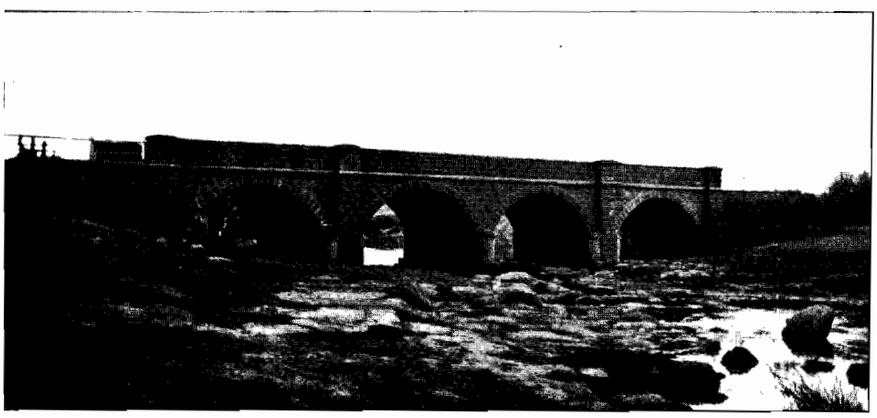
of a type that has not been used for many years are also a feature of the roads constructed at that period. It is fortunate that roads of this character were constructed in this district. The city of Geelong is now a rapidly growing port and commercial centre, towards which the heavy agricultural produce is attracted from an extensive

and fertile surrounding country, and the majority of the main roads, which in many instances are worn down to the bare foundation stones for want of maintenance, can be brought up to a good condition by simply re-sheeting the old foundations with a sufficient thickness of metal.

In the case of the Melbourne-Geelong road, however, a short section near Little River appears never to have been constructed, while other extensive sections are in such a condition that reconstruction is now necessary, and contracts are already in progress for sections of the road near the township of Werribee.

In the northern part of the area of the Cape Otway group, which includes the Shires of Winchelsea, Leigh, Colac, Hampden, and Mortlake, the main roads were well constructed in the first instance, and owing to the country being largely held in grazing areas the roads are exceedingly good, and consequently comparatively little loan expenditure will be necessary. In the southern or coastal area, however, from Barwon





Plates 30 and 31. Showing examples of stone bridges erected over 50 years ago in the Geelong District.

Heads westerly to Warrnambool, which includes the Cape Otway and Heytesbury forests, the conditions are identical with those that exist in South Gippsland. Here, also, the original road location surveys have been faulty, and the same ineffective efforts have been made by the shire councils, aided by small Government grants, to improve gradients at isolated points where vehicular traffic was difficult even in dry weather.

Perhaps the worst instance of the kind is the main road from the Forrest railway station through Barramunga to Apollo Bay, where the surveyed road passes over the highest point in the Cape Otway ranges at Mount Sabine. Considerable expenditure has been incurred all along this road in making short deviations and side cuttings, and although these are a great improvement on the original road, they are still unsatisfactory for the only main road from the coast to the Forrest railway station.

In the Beech Forest district, there still exist many miles of the primitive corduroy tracks which serve as roads. In one case, there is a continuous stretch, 13 miles in length, which is the greatest length of this form of track remaining in the State. The position of the settlers there, however, has been much improved by the construction of the narrow-gauge railway from Colac, but considerable expenditure will be necessary in regrading, widening, and constructing the principal roads leading to the railway from the fertile coastal districts and river valleys.

Plate 31A. Mail coach on Forrest to Apollo Bay road. Four horses required to draw light trap.

The remarks made on page 18 of this report referring to the necessity for subsidiary roads in Gippsland apply with equal if not greater force to the Cape Otway district.

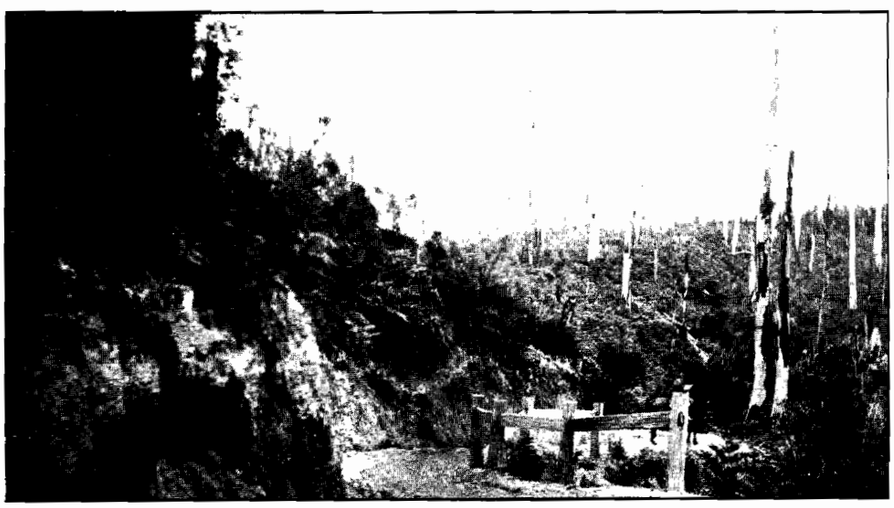


Plate 32. Showing sharp bend and narrow side cutting on Beech Forest–Apollo Bay road.

In 1852, a Committee of the Legislative Council of Victoria appointed to inquire into the state of the roads and bridges, described them as being "allowed to remain unimproved and neglected to such an extent as to present in winter the wretched aspect of a succession of quagmires, impassable for wheel carriages, and traversed by pack-horses conveying goods and merchandise at an enormous cost of transit, rendering all travelling difficult and dangerous, the conveyance of the post irregular, and a heavy charge on the revenue." This description did not refer to the roads in Gippsland or

Cape Otway, because at that period these districts were unoccupied, but it is remarkable that the statement made 62 years ago is singularly applicable to many of the roads in these districts at the present day.

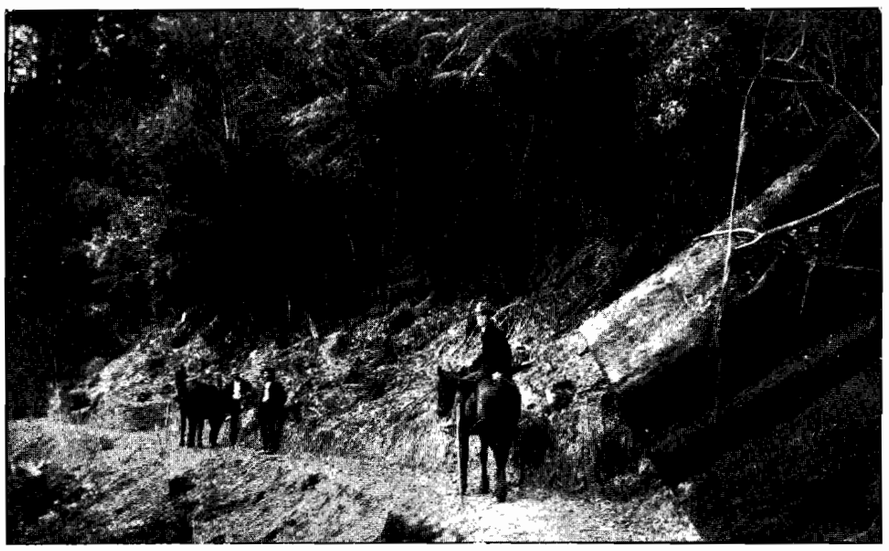


Plate 33. Showing sharp bend and narrow side cutting on Beech Forest–Apollo Bay road.

NORTH-EASTERN DISTRICT (GROUP No. 4).

In point of area the North-Eastern district is the largest the Board has yet inspected in one group, the object being to include in one inspection the whole length of the Sydney-road as far as the Murray River at Wodonga, and also to link up this system with the main roads already inspected in the southern and south-eastern parts of the State.

In the investigation of the area referred to, a commencement was made with the Kinglake district, being the area of heavily timbered and fertile country along the Divide, between Whittlesea and Healesville, including West Kinglake, Kinglake, East Kinglake, and Toolangi. At no point is this district more than 30 miles from Melbourne, yet, owing to the absence of road facilities, very few of the holdings are being fully utilized, while a great number are practically unoccupied. The fact that this stretch of country is on the boundaries of no fewer than four municipalities, with the consequent divided municipal responsibility, is the principal reason of the slow progress in road construction. This district has an ample and regular rainfall, and fertile soil, and being comparatively close to the city, would quickly develop if reasonable road facilities were provided. With this object, the Board has given the matter careful consideration, and is of opinion that the western half, or the portion between Joyce's Corner and Kinglake, will best be served by the re-location and construction of the road from Whittlesea through Scrubby Creek to Joyce's Corner, thence along the Divide to Kinglake, and from Kinglake *viâ* Queenstown to the Hurst Bridge station. At the eastern or Healesville side, a road has been constructed up Myers' Creek Valley to Toolangi, which is being extended by the Public Works Department, through Toolangi to join with the existing road from Yarra Glen to Yea. This road, which connects with the railway at the important and growing town of Healesville, is considered to be the most suitable for serving the Toolangi district, and the least costly to construct. There then only remains the isolated portion of the district known as East Kinglake, midway between Toolangi and Kinglake. Neither of the roads mentioned can serve this area, and as the shortest outlet would be *viâ* the Valley of Steele's Creek to the Yarra Glen railway station, it is proposed to construct a short road from the existing Steele's Creek road to a point on the Divide east of Mount Slide, on or near a survey made by the Lands Department.

The Board then inspected the Shires of Yea, Alexandra, Walhalla, Howqua, and Mansfield. The Shires of Howqua and Walhalla present a difficult problem, owing to the great length of road in their respective districts, the mountainous nature of the

country, and their poor financial position, consequent on the decline of the mining industry. These and several other shires are the subject of a special memorandum to the Minister of Public Works. The Howqua Shire Council desires to connect with the railway system at Alexandra instead of Mansfield, as at present, and some expenditure has already been incurred by the council in this direction with the aid of a Government grant. Further expenditure on this road should be deferred, however, pending a determination regarding the proposal to construct extensive water conservation works on the Upper Goulburn, near Darlingford.

From Mansfield, the Board proceeded *viâ* the Tolmie district to Whitfield, in the Shire of Oxley. The Tolmie and Toombullup tablelands present conditions almost identical with those described at Kinglake, in that the country generally speaking is good, heavily timbered, and situated on the outskirts of the Shires of Mansfield, Oxley, and Benalla, but with the additional disadvantage of being further from the metropolis and the railway system. The tablelands embrace a fairly extensive area, and it is certain that one main road is not sufficient to serve the whole district. Three roads are considered necessary—one to the Mansfield station on the south, one to the Whitfield station on the north, and another towards Benalla on the west. On the Benalla side the construction of the new railway to Tatong will be of great benefit, but a good road is required from the tableland to the new railway station at Tatong. The road indicated on the map is known locally as the Fernhill-road, but the gradients are such that it may be necessary to abandon this above Dodd's Bridge, and construct a road along the valley of Holland's Creek. This, however, will be determined after a more minute investigation of the Toombullup tableland.

Plate 34. Section of Sydney-road, showing foundation stones exposed through neglect of maintenance.

The construction of new railways, such as that from Benalla to Tatong, has the effect of diverting traffic from its former route to the new railway, and traffic that hitherto travelled by road from Tatong and Nillahcootie to Benalla, will now make for the new railway. It may, therefore, be necessary, in addition to the road from Tolmie and Toombullup to Tatong, to construct a road from Nillahcootie to the Tatong railway.

The route and construction of a road from Tolmie to Whitfield will depend upon the report of the Railway Standing Committee, which has investigated the proposal for extending the narrow-gauge railway from Whitfield.

The Board then visited the Shires of Oxley, Bright, Omeo, and Towong, proceeding from Tallangatta as far as the Bringinbrong Bridge over the Murray River east of Corryong, returning to Wodonga *viâ* the Upper Murray road, through Tintaldra, Walwa, and Bethanga. The extension of the railway from Tallangatta to Cudgewa, which is now in course of construction, will have the effect of throwing the main road *viâ* Koetong out of use except for local traffic. Consequently, it is not considered

justifiable to expend any additional money upon this road at present. It is proposed to construct the roads from the new railway terminus at Cudgewa *viâ* Corryong to the bridge over the Murray River at Bringinbrong, and from Cudgewa to the bridge at Tintaldra, which roads will serve a large area of good country on both sides of the river.

In the inspection of the shires between Wodonga and Melbourne, the Board traversed on several occasions the whole length of the Sydney-road, and made copious notes of its condition in every shire through which it passes. There appears to be a general impression that this road was well constructed by the Government throughout

Plate 35. Picturesque natural avenue on Sydney-road, near Kilmore.

its entire length of 187 miles before the establishment of local government institutions, and since then it has been allowed to deteriorate. This impression is correct only to a certain extent. Inquiries made elicited the fact that the Government of the day did not enter upon the construction of the road with any fixed intention of carrying it through to Wodonga on a systematic plan. Prior to 1852, sections of the road had already been constructed between Melbourne and Kilmore. At this time, the Committee

Plate 35A. Section of main Sydney-road, illustrating wasteful and useless method of construction. Note crop of grass and size of metal. To avoid this the traffic uses the near side of road to left of figure.

of the Legislative Council previously referred to, which was appointed to inquire into the condition of the roads and bridges of the State in 1852, recommended the construction of the Wodonga to Melbourne Road, *viâ* Kilmore, and the appointment of a Central Road Board, which recommendations were given effect to in 1853. Even then it does not appear that any definte scheme was adopted to carry the work through.

Grants were apparently made from time to time for the construction of disconnected sections which had become unfit for traffic. That this was so is evident, as there are comparatively short sections of substantially formed and pitched roadway, with massive bluestone or granite bridges and culverts, while between these sections there are long stretches that have apparently been merely cleared of timber.

Of the present condition of the road generally, it may be said that it is in a very bad state, portions of it, where it has not been metalled, being impassable in wet weather for vehicular traffic ; and for the greater part it is quite unfit for a main national highway connecting the two largest cities in the Commonwealth.

Plates 36 and 37. A fine example of stone culvert on old Sydney-road, near Longwood, now practically abandoned.

The best section of the road is between Melbourne and Tallarook, which will only require maintaining, except in the Shire of Broadmeadows, where the road is subject to heavy traffic from the clay pits at Campbellfield, and other comparatively short sections near Beveridge, Broadford, and Kilmore, where it will require re-sheeting.

Between Seymour and Longwood the old Sydney-road has practically been abandoned, and the traffic now follows a road parallel with the railway line. On this section, for considerable distances, the timber has not even been cleared, and the traffic has to wind its way in and out amongst the trees.

Between Longwood and Wangaratta there are several fairly long sections which have originally been cleared and formed only, where the formation, and in some cases the clearing, is hardly discernible. Beyond Wangaratta the road is generally in better condition, and will not require the same amount of expenditure per mile as between Wangaratta and Seymour.

It is the Board's intention to first proceed with the construction of the worst sections of the road, and then to gradually improve the remainder where the traffic does not now suffer serious inconvenience.

In the case of the shires or portions of shires inspected on the western and north-western side of the Melbourne to Sydney railway, there are few, if any, roads of a purely developmental nature. This part of the country is well settled and generally level. Consequently the roads proposed to be declared main roads in this area are those which either connect with the Inter-State bridges over the Murray, or form connecting links between the more important country centres of population.

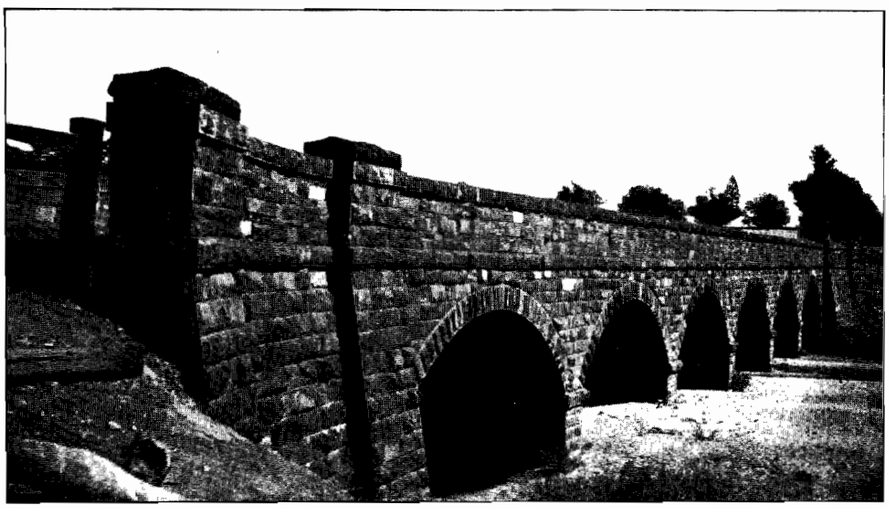


Plate 38. Showing stone bridge at Avenel, on main Sydney-road.

In the North-Eastern District there are some fine examples of the type of roads and bridges constructed in the early sixties.

Some of these are on sections of the Sydney-road already referred to, and another in particular is the section of the Wangaratta to Beechworth road between Wangaratta and Everton.

The latter road, constructed many years ago, is equal in condition to any road that the Board has inspected although it carries considerable traffic, and but little has been expended upon it in maintenance. This road is a splendid example of the result of sound construction in reducing maintenance charges.

SOUTH-WESTERN DISTRICT (GROUP No. 5).

Considering the area to be served, it must be admitted that the proposals of the Board for the South-Western portion of the State are on a somewhat modest scale compared with those for other parts of the State. This is due to a number of causes, the principal being the nature of the occupancy of a large proportion of the area, namely, grazing, the class of country to be served, and the fact that two important railways, viz., the Hamilton-Cavendish and Balmoral line, and the Heywood to Mount Gambier line, are in course of construction. The construction of these lines necessitates the postponement, for the present, of the consideration of road proposals through the large areas to be served by these railways.

The Board commenced its inspection of this group at Mortlake, travelling thence to Warrnambool, Koroit, Port Fairy, and Portland. Owing to an unlimited supply of good basalt for road making, and the traffic through the grazing areas being comparatively light, the roads generally are in fair, and, in some instances, in first class condition; but in the vicinity of the towns of Warrnambool, Koroit, and Port Fairy,

where they are subject to the concentrated traffic of perhaps the richest and most closely-settled agricultural district of the State, the roads are not in the condition or of the standard required for this traffic. This is due, not so much to the excessive use to which they are subjected, as to the failure of the municipalities to adopt a better system of road construction and maintenance and to exercise a more careful selection and employment of the road materials available. For instance, the main road from Port Fairy to Warrnambool was probably constructed in the fifties by the District Roads Board when the traffic must have been infinitesimal compared with what it is to-day. There is evidence that it was originally metalled 18 feet wide. At present, however, the metalled roadway is only being maintained for a width of 10 to 11 feet, and the stone employed is not of a consistently hard texture.

Plate 39. Showing remains of old stone culvert constructed by Belfast District Roads Board, 1856.

On these heavily trafficked roads, a greater width of macadam is required, and the materials used should consist of the best selected stone obtainable in the neighbourhood, consolidated by steam road rollers and followed by the adoption of a system of continuous maintenance.

Plate 40. Showing unformed section of the road between Castlemaine and Bendigo.

Leaving Port Fairy, the Board proceeded *viâ* the Coast road to Portland, and while there had the opportunity of inspecting the Heath country lying to the west of that port, which the Government is endeavouring to put to profitable use. Some very fine samples of potatoes and other root crops were seen, and the settlers spoken to are hopeful of success. Better facilities are required, however, for getting their produce to market at the proper season. To this end, the Board proposes to construct a road through the two areas thrown open, with the intention of extending it to the third area when that is made available for selection.

From Portland the Board proceeded to Casterton, which, partly owing to the success of the Wando Vale and Dunrobin settlements, is now a progressive and thriving centre. The roads from Casterton to Mount Gambier, and from Casterton to Penola in South Australia, were both inspected. It is notable that on the South Australian

Plate 41. Showing well-maintained and picturesque section of Bendigo-road, near Mount Macedon.

side the roads are constructed to the border, but, on the Victorian side, they are unmade. The Mount Gambier road is the more important of the two, as an Inter-State road. From Casterton, the Board travelled through the Coleraine and Hamilton district. At Hamilton it met the South Australian Royal Commission on Roads, and gave evidence relating to the provisions of the Country Roads Act, and the methods of road

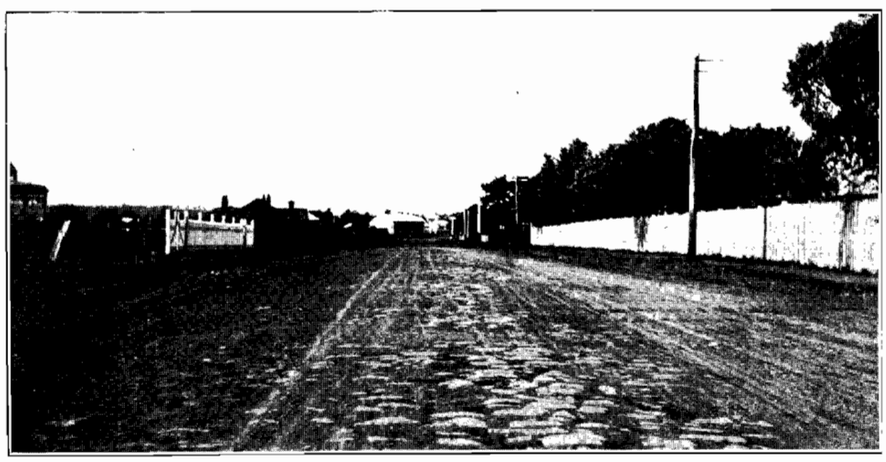


Plate 42. Showing section of Bendigo-road, with foundation pitchers exposed through neglect of maintenance.

construction to be adopted by the Board under various conditions. From Hamilton the Shire of Kowree was inspected as far north as the railway terminus at Goroke, and again to the South Australian border from Edenhope *viâ* Apsley. This is another important Inter-State road. The Shires of Wannon, Dundas, Minhamite, and Mount Rouse were then inspected. In all these shires the roads are generally in good condition, particularly the road from Penshurst and Koroit, through the Minhamite Shire.

In addition to the five groups of municipalities included in the Board's investigations to date, the main Melbourne to Bendigo road and the Melbourne to Ballarat road have also been inspected.

With regard to the former, the section between Castlemaine and Bendigo, which has been the subject of frequent representations to the Government for years, was found in such a condition as to justify immediate steps being taken for its construction, and contracts for the work are in progress.

Portions of this road appear to have been well constructed many years ago, but have been allowed to get into a state of disrepair, while other sections would appear never to have been constructed.

On the section of this road between Melbourne and Castlemaine, there are some portions in fair order, while in others maintenance has been neglected to such an extent that the surface coating of metal has entirely disappeared, leaving the foundation exposed as shown on the accompanying photograph.

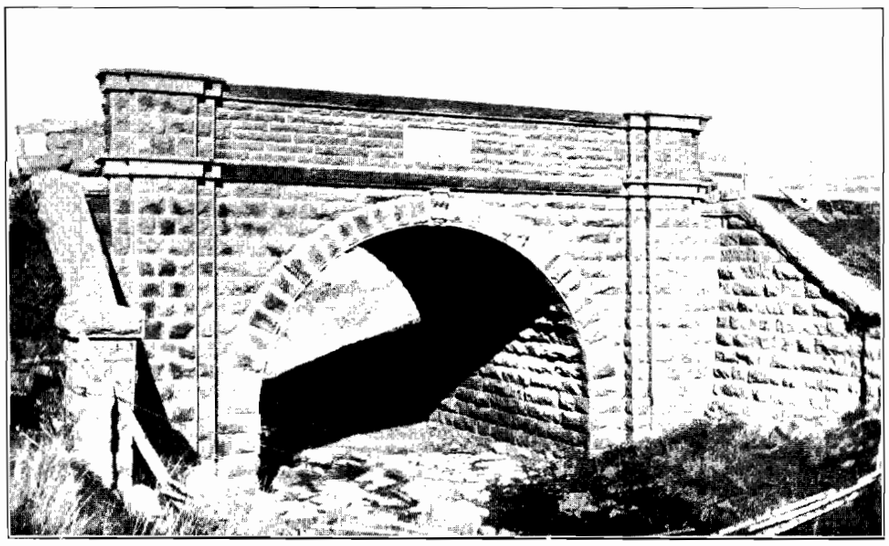


Plate 43. Showing stone culvert on Bendigo-road, near Gisborne, erected 1861.

The main Melbourne to Ballarat road is generally in fair order with the exception of certain sections, particularly between Ballan and Ballarat, where portions require to be reconstructed. Two bridges also require renewal. The Melbourne end of the road in the Shire of Braybrook was practically worn out, but it has now been reconstructed by that shire under the authority of the Board, and is now in first class condition.

The above comprises the area of investigation covered by the Board during the first year of its operations; and the roads in the area which, in the opinion of the Board, are of sufficient importance to be declared main roads, are indicated on the accompanying map.

The investigation of the remaining portion of the State will be entered upon immediately, and concurrently works of construction and maintenance will be proceeded with on the roads gazetted as main roads.

Condition of Roads.

Speaking generally of the roads throughout the areas of the State already inspected, it must be said that their condition is anything but satisfactory.

Certainly there are exceptions to this general statement. In a number of the Western District shires, the roads are in good condition. There is also a considerable mileage of good trafficable roads in the Rosedale and Sale districts. In these districts materials in the shape of basalt and gravel are easily accessible, and the topography of the country presented few engineering difficulties in the way of road location; but, with these exceptions, there are only isolated examples of roads that may be classed as good.

In the Gippsland district few roads are to be met with that may be termed passable roads beyond a radius of four or five miles from the principal towns on the main lines of railway.

Of this district it must be said that road construction has never kept abreast of settlement, and the task has quite outgrown the resources of the shire councils.

In this hilly, timbered region, road building is more than ordinarily a slow and expensive process, and it is evident that without some form of State assistance the municipal councils would be unable, from their own revenues, to serve the outlying districts with passable roads for the next 20 or 30 years.

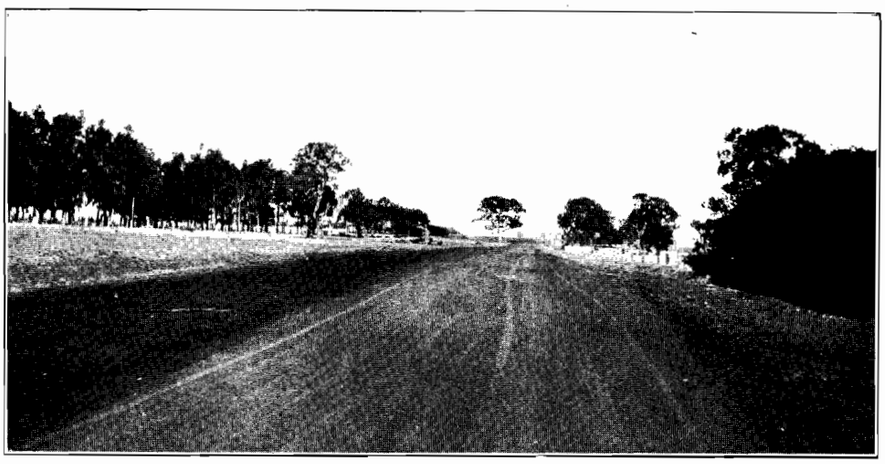


Plate 44. Mortlake Shire, showing fine stretch of Mortlake–Lake Bolac road, near Woorndoo, constructed of ironstone gravel.

Plate 45. Mortlake Shire. Mortlake–Lake Bolac road, showing plantation on roadside.

Plate 46. Hampden Shire. Camperdown–Ballarat road, showing plantation of gum trees along roadsides, near Skipton.

The same remarks are applicable to the Beech Forest and Cape Otway districts and the undeveloped sections of the North-Eastern District.

In the older settled districts inspected, there has been an unmistakable deterioration in the character of the works executed from the period when the District Roads Boards ceased to have control of the main roads to the present time. This remark applies also to the standard of bridge design, which, under the *régime* of the District Roads Boards, was characterized by an air of permanency.

Plate 47. Hampden Shire. The Camperdown–Ballarat road, showing plantations of gum trees along road, near Lismore.

There could be no better illustration of the extravagance of a policy of cheap construction than is afforded by a comparison of the older and later methods.

Many of the old solidly built roads inspected have stood the traffic of years, and are still in fair condition, while many roads of comparatively recent construction have failed utterly.

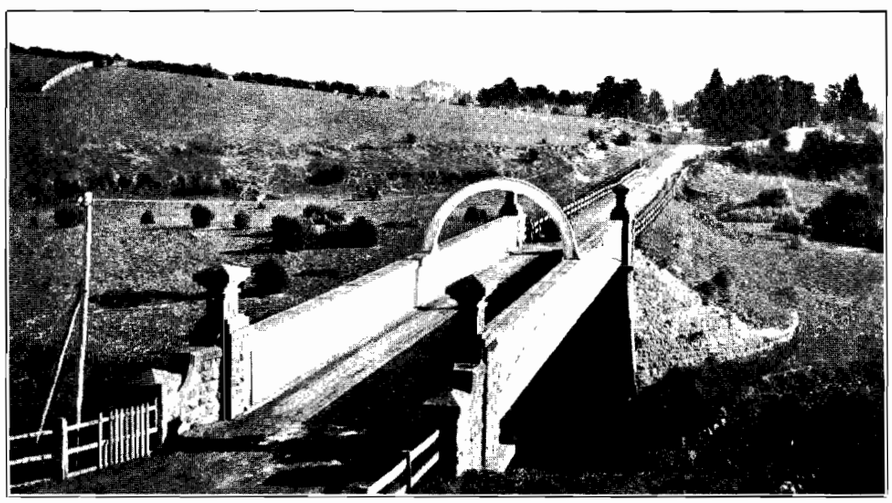


Plate 48. Shire of Keilor. Bridge on main Bendigo-road; erected by Keilor District Road Board, 1868.

The reasons for this deterioration in the standard of road construction are lack of funds and the absence of a systematic policy.

With each shire council working however conscientiously for its own interests, and each councillor in the interests of the ratepayers in his own riding, there can be no systematic system of road construction.

In the desire to make the available funds go as far as possible, the general practice is to annually vote a portion of the municipal funds to the construction of isolated patches of roads in sections seldom exceeding a quarter of a mile in length distributed throughout the shire's ridings. Had these sections been designed to permanently

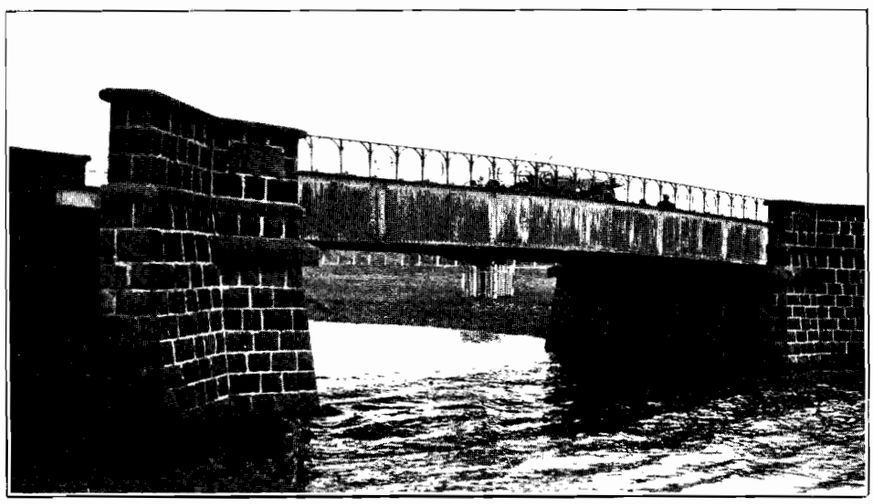


Plate 49. Portland Shire. Showing bridge near Hotspur; erected 1870.

improve the worst portions of the roads with a view to their being linked up in a systematic scheme of construction in the future, the policy would be sound enough, but frequently the work has been done in the cheapest possible manner, and without a complete survey of the whole road to insure that the sections constructed would form suitable links in the completed chain.

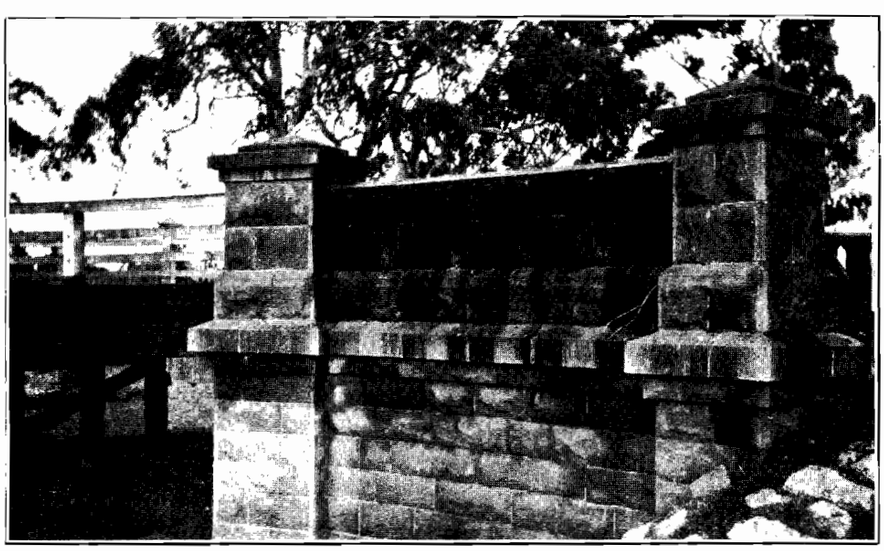


Plate 50. Showing fine example of bridge abutment and wing wall at Cavendish.

ROAD LOCATION AND GRADIENTS.

The important questions of road location and gradients can scarcely be considered separately, as the second, excepting on level country, depends on the first. They may be termed the fundamental principles of road engineering, and are deserving of the most careful consideration.

As the State roads may be considered a permanent investment, and will be there for all time, the aim should be to obtain the best location practicable.

Even though some expenditure of funds be necessary to acquire land for the improvement of existing road gradients, this should not be delayed a day longer than is necessary, as the difficulty and expense of securing land for road deviations must become greater with increase of settlement and land values. The road surface, when constructed, may require renewal, but there will be no necessity for further expense because of improper location and grading, if the best procurable route be selected to begin with.

Badly located and badly graded roads are a heavy and constant tax on any community, as the steepest gradient on a road determines the maximum loading for all forms of produce to be hauled over it. Nor is this all. Steep gradients cause increased erosion by water and increased abrasion from the impact of horses' feet and the wear of traffic. The expense of maintenance is thus greatly increased, so much so that the additional cost each year may exceed the amount of interest on the capital that would have been necessary in securing the better grade in the first instance.

As an illustration of the increased cost of maintenance due to a steep gradient, an instance may be cited in the Shire of Woorayl, where a length of the Mirboo road was constructed in 1897 of good basaltic stone, laid to a depth of 7 inches, and bonded with good quartzite sand. Part of this length of the road was on a grade of 1 in 12, and part on level ground at the foot of the hill. The work was done under the same contract, and under similar conditions in every respect. In 1911, the portion on the grade had to be re-constructed owing to abrasion and scour, while that on the flat was still in good condition, and showed very little signs of wear, although no maintenance metal had been used, and both portions were subjected to the same heavy agricultural traffic.

If the extra haulage cost per mile over the whole State due to steep gradients be taken into consideration, it would represent an enormous annual loss to the producers, as the following data will suggest :—

If it be assumed that one horse could draw 1 ton on a level, smooth road, it can only draw the following weights on the undermentioned gradients :—

Level	1 ton
1 in 50	$\frac{2}{3}$ ton
1 in 33	$\frac{1}{2}$ ton
1 in 20	$\frac{2}{5}$ ton
1 in 11	$\frac{1}{4}$ ton

In other words, if one horse be required to draw 1 ton on a level road, it will require two horses for the same load on a 1 in 20 gradient, and four horses on a gradient of 1 in 11.

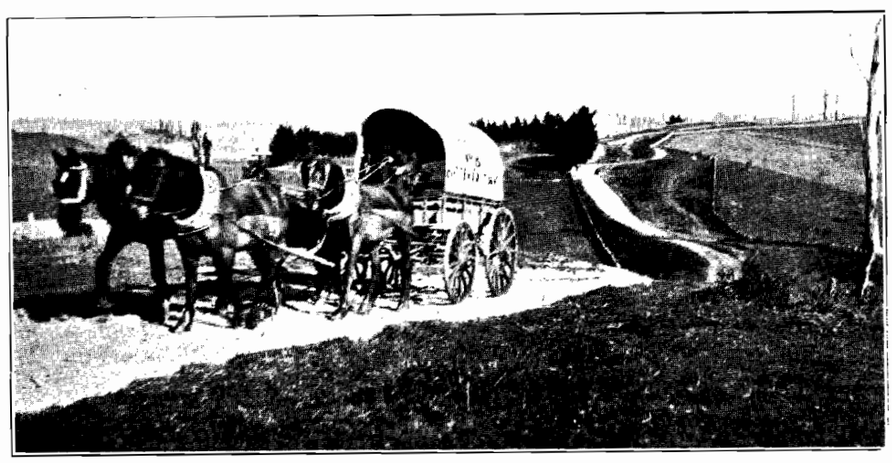


Plate 51. Showing four horses required for a Gippsland cream waggon.

The transport of all produce begins on the roads, and every means should be employed to reduce the cost of haulage and enable the producers to compete in the world's markets.

Considering these facts, the Board, at its inception, decided that no expenditure in the way of permanent improvements should be incurred on any road, and particularly on unmetalled roads, until it was ascertained by investigation that the location and

grades could not be improved at a reasonable cost. While this has occasioned the employment of considerable time and labour in surveys and investigations, it was strongly felt that it would be a sound policy to first locate and grade roads on the best possible routes—even if their final construction had to be delayed—rather than hasten expenditure on existing roads which would for all time be a freight tax on the community.

To the adoption of this principle by the Board is partly due the fact that in Gippsland, the first province inspected, several of the shires have not yet let a new road contract.

Should any indorsement of this policy be necessary, it may here be noted that at the International Roads Congress held in London last year, the following resolution was carried unanimously :—

> " Gradients on new roads should be as easy as possible, having regard to the physical character of the country through which they pass, and they should be easier where there are curves, or a preponderance of heavy traffic."

FOUNDATIONS AND DRAINAGE OF ROADS.

Foundations.—It is now recognized that in the future much more consideration should be given to the character of the road foundations, because of the tendency to increase the loading capacity of vehicles, particularly of those which are self-propelled.

There can be no model type of road suitable alike for every kind of soil, climate, or traffic.

In considering the type to be adopted for roads, local conditions, as regards climate, nature of sub-soil, choice of road-making materials, and the kind and volume of traffic likely to use the road must be taken into account.

It should be remembered that the natural soil is the primary foundation which ultimately bears the weight of any superimposed load on the road surface ; it is therefore the weight-bearing quality or the non-compressibility of the sub-soil which determines the system of construction to be applied.

The supporting power of soil usually varies from about half a ton per square foot for wet yielding soils, to about 4 tons per square foot in the case of firm, dry clay.

For moderately dry soils, the safe load may usually be taken at 2 tons per square foot. If the sub-soil of a road could be kept permanently dry, there would be few road failures. It is therefore a matter of primary importance to provide for the efficient drainage of the road bed in the first instance, and efficient surface drainage by the provision of a compact water-tight surface to shed the water to the side channels is also essential. Where the natural sub-soil is of a yielding character or liable to become water-logged, some special foundation may be necessary to distribute the surface load over a greater area of the sub-soil. The foundation usually adopted, and which has stood the test of time, to the present day, is a bottom layer of large stones packed by hand, laid in courses across the road with their broadest faces downwards and kept in place by chips of stone wedged in with a hammer. This system is known as " Telford pitching," and is the foundation usually found in the old main roads in this State. It may be seen on the Sydney, Bendigo, Ballarat, and Geelong roads. This bottom paving is usually covered with a layer or wearing coat of broken stone from 4 to 8 inches in depth, and in the case of the old well-built roads constructed in the fifties and sixties, the surface coating of stone has almost disappeared owing to the combined influence of traffic and weather. These roads have continued to serve their purpose and still remain intact, except in cases where the traffic has been exceptionally heavy.

In certain districts hand pitched foundations have fallen into disfavour, and there are instances where these, originally laid at great cost by the old road boards or the Government of the day, have been picked up and replaced with ordinary macadam. The reason given for this action is the expense of maintaining the metalled surface over these foundations. This may be the case on steep gradients, and where the object has been to improve the gradient, the removal of the pitching may have been justifiable, but not otherwise.

The reason why roads constructed on pitched foundations have not appeared satisfactory is that the authorities have failed to realize the necessity and subsequent economy of maintaining the surface coat of metal to a sufficient thickness. Many

of these roads have been so neglected that they have been worn down to the stones forming the foundation. These have been worn smooth by the traffic, and where metal has been applied, the coating has been so thin that the stone used for surfacing was either scattered to the road sides or crushed into powder by the traffic in the same manner as if between a hammer and anvil.

It is clear that however desirable a hand pitched foundation would be in view of future developments in traffic conditions, it is now out of the question in this country, taking into consideration the high cost of labour and the great length of road mileage to be constructed, and, further, it is imperative that if settlement and agricultural production are to be encouraged, the general standard of road construction adopted must be within our means, and the rate of construction as fast as practicable, so that those who have so long laboured under the disadvantage of the absence of trafficable roads will secure some benefit during this generation.

In any works of road construction undertaken by the Board in conjunction with the municipal councils, the standard of construction will be made on as sound lines as possible with the materials available, keeping in mind the nature and volume of traffic that now uses, or is likely to use, the roads. The Board, as trustees of the fund placed at its disposal, has on all occasions made it clear that, as far as these funds will admit, the best available materials will be used, in accordance with approved modern practice, in the structure of any roads to be subsidized with the funds at its disposal.

It is impossible to predict the extent to which motor traffic will increase in this country, particularly in the case of motors used for commercial purposes. That it will increase is certain, and it is equally certain that the improvement of the roads will draw more traffic to them. This fact must be taken into consideration.

There is no doubt that a sound well built road will be much less costly in up-keep than a poor weak one. It is hoped that improved methods of construction of main roads in country districts will have the effect of inducing a demand for a higher standard of construction in the case of other road works undertaken by the local authorities.

Where the soil is naturally hard and firm, or, where by artificial draining and rolling the road bed may be made firm, the expense of a special foundation is unnecessary, and a layer of macadam or gravel may be used, the depth of the coating of material depending upon the weight resisting quality of the soil, and the intensity of the present or future traffic.

The foundation of a road has been fitly defined by Professor M. Lelievre, of Paris, as being " A body supplementing the insufficiency of the resisting powers of the natural soil, or of the previous consolidation of the latter in order to carry a roadway effectively."

Fortunately, in most districts of the State visited, boggy or water-logged soils are exceptional, and only in those instances where the conditions are such that ordinary macadam would be insufficient, and where suitable stone and labour is available for hand pitching, will any special foundation be provided.

In other cases where the foundation soil is unstable and the traffic considerable, a medium course will be followed, which is a compromise between the systems of Telford and Macadam, viz., the laying of a bottom course of broken stone of $2\frac{1}{2}$-inch to $3\frac{1}{2}$-inch gauge metal as a foundation course, which, after rolling, will be covered with a surface or wearing coat of 2-inch stone, well rolled and bound with clean binding of gravel, chippings, or coarse sand, the bottom coat being considered as the foundation, and the upper, the wearing coat, which may be renewed or thickened and strengthened, should increased traffic require it. Though this method may not have the stability of a hand pitched foundation, it is much less costly.

Where the foundation consists of wet clay likely to work upwards and exude through the metal, it is advisable to spread a layer of gravel, sand, or sandy loam, and roll this with a horse roller before laying the bottom course of metal.

It is imperative that the road, to withstand the weight of traffic without injury, should have a foundation either natural or artificial that is thoroughly solid and rigid, otherwise the subsoil will yield beneath surface loads and the road surface will sink and become permanently deformed, causing hollows or ruts to remain.

Should the road bed be ineffectually drained, it will be still more liable to yield. It is therefore of the utmost importance to secure and maintain a dry sub-bed.

On low lying or flat ground it is usually inadvisable to break into the natural surface any more than is necessary to properly grade the road bed.

A common error noticed in road bed formation is the practice of excavating or "boxing out" the metal bed to a uniform depth and cross section, irrespective of the nature of the subsoil or the natural drainage facilities. To excavate the metal bed on low-lying flat ground, where there is insufficient fall from the bottom of the bed to the watertable, is equivalent to spreading the metal in a drain.

Typical cross sections of roads for adoption under this and other varying conditions as well as a longitudinal section, showing method of grading by means of vertical curves are illustrated on sheets 1, 2 and 3 of the Appendices to this Report.

DEPTH OF METAL OR GRAVEL.

The depth of metal or gravel will depend upon the nature of the soil and the amount and kind of traffic.

Yielding soil and heavy loading require a greater thickness than a hard dry subsoil and light traffic.

In the latter case, a consolidated depth of 6 to 7 inches may be sufficient, but usually an average depth of 8 to 10 inches will be required, this depth of crust being usually necessary to effectively distribute the surface load to the sub-base or road bed.

On a good macadamized road, compacted by rolling, the surface load is usually assumed to be transmitted to the base at an angle of approximately 30 degrees so that the area of the sub-base which is called upon to bear the load is the base of a cone whose area increases with the depth of crust.

On this assumption, the pressure transmitted from a surface load of one ton to the road bed would be as shown by the accompanying diagrams and tables, for different thicknesses of metal. (See Diagram No. 5).

If, for example, it be assumed that a wheel load of 1 ton be applied to and rests upon an area of 1 square inch of the road surface, and if the angle of transmission of this pressure be 30°, then with a crust of metal 6 inches in depth, the area of the road bed acted upon by the surface load would be 50.64 square inches, and the pressure would be 2.8 tons per square foot of formation, which would in this case require to be of a hard and rigid character to withstand this load without yielding.

If, however, the depth of the road crust were increased to 9 inches, the area of the sub-bed acted upon would be increased to 103.87 square inches, and the pressure would be reduced to 1.4 tons per square foot, or exactly half of what it would be in the case of a 6-in. crust. The majority of soils will withstand this load without permanent deflection. If, again, the soil were of a soft, yielding character, and the road crust were increased to a depth of 12 inches, the area of sub-base acted upon would be 175.77 square inches, and the pressure would be 0.82 tons per square foot of foundation.

From this may be realized the great value of a small additional depth of material in the metalled coat in the direction of maintaining a rigid and even road surface.

To the want of adequate thickness of the macadam in affording sufficient rigidity, combined with other faults in construction, may be attributed many of the failures noted in the damaged condition of the country roads.

CAMBER OF ROADS.

In order to shed the surface water to the side channels, it is necessary to build roads with a crown or camber, the degree of camber depending upon the kind of pavement adopted, a rough, uneven surface requiring more cross fall than a firm, smooth one. But whatever the road surface may consist of, the fall should be sufficient only to allow surface water to run freely to the sides. It has been observed that usually the roads constructed in the country are built with a crown that is much too high, both as regards their convenience and safety for traffic, and their economical upkeep.

The question of road crowns has been the subject of frequent discussion between shire councillors and the Board.

While only a small number of shire engineers met with approve of excessively high crowns, some are induced, against their better judgment, to adopt a barrel-shaped road to meet the popular but erroneous idea that this is necessary for the drainage of a road, forgetting that no degree of convexity will allow of free drainage from the road if the surface is allowed to become worn into holes and ruts. The absence of rolling is another reason for roads being made with a steeper camber than is desirable.

Where roads are constructed without being rolled, it is necessary to leave the crown somewhat higher than if the metal or gravel, after spreading, is made compact and smooth by rolling, as newly-made roads settle for some time after their construction.

Where a steam roller is available, 1 in 24 ($\frac{1}{2}$ inch to the foot) is the cross fall adopted by the Board in the case of macadamized roads, and this fall is slightly increased where only a light roller is available.

But for the necessity of surface drainage, there is no reason why the road should not be made perfectly flat in cross section, which would be the ideal condition for traffic.

Roads are frequently constructed with macadam or gravel to a width of 10 feet, and when such narrow roads have an excessive camber, they are liable to be damaged in the following manner :—

The centre of the road is the only portion of the surface where a vehicle can comfortably and safely travel, and traffic is thus concentrated in one track, consequently ruts are formed, which, if not constantly raked in and rolled, result in permanent damage. This expense would be avoided if a reasonable width and camber were adopted to begin with.

On narrow roads of 12 feet and under, special attention should be given to the banking up and consolidation of 3 or 4 feet of the earth shoulders to keep the metal in place and prevent its being pushed out under the pressure of traffic.

Another important factor in connexion with damage to roads, but which is seldom taken into account, is the fact that in the case of roads constructed with an excessive convexity, the tires of vehicles do not bear evenly upon the curved surface, consequently the whole weight of the wheel load is concentrated on one edge of the tire, which cuts into the road. In this case any increase in the width of tires will have little effect in the preservation of the road surface. (See Diagram No. 6.).

ROAD MATERIALS.

While the evolution in the form of modern traffic has made the problem of road construction a difficult one to road engineers, and revolutionized methods of road building in the old world, its effects are just beginning to be felt in this country, and principally in the large centres of population.

In Melbourne, the advent of the motor bus has brought the problem home to the metropolitan councils, who are coming to realize the fact, already recognised in older countries, that ordinary weak macadam roads are not suitable for this form of traffic, and where these vehicles are constantly in use in large numbers, such roads will soon be broken up.

Considering the immense mileage of roads awaiting construction in the country, the choice of road-making materials must be limited to broken stone or gravel for many years to come, if only for reasons of economy. The rate of increase of motor transport in the future cannot be predicted, as the increasing reliability of these vehicles, together with an improvement of the roads, will tend to encourage their use for transport of produce. It would appear desirable to anticipate this traffic by making the best possible use of the materials available, and the provision of reasonably sound foundations on the main traffic routes.

There are few localities in the portions of the State already inspected where supplies of stone or gravel cannot be obtained within reasonable distance. In some localities where road works are in progress it has been necessary to transport road metal for long distances by rail, not because there was no stone procurable close at hand, but because no effort has been made to prospect for and develop the stone deposits in the district.

In several instances the Board's officers have already been successful in finding stone suitable for road purposes, the existence of which was not known locally. In other instances where suitable stone is known to exist, it has not been availed of owing to the inability of the municipal councils to undertake the capital expenditure of a quarrying and stone-breaking plant.

In one instance, the Board observed that a comparatively inferior class of road metal had been transported by rail for a distance of 73 miles at a freight charge of 3s. per cubic yard, while on the side of the road where this metal was being used there existed an outcrop of a much superior basaltic stone.

The reverse was usually found to be the case, and as a rule the road authorities have been tempted to use local material of inferior quality, when more suitable and durable materials could have been obtained at a small additional cost.

Where the traffic is heavy, such as through and approaching country towns, or on roads converging at important railway stations, it will generally be found economical in the long run to select the best and most durable stone which can be procured at reasonable cost.

The fact should be borne in mind that the first cost is only one of the factors to be considered, as the subsequent annual cost of upkeep is the true test of economy.

In every case where construction is contemplated, the local conditions of traffic will be considered in the selection of the materials to be used, and as far as practicable, and consistent with the purpose of the particular road, the best use will be made of materials near at hand.

Throughout Gippsland and in the Cape Otway Forest, there are extensive deposits of sandstone and limestone of more or less inferior quality. These materials do not " weather " or wear well, but such comparatively soft stones are suitable if used for a foundation where they are protected from the influence of the weather and where they are not subject to severe traffic stresses, and covered with a light wearing crust of more durable stone.

With the great demand for road stone consequent upon the Board's operations, the development of suitable stone quarries at convenient distributing centres throughout the State is advisable in order to lessen the cost of road construction, particularly in localities where the stone deposits are within convenient distance of railway transport.

Already some of the shire councils are moving in this direction. The Shire of Benalla, *e.g.*, is taking steps to install a stone-crushing plant at its granite quarries at the Glenrowan Railway Station, whence the stone products may be distributed to various points along the railway line.

The great economy that will result from this and similar enterprises may be here instanced.

The Borough of Wangaratta has in the past been under the necessity of procuring stone from Melbourne for its town streets at a cost delivered on the roads of 14s. per cubic yard.

It is certain that with the equipment and operation of the Glenrowan Quarries, road metal could be delivered at Wangaratta by rail at a cost not exceeding 7s., or half the former cost.

As stone and gravel are the materials upon which reliance must be placed for the construction of the country roads, the location and development of the deposits of these materials, which occur in accessible localities, will form one of the most important functions of the Board as influencing the economical aspect of the work.

Under section 15 of the Country Roads Act, the Board is empowered to " carry out all such surveys and investigations as may be necessary or expedient to ascertain the nature and extent of the resources of Victoria in metals, minerals, and materials suitable for the purposes of road making and maintenance, and the most effective and economical methods for dealing with the same, and for supplying or utilizing the same for the said purposes, in the whole or any part of Victoria."

Owing to the time occupied in its preliminary investigations and in the pioneering work incidental to the organization of a new department, the Board has not yet been able to enter upon a thorough and systematic investigation as regards road-making materials, other than making observations in a general way, of the materials that have been used by the several authorities for the construction of roads.

In connexion with their road surveys, the Board's engineers have been careful to note the existence of any stone or gravel likely to be suitable for road purposes, and in this direction the Board has received much valuable assistance from the Geological and Survey Branch of the Mines Department, which has provided for the use of the Board geological maps and much useful information.

ROAD STONES.

The suitability of stone for road metal depends upon the following factors :—

That it shall be easily accessible, inexpensive to quarry, and suitable for the class of traffic it will be called upon to carry. It should also possess the following characteristics :—

1. Hardness.
2. Toughness.
3. High cementing value.

The quality of hardness prevents the stone from wearing by the abrasion or grinding action of the traffic.

The quality of toughness enables it to withstand fracture from the impact of horses and vehicles with iron-tired wheels. A stone may be hard, but it may lack the quality of toughness. For this reason flints and quartz do not make good road stones owing to their brittle character.

The cementing value of the stone is its ability to form from the dust or gritty particles worn from it, in combination with moisture, a cement which fills the interstices between the individual stones and keeps them wedged firmly in position, thus forming a close waterproof surface.

In addition to these prime qualities, other important physical properties are its specific gravity and closeness of texture, a porous stone being liable to fail from the effects of water and frost. The best known stone for road purposes in this State is basalt, which, owing to its proximity to the city, is practically the only stone used in the metropolitan area for macadamized roads. Though not particularly hard, it is a good, useful road stone, and the grit worn from it has a considerable cementing value. This stone would be more suitable for country roads than for city streets with heavy traffic, where frequent surface renewals are necessary.

Basalt is also found in the western districts of Victoria over an extensive area extending from Footscray to Coleraine, and is the material used on the excellent roads thoughout this district. Up to the present, however, the road metal used has been mainly from surface stone gathered from the fields, which is less uniform in quality than stone obtained from a quarry. In consequence of this want of uniformity, the road surface wears unequally, and under heavy traffic will not be durable. In order to wear evenly, the stone forming the road crust must be homogeneous in quality and texture. To this want of uniformity is mainly attributed the failure of the heavily trafficked roads converging on the towns of Warrnambool and Port Fairy.

Excellent stone for road making is also found in the dacites in the districts of Mount Dandenong, Healesville, and Warburton. This stone is much harder than the basalt, and for this reason is more suitable for heavy than for light traffic. It has a lower cementing value, is more expensive to quarry, and to obtain a smooth road pavement must be broken to a smaller gauge. Under light traffic there would probably not be sufficient grit produced to form a natural binding, and the surface stones may " ravel."

The older limestone, such as that obtained at Cave Hill, Lilydale, and Buchan, East Gippsland, is also suitable for road making. It is not a hard stone, and will be less durable than basalt or dacite for heavy iron-tired traffic. It forms a smooth surface owing to the high cementing value of the limestone dust worn from it, and for this reason is less liable to damage by fast motor traffic than a harder and more durable stone.

In this State, our experience regarding the suitability of stone for road-making purposes has been gained from the actual behaviour of the road metal under traffic. In Great Britain, France, and the United States are now established physical laboratories for the testing of stone in order to ascertain its suitability for road purposes. In England there is the National Physical Laboratory at Teddington, Middlesex ; in France there are three large testing laboratories ; and in the United States a similar laboratory has been established in connexion with the Office of Public Roads at Washington, which is under the able direction of Dr. L. W. Page, and contains a very complete equipment of apparatus for testing the physical and mechanical qualities of road materials. At these institutions the principal tests are—

(*a*) The attrition test, which is to determine the rate of wear of the stone due to the grinding action set up under the pressure of traffic.

(*b*) The abrasion test.

(*c*) The impact test, to ascertain the degree of toughness of the stone, and its power to resist impact such as that due to horses' hoofs or heavy traffic.

(*d*) The determination of the cementing value of the stone.

While the best test of a road stone is its wearing qualities under actual traffic conditions, experiments to ascertain its value in this way may take years, and extensive experiments with a stone of unknown quality might prove costly. Laboratory tests of road materials are therefore of great value in affording an accurate indication of the suitability of a stone for traffic purposes of a variable nature. If under the laboratory

tests enumerated, a stone exhibits similar qualities to that observed in a stone which has proved suitable under actual traffic conditions, it may be predicted with some degree of confidence that the stone under test will also prove suitable under the same conditions.

The Melbourne University authorities are co-operating with the Board in the matter of testing materials. They are giving the same terms that they grant to other State Engineering Departments, namely, that all tests shall be carried out free of charge.

The Board will thus have the effective use of the testing plant at the Engineering School, which plant consists of 100,000 lbs. testing machine, cement testing plant schlerscope, and they are now constructing an abrasion machine, which will shortly be finished. There is also another testing plant on order, and systematic investigation of road materials and its cementatious value, together with asphaltic substances, can be undertaken.

It is the Board's intention, as soon as practicable, to enter upon this research work. Samples of stone will be obtained from every district throughout the State for the purpose of testing their suitability for road-making purposes. It is proposed to tabulate the results of these tests so that the different classes of stone obtained from the various districts may be classified in a manner to indicate their suitability for road making under the various traffic conditions. This research work will prove of the utmost value not only to the Board in connexion with its direct operations, but to the shire councils and all other authorities interested in the subject.

The Board is frequently asked for advice by shire councils regarding the opening up of quarries and the installation of stone-breaking machinery, and if equipped with reliable data, it would be in a position to advise with some degree of confidence as to the suitability of stone for road purposes before the expense of purchasing and installing a plant is incurred.

MAKING USE OF MATERIALS AT HAND.

Where suitable stone for road making is unobtainable, good results may be achieved by the judicious selection and use of materials at hand. The photograph shown in Plate 52 is that of a section of the Mansfield-road in the Benalla Shire.

This section of road was constructed in June, 1905, under the direction of the Shire Engineer, Mr. S. Jeffrey, C.E., the material used being a decomposed granite, in appearance a sandy loam of comparatively fine grain.

Plate 52. Showing section of the Benalla-Mansfield road, constructed of granite sand.

The material was carefully selected, laid, and rolled in two layers while slightly wet, the cost being £225 per mile.

This section of road has carried the heavy timber traffic from a saw-mill in the Toorour district for nine years, and was still in good condition when inspected by the Board.

This instance is mentioned to illustrate what may be accomplished by those responsible for the care of roads by the exercise of observation and skill in the employment of unpromising materials.

In several Gippsland shires goods roads for light or even moderately heavy traffic have been constructed of local gravel. The deposits in that district usually consist of a coarse-grained sand, in which the individual particles are not larger than a pea. Some of these sand deposits contain a percentage of natural binding or cementing material, and when judiciously applied to the road and rolled, have given successful results on roads with level or moderate gradients; but on gradients steeper than 1 in 20 they are liable to erosion by surface water.

Plate 52A. Showing right and wrong use of local materials on an earth road. Left side formed of surface loam and right side with clay from gutter and bank on upper side.

On the road between Grantville and Bass, in the Shire of Phillip Island and Woolamai, very fair stretches of road have been constructed of burnt clay. A section of 15 chains in particular, constructed over 35 years ago, is still in good condition, although to the knowledge of the Shire Engineer practically nothing has been expended in the maintenance of the section. This road had been originally well formed, with a coat of burnt clay about 18 inches in thickness, and in the opinion of the Shire Engineer

Plate 53. Shire of Phillip Island and Woolamai. Showing road constructed of burnt clay; in use over 35 years.

it is necessary that there should be a thickness of not less than 15 inches with this class of material. It is possible that, in some parts of the State, where more suitable material is unobtainable, and where there is sufficient timber for burning, and the local clay of suitable composition, this form of construction may be found practicable.

In the Shire of Seymour there are several good sections of roads constructed of Mangalore gravel, which probably is amongst the best gravel deposits in the State for road purposes. In this and several other northern shires, ironstone gravel has been used with excellent results on short sections of roads. This material forms a firm and smooth road surface if well maintained. The deposits are usually found on ridges in shallow layers, and are difficult to obtain in large quantities.

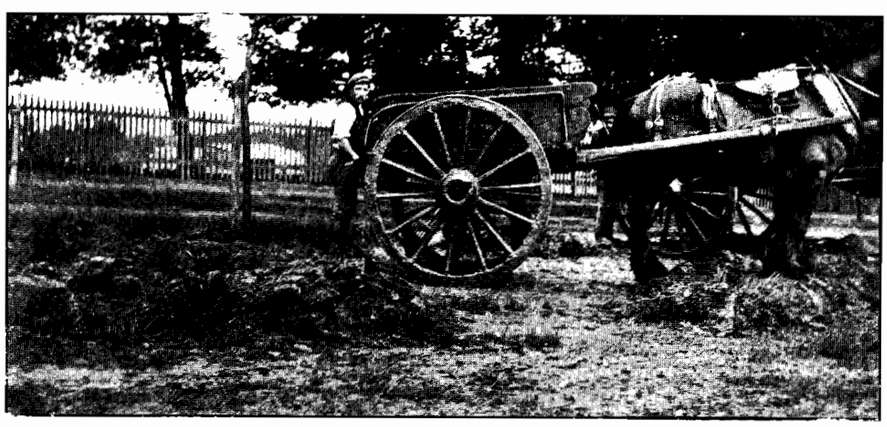
ROAD BINDERS.

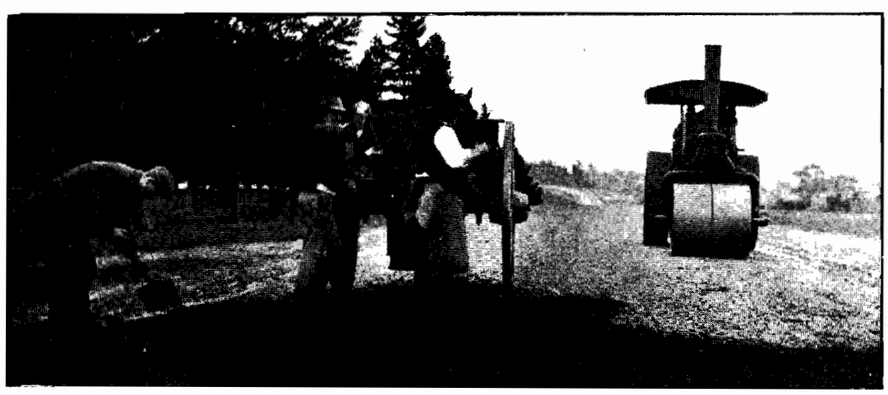
An important detail in the finishing of a macadamized road, which does not receive the consideration it warrants, is the choice of a suitable binder.

One of the necessary qualities of a road to enable it to stand modern traffic is that its surface must be watertight.

The main object of using a binder is to achieve this purpose by filling the interstices between the surface stones, and if the binder possess cementing properties, it serves as a mortar to hold the surface stones in position.

Where no road roller has been available, it has been necessary, in order that traffic may use the road, to cover the rough stones with some more or less suitable material, otherwise the wheels of vehicles and feet of animals would suffer injury, and this latter consideration has led many road makers to use materials wholly unsuitable for the purpose, such as earth, clay, weeds and other rubbish, which practice cannot be too strongly condemned. Such materials have no strength or cementing value, and are





Plates 54 and 55. Showing earthy material and weeds being taken from water tables and spread on metalled roads.

distinctly wasteful and injurious to the life of the road. In wet weather they form mud, and cause the picking up of the surface stones by traffic ; in dry weather they form dust, which also causes the road stones to loosen and grind against one another, and, finally, when the cavities between the stones are filled with earthy material of an absorbent character, water will find its way through this medium to the injury of the road bed.

In connexion with contracts on main roads in which the Board is interested, the use of none but suitable binders will be sanctioned, but the practice of using harmful and wasteful materials for covering metalled roads is still a matter of every day occurrence in many districts.

Plates 56 and 57. Showing earthy material and weeds being taken from water tables and spread on metalled roads.

The use of such materials for " blinding " metalled roads as illustrated on plates Nos. 54 to 57 is only a source of future trouble and expense. If no suitable binder is available—which is seldom the case—it would be preferable to leave the metal or gravel without any covering material.

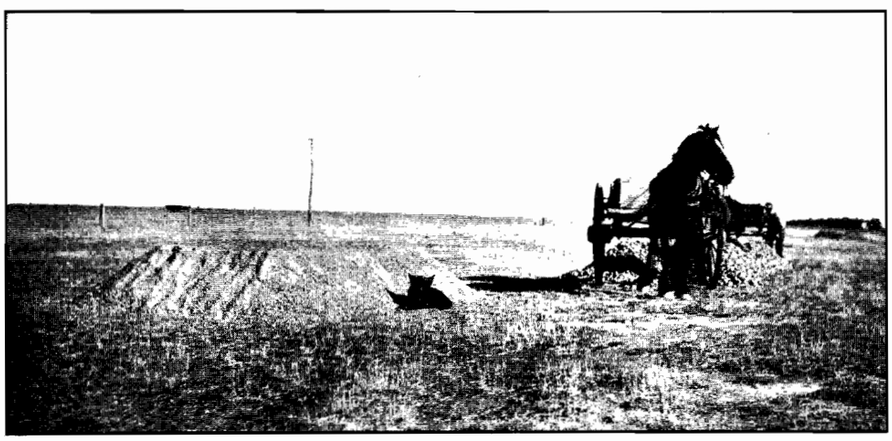


Plate 58. Showing heaps of metal and stone chippings for binder, on side of road, in the Shire of Hampden.

These comments are made in order to induce road authorities to discontinue the practice under all circumstances in connexion with road works, no matter how unimportant, comparatively, the road may be.

Where a heavy roller is used, the practice of using earthy material as a binder is still more reprehensible. The roller, in this case, forces the soil through the interstices between the stones, thus providing an easy medium for the passage of water to the road foundations.

A binder should consist of clean, gritty material. Where stone-breaking plants are in use, the screenings and chippings from the crusher may be used.

A number of the Western District shires are equipped with portable crushing plants, and there may be seen, alongside the main roads, alternate heaps of metal and chippings for binding.

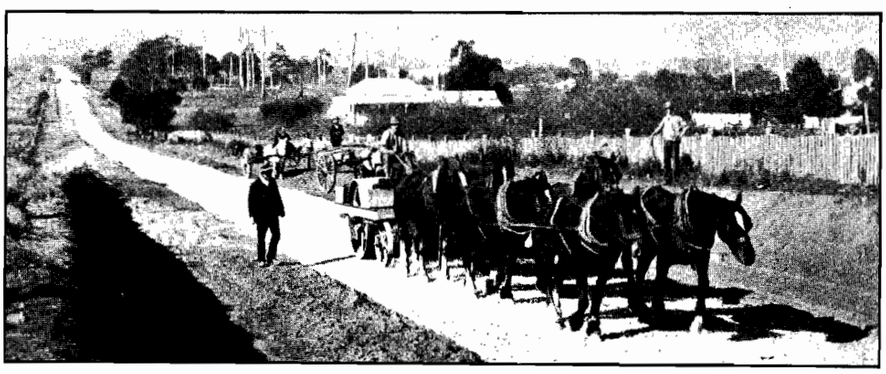
Amongst the gravels, ironstone gravel is probably the best material that can be used as a binder. Some of the best road surfaces observed by the Board had been surface dressed with this material. It wears smooth and forms a good binder. The Cranbourne gravel makes an excellent binder, but any fine gravel will serve, particularly if it contains oxide of iron, lime, or other cementing material, and is free from an excess of clay, earth, or organic matter.

Whatever the material may be, it should only be used in quantities sufficient to fill voids between the stones in the road surface. Any excess is harmful; it will only grind into dust and form mud in wet weather. The main object of the binder is to make the road surface impermeable to water.

ROAD ROLLING.

A good road for modern traffic cannot be made without the use of an efficient road roller.

Macadam, whose name will always be associated with macadamized roads, caused the metal to be broken to a gauge not exceeding 2 inches. His practice was to lay a coat of stone 7 inches to 8 inches in thickness and allow it to be worked in by the traffic, the ruts and hollows formed in the loose material being kept constantly raked in until



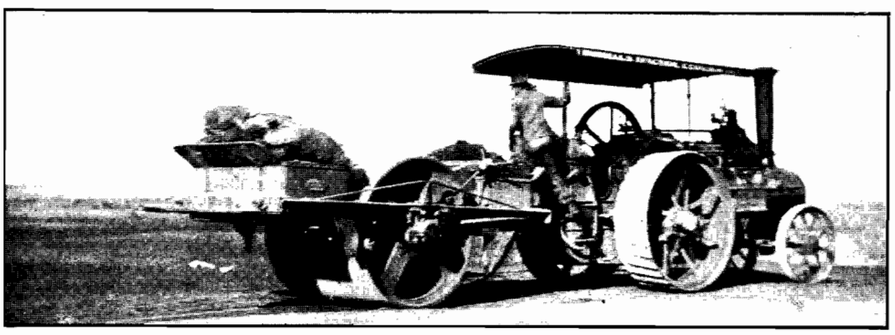
Plates 59 and 60. Showing different types of rollers now in use on country roads.

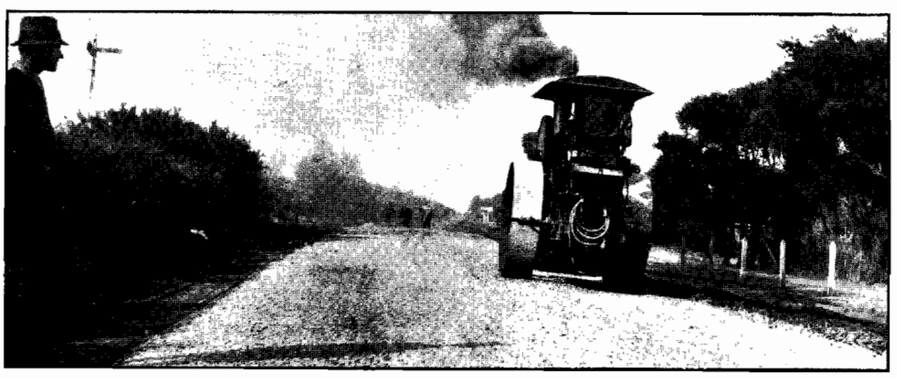
it had become set by the traffic. This was a slow and somewhat crude process, and should not now be tolerated, but in those days (about the year 1815), road rollers were not known, and Macadam would never allow of earth being used as a binder.

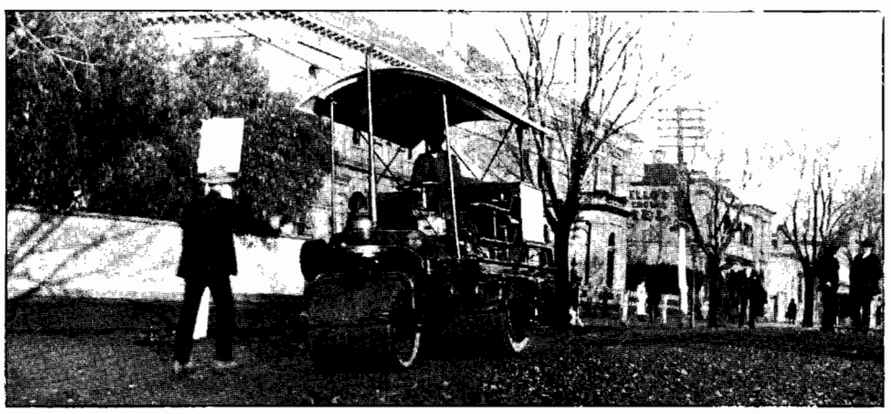
In 1843 the use of horse drawn rollers was first advocated by Sir John F. Burgoyne, R.E., Chairman of the Board of Works for Ireland. The first steam roller was constructed for use in Great Britain in 1865, and since then road rollers have

gradually been perfected, and at the present time have reached a high state of efficiency. In addition to those propelled by steam, motor rollers are now being manufactured, to be driven by petrol and paraffin. The first roller of this type was put on the market by an English firm in 1905.

It is claimed for the last-mentioned type of roller that it is more easily managed than a steam roller, and it can be started quickly without waiting for steam raising, which is an advantage, particularly when there is not enough work to keep a roller constantly in use.





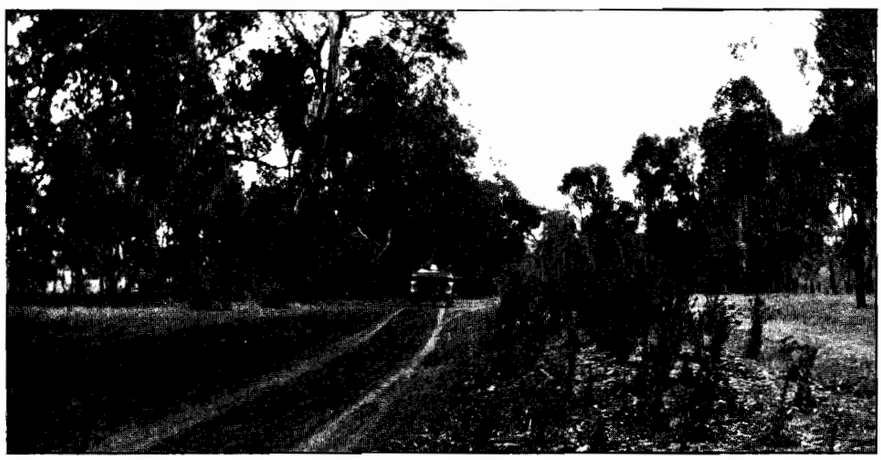


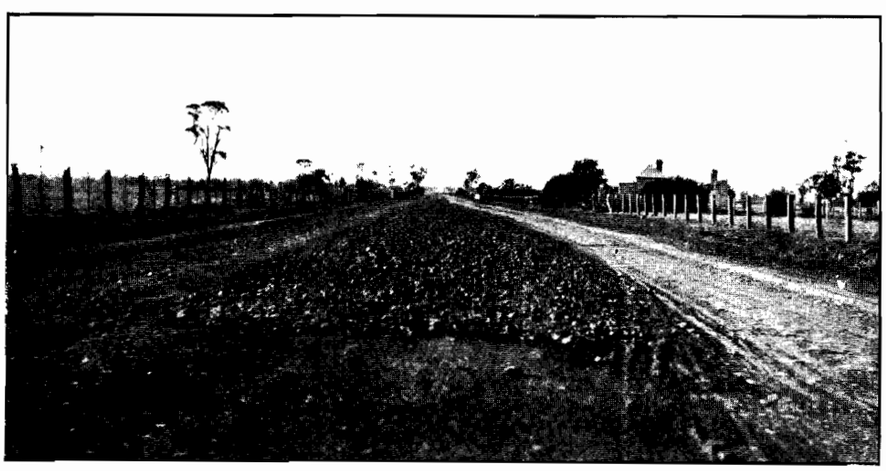
Plates 61, 62, and 63. Showing different types of rollers now in use on country roads.

An ample choice of self-propelled rollers suitable for country road works is, therefore, offered by many reputable manufacturers. These rollers vary in weight from 5 tons to 15 tons, but the Board considers that rollers of from 8 to 10 tons are the most suitable for ordinary country roads.

In many districts where the traffic is light, and where the financial position of the shire may not warrant the expenditure necessary for a steam or motor roller, horse-drawn rollers may be obtained. The most suitable rollers of this type are those with a reversible fore-carriage, weighing from 4 to 5 tons when empty, and capable of being loaded to 6 or 7 tons with water or other ballast.

Suitable rollers of this type cost about £135, and should therefore be within the reach of even the poorest shire. The rolling of a road not only effects a direct economy in the time taken in construction, but also in the quantity of material. If the metal be left to be solidified by the traffic, and the ruts are not constantly raked in, a considerable portion of the metal is scattered by the traffic until the sharp angles





Plates 64, 65, and 66. Showing material spread or dumped on roads without rolling.

are worn off, to the detriment of its setting qualities. The discomfort and damage to horses and vehicles compelled to travel over the loose material is also obviated. Traffic will avoid the loose and rough metal as long as the road-sides remain passable, and in this way the water tables are "tracked" and the surface drainage is diverted from the side channels, thus causing erosion along these tracks and further damage to the road.

The action of a roller in passing over the broken stone adjusts and presses the stones together, and interlocks the angular fragments, leaving a compact homogeneous body with the minimum of voids. The surface is left smooth and firm, is capable of shedding the surface water, and is fit for traffic as soon as the work is completed.

With the old system of macadam the road was made *by* the traffic, but with the use of a roller the road is made *for* the traffic. The purchase of an efficient roller will be more than justified on the score of both comfort and economy.

WATERING OF ROADS.

The repairing and re-sheeting of existing macadam roads should preferably be done in the autumn after rain has fallen. The metalled surface is then soft, and the new material can be more readily pressed into and bonded with the old surface.

If this work be undertaken during summer when the old metal surface is hard and dry, artificial watering will be necessary.

The water may be applied by means of an ordinary horse-drawn sprinkler watering van or cart, with a tank capacity of from 200 to 400 gallons, according to circumstances.

Only enough water should be applied to moisten the old surface sufficiently to allow the stone to be "set" into position. Repeated light sprinkling with water should be done while rolling is in progress, to aid consolidation of the metal and to prevent its picking up under the roller wheels.

When the binder is applied, alternate rolling and sprinkling is again necessary to flush the binder into place between the interstices of the surface stone.

In the latest types of steam rollers, a very useful part of the equipment is a set of tubes with jets for spraying water upon the roller wheels.

While this attachment reduces the quantity of water necessary when rolling the roads, it also increases the rolling efficiency.

The water tubes are fed either from the engine tank or from a supplementary water tank by means of an ejector.

ROAD MAINTENANCE.

If it be sound policy to build good roads, it is equally important that they should not be allowed to deteriorate.

Neglect of maintenance means an immense waste of labour and materials. No enduring road-making material has yet been, or is likely to be, discovered. Roads, of

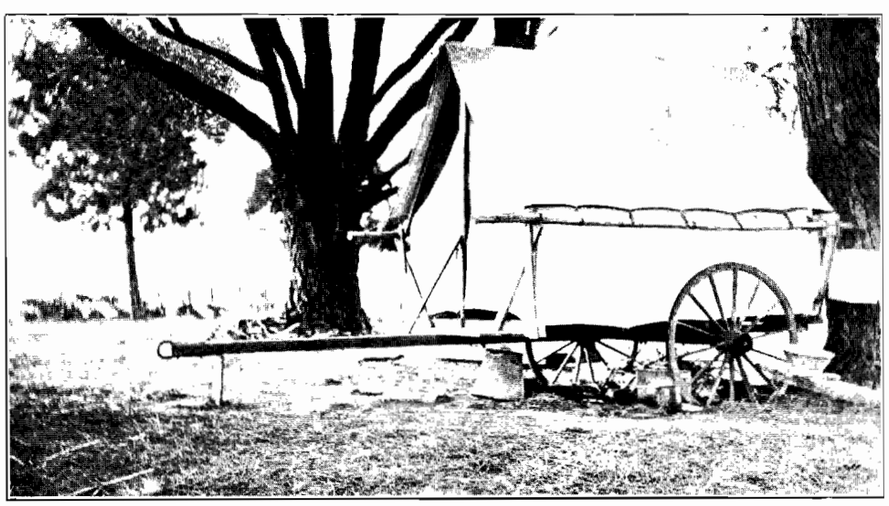


Plate 67. Showing portable camping outfit supplied to roadmen by the Cranbourne Shire Council.

whatever kind, require to be maintained, and the less durable the material of which the surfaces are constructed, the more will be the expenditure necessary for their upkeep.

The country roads mainly consist of earth, gravel, or metal. It costs more in labour to keep an earth surface in repair than one of gravel, and more to maintain a gravel road than one of good broken stone.

The authorities in charge of the roads have failed to appreciate the economy resulting from a proper system of maintenance. There are, of course, exceptions, but, generally speaking, throughout the portions of the State already inspected, road maintenance has been sadly neglected. Certainly the roads in a number of the Western District shires have been well maintained on a system of periodical or annual repair, but the Board is of opinion that there would be still better results if a continuous system of maintenance were inaugurated in place of the system of intermittent repairs.

Although in the case of Hampden, Colac, Mortlake, and other shires, heaps of metal and stone chippings for binding are stacked along the road-sides for repair purposes, the year's traffic causes continuous depressions to form in the wheel tracks, and although these tracks are filled and rolled during the autumn repairs, the greater depth of new material in the tracks causes an uneven settlement of the surface, and even these comparatively good roads are seldom without wheel tracks more or less apparent.

A notable exception is the Penshurst–Koroit road, in the Shire of Minhamite. This road has the almost constant attention of a skilled and careful road foreman, and the result is a road on which it is a pleasure to travel. There have been other isolated instances noticed where the excellent condition of a section of road was the result of the constant care of a man in charge of the section.

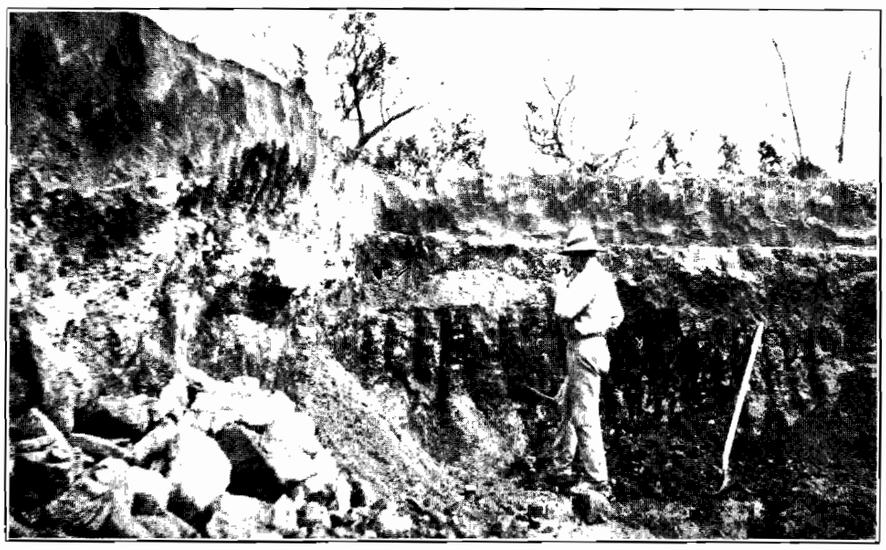


Plate 68. Showing gravel pits whence the binding material is obtained for the Cranbourne roads.

The Shire of Cranbourne has adopted an excellent system of continuous maintenance. During the summer months, heaps of metal and gravel for binding are hauled and stacked on the road-sides for the use of road men, who, each equipped with a horse and dray and the necessary tools, have certain lengths of the road allotted to them, these lengths varying up to 14 miles. These men provide their own drays, which the shire stipulates must have $4\frac{1}{2}$-in. tires, and a portable tent is supplied by the council for the use of the men when working at some distance from their homes.

The roads thus maintained are kept constantly in first class condition. The main road from Dandenong to Cranbourne, with this system of constant and judicious patching, has been maintained with a good surface and in excellent condition, though the metal has been worn down to a crust of from 3 to 4 inches in thickness. There is no doubt that reconstruction would have been necessary years ago but for this practice of constant and systematic maintenance.

One of the factors tending to the satisfactory condition of the principal roads in Cranbourne is that suitable metal is used for repairs, and only first-class gravel is used for binding, of which material fortunately there are extensive deposits within the shire.

"MAINTENANCE" AND "REPAIR."

There is a distinction between "maintenance" and "repair."

To repair a road implies that it has been allowed to get into disrepair through lack of maintenance.

To maintain a road means the carrying out of all the operations necessary to prevent it from deteriorating.

A road properly maintained may not need "repairs" for an indefinite period.

The critical period in the life of a road is that immediately following its construction. If, during this period, the road is "nursed" and the surface is kept solid and smooth, comparatively little expenditure will be necessary during the years immediately following. As soon as a road is constructed, its maintenance should begin. If ruts or hollows are allowed to form before the road crust has thoroughly set and become smooth and compact, water will accumulate in these depressions and penetrate to the sub-bed, which will become permanently deformed. This immediate attention to a newly-constructed road is the more necessary where an efficient steam or other roller is not available to solidify the crust and leave the surface smooth. With a well-organized system of maintenance, the road may be kept in good condition for an almost indefinite period without the expensive work of reconstruction, this period depending upon the intensity of the traffic.

Plate 69. Showing main road to Cranbourne, maintained by the constant patrol system.

Many of the main national highways have been so systematically neglected that there only remains the worn foundation pitching, the reason usually given, apart from that of lack of funds, being that these roads are used more by "foreign" traffic than by the local ratepayers, and a number of the shire councils, through whose territory these arterial roads pass, consider that such thoroughfares should be wholly maintained by the State.

The reason for neglecting the maintenance of many of the local roads is less apparent, and can only be attributed to the want of appreciation of the "stitch in time" policy, or the want of realization by the farmers of the extent of the tax imposed upon them by the loss of time and the extra wear and tear resulting from the unsatisfactory condition of these roads. The additional expenditure caused to people in the country in the upkeep of vehicles, harness, and horses must in itself amount to a greater tax than a small additional rate expended on road maintenance. The majority of shire councillors are farmers, and know that a farm requires constant care and attention, but they do not appear to realize that the same principle should apply to the public highways under their control.

Hitherto, the funds available for the maintenance of the roads depended upon the amount the shires could afford to devote to this work from their annual revenue. Under the provision of the Country Roads Act this will no longer be the case. The State will, in the first instance, provide the necessary funds for the maintenance of main roads, and in the year following the shires will only be called upon to refund half of the amount expended during the previous year.

To inaugurate an efficient system of maintenace requires an effective organization and business management by the authorities in charge of the roads. The arranging for supplies of materials for repairs at the season when these materials can be procured and delivered at the lowest cost and with the least damage to the roads over which they are hauled, and the organization of the necessary labour require the same careful thought and supervision which is necessary for planning new works.

In order to institute a continuous and constant system of road maintenance, it is considered desirable to train a body of skilled workmen, whose duty it will be to constantly patrol and maintain certain lengths of road allotted to them, the length depending upon the local conditions as regards traffic. It is a fallacy to suppose that any casual labourer is capable of properly and skilfully repairing or otherwise caring for the roads, as this work requires the exercise of both intelligence and skill. A good roadman must possess a trained eye and powers of observation. The conditions of employment and remuneration to these men should be such that the best class of men will be attracted to the work. If such a system can be organized, it may be confidently expected that the roads constructed by the Board, in conjunction with the shires, will be maintained to an efficient standard and kept in trafficable condition to the date on which the liability of the shires for their portion of the cost of construction has expired.

The adoption of the patrol system may not be practicable in those portions of the State where the population is sparse and the traffic light, but there is no doubt that it could be successfully employed with good results on the principal roads in many of the more closely settled districts where there is considerable traffic.

Plate 70. Showing road being repaired by the intermittent or annual system.

The patrol system is adopted in countries where road construction has reached the highest standard of efficiency. In France it has been adopted successfully for upwards of 100 years, and in Great Britain the roads are almost universally divided into lengths, in charge of "length men" who receive temporary help, if necessary, during certain periods of the year. The lengths of road allotted to the care of these "length men" varies from 1 to 17 miles, according to the intensity of the traffic. The system has also been adopted in Germany, Hungary, Belgium, and a number of the American States. It has been found that the men take a pride and interest in keeping their respective sections of road in good order.

In France, where the national road system has attained the highest degree of organization, the roadmen must have first fulfilled their military obligations.

They must be between 20 and 35 years of age, of good moral character, free from infirmity, and able to read and write. The average length of road allotted to them is $3\frac{3}{4}$ miles. The men receive an annual salary, from which 5 per cent. is deducted for an old-age pension fund. They may demand release from duty, and obtain their pension, on reaching the age of 60, but they may be retained until 65 years of age.

In Belgium, the roadmen, besides their ordinary duties of repairing the roads, are responsible for the policeing of them, and are authorized to summon persons for any damage to the roads or infraction of the laws.

In its numerous interviews and discussions with municipal councils on the question of road up-keep, the Board has advocated the patrol system for the maintenance of the principal traffic-bearing roads, and there is no doubt that many of the shires will be induced to adopt a system which has proved the most successful in other countries, and which has given satisfaction in the Shire of Cranbourne.

The Board has drawn up a code of instructions for the guidance of patrol men, which forms one of the appendices to this Report. It is proposed to have these printed in pamphlet from and forwarded to councils in order that a copy may be handed to all men employed on road maintenance.

MOTOR TRAFFIC AND ITS EFFECTS UPON ROADS.

In any scheme of road construction and improvement, the influence of motor transport is now an important factor, and must be taken into account. The recent abnormal increase of self-propelled vehicles for pleasure as well as transport of merchandise, and particularly since 1905 has, in the Old World and America, completely revolutionized systems and methods of road construction.

In his opening address at the International Road Congress held in London in June last year, Mr. Lloyd George stated that there were then in Great Britain and Ireland 220,000 motor vehicles, and Sir George Gibb, Chairman of the Imperial Road Board, stated that " the roads of that country had to be adapted to suit these vehicles."

In 1912 there were in use in U.S.A. over 1,000,000 automobiles, including commercial vehicles.

In this State also, the number of motor vehicles is increasing rapidly. In 1910 when the Motor Car Act came into force, the registered number was 2,181. At the end of the present financial year this number had increased to 9,400. In this country, these vehicles are mainly of the light motor class, commercial vehicles being scarcely known outside the metropolitan area, for the reason that the country roads are unfitted for the economical running of this class of transport vehicle. The exceptions noted were at Colac and Camperdown in the Western District, where motor lorries are used to collect and carry cream to the local butter factories, this being one of the few districts where the roads are such as to make it possible to adopt motor traction.

With a general improvement in the country roads an increase of this form of transport in at least some districts and on certain roads may be accepted as a natural corollary, and the question of constructing roads in a manner to withstand this class of traffic cannot be lightly set aside.

As regards the great majority of the country roads, however, where so many miles of tracks are in urgent need of improvement to render them even passable for ordinary farm vehicles, any special treatment for modern forms of traffic would be out of the question in view of the funds available for road construction.

It would not only be wasteful to construct roads in outlying districts to a standard above present traffic requirements, but an injustice to the many out-back settlers who would welcome a metalled road of any description as a luxury.

Only on certain main traffic thoroughfares radiating from Melbourne and carrying a considerable motor traffic, will any special provision be made at present to render them suitable for, and less liable to damage by, this traffic.

One such thoroughfare, the Point Nepean-road, between Mordialloc and Frankston, is proposed to be surface-dressed with tar during next summer, such treatment being the cheapest and therefore the only method of bituminous surface-dressing the Board feels warranted in undertaking, and this mainly in the interest of the life of the road.

The two essential provisions in constructing roads to withstand heavy motor traffic are :—

1. A strong and rigid foundation.
2. A perfectly smooth and even surface, and at the same time possessing some degree of resiliency.

The first condition should be an essential for all classes of roads subject to considerable traffic. If the general form of the road be good and the foundation substantial, the road crust (metal or gravel) may be designed to meet present traffic conditions, and should increased traffic require it, the crust could be strengthened or thickened with an additional layer of stone, or if need be, a carpet of some bituminous material, 3 or 4 inches in thickness, could be laid over the macadam in special cases.

For the second condition an ordinary macadamized road, properly consolidated by rolling and bound with a suitable binding material meets the case, but where motor traffic is considerable and constant, such a surface will quickly be disintegrated and finally broken up unless the surface is sealed with some elastic and adhesive binding material.

Such binding substances are commonly known by the general term of "bituminous binders" which term includes tar, tarry compounds, asphalt, bitumen, and other such materials.

These surface binders have little or no influence upon the strength of the road crust, their value as road preservatives being that, when applied under favorable conditions to the surface of macadamized roads, the tarry compound penetrates from half to three quarters of an inch beneath the surface, and serves to bind the smaller particles of stone together and to keep the surface stones firmly wedged in place. They also form a surface seal and prevent water from penetrating through the road crust and weakening both the crust and road bed.

Bituminous treatment of roads has passed the experimental stage, and is now recognised as a valuable road preservative, especially when the roads are subject to any considerable amount of motor traffic of a light nature. This form of treatment was at first employed as a means of mitigating the dust niusance, but it was found that surface tarring materially reduced the wear of roads so treated, the saving in the life of the road through its use being variously estimated at from 25 to 50 per cent.

Surface tarring of ordinary macadam roads would not however be sufficient for city or other roads which bear constant traffic of the heavy commercial class such as motor lorries and motor buses; a more rigid and enduring road with strong foundation and smoothly paved surface is necessary, it being now an accepted fact that ordinary macadamized roads are unsuited for, and soon become ruined by, regular heavy motor traffic

In Great Britain gas tar and its compounds is the material most generally used owing to its efficiency and comparatively low cost, and the same may be said of our experience in this country. The cost of surface application of tar by spraying with mechanical sprayers is from 1d. to 2d. per square yard, according to locality, and on a road 15 to 18 feet wide would cost £50 to £60 a mile. It is obvious that unless the cost of maintenance of a road already approaches these figures, the extra cost of surface tarring would not be justifiable.

Special surface treatment, at least for some time to come, will therefore be limited to a small percentage of the country roads in cases where these, radiating from the cities, already bear a considerable amount of motor traffic, or where the ordinary traffic is of such volume as to entail the cost of frequent surface renewals of stone. Surface tarring is also proposed where main highways pass through country towns and boroughs.

Besides the value of tar spraying for road surfaces as an undoubted saving in their maintenance, there is the further advantage of the lessening of the dust nuisance from roads so treated, and it should not be overlooked that, while surface tarring renders the roads suitable for motor traffic and preserves the roads from damage by this class of vehicle, every other class of traffic benefits to some degree, as roads that are fitted for motor traffic must certainly cause less wear and tear and discomfort to all other road users.

For the spraying of large areas of road surfaces with tar or similar surface binders, it is essential, in the interest of economy, to employ mechanical spraying machines.

In America, and particularly in California, "asphaltum" is used in the same way as tar for surface dressing of roads. This material is a residual from the distillation of crude petroleum.

With the rapidly increasing demand for tar in the metropolitan area for road purposes, a shortage in the supply of this product is threatened, and it is possible that asphaltum or other suitable substitute for tar may have to be looked for.

It is almost certain that with a general improvement in the country roads, motor transport will form an important factor in the dairying industry of the State. Facilities for quick and regular collection and delivery of cream in good condition at the factories should have an important influence on the quality of produce, and at the same time should considerably reduce the cost of collection and delivery.

DO MOTORS DAMAGE ROADS?

The question of the extent to which, and under what conditions, roads are damaged by motors and the reason of the damage, has occupied a prominent place in all recent discussions on road problems, and where it has been established that substantial damage

has been occasioned by these vehicles, the reasons for the damage are well understood by road authorities, who are also generally agreed that the effect of self-propelled vehicles is only more damaging than those drawn by horse when the road is unsuitable for the use of such vehicles.

LIGHT MOTORS.

It has been clearly established that light motor cars do no damage to roads when the surface is smooth and sealed with some waterproof coating, *e.g.*, tar.

On well-made waterbound macadam roads with smooth and even surface there is little or no damage if cars are driven at a moderate speed.

Damage takes place on the last-named class of road when subjected to a considerable amount of motor traffic driven at high speed, the extent of damage being in proportion to the square of the velocity of the vehicles.

The damage is caused by the removal of the small gritty particles of stone forming the binding which serves to keep the surface stones in place. This damage takes place more particularly in summer when the road is dry.

These small particles of stone are not removed by suction of the pneumatic tires as has been popularly supposed, but by the shearing action caused by the rear or driving wheels of the car. This shearing or tractive force is exerted at the point of contact of the rear or driving wheels with the road surface. It tends to tear the surface, thus loosening the gritty particles forming the bond between the stones.

The damage will be greater if the road be out of repair and the surface uneven, the force of the impact of the wheels in the hollows causing depressions to become deeper, especially during wet weather, when these depressions contain water.

HEAVY COMMERCIAL MOTOR VEHICLES.

Heavy motor vehicles, especially those shod with metal tires, are a great source of damage to weak macadamized or gravelled roads.

The damage is caused by—

(1) Shearing.
(2) Impact.

Shearing.

The effect of shearing is due to the tractive force of the driving wheels. Damage from shearing is proportionate to the weight and speed of the vehicle.

Impact.

The force of impact (or the pounding force) increases with the square of the velocity.

For example, if one vehicle carrying a load of 5 tons travels at a speed of 4 miles per hour, and another, similarly constructed and loaded, travels at the rate of 12 miles per hour, the force of the wheel impact (and consequently the damaging effect upon the road) will be in the ratio of 1 to 9. Damage from impact does not occur to any appreciable extent with pneumatic tires.

WHEEL DIAMETER.

The diameter of wheels is another factor which has an important influence on damage to roads, the damage being much greater with small than with wheels of large diameter.

According to some authorities, the damage to the road due to impact will be reduced inversely as the square of the diameter of the wheels.

The fact is now conceded that ordinary macadam roads are not suitable to withstand the continuous traffic that may be expected in the vicinity of populous centres of either light high-speed traffic or heavy motor vehicles for commercial purposes.

TRAFFIC REGULATIONS.

The aforementioned opinions have received the indorsement of many of the foremost road authorities of the world at various road congresses and elsewhere.

When it is considered that ordinary macadam will, for reasons of economy and force of circumstances, be the material upon which reliance will have to be placed for the construction of the country roads, it would be desirable to regulate the traffic which will use these roads before they suffer serious damage rather than to legislate after the damage has taken place.

Regulations providing for increase of tire widths in proportion to the total load are not alone sufficient. Motor vehicles carry the greater part of the load on the hind wheels, and as road surfaces require to be formed with a camber, and as tires of wheels do not bear evenly on the surface, it would be desirable to limit the axle load on motor vehicles.

At the first International Roads Congress, 1908, it was agreed that the weights on heavy motor cars or traction engine wheels should not exceed 825 lbs. per inch of tire, and that the total load per wheel should be limited. It was also resolved that " the weight on the heaviest axle should not exceed 4 tons when working."

These comments are not made with a view to discouraging or unduly restricting the use of motor vehicles which, in these modern days, have become a necessity for pleasure as well as for business purposes. Indeed, the use of motor cars is having a powerful influence in making life more attractive to country people, a condition greatly to be desired, and a factor which will tend to counteract the modern tendency of country people, and especially the young people, to gravitate to the cities.

At the same time, all reasonable means should be employed which will have the effect of reducing the damage to roads by excessive speed in the case of light motor cars, or by excessive loading or defective design of heavy commercial vehicles.

Any regulations adopted to control motor traffic should include provisions for—

1. Limit of speed of light motor cars.
2. Limit of weight and speed of heavy motor vehicles, and

in connexion with this latter the following factors should be considered :—

(*a*) Limit of speed.
(*b*) Limit of total weight.
(*c*) Limit of axle load.
(*d*) Minimum diameter of wheels.
(*e*) Prohibition of solid metal tyres.
(*f*) Methods of springing.

One of the resolutions passed at the International Roads Congress (1913) was -

> " That all regulations for the control of road traffic should be based on the principle of allowing the speed practicable for each different kind of vehicle, consistent with public safety and general convenience, *and the normal wear of the road.*"

ROAD-MAKING MACHINERY.

It is impossible to build roads to meet the requirements of modern traffic without efficient road-making plant.

That there is so little in the way of efficient road-making appliances owned either by the councils or by private contracting firms is a matter for comment.

Many of the municipalities have no road-making appliances of any description, not even a horse-roller.

For many years past few road contracts of any great extent have been carried out in the State. Practically all the road-making done has consisted of short sections of road which could be undertaken by local settlers or teamsters. Consequently, there is a dearth of road contractors equipped with plant, who are capable of economically and expeditiously carrying out large contracts. To this circumstance may be attributed the comparatively few tenders received by the Board for contracts of any extent in the country districts.

To move teams and plant from one district to another for the construction of small contracts costs money and involves waste of time, and road contracts of considerable extent should cost less per mile than if the work were let in short lengths.

Ordinary earth work, timber clearing, and formation contracts, which are largely a question of labour, assisted by road ploughs and scoops, may well be let in small sections, and this affords an opportunity for settlers to earn some ready cash in their slack seasons.

But in the case of quarrying and breaking stone, and transporting the stone to the roads, it is essential, if value is to be received for expenditure, that the most up-to-date and efficient appliances procurable should be applied to the work.

There are a number of portable stone-breaking plants owned by shires as well as by contractors, but it has been noted that considerable loss of time is involved, both in the case of portable and stationary stone crushers, in the loading of the crushed stone

into the drays. Considerable economy would result if the metal from the crusher were delivered into storage hoppers, so that drays or waggons could receive their loads at once from the hopper, instead of standing beneath the delivery shoot for quite ten minutes at each trip to receive the stone as it is delivered from the crusher.

One of the most costly items in road construction is the transport of material from the point of its production to the road works. Road metal is now carried by the Railway Department at the " bed-rock " rate of 1s. 9d. per ton for 30 miles, consequently any reduction in transport charges must take place between the railway and the site of the road works. In this case every means should be adopted to reduce the number of times the stone is handled or shifted, either by removing the stone directly into the carts or waggons from the railway trucks, or into storage bins, from which the carts may be loaded direct. Where the distance from the railway to the site of the work is under, say, 2 miles, cartage by ordinary horse teams may prove as economical as other means of transport; but where this distance is exceeded, considerable economy will be effected by the employment of traction engines and waggons. While the tractor is employed in hauling the loaded waggons, the empty waggons could be filled in readiness for its return.

As a rule the larger the unit employed, the less will be the cost of haulage per ton, but there are other considerations which render it inadvisable to employ engines or waggons of excessive weight. The majority of country roads have not been designed to stand heavy traffic, and the damage done to these, not to mention bridges and culverts, would more than outweigh the saving in freight on the material. The Board, therefore, favours the employment of road rollers and traction engines which do not exceed a weight of approximately 10–12 tons when equipped in working order for the road. The smaller engines have the further advantage of being easier to handle at railway sidings, quarry sites, and other awkward and confined positions; they are also more easily extricated when in difficulties in soft unformed roads. Another desideratum is that the tractor be mounted on springs, in order to minimize shock, thus reducing wear on both the engine and the roads.

WAGGONS.

Metal waggons of the hopper self-spreading type are now manufactured by different firms. Those adopted by the Board for its own use are constructed of steel. They weigh 3 tons when empty, and have a loading capacity of from 5 to 6 tons, so that the total load does not exceed approximately 8 tons, or 2 tons per wheel. The wheel tires are 9 inches in width, and the wheel diameter is 4 feet, this large diameter of wheel requiring a comparatively small tractive effort to pull the waggon. These waggons are capable of distributing their load to any thickness desired, and to a width of 6 feet. As railway trucks usually carry 10 or 15 tons of road metal, 5 tons is a suitable capacity for waggons used in taking delivery from the trucks—two waggons carrying the load from a 10-ton, and three waggons from a 15-ton truck.

STONE-BREAKING MACHINES.

A number of the shires as well as contracting firms own stone-breaking machines, mostly of the portable type. Few, however, are equipped with elevators and efficient screens to separate and grade the metal. These screens should be capable of grading the metal into three sizes, the first for foundation metal of $2\frac{1}{2}$ to $3\frac{1}{2}$ gauge; the second size of approximately 2 inches for the surface coat, or for maintenance purposes; and the smaller sizes from $\frac{3}{4}$ inch down to dust for use as a binder. A useful size of crusher is that having an output of 70 to 80 tons of stone in a day of eight hours. It may be here mentioned that one 10-ton steam roller cannot efficiently consolidate more than this quantity of stone in one day.

Stone-breakers of the portable type should be constructed wholly of steel, in preference to cast-iron, for ease in transport; there is also less likelihood of delays and expense from breakages with the steel frames. The jaw faces and working parts should consist of specially hard and tempered steel, particularly where the stone to be broken is hard, and all working parts should be made easily renewable, as rock breakers are subject to great wear and tear owing to shocks and jars.

A desirable part of the equipment of stone-breaking plants are metal storage bins. These may be procured either of the stationary or portable type, and where employed will effect a considerable saving in loading the carts or waggons.

In selecting a stone-breaking machine, consideration should be given to the shape of the stone broken by the crusher. Some of the machines turn out " flaky " stones, while others, owing to the design of the jaw faces, break the stone into cubical pieces, which " set " much more effectually and form a stronger road crust.

ROAD ROLLERS.

As previously noted under " Road Rolling," there is a wide choice of road rollers for all the purposes and varying conditions of road-making, and no municipality should be without this most essential adjunct to its road-making plant.

Wealthy municipalities with extensive mileage of macadam or gravel roads will find a self-propelled roller driven either by steam or oil the most efficient and satisfactory. There does not appear to be any decisive advantage of one type over the other, each having its advantages in its own sphere of operations and conditions. These rollers are much more effective and economical when they can be kept in fairly constant work than those drawn by horses, and these latter, if heavy enough to be effective, are difficult to pull on gradients in hilly country. The hollows left by the horses' feet in the loose metal in this case generally remain even after the road has been rolled. The nature and degree of hardness of the stone or other material to be rolled should be one of the factors to be considered in determining on the weight of roller to be selected, a soft stone requiring a lighter roller than a hard one.

The Board favours rollers having a weight when empty of from 8 to 10 tons for ordinary work on country roads. If heavier than this, they are destructive to weak roads, bridges and culverts, and are liable to give trouble by being " bogged " in soft soils.

Of steam rollers, those of the compound type are generally favoured. They have the advantages that they can be started at any position of the crank. They work more smoothly, are more economical in the consumption of fuel and water, and make less noise than those with a single cylinder.

If fitted with a pulley wheel, they may be used for driving a stone-crusher when not required for rolling. A 10-ton steam roller may be purchased at prices varying according to type and make, of from £650 to £800.

Motor rollers propelled by benzine or paraffin as fuel may be obtained of several types. Some advantages claimed for rollers of this type are—That they are ready to start at any moment without heating; there is small space required for carrying fuel; and they emit no smoke or steam, and are practically noiseless, which is a decided advantage on narrow country roads, where the risk of frightening horses is a factor to be considered. These rollers may be obtained of weights ranging from $1\frac{1}{2}$ to 14 tons. Those weighing 5 tons and under are used for rolling tar pavements, and any under 7 or 8 tons in weight are not suitable for rolling macadam roads. Motor rollers weighing from 6 to 8 tons cost about £650.

Motor rollers designed with three axles have recently undergone successful trials in England.

Probably the particular field of usefulness of these rollers will be in the consolidation of tar-macadam and other bituminous road surfaces.

The particular advantage of this type of roller is that the weight of the machine can be adjusted and distributed over three rollers. The effect aimed at is to eliminate the tendency of such mastic bituminous materials to form a rythmic succession of waves in the finished surface when rolled by the usual two-axle rollers.

HORSE ROLLERS.

Horse rollers are useful for rolling earth roads, or for consolidating the sub-bed of metal or gravel roads before the material is spread on the formation, or in other cases where the soil is incapable of withstanding the weight of a heavy roller; or for the use of shires where the amount of work to be done would not warrant the capital and interest charges required for a steam or motor roller.

The desirable features in the designs of rollers of this class are that the cylinder should be of ample diameter, not less than about 5 feet, that they should have an easily detachable and reversible fore-carriage to steady the roller and take the weight off the backs of the horses. They should also be provided with effective brakes for use

on gradients. The unloaded weight should be not less than 4 to 5 tons, and they should have facilities for being " ballasted " up to a weight of 7 tons. They may be adapted to be drawn either by bullock or horse teams, or by a traction engine. Suitable rollers of this type may be obtained at a cost of about £135.

ROAD SCARIFIERS.

These implements are found very serviceable, particularly in connexion with the maintenance and repair of existing macadam roads.

For the application of small patches of metal, hand picking of the old surface would probably be found expedient, but where considerable lengths of road require renewal, and more particularly where the existing surface is " pot holey," and uneven, the saving of much time and considerable new material will be effected by the use of a scarifier to level down bumps and partly fill up the holes in the old surface, before applying the new metal. After the surface has been loosened to a depth of several inches, the old metal may be screened, the worn out dust put aside, and the loosened stone spread evenly over the surface. Fresh material may then be added, and the whole consolidated by rolling. By this means a formerly rough and uneven road may be renewed and the surface left smooth and even at considerable less cost than if the old surface had been re-coated without previous use of the scarifier. Also, a better union can be effected between the old and new material if the old surface has been scarified.

Hand picking of an old metalled surface is a laborious operation, and will cost about 5d. per square yard. With the use of a scarifier, the cost should not exceed $\frac{1}{4}$d. per square yard, or about one-twentieth of the cost of hand picking.

There are many different types of scarifiers, but these may be broadly classed under two distinct types :—

1. Those attached to the road roller (steam or motor) ;
2. Independent scarifier to be drawn behind a roller or traction engine.

Of the above two classes of scarifier, the cost is about the same (approximately £110). The advantage of the first is– that it is ready at any time when required, being practically an integral part of the roller.

The advantage of the second is that it can be drawn behind either a road roller or traction engine, and as the attachment of a spring chain or cable is more elastic, it causes less jar and strain to the engine.

ROAD GRADING MACHINES.

In some shires effective work is being performed by road grading machines. If skilfully handled by an experienced man, these can be used not only for the forming of new roads, but in reforming and trimming old roads, and cutting and cleaning water tables, which latter work can be done at the rate of 5s. per chain where the soil is favorable. To be effectively operated, these machines require a team of not less than six horses.

DRAG AND WHEEL SCOOPS.

These implements are most useful for moving earth in sandy and loamy country—the ordinary scoop being most suitable for short hauls, and the wheel scoop for deepening drains or for use when the soil has to be moved for some distance.

ROAD DRAG.

The split log drag or road hone has been used in Canada and United States of America with considerable success for the maintenance and repair of earth roads and to a minor extent in this State.

These simple and inexpensive appliances may be made of various designs by any handy bush carpenter at a cost of £1.

If used at the right season, an earth road may be reformed and made fairly smooth and trafficable.

This work should be done in the spring for preference, when the soil is still moist and easily moulded into shape.

A team of two or three horses is required, and the drag is pulled first up one side of the road and down the other, the operation being repeated until the whole surface has been smoothed and left even. The work done by the drag is a combined paring and puddling action.

If the road has become dry, the drag work will be useless, the lumps or ridges being too hard to shift with the drag, and any material moved will only form dust.

Illustrations of various forms of drags are shown on Sheet 4 of the Appendices attached to this report.

Recognising the necessity of the employment of mechanical aids wherever possible to expedite and cheapen the ever increasing cost of road works, the Board has already obtained a quantity of plant which is being hired to the municipalities or road contractors at fees sufficient to cover interest and depreciation charges, and in the case of the road rollers, to cover the wages of the drivers, who are employed directly by the Board, and are responsible for the care and working of the engines. Up to the present, the plant consists of five steam rollers, two of these being convertible into road tractors, four self-spreading hopper waggons, and two scarifiers.

In addition to the above, two tar spraying machines and additional metal waggons are under order.

As expensive plant, such as stone breakers, mechanically propelled road rollers, and traction engines can only be acquired and worked economically by the wealthier municipalities which have sufficient work to keep such machinery constantly employed, it is proposed to obtain additional plant from time to time as the work progresses, to enable the smaller municipalities to effectively carry out their works.

BRIDGES AND CULVERTS.

The subject of road bridges and culverts is one in which the Board is directly interested, in conjunction with the municipalities, in the construction and maintenance of the proclaimed main roads.

In its interviews with municipal councillors, the Board has strongly advised the erection of bridges of permanent materials, instead of the really more costly timber structures which have generally been erected during the past 50 or 60 years.

It has already been noted in another section of this Report, that in the fifties and sixties, the bridges erected by the Government or the old road boards were almost without exception built of stone or iron, or at least the piers and abutments were built of stone, and only the easily renewable superstructure consisted of wood. These old structures remain to-day as eloquent testimony of the wisdom of a policy of permanency in bridge design, particularly when compared with the erections of later years.

As in the case of other structures, the first cost, though important, is a secondary consideration to the capitalized cost, and in the case of bridges, those of timber are really the most expensive of all.

It is doubtful if the life of a wooden bridge, even under favorable conditions, with the timber now available, can be estimated at more than twenty years, which means an annual charge of 10 per cent. for depreciation and sinking fund. To this should be added a sum of from 5 per cent. to 6 per cent. for repairs, painting, &c., or an annual charge of 15 per cent. to 16 per cent., exclusive of interest on capital cost.

The life of concrete or reinforced concrete is indefinite, but from the experience gained of these materials during recent years, it is presumably safe to say that the charge for depreciation should not exceed 2 to 3 per cent., and as the only item requiring maintenance is the material of the deck covering, for which 2 per cent. should be ample, 5 per cent. should be a liberal allowance for these charges.

The respective annual charges for the types of bridges mentioned, exclusive of interest on capital cost, will therefore be approximately as follows:—

Timber	15 per cent.
Concrete	4 to 5 per cent.

From this it will be seen that in the case of a timber bridge the first cost is small compared with capitalized cost, and that, generally, it will be more economical to erect a permanent structure of concrete if the first cost does not exceed that of a timber structure by, say, 33 per cent.

In the experience already gained by the Board, it has been found that the cost of a simple beam reinforced concrete bridge without any ornamental embellishments is little, if any, more than one of timber, where the materials for concrete are at hand. There are cases where, in inaccessible districts, it may be found economical to erect bridges of wood where there is timber of good quality at hand, and where it would be expensive to transport the cement, steel, and the skilled labour and supervision necessary for reinforced concrete—but these cases are exceptional.

The type, cost, and design of bridges erected will be adapted to the site and circumstances surrounding each case.

The æsthetic aspect of bridge design should also be considered, and, as far as practicable, the bridges erected will be designed to harmonize with their surroundings. Fortunately, reinforced concrete lends itself to variety in the way of design, and bridges of this material can be erected of either the beam, arch, or truss type of construction.

The designs will be standardized as far as possible, and those erected in connexion with the main roads will be built to carry a moving load of at least 16 tons, and the minimum width of deck will be 15 feet.

The maintenance of bridges, like roads, has been very much neglected in this State, and within the next few years great cost will be incurred in the repair and renewal of the old timber bridges, many of which are now arriving at the termination of their useful life.

Steel and timber bridges should be examined periodically, bolts kept tightened up, and the timber and steel members of the structure kept clean and free from all accumulation of dirt, and drainage attended to so that no water should be allowed to lodge about the angles of the lower structural members or beams. They should also be painted every third or fourth year.

CULVERTS.

Wherever possible, culverts should be of permanent materials instead of timber; the locality and materials available governing the type adopted. Reinforced concrete pipes may now be obtained in sizes varying from 9 inches to 5 feet in diameter; and the cost of their transport by rail is not a serious item.

In districts, such as some portions of the Mallee country, where suitable materials for concrete are not available, and the railway freight over long distances would be a heavy charge, corrugated iron pipes may be successfully used. These pipes are comparatively light, easy of transport, and easily laid with the use of unskilled labour. They are procurable of all lengths, and in diameter ranging from 10 inches to 6 feet.

Many of the existing culverts have stone inverts and side walls, with timber covers. Where the latter have perished, and the side walls remain in good condition, the timber decks may be replaced with slabs of reinforced concrete, in spans up to 10 or 12 feet. These concrete slabs may either be constructed *in situ*, or made in the works depôt, and carted to the site of the culverts.

Several shire engineers have successfully constructed concrete pipes from locally-obtained materials by the use of suitable pipe moulds.

On country roads, 12 inches should be the minimum diameter of any pipe culvert.

INVERT CROSSINGS OR CAUSEWAYS.

In many districts open crossings are adopted in place of culverts. When designed rationally, these crossings are alike efficient and economical. They are

Plate 71. Good type of invert crossing on the Buchan road, constructed by the Shire Engineer of Tambo.

suitable for remote localities and particularly in timbered country, where the constant maintenance and clearing of culverts cannot be supervised, and storm water may pass freely without damage to the road.

In many instances, where this type of crossing is used, the drop into the invert is much too abrupt, and is a consequent source of danger and damage, particularly to the springs of vehicles.

Water crossings of this type should be provided with easy approaches and the inverts macadamized, with the sides protected from scour by substantial sills and aprons of hand-packed stone.

WIDTH OF ROADS.

After careful consideration of the question of the width of the roads to be constructed under the provisions of the Country Roads Act, the Board has adopted a minimum width of 12 feet of macadam or gravel for the less important roads, and 15 to 16 feet for the more important highways.

While a width of 9 or 10 feet is sufficient for a single-track road, it has been noted that these narrow roads are seldom satisfactory, for the reasons stated elsewhere in this Report.

For the national arterial roads and other roads which already carry considerable traffic, a width of 15 to 16 feet is considered sufficient for a double-track road. This width will allow two vehicles to pass one another without their having to leave the metalled portion of the carriage way.

Many of the old roads, such as portions of the Sydney-road, Ballarat, and Bendigo roads, &c., have been pitched and metalled for a width of 20 feet, and even wider; but it is considered unnecessary to incur the expense of metalling a greater width than 16 feet, excepting where these important highways receive the concentrating traffic at the approaches to large centres of population, where the width may be increased to 18, or, in exceptional cases, to 20 feet.

Where main highways pass through country towns, it is proposed to adopt a width of 18 feet, leaving the local authorities to bear the cost of any additional width they may consider necessary for local interests.

MILE-POSTS.

In the early days it was the practice to erect mile-posts along the route of the main roads constructed. Some of the shires have continued to maintain these distance marks in serviceable condition, but in the majority of cases they have become unintelligible, and where destroyed, have not been replaced.

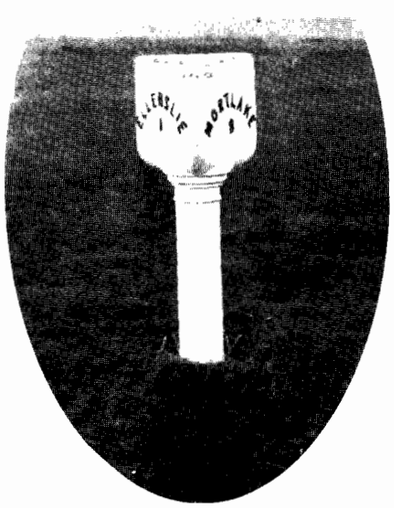


Plate 72. Showing good type of mile-post. Shire of Mortlake.

On the main arterial roads, it is proposed to re-introduce the system of marking road mileages by the provision of mile-posts, preferably of some non-destructible material and of a type as nearly uniform as practicable.

These should show the distance from the nearest township, and from the next large, important town, in such a manner that distances from these may be easily read and the lettering may not be liable to disfigurement. All place names and distances will be legibly painted in plain block letters and figures in black colour on a white ground.

DIRECTION NOTICES.

It is also proposed to erect direction signs or notices, which are most useful to travellers on country roads, and are much needed.

These direction notices should be made as nearly uniform as possible as regards their general design, colour, lettering, and height above the ground. The posts carrying the arms should be erected at easily visible positions at all important intersecting roads.

The posts may be of hardwood, strutted, and firmly fixed in the ground, and painted white.

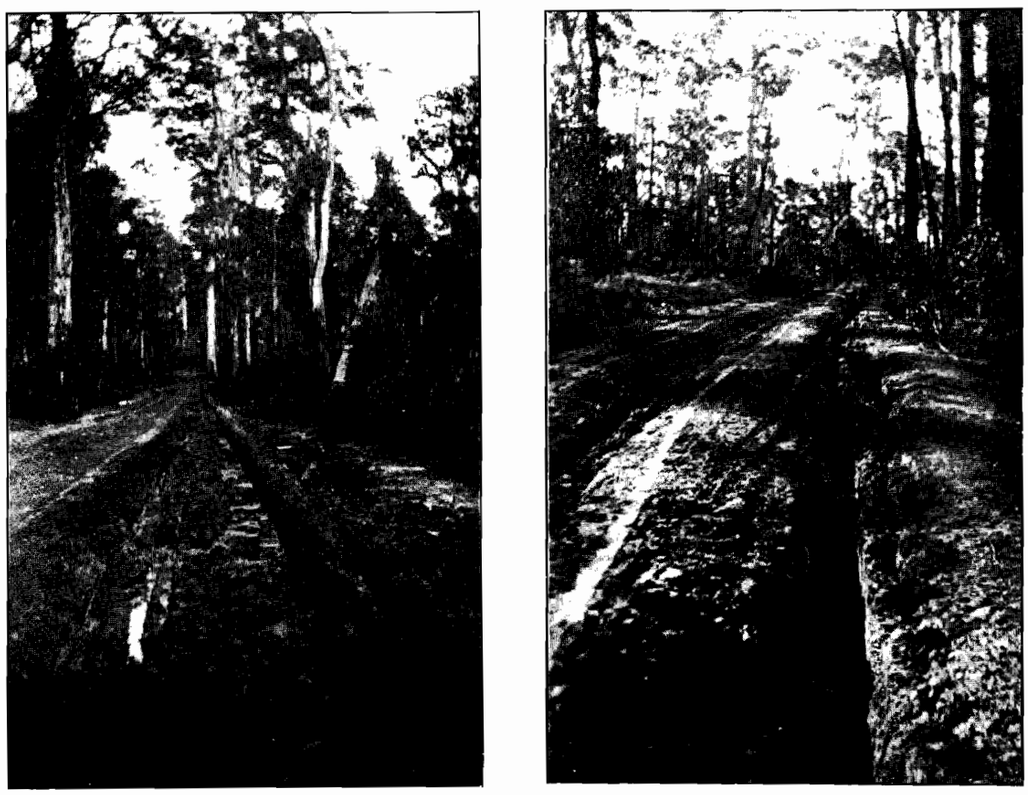
The name boards should be of pine, 1 inch in thickness and 6 inches or 7 inches deep, securely bolted to the posts in lengths varying to accommodate the place names, which, if more than one are indicated, should be painted on separate arms, fixed one above the other on the posts, so that the view of none will be obstructed.

The height of the underside of the board should be 8 feet above the ground.

The names and distances should be in plain black block letters and figures, spaced widely apart to render them easily legible. The depth of the lettering should be approximately $3\frac{1}{4}$ inches. Any superfluous words, such as "To," before place names or "Miles" after distance figures, only take up space and sacrifice legibility. All posts and arms should be kept well painted.

WIDTH OF TIRES AND EXTRAORDINARY TRAFFIC.

It has long been realized that the relation of the width of tire to the load carried has a most important bearing upon the cost of maintenance of roads.



Plates 73 and 74. Showing effect of timber traffic on roads in Winter.

The Imperial Road Board of England refuse grants for road improvements to County Councils which have adopted no by-laws regulating the width of tires, and in Jersey, U.S.A., a rebate of 4s. 2d. is allowed in the taxes to the owners of vehicles for every wheel of 4 inches width or over.

The damage done to roads by narrow tires is particularly noticeable on narrow country roads, where there is only sufficient room on the metalled portion of the road for the vehicles to follow one track.

Plate 75. Showing effect of timber traffic on road in Winter.

It is obviously reasonable that roads constructed at great cost should be protected from avoidable damage by regulating the design of the vehicles as well as the manner of their loading.

Existing provisions for regulating the width of tires are unsatisfactory, and even when adopted by the municipalities are not in all cases rigidly enforced.

The proposed amendments and additions to the width of tires provisions of the Local Government Act included in the Amending Local Government Bill introduced in the Legislative Assembly last session will, when passed, have a salutary effect in making the adoption of the width of tires regulations compulsory, and in prohibiting the construction after a stated period of vehicles with tires of widths not in compliance with these regulations.

There are, however, instances where even this excellent measure will have little effect in preventing damage to certain classes of roads under what is technically known as " Extraordinary Traffic." This question of " Extraordinary Traffic " has been the subject of much litigation in Great Britain, but of later years, legislation has been directed to the recovery of expenses incurred by a municipal council in the repairing of damage done to roads by traffic of a nature out of the ordinary.

In this country extraordinary damage is occasioned to roads, and particularly on unmetalled earth roads, by waggons engaged in the timber industry.

The damage done by these heavily-laden waggons in known instances during one week in the wet season has been greater than would have resulted from the ordinary traffic of the district in a year, and those responsible for the damage are seldom ratepayers of the district.

The proposal to give authority to municipalities to close roads against traffic of this nature during certain stated months of the year is, in the opinion of the Board, the only effective way of preventing damage to roads subject to this class of traffic.

ÆSTHETIC ASPECT OF ROADS.

Apart from their utilitarian aspect, roads should be made as interesting and attractive as possible.

Several of the illustrations in this Report show the beautifying effect of natural tree avenues. Others show the effects of tree plantations bordering some of the roads in the wind-swept plains of the Western District.

These tree belts, planted by the land-owners as shelter for stock, have converted otherwise dreary roads into pleasant avenues.

In contradistinction to this, many settlers in Gippsland and other districts formerly heavily timbered, are clearing their holdings to the boundary fences, and the native trees are rapidly disappearing, in the interests of grazing and agriculture.

Some of these districts promise to become as barren of trees as the Werribee Plains.

The Board will use its influence to preserve the existing native trees bordering on main roads as far as practicable, and will not sanction the removal of trees and shrubs unless it is necessary for the safety of traffic, or where vegetation is injurious to the road and prevents the drying action of the sun and wind.

MILEAGE OF MAIN ROADS GAZETTED AND PROPOSED FOR GAZETTAL.

In the course of its investigations, the Board has travelled 21,600 miles, of which 1,400 miles was undertaken on horseback, where no other means of travelling was possible, owing to the character of the country and the condition of the roads.

To 30th June, the total number of miles of roads proposed to be declared main roads, and agreed to by the Councils and gazetted, was 2,017 miles. In addition to this there are 943 miles of proposed main roads not yet gazetted.

ENGINEERING STAFF.

The first engineer to be appointed to the Board's staff was Mr. A. E. Callaway, C.E., formerly Engineer to the Shire of Woorayl, an officer with a long and varied experience in road location and construction, particularly in rough forest country.

Mr. J. R. Kemp, C.E., formerly Shire Engineer for Karkarooc Shire, was also appointed in November last.

These officers have been engaged in the examination of plans and specifications submitted by the Shire Councils, the investigation of road and bridge proposals, and in the inspection of road works in progress.

In addition to road location, surveys have been undertaken by the Board's own staff, where the work was urgent and where it was not possible to obtain the services of the Shire Engineer, owing to the pressure of other shire work, or in cases where important main roads formed the boundaries of adjoining shires, or passed through a number of Shires, and it was desirable to adopt a uniform method of construction and supervision throughout; and in certain instances where the Shire Councils requested the Board to undertake the surveys.

This work has occupied a considerable proportion of the time and attention of the engineering staff, and necessitates the constant employment of four or five survey parties.

Up to 30th June, the total length of road surveys completed by the Board's staff was 173 miles.

Four engineering pupils have been appointed by the Board under similar conditions and terms of service to those in practice in the Public Works Department for similar appointments.

These appointments have been found most satisfactory. The pupils have proved of great service to the Board from the date of their appointment; at the same time they are being afforded facilities for their education and training as road engineers and surveyors.

FINANCIAL.

Section 25 of the Country Roads Act provides that the cost of making permanent works and of maintenance of roads shall, in the first instance, be paid by the Treasurer, which means that the Government, through the Board, will provide the funds for all such works during the year in which they are constructed.

The great advantage of this provision is that the road is constructed or maintained as the case may be, and the public have the use and benefit of the improvement before the councils are required to make any provision towards its cost. This is strikingly illustrated in the statement of expenditure on permanent works, together with the municipal contribution thereto under the heading " Interest and Sinking Fund " shown in Appendix " A."

The municipal contribution is calculated at 6 per cent. per annum (4½ per cent. interest and 1½ per cent. sinking fund) from the first day of the month following that in which each progress payment was made, and is not payable until 1st January, 1915.

PERMANENT WORKS.

The amount authorized under this heading during the year was £179,291, affecting 33 municipalities; that is, the Board and the municipalities, through their engineers, had completed surveys and prepared plans and specifications, and the Governor-in-Council had approved of works estimated to cost that amount, for which the necessary authority to invite tenders had been given.

CONTRACTS AUTHORIZED FOR PERMANENT WORKS.

The total amount of contracts for permanent works approved by the Board during the year, affecting 28 municipalities, was £94,876 15s. 9d. of which £23,440 0s. 6d. represents contracts let directly by the Board, and £71,436 15s. 3d. by the municipalities.

The first contract under the Country Roads Act was let for metalling on the Olinda-road in the Shire of Fern Tree Gully, on 23rd December, 1913, while the first to be completed was on the main Gippsland-road, in the Shire of Warragul. The official opening of the latter road by the Hon. F. Hagelthorn, M.L.C., Minister of Public Works, is illustrated by Plate No. 77.

Plate 76. Commencing a new work. The Honorable F. Hagelthorn, Minister of Public Works, turning the first sod, Bear Creek Deviation, Shire of Warragul.

Plate 77. Official opening of section of Main Gippsland Road, Warragul Shire. First contract completed under Country Roads Act.

Plates 78, 79, and 80. Showing road works in Gippsland—Woorayl Shire. (1) Early stages of the work. (2) Contractor's portable stone-breaking plant. (3) Finished roadway.

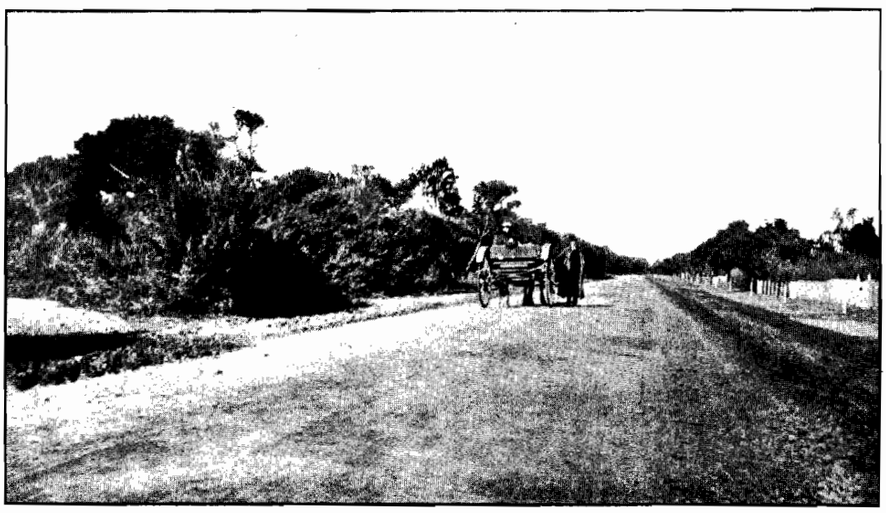


Plate 81. Showing completed section of Point Nepean-road between Mordialloc and Frankston.

Particulars of the above contracts, also of those for the supply of road-making machinery, are shown in Appendix " B."

EXPENDITURE ON PERMANENT WORKS.

The statement of expenditure on permanent works under the heading " Principal," in Appendix " A," shows the total amount of accounts passed to the Treasury for payment and debited to the Country Roads Board Loan Account as on the 30th June, 1914. The total of £24,439 17s. 8d. does not, therefore, represent the value of works executed at that date, because the progress payments for the month of June on contracts amounting to £94,876 15s. 9d. have not been included.

It will be noticed in the summary, also, that the number of municipalities in which contracts were let was 28, while the number in which expenditure was incurred was 37. This is explained by the fact that in some instances the expenditure shown represents the cost of surveys, which has been debited to Permanent Works Account.

Summary—Permanent Works.

Amount authorized	£179,291.
Number of municipalities affected ..	33.
Amount of contracts let	£94,876 15s. 9d.
Number of municipalities affected ..	28.
Expenditure incurred	£24,439 17s. 8d.
Number of municipalities affected ..	37.

MAINTENANCE.

The importance of making regular provision for maintenance has been referred to earlier. It has, therefore, been decided, as soon as a road is gazetted, to make a sum available for its maintenance, so that at least the state of utility that the road was in at the date of its gazettal might be maintained.

The constitution of the Country Roads Board Fund, and the creation of a permanent maintenance fund under sections 38 and 39 of the Act enables this to be done. The importance of the establishment of this fund, which enables regular and systematic provision to be made for the maintenance of main roads, cannot be over-estimated. It is hoped that the effect of this will be that, not only will deterioration be arrested, but that many of the roads will be improved, for it is recognised that, while an existing good road can be preserved, a comparatively bad road may be converted into a good one, by judicious and continuous maintenance.

To assist the Board in arriving at a decision as to the amount that should be provided for the maintenance of each main road, municipalities are asked to supply particulars as to the amount that has been expended in maintenance thereon during the last four or five years, and this is taken as a basis. In many cases, however, the information cannot be supplied, owing to the absence of any system of discrimination

between maintenance, repairs, metalling, re-construction, &c. In such cases, the advice of the shire engineer is taken. Should the amount provided in the first year prove to be insufficient, a larger sum will be provided in the subsequent year. By this means it is hoped to eventually arrive at the approximate annual sum necessary to adequately maintain every main road in the State.

The expenditure for the year under this heading as affecting 27 municipalities was £9,490 0s. 10d., and is shown in detail in Appendix " A." It is explained, however, with regard to the expenditure, both on permanent works and maintenance, that many of the roads were not gazetted until late in the financial year, consequently the expenditure in some instances covers a short period only.

SUMMARY—MAINTENANCE.

Amount authorized	£28,178 15s.
Number of municipalities affected ..	50.
Amount expended	£9,490 0s. 10d.
Number of municipalities affected ..	28.

COUNTRY ROADS BOARD FUND.

It will be observed that the statements showing revenue and expenditure on account of the Country Roads Board Fund, Appendix " C," cover a portion of the financial year 1912–1913, as well as the financial year 1913–1914. This is explained by the fact that the Board was constituted in March, 1913, but as no expenditure was incurred either on permanent works or maintenance before the 30th June of that year, a report giving an account of the moneys received and expended for the last few months of the financial year 1912–1913 was not prepared. The information, however, is now supplied and shown separately on Appendix " C."

The sources of revenue for the year 1913–14 were Motor Car Act, No. 2237, Registration Fees, £26,010 15s. 9d. ; Licence fees, £1,800 3s. 3d. ; Fines, £1,142 18s. 6d. ; Unused Roads and Water Frontages Act, No. 1894, Licence Fees, £19,193 1s. 11d. ; Registration of Traction Engines and Fines under the Country Roads Act, No. 2415, £1,128 14s. ; Sale of Plans, £3 7s.

For the year 1914–15, however, and henceforth, the sources of revenue will include the contributions from municipalities on account of works carried out during the previous year.

With regard to the licence fees under the Unused Roads and Water Frontages Act, the gross receipts for the year were £26,515 9s. 11d. This, however, was subject to the following reductions :—Cost of collection, £1,674 17s. 7d. ; refunds, £25 1s. 7d. ; Reduction under the authority of Act No. 2498, £5,622 8s. 10d., leaving a net return of £19,193 1s. 11d.

The net receipts of the fund for the year from all sources, therefore, were £49,279 0s. 5d.

COUNTRY ROADS BOARD LOAN ACCOUNT.

The amount placed to the credit of this account towards the cost of permanent works during the year was £26,550, against which payments were made amounting to £24,439 17s. 8d., as per statement in Appendix " A," leaving a balance of £2,110 2s. 4d.

PLANT HIRING ACCOUNT.

As explained previously, the Board has acquired a quantity of road-making plant, such as steam rollers, waggons, and scarifiers. The cost of this plant has been debited to the Country Roads Board Fund, and is being hired to councils and contractors at a rental sufficient to cover interest at 5 per cent. and depreciation 10 per cent. per annum.

INTEREST AND SINKING FUND ACCOUNT.

In Appendix " A," under the heading " Interest and Sinking Fund," is shown the total amount due by the municipalities in respect of one-half of the expenditure incurred on permanent works, the amount of such expenditure on each road being shown under the heading " Principal."

CONCLUSION.

In conclusion, the Board desires to express its appreciation of the courtesy and consideration extended to it, without exception, by the councillors and officers it has had the privilege of meeting, and of their expressed desire to heartily co-operate with the Board in carrying into effect the provisions of the Country Roads Act.

Shire councillors and officials have on all occasions afforded facilities to the Board for making the necessary investigations, and, frequently, at considerable personal inconvenience, have accompanied the members on their inspections.

The Board wishes to intimate to councils and officers that it is prepared and anxious at all times to render assistance or give advice on all aspects of the question of road construction and maintenance, and to invite municipal engineers throughout the State to furnish particulars for publication in subsequent reports of any instances of the effective treatment of road materials, or of methods of road and bridge construction, peculiar to the districts under their control, which have proved successful and economical.

It is also desired to record the courteous assistance given to the Board by the various State departments in granting all available data required.

APPENDICES.

Particulars as to the roads declared and proposed to be declared main roads, the permanent works in course of construction, the roads maintained, an account of moneys received and expended under the provisions of the Act, statement of contracts, and diagrams, maps, &c., are shown in Appendices, a list of which is given in the Index.

W. CALDER, Chairman.

W. T. B. McCORMACK, }
F. W. FRICKE, } Members.

W. L. DALE, Secretary.

1st September, 1914.

APPENDIX A.

COUNTRY ROADS BOARD.

STATEMENT OF EXPENDITURE IN CONNEXION WITH CONSTRUCTION AND MAINTENANCE OF MAIN ROADS FOR THE YEAR ENDING 30TH JUNE, 1914.

Name of Municipality.	Name of Road.	Permanent Works.						Maintenance.		
		Interest and Sinking Fund, 6 per cent.			Principal.					
		£	*s.*	*d.*	£	*s.*	*d.*	£	*s.*	*d.*
Alberton Shire ..	Balook–Traralgon road	..			..			38	9	9
	Boolarra–Welshpool road	0	0	1	31	10	8	77	12	0
	Carrajung–Gormandale road ..	..			..			117	10	0
	Yarram–Boolarra road	..			..			38	4	9
	Yarram–Port Albert road	..			..			147	15	0
Avon Shire ..	Maffra–Sale road	..			..			3	0	0
	Main Gippsland road	..			..			9	17	0
	Dargo road	0	14	3	171	7	9	66	6	6
Bairnsdale Shire ..	Main Gippsland road	..			121	2	6	..		
Bannockburn Shire ..	Geelong–Ballarat road	..			..			177	0	0
	Inverleigh road	..			..			539	0	8
	Shelford–Bannockburn road ..	..			18	6	5	20	16	0
Barrarbool Shire ..	Geelong–Warrnambool road ..	..			..			175	6	1
	Anglesea road	..			..			90	0	0
Bellarine Shire ..	Geelong–Portarlington road ..	..			..			484	5	6
	Geelong–Queenscliff road	..			..			564	14	11
Berwick Shire ..	Main Gippsland road	..			..			191	19	6
	Woori Yallock–Koo-wee-rup–Pakenham road	..			..			17	2	6
Braybrook Shire ..	Melbourne–Geelong road	0	3	3	9	2	0	..		
	Ballarat road	2	17	3	1,435	11	5	117	10	0
Buln Buln Shire ..	Loch Valley road	..			..			42	0	3
	Magpie–Duggan road	..			..			26	10	3
	Main South road	..			..			184	15	7
	Neerim road " B "	..			..			460	10	0
	Westernport road	..			..			38	7	3
	Main Gippsland road	2	2	8	967	9	3	170	16	11
Colac Shire ..	Forrest–Apollo Bay road	0	11	9	139	14	3	..		
Corio Shire	Melbourne–Geelong road	2	0	8	210	13	10	185	6	1
	Bacchus Marsh road	..			..			133	18	5
	Ballarat road	0	15	0	660	0	0	100	8	2
Cranbourne Shire ..	Main Coast road	..			..			603	9	11
	Koo-wee-rup–Pakenham road ..	..			..			183	5	1
	Westernport road	..			..			127	6	2
Dandenong Shire ..	Cheltenham road	..			..			94	12	2
	Main Gippsland road	..			..			564	11	8
	Point Nepean road	8	16	6	5,365	12	5	126	18	4
Eltham Shire ..	Hurstbridge–Kinglake road ..	0	5	4	383	3	2	..		
Ferntree Gully Shire	Main Emerald road	0	15	8	322	16	0	..		
	Main Ferntree Gully road	0	3	6	71	0	0	192	1	1
	Monbulk road	0	5	0	142	0	0	198	13	9
	Olinda road	0	14	4	211	15	4	..		
Flinders Shire ..	Hastings–Flinders road	1	17	4	1,630	11	6	..		
Frankston and Hastings Shire	Point Nepean road	1	16	0	562	10	0	..		
Hampden Shire ..	Camperdown–Ballarat road ..	..			..			378	13	0
	Geelong–Warrnambool road ..	..			..			162	18	11
Healesville Shire ..	Healesville–Alexandra road.. ..	1	2	8	129	6	8	354	18	1
	Healesville–Woori Yallock road ..	1	10	1	72	15	10	..		
	Marysville road	..			..			93	14	6
Heidelberg Shire ..	Heidelberg–Eltham road	0	2	8	426	10	3	334	11	9
	Greensborough–Hurstbridge road ..	..			..			164	11	8
Heytesbury Shire ..	Cobden–Port Campbell–Princetown road	..			8	0	0	66	3	11
Lillydale Shire ..	Main Healesville road	4	12	8	842	9	10	28	11	0
	Monbulk road	0	1	9	41	8	8	5	16	3
	Ringwood–Warrandyte road ..	..			..			1	5	6
	Main Warburton road	..			..			52	15	0
	Yarra Glen road	0	0	6	5	2	9	1	13	0

APPENDIX A.—COUNTRY ROADS BOARD.—STATEMENT OF EXPENDITURE IN CONNEXION WITH CONSTRUCTION, ETC., OF MAIN ROADS—*continued.*

Name of Municipality.	Name of Road.	Permanent Works.		Maintenance.
		Interest and Sinking Fund, 6 per cent.	Principal.	
		£ s. d.	£ s. d.	£ s. d.
Maffra Shire ..	Dargo road	0 2 5	16 3 1	..
	Licola road	..	..	87 2 0
	Tinambra–Newry road	..	..	12 10
Maldon Shire ..	Main Bendigo road	0 15 8	46 10 10	..
Marong Shire ..	Main Bendigo road	0 12 3	367 4 8	..
Metcalfe Shire ..	Main Bendigo road	0 15 0	42 10 6	..
Mirboo Shire ..	Mirboo–Allambee East road ..	..	..	92 14 9
	Main South road	2 9 6	1,234 0 0	45 10 10
	Mardan road	..	..	10 15 5
Mortlake Shire ..	Mortlake-Ararat road	..	..	34 8 8
Morwell Shire ..	Boolarra–Welshpool road	1 13 7	278 15 4	..
	Main Gippsland road	0 3 4	20 12 9	..
Mulgrave Shire ..	Main Gippsland road	..	..	6 5 0
	Ferntree Gully road	..	..	6 5 0
Narracan Shire ..	Main Gippsland road	1 2 9	1,558 5 10	..
	Yarragon–Leongatha road	4 8 10	290 0 10	52 17 4
Oakleigh Borough ..	Ferntree Gully road	..	..	43 4 6
	Main Gippsland road	..	..	242 8 10
Omeo Shire ..	Bruthen–Omeo road	0 5 0	50 0 0	..
Orbost Shire ..	Orbost–Genoa road	0 7 0	296 0 0	..
Phillip Island and Woolamai Shire	Wonthaggi–Loch road	2 7 7	398 1 6	..
Poowong and Jeetho Shire	Loch-Wonthaggi road	..	27 10 0	..
	Nyora–Poowong road	..	150 0 0	..
Rosedale Shire ..	Gormandale road	..	..	45 0 0
	Main Gippsland road	..	..	89 0 0
	Sale–Yarram road..	..	..	88 15 0
South Barwon Shire..	Barwon Heads road	..	..	148 10 8
	Barwon Bridge	0 0 1	1 18 0	..
South Gippsland Shire	Boolarra–Welshpool road	..	..	28 16 0
	Falls road	..	7 0 0	..
	Foster–Boolarra road	0 0 5	30 16 0	..
	Stoney Creek–Dollar road	..	..	62 2 0
	Toora–Gunyah road	..	..	29 18 6
Traralgon Shire ..	Calignee road	..	106 0 0	..
Upper Yarra Shire ..	Healesville–Woori Yallock road ..	0 2 11	7 6 6	..
	Warburton road	0 7 6	150 0 0	..
Warragul Shire ..	Main Gippsland road	3 7 10	1,426 18 6	..
Werribee Shire ..	Melbourne–Geelong road	1 2 8	72 10 7	76 1 4
Winchelsea Shire ..	Forrest–Apollo Bay road	0 5 10	101 0 4	..
Wonthaggi Borough	Loch–Wonthaggi road	1 4 5	907 15 0	..
Woorayl Shire ..	Farmer's road	0 14 9	414 7 6	77 4 3
	Inverloch–Leongatha road	6 7 5	1,577 12 0	59 2 8
	Leongatha–Warragul road	0 8 7	215 14 5	24 16 8
	Leongatha–Yarragon road	2 15 11	665 3 0	80 1 1
	Lower Tarwin road	..	..	58 9 0
	Main South Gippsland road ..	..	..	7 8 0
	Mardan road	..	..	24 19 6
	Total	63 10 2	24,439 17 8	9,490 0 10

APPENDIX B.

COUNTRY ROADS BOARD.

STATEMENT OF CONTRACTS FOR PERMANENT WORKS ON MAIN ROADS FOR THE YEAR ENDING 30TH JUNE, 1914.

Name of Shire.	Name of Road and Particulars of Work.	Name of Contractor.	Amount of Contract. £ s. d.
Bairnsdale Shire ..	Main Gippsland road—Construction of Section 2 at Providence Ponds	Tobin and Bell	1,456 5 0
Braybrook Shire ..	Ballarat road—Metalling between Ashley street and Rosamond road	J. O'Connor	232 5 10
		W. T. Roberts	27 10 0
		W. T. Roberts	137 10 0
		J. O'Connor	170 0 0
		J. O'Connor	341 13 4
Buln Buln Shire ..	Main Gippsland road—Between Drouin and Warragul, Sections 1 and 2, construction and metalling	J. Watts	670 5 0
		J. Cook	395 5 0
	Main South road—Section 1, construction ..	A. D. Smith	835 9 0
Corio Shire ..	Geelong–Ballarat road—Supply of spalls, crushing and spreading	J. Grace and Sons ..	1,472 10 0
Dandenong Shire ..	Pt. Nepean road—Reconstruction from Mordialloc Creek to Shire boundary at Carrum—		
	Section 1	S. Crawford	3,658 3 0
	Section 2	Footscray Quarrying Co.	4,140 5 5
Eltham Shire ..	Main Hurstbridge–Kinglake road—Metalling, &c. ..	T. Irvine	1,158 0 6
Ferntree Gully Shire ..	Main Olinda road—		
	Supply of spalls	W. E. Clarke	175 0 0
	Carting and spreading metal	W. E. Clarke	156 5 0
	Main Ferntree Gully road—Construction 1 mile 16 chains	G. J. Williams	1,591 10 0
	Emerald road—Section 1, construction	J. Hermon	179 3 4
Flinders Shire ..	Hastings–Flinders road—Construction—		
	Section 1	Albion Quarrying Co. Pty. Ltd.	2,482 2 6
	Section 2	Van Suylen Bros. ..	1,615 1 5
	Section 3	Albion Quarrying Co. Pty. Ltd.	3,239 1 0
	Mornington–Flinders road—Erection of Hearne's Bridge	Reinforced Concrete and Monier Pipe Co.	314 15 0
Frankston and Hastings Shire	Pt. Nepean road—Between Carrum and Oliver's Hill, construction	S. Willis Bros.	9,954 10 0
Healesville Shire ..	Healesville–Alexandra road—		
	Repairs to culverts	A. Kirwan	265 5 6
	Construction and metalling—		
	Section 1	E. C. Douglas	2,699 2 6
	Section 2	J. and M. McGuinness ..	2,345 12 0
	Section 3	J. and M. McGuinness ..	933 15 0
	Supply of reinforced concrete pipes for use on above contract	Reinforced Concrete and Monier Pipe Co.	94 10 0
Heidelberg Shire ..	Heidelberg–Eltham road—Metalling between Merri Creek and Darebin Creek	Waters and Wales ..	1,325 13 6
Lillydale Shire ..	Main Healesville road—Construction	H. Hermon and Co. ..	8,763 3 0
Mirboo Shire ..	Mirboo South road—		
	Construction of Mirboo South deviation ..	J. Cookson	1,292 18 0
	Construction of Perrin's Hill deviation ..	Peters and Wanke ..	1,161 17 9
Maldon, Marong, and Metcalfe Shires	Main Bendigo road—Formation—		
	Section 2	Cullip and Waller ..	560 10 0
	Section 5	J. Murray	591 0 0
	Section 6	J. Murray	1,018 0 0
	Section 7	J. Kett	716 4 0
	Section 8	J. Kett	542 13 0
	Section 9	J. Kett	376 0 0
	Section 10	J. Kett	664 5 0
Narracan Shire ..	Main Gippsland road—		
	Construction between Moe River and Yarragon ..	W. H. Ellingsworth ..	2,196 9 7
	Constructing timber bridges between Yarragon and Trafalgar	A. J. Arndt	179 10 0
	Construction and metalling between Yarragon and Trafalgar	A. D. Smith	2,128 2 0
	Clearing, forming, and grading Haunted Hills ..	W. Johnston and Beck Bros.	710 0 0
Omeo Shire ..	Omeo–Bruthen road—Forming and gravelling ..	W. Boucher	54 12 3
Orbost Shire ..	Orbost–Genoa road—Between Orbost township and north-west angle of allotment 17c, parish of Neumeralla (Orbost–Cunninghame road)	R. S. Napier	486 10 0
	Cann Valley road—Erection of bridge over Cann River	M. Parker	750 0 0
Poowong and Jeetho Shire	Korumburra–Warragul road—Construction of Section 1	A. Alp	1,729 19 10
	Poowong–Nyora road—		
	Construction of Section 1	Hughes and King ..	304 15 0
	Construction of Section 2	Hughes and King ..	850 14 0
Rosedale Shire ..	Sale–Yarram road—Construction—		
	Section 1	F. Carmody	809 4 0
	Sections 2 and 3	J. H. Cartledge	690 0 0

APPENDIX B.—COUNTRY ROADS BOARD.—STATEMENT OF CONTRACTS FOR PERMANENT WORKS ON MAIN ROADS, ETC.—*continued.*

Name of Shire.	Name of Road and Particulars of Work.	Name of Contractor.	Amount of Contract.
			£ s. d.
South Gippsland Shire	Falls road—Erection of bridge over Fish Creek and formation of roadway	Reinforced Concrete and Monier Pipe Co.	1,344 1 0
Upper Yarra Shire ..	Main Warburton road—Formation and metalling between Launching Place and West Warburton	J. T. Hermon	5,368 7 6
Warragul Shire ..	Main Gippsland road—Construction between Drouin and Warragul	A. D. Smith	428 11 6
	Leongatha–Warragul road—Construction, Section 1, at Bear Creek	Kelly and Malady ..	596 6 7
	Main Gippsland road—Forming and metalling between Nilma and Yarragon—		
	Section 1	E. Elliott	332 3 0
	Section 2	S. Smith	137 12 0
	Section 3	A. H. Mann	623 4 0
Woorayl Shire ..	Leongatha–Yarragon road—		
	Construction at Watts and Crighton's deviations	J. L. Kenny	508 3 0
	Section from cross roads at Allambee to White Sand	J. T. Quinn	1,899 16 0
	Section between above contract and Sand road, at the Run, Allambee	J. T. Quinn	574 6 6
	Farmers road—Forming, grading, &c., and metalling (between Whitelaw street, Meeniyan, and Knibbs deviation)	T. Canty	555 5 11
	Lower Tarwin road—Metalling, sanding, &c., Tarwin Hill deviation at Tarwin Railway Station	Rumpf and Ebeling ..	289 4 0
	Inverloch–Leongatha road—Clearing, metalling, &c., from Johnson's Flat to Beilby's Corner	Rumpf and Ebeling ..	2,360 11 0
	Leongatha–Warragul road—Construction ..	J. T. Quinn	227 18 6
Werribee Shire ..	Melbourne–Geelong road—Reconstruction—		
	Section 6	Gillis and Starling ..	3,834 10 6
	Section 7	Gillis and Starling ..	5,623 15 0
Wonthaggi Borough	Loch–Wonthaggi road—Construction	O. S. Williams	1,530 3 6
	Total	.. .. ..	94,876 15 9

STATEMENT OF CONTRACTS ENTERED INTO BY THE BOARD FOR PLANT, YEAR ENDING 30TH JUNE, 1914.

Name of Contractor.	Particulars of Contract	Amount.
		£ s. d.
Arthur Leplastrier and Co.	Supply and delivery of one self-spreading hopper waggon ..	145 0 0
Jaques Bros.	Supply and delivery of one self-spreading hopper waggon ..	135 0 0
R. J. L. Hildyard	Supply and delivery of one self-spreading hopper waggon ..	130 0 0
Horrocks, Roxburgh Pty. Ltd. ..	Supply and delivery of one self-spreading hopper waggon ..	127 10 0
Noyes Bros. (Melbourne) Pty. Ltd. ..	Supply and delivery of two 10-ton steam road-rollers	1,465 0 0
Noyes Bros. (Melbourne) Pty. Ltd. ..	Supply and delivery of two 7/8-ton steam road-rollers with interchangeable roller and tractor wheels	1,914 0 0
Welch, Perrin, and Co.	Supply and delivery of two road scarifiers	200 0 0
Austral Otis Engineering Co. Pty. Ltd.	Supply and delivery of one 12½-ton steam road-roller	1,093 3 0
Robert Bryce and Co. Pty. Ltd. ..	Supply and delivery of one 5-ton pneumatic tar-spraying machine..	1,193 0 0
Horrocks, Roxburgh Pty. Ltd. ..	Supply and delivery of one 5-ton superheated steam tar-spraying machine	930 0 0
	Total	7,332 13 0

SUMMARY.

	£ s. d.
Permanent Works	94,876 15 9
Plant	7,332 13 0
Total	102,209 8 9

APPENDIX C.

COUNTRY ROADS BOARD FUND.

STATEMENT OF REVENUE AND EXPENDITURE FOR THE YEAR ENDED 30TH JUNE, 1913.

Revenue.	£ s. d.	£ s. d.
Motor Car Act No. 2237—		
Registration Fees ..	15,762 16 6	
Licence Fees	2,069 6 6	
Fines	1,142 17 6	
		18,975 0 6
Unused Roads and Water Frontages Act No. 1894—		
Licence Fees		25,084 2 10
Country Roads Act No. 2415—		
Registration of Traction Engines		1,244 5 0
		45,303 8 4

Expenditure.	£ s. d.
Salaries	682 8 9
Wages	4 0 0
Purchase of Motor Car	675 0 0
Travelling Expenses	102 14 8
Horse and Vehicle Hire	31 9 2
Printing and Stationery	69 9 8
Office Furniture	22 19 0
Motor Car Expenses	11 8 9
Surveying Instruments	7 4 7
Sundries	8 16 3
Postage	5 0 0
Petty Cash	4 0 3
Plans	7 16 9
Advertising	1 19 0
Balance	43,669 1 6
	45,303 8 4

RECONCILIATION STATEMENT.

	£ s. d.
Balance as per Treasury Books	43,765 11 11
Less Unpaid Accounts	96 10 5
Balance as above	43,669 1 6

COUNTRY ROADS BOARD FUND.

STATEMENT OF REVENUE AND EXPENDITURE FOR THE YEAR ENDED 30TH JUNE, 1914.

Revenue.	£ s. d.	£ s. d.
Balance 30th June, 1913		43,669 1 6
Motor Car Act. No. 2237—		
Registration Fees ..	26,010 15 9	
Licence Fees	1,800 3 3	
Fines	1,142 18 6	
		28,953 17 6
Unused Roads and Water Frontages Act No. 1894—		
Licence Fees		19,193 1 11
Country Roads Act No. 2415—		
Registration Fees—Traction Engines ..		1,127 14 0
Fine		1 0 0
Sale of Plans		3 7 0
Repayment		0 17 9
		92,948 19 8

Expenditure.	£ s. d.
Maintenance of Main Roads	9,490 0 10
Purchase of Plant	4,232 11 2
Salaries	3,877 10 4
Wages	296 7 0
Travelling Expenses	638 12 1
Horse and Vehicle Hire	184 18 3
Printing and Stationery	508 13 5
Sundries	19 6 9
Petty Cash	31 0 0
Motor Car Equipment	84 19 6
Motor Car Expenses	254 19 4
Postage	42 7 6
Office Furniture	24 19 5
Surveying Instruments	418 9 6
Plans	109 16 2
Advertising	30 6 3
Oil, Fuel, &c.	32 1 0
Office Telephone	31 0 2
Camp Equipment	157 11 6
Purchase of Motor Cycle	80 10 6
Balance	72,402 19 0
	92,948 19 8

RECONCILIATION STATEMENT.

		£ s. d.
Balance as per Treasury Books		£79,904 13 4
Less unpaid accounts	£7,506 1 6	
Less Plant hire	20 6 10	
		7,526 8 4
		72,378 5 0
Add amount debited to Country Roads Board Fund to be subsequently transferred to Loan Account ..		24 14 0
		£72,402 19 0

APPENDIX D.

COUNTRY ROADS BOARD LOAN ACCOUNT.

Dr. *Cr.*

1914.	£	s.	d.	1914.	£	s.	d.
June 30—To Permanent Works ..	24,439	17	8	June 30—By proceeds of Government 3½ per cent. Stock	26,550	0	0
Balance	2,110	2	4				
	26,550	0	0		26,550	0	0

RECONCILIATION STATEMENT.

	£	s.	d.	£	s.	d.
Balance as per Treasury Books				8,126	1	5
Less Hire of Plant	100	7	6			
Less unpaid accounts	5,915	11	7			
				6,015	19	1
Balance as above				2,110	2	4

APPENDIX E.

PLANT HIRING ACCOUNT.

Dr. *Cr.*

1914.	£	s.	d.	1914.	£	s.	d.
June 30—To Balance	120	14	4	June 30—By hire of plant on account Permanent Works	100	7	6
				Maintenance Works	20	6	10
	120	14	4		120	14	4

APPENDIX F.

INTEREST AND SINKING FUND ACCOUNT.

1914.	£	s.	d.	1914.	£	s.	d.
June 30—To Balance	63	10	2	June 30—By interest on half cost of Permanent Works as per Appendix "A" ..	63	10	2
	63	10	2		63	10	2

APPENDIX G.

COUNTRY ROADS BOARD.

PARTICULARS OF SURVEYS, ETC., ON ROADS DECLARED MAIN ROADS UNDER THE PROVISIONS OF THE COUNTRY ROADS ACT.

Name of Municipality.	Name of Road and Locality of Work.	Lengths of Roads. For which Permanent Surveys have been Made.	For which Plans have been Prepared.	For which Tenders have been Invited.	For which Tenders have been Accepted.
		Miles.	Miles.	Miles.	Miles.
Alberton Shire ..	Boolarra road (Yinnar track)	2¼	..	..	..
Avon Shire	Dargo road	15	..	..	..
Bairnsdale Shire ..	Sale–Bairnsdale road (from Providence Ponds to railway crossing, Bairnsdale)	18¼	4½	4½	2
Bannockburn Shire ..	Bannockburn–Shelford road	1¼	1¼	1¼	..
Barrarbool Shire ..	Colac road	12	..	..	..
	Anglesea road	16	..	..	..
Berwick Shire	Pakenham–Koo-wee-rup road	1½	1½	..	..
	Gembrook–Pakenham road	1½	1½	1½	..
	Main Gippsland road (from Tynong to Bunyip)	2½	2½	..	..
Braybrook Shire ..	Ballarat road (from Sunshine to Footscray)	..	..	..	3¼
	Geelong road	2	..	..	..
Buln Buln Shire ..	Drouin–Westernport road	¾	¾	..	..
	Main Gippsland road	6	6	1¼	1¼
	Drouin–Korumburra road	3	3	1¼	1¼
Colac Shire	Apollo Bay–Forrest road	20	..	..	..
	Apollo Bay–Forrest road (at Apollo Bay) ..	3¾	3¾	..	..
	Colac–Cressy road	3¾	3¾	..	..
	Laver's Hill road to Barupa	2¼	..	..	..
Corio Shire	Geelong–Melbourne road (between Little River and Geelong)	9½	9¼	9¼	..
	Geelong–Ballarat road (from Geelong to Batesford)	4½	4½	..	..
Dandenong Shire ..	Point Nepean road (between Carrum and Mordialloc	5¾	5¾	5¾	5¾
Eltham Shire	Hurstbridge–Kinglake road	3¼	3¼	1	1
Ferntree Gully Shire ..	Ferntree Gully road (between Ferntree Gully and Belgrave)	3	1½	1½	1½
	Monbulk-road (between Belgrave and South Sassafras)	2¼	1¾	1¾	..
	Olinda-road (at Ferny Creek)	1	1	..	..
	Emerald-road (between Emerald and Avonsleigh House)	2	2	2	½
Flinders Shire	Hastings–Flinders road (from shire boundary south to Wonnenguite Creek)	5½	5½	5½	5½
Frankston and Hastings Shire	Point Nepean-road (between Carrum and Oliver's Hill)	5	5	5	5
	Frankston–Flinders road, Mount Eliza section (between Frankston and Somerville)	6¼	..	..	..
Healesville Shire ..	Dalry road	6½	..	..	..
	Healesville–Alexandra road	10	10	7	5¼
	Lilydale–Healesville road	3	3	..	..
Heidelberg Shire ..	Heidelberg–Eltham road (from Merri Creek to Darebin Creek bridge)	1¾	1¾	1¾	1¾
	Heidelberg–Hurstbridge road (deviation road at Grace Park)	1	1	..	..
Leigh Shire	Shelford–Inverleigh road (near Shelford) ..	2½	..	..	..
Lilydale Shire	Healesville road	8½	8¼	6	6
	Yarra Glen road	4	4	..	..
	Monbulk-road	3½	3½	..	..
Maffra Shire	Glen Falloch road (4 M.)	4	1	..	..
	Freestone-road, Dargo road (4 M.)	4	4	..	..
Maldon Shire	Main Bendigo road	5	5	5	2½
Marong Shire	Main Bendigo road	5½	5½	5½	5½
Metcalfe Shire	Main Bendigo road	1¼	1¼	1½	..
Mirboo Shire	Mirboo North–Mirboo road	4	4	43	4
Mornington Shire ..	Point Nepean road	9½	9½	43	3

COUNTRY ROADS BOARD—PARTICULARS OF SURVEYS, ETC.—*continued.*

Name of Municipality.	Name of Road and Locality of Work.	Lengths of Roads. For which Permanent Surveys have been Made.	For which Plans have been Prepared.	For which Tenders have been Invited.	For which Tenders have been Accepted.
		Miles.	Miles.	Miles.	Miles.
Morwell Shire	Boolarra–Welshpool road	27	5	..	..
	Jeeralang West-road (parish of Jeeralang) ..	5	..	..	..
	Haunted Hills	3	3	3	3
Narracan Shire ..	Yarragon–Allambee–Leongatha road ..	7½	5	..	.. ½
	Main Gippsland road	10½	10½	4¾	4¾
	Shady Creek road	7½	..	..	..
	Haunted Hills (Main Gippsland road) ..	4½	3	..	..
Oakleigh Borough ..	Dandenong-road	..	..	1¾	1¾
	Ferntree Gully-road	..	..	¼	¼
Omeo Shire	Omeo–Bairnsdale road (Tongio Gap) ..	10	..	..	..
Orbost Shire	Cann Valley-road (20 to 22 miles).. ..	2	2	2	..
	Nowa Nowa–Orbost road	1	1	1	1
Phillip Island and Woolamai Shire	Almurta-road (from Almurta to Glen Alvie)	1¼	1¼	..	..
	Wonthaggi–Inverloch road	3¾	3¾	..	..
	Wonthaggi–Loch road	25	5	..	..
Poowong and Jeetho Shire	Korumburra–Warragul road	2½	2	¾	¾
	Bena–Poowong road	1¼	4	..	..
	Poowong–Nyora road	1½	½	¼	¼
Rosedale Shire.. ..	Sale–Port Albert road	5½	5½	1½	1½
	Traralgon–Gormandale road	1¾	1¾	..	..
	Rosedale–Willung road	4¼	4¼	..	..
South Gippsland Shire ..	Fall's-road	3½	½	½	½
	Dollar–Stony Creek road	¾	..	..	..
	Toora–Gunyah road	½	..	..	..
	Turton–Scanlon road	3	..	..	..
Tambo Shire	Nowa Nowa–Buchan–Gelantipy road ..	2½	..	..	..
	Swan Reach–Cunninghame road (Esplanade, Lakes' Entrance)	1¼	..	..	..
Templestowe Shire ..	Warrandyte-road	2	..	..	..
Traralgon Shire ..	Calignee road (between Traralgon and Red Hill deviation)	7¾	7¾	4	4
	Gormandale-road (Traralgon South, near Flynn's Creek State School)	¾	¾	¾	¾
Upper Yarra Shire ..	Main Warburton road (from Launching Place to Warburton)	7½	4¾	4¾	4¾
	Don-road (north from Launching Place to the shire boundary)	5¾	..	..	..
Warragul Shire ..	Main Gippsland road	1¾	1¾	1¾	1¾
	Warragul–Leongatha road	4	2	2	2
Warrnambool Shire ..	Geelong–Port Fairy road (from shire boundary to Dennington)	2¼	2¼	2¼	..
Werribee Shire ..	Geelong road	19	19	12	4½
Whittlesea Shire ..	Whittlesea–Kinglake road	4¾	..	..	..
Wonthaggi Borough ..	Wonthaggi–Loch road	1¼	1¼	1¼	1¼
	Wonthaggi–Inverloch road	2	2	..	..
Woorayl Shire ..	Wonthaggi–Inverloch road	1½	1½	..	..
	Leongatha–Yarragon road	4½	4½	4½	4½
	Leongatha–Warragul road	¼	¼	¼	¼
	Leongatha–Inverloch road	2½	2½	2½	2½
	Tarwin–Lower Tarwin road	¼	¼	¼	¼
	Meeniyan–Dambalk road..	½	½	½	½
	Total	438¼	238¾	127¾	95¾

APPENDIX H.

COUNTRY ROADS BOARD.

STATEMENT SHOWING MILEAGE AND LOCALITY OF WORKS CONSTRUCTED AND ROADS MAINTAINED.

Name of Municipality.	Name of Road.	Particulars as to Locality of Works Constructed.		Mileage of Works. Constructed.	
		Permanent Works.	Maintenance.	Permanent Works.	Maintenance.
Alberton Shire ..	Boolarra road (Yinnar track)	On Upper Hill section	Church and Jack road and Yinnar track	1/8	14
	Balook–Traralgon road ..	Speed's Hill ..	.. ..	3/4	15
	Carrajung–Gormandale road	.. .. ..	North section	..	3 3/4
	Yarram–Alberton road ..	.. .. ..	Practically throughout	..	3
	Wonyip road	.. .. ..	.. ..	..	10
Avon Shire ..	Dargo road	.. .. ..	.. ..	..	20
	Sale–Bairnsdale road ..	.. .. ..	.. ..	..	15
	Glen Falloch road ..	.. .. ..	.. ..	..	20
Bairnsdale Shire ..	Swan Reach–Cunninghame road	.. .. ..	.. ..	..	10
	Main Gippsland road ..	.. .. ..	.. ..	1	10
Bannockburn Shire ..	Inverleigh road	.. .. ..	.. ..	..	1 3/4
	Ballarat road	.. .. ..	.. ..	..	1 1/2
	Bannockburn–Shelford road	.. .. ..	.. ..	..	1/4
Bellarine Shire ..	Geelong–Portarlington road	.. .. ..	Geelong City boundary to Portarlington	..	17
	Geelong–Queenscliff road ..	.. .. ..	Geelong City boundary to Queenscliff	..	14
Berwick Shire ..	Main Gippsland road ..	.. .. ..	Dandenong to Pakenham	..	17
Braybrook Shire ..	Ballarat road	Sunshine to Footscray	.. ..	3 1/4	..
Buln Buln Shire ..	Fumina road	.. .. ..	.. ..	..	3
	Loch Valley road ..	.. .. ..	.. ..	..	3 1/2
	Main Gippsland road ..	Between Drouin and Warragul	Between Longwarry and Murray's Hill	1 1/6	7
	Drouin–Korumburra road ..	.. .. ..	Reforming bad portions	..	12
	Westernport road ..	.. .. ..	.. ..	..	4
	Neerim road "B" ..	.. .. ..	.. ..	2	..
Colac Shire ..	Main Warrnambool road and Cressy road	.. .. ..	.. ..	2	..
Corio Shire ..	Geelong–Ballarat road ..	From Geelong to Batesford	.. ..	4 1/2	..
Cranbourne Shire ..	Westernport road	.. .. ..	From Lang Lang Station to Patullos road	..	5 1/4
	Main Coast road	.. .. ..	From shire boundary near Dandenong to Lang Lang	..	29
	Koo-wee-rup–Pakenham road	.. .. ..	Main Coast road to near Humphries..	..	4 1/4
Dandenong Shire ..	Point Nepean road ..	Between Carrum and Mordialloc	.. ..	4 1/4	..
	Gippsland road	.. .. ..	Between Springvale and junction with Cranbourne	..	6
	Dandenong–Cheltenham road	.. .. ..	Between Gippsland road and junction with Moorabbin	..	4
Eltham Shire ..	Hurstbridge–Kinglake road..	Foster's cutting ..	Between Hurstbridge and Kinglake	1/4	15
Ferntree Gully ..	Ferntree Gully road ..	.. .. ..	Between Upper Ferntree Gully and Wheeler's Hill	..	6 3/4
	Monbulk road	.. .. ..	Between Begley's Bridge and Foster's Springs	..	1 1/4
Flinders Shire ..	Hastings–Flinders road ..	Parish of Bittern, eastern boundary of allotments 95A, 78, 79, 82, 81	.. ..	1 3/4	..
		Parish of Bittern, allotments 113B, 113A	.. ..	1 1/8	..
		Parish of Balnarring, north boundary allotments 42 and 43	.. ..	1/8	..
	Flinders–Dromana road ..	.. .. ..	Parish of Flinders, west boundary of allotments 24 and 27	..	1/4
Frankston and Hastings Shire	Point Nepean road ..	Between Shire boundary and Oliver's Hill	Between Oliver's Hill and Shire boundary	1 1/4	2
	Frankston–Flinders road ..	.. .. ..	Between Frankston and Hastings ..	..	6
Hampden Shire ..	Camperdown–Ballarat road..	.. .. ..	Between Heytesbury and Camperdown	..	4
			From Shire boundary at Grenville to 20 miles south	..	20
	Terang–Mortlake road ..	.. .. ..	From Terang to Mortlake ..	5	..
	Geelong–Warrnambool road	.. .. ..	Camperdown, 9 miles east ..	..	9
Healesville Shire ..	Lilydale–Healesville road ..	.. .. ..	.. ..	..	3
	Healesville–Alexandra road	.. .. ..	.. ..	..	19 1/4
	St. Fillan's–Marysville road	.. .. ..	.. ..	..	6 1/4
Heidelberg Shire ..	Heidelberg–Hurstbridge road	.. .. ..	Between Eltham and north end of road	..	3/4
	Heidelberg–Eltham road ..	Between Merri and Darebin Creeks	.. ..	1 3/4	..
		Between Darebin Creek and Plenty River	.. ..	5/6	..

COUNTRY ROADS BOARD—*continued.*

Name of Municipality.	Name of Road.	Particulars as to Locality of Works Constructed.		Mileage of Works Constructed.	
		Permanent Works.	Maintenance.	Permanent Works.	Maintenance.
Heytesbury Shire ..	Cobden–Camperdown road ..	.. .. ..	Between Cobden and Shire boundary	..	5
	Cobden–Port Campbell road	.. .. ..	.. ..	..	7
	Port Campbell–Princetown road	.. .. ..	At first and second creeks from Port Campbell	..	¼
Lillydale Shire ..	Healesville road	.. .. ..	.. ..	..	10
	Warburton road	.. .. ..	.. ..	..	7
Maffra Shire ..	Glenfalooch road	.. .. ..	.. ..	..	20
	Main Sale road	.. .. ..	.. ..	..	11
Marong Shire ..	Bendigo–Melbourne road ..	.. .. ..	Between Old Melbourne Inn and Big Hill	..	1¾
Mirboo Shire ..	Mardan road	.. .. ..	Metalling, west of allotment 41, parish of Mirboo	..	7
	Mirboo South road ..	Mirboo South deviation	Reforming between allotments 1, 8, and 9	2	..
		Perrin's Hill deviation	Parish of Mirboo South	2	2
	Allambee road	.. .. ..	Parish of Allambee East	..	3½
Mornington ..	Point Nepean road ..	.. .. ..	North of railway crossing ..	..	½
			At Mount Martha	..	¼
Mortlake Shire ..	Mortlake–Ararat road ..	.. .. ..	Between 5 and 6 miles from Woorndoo	..	⅜
Narracan Shire ..	Main Leongatha road ..	.. .. ..	From Yarragon to Higgin's House	..	½
	Main Sale road	Between Moe River and Trafalgar	At Yarragon	4¾	¼
	Hill End road	.. .. ..	Trafalgar to Griffith's Hill ..	..	2
Oakleigh Borough ..	Dandenong road	.. .. ..	From Poath road to Box Hill road ..	..	1⅝
	Ferntree Gully road ..	.. .. ..	From Dandenong road to Box Hill road	..	½
Omeo Shire ..	Omeo–Bairnsdale road ..	1¼ miles south of Tongio	.. ..	..	..
Orbost Shire ..	Cann River road	.. .. ..	Brodribb road to Bellbird Creek ..	..	17
Phillip Island and Woolamai Shire	Almurta–Glen Alvie road ..	.. .. ..	From factory to Bowman's ..	..	2
	Loch–Wonthaggi road ..	.. .. ..	From Bowman's to Shire boundary	..	5½
	San Remo Coast road ..	.. .. ..	At Bass	..	2
Poowong and Jeetho Shire	Korumburra–Warragul road	.. .. ..	Korumburra to McDonald's track ..	..	6
	Bena–Poowong road ..	.. .. ..	Bena to Poowong	..	6
	Poowong–Nyora road ..	.. .. ..	Poowong to Nyora	..	6
	Korumburra–Drouin road ..	.. .. ..	Whitelaw's track to Shire boundary	..	6
	Korumburra–Leongatha road	.. .. ..	Korumburra to Shire boundary ..	..	6
	Korumburra–Wonthaggi road	.. .. ..	Korumburra to Kongwak	..	10
	Lock–Wonthaggi road ..	.. .. ..	Loch to the Shire boundary ..	..	4
Rosedale Shire ..	Sale–Port Albert road ..	.. .. ..	Longford to Andrews	..	5½
	Traralgon–Gormandale road	.. .. ..	From north-west corner of allotment A31 to north-east corner of allotment A54B, parish of Tong Bong	..	1⅝
South Gippsland Shire	Dollar–Stony Creek road ..	.. .. ..	Carmichael's Saddle westerly ..	..	2¼
	Toora–Gunyah road ..	.. .. ..	Downing's Hill to Mount Best ..	..	10
	Welshpool–Boolarra road ..	.. .. ..	Welshpool to Shire boundary ..	..	5
Tambo Shire ..	Bairnsdale–Bruthen road ..	.. .. ..	From Sarsfield bridge eastward ..	..	2
	Swan Reach–Cunninghame road	.. .. ..	From Nicholson River bridge eastward	..	2
			Kalimna Hill and Esplanade, Lake's Entrance	..	2
Templestowe Shire ..	Warrandyte road	.. .. ..	.. ..	..	7
Traralgon Shire ..	Calignee road	.. .. ..	At Tassie's Hill	..	1
Upper Yarra Shire ..	Main Warburton road ..	.. .. ..	Between Woori Yallock and Launching Place	..	2½
	Woori Yallock–Cockatoo road	.. .. ..	.. ..	..	2
Warragul Shire ..	Main Gippsland road ..	Warragul to Yarragon	Warragul to Drouin and Nilma ..	1¾	4½
	Warragul–Leongatha road ..	.. .. ..	.. ..	..	9
	Warragul–Korumburra road	.. .. ..	.. ..	..	6
Warrnambool Shire ..	Nirranda road	.. .. ..	Between Allansford and Nirranda road	..	½
	Geelong–Port Fairy road ..	.. .. ..	To third-mile post towards Allansford	..	¾
			From town boundary to Allanfsord bridge	..	3½
			Between Allansford and Terang ..	..	3½
Werribee Shire ..	Melbourne–Geelong road ..	.. .. ..	Through Werribee township ..	..	4
Wonthaggi Borough	Wonthaggi–Loch road ..	Between railway and north-west corner of borough	.. ..	1	..
Woorayl Shire ..	Leongatha–Yarragon road ..	Three sections ..	Leongatha to Mark's Bridge ..	4½	14
	Leongatha–Warragul road ..	Cross roads to Walford's	Cross roads at Allambee to Trida ..	¼	6
	Leongatha–Inverloch road ..	Beilby's lane to Johnson's Flat	Leongatha 8 miles to horse trough	2	8
	Tarwin–Lower Tarwin road	Railway crossing to Whitelaw's track	Tarwin Station to Lower Tarwin Post Office	2¼	16
	Meeniyan–Dumbalk road ..	Whitelaw-street to Knibb's Hill	Meeniyan to Dumbalk State School..	½	12
			Total	45⅛	630⅝

APPENDIX I.

COUNTRY ROADS BOARD.

Instructions to Engineers regarding Investigation Surveys.

All measurements for road surveys should be made with a 100-ft. chain, and levels taken with a dumpy level and staff.

Investigation.

Before adopting any existing line of road or formation, or permanently marking any line of proposed road or deviation of any existing road, the Engineer or Surveyor must submit for the approval of the Chairman a longitudinal section of the road, and any deviations from the same, and cross sections taken with a clynometer, and plotted to a scale of 400 feet to an inch horizontal, and 40 feet to an inch vertical, together with a locality plan, plotted to a scale of 1,000 feet to an inch, or a tracing from the 20-chain parish plan of the locality.

The plan should show if the road is formed or constructed, and the lengths, widths, and depths of any metal or gravel construction.

The locality, material, and dimensions of all bridges and culverts should also be indicated.

Before entering upon private property for the purpose of making investigation surveys, the Surveyor shall advise the owners or occupiers of his intention, and he shall take every precaution against damage to property or stock.

Alignment.

Where the surveys follow an existing road which has been partly constructed, and straight lines may be obtained exceeding 1,000 feet in length, the centre line shall be ranged out with a theodolite, following as closely as possible the centre of the surveyed boundaries, and using the previously-constructed formations. Angles and curves shall be accurately laid out of not less than 165 feet radius. Where the survey follows an existing metalled road, the centre line of the metal is to be followed unless there are substantial advantages to be gained by its abandonment.

Marking.

Reference pegs, 2 inches x 2 inches, in section, with sawn and painted tops, and stamped with the chainage, shall be placed at intervals of 500 feet, and where the centre line is clear of the travelled portion of the road, similar pegs shall be driven at every 100 feet. In other cases the reference pegs shall be driven square off from the centre line at a convenient distance, say, 25 feet.

Reference pegs shall also be placed opposite all tangent points. All reference pegs shall be indicated by triangular trenches pointing in the direction of the road thus :—

Lock-spit trenches, 3 feet in length, shall also be cut on both sides of other centre-line pegs. All pegs to be driven flush with the ground.

Levels.

Level books for the purpose of the Board's surveys will be supplied by the Board, and must be returned along with the plans. Levels must be taken at intervals of every 100 feet longitudinally, and at intermediate distances where necessary, and cross-section levels shall be taken at intervals of at least 500 feet, and wherever the grading exceeds 1 foot in cut or fill, at intervals of every 100 feet, extending 25 feet right and left of the centre line.

Bench Marks.

At intervals of every 500 feet, and adjacent to all important bridge sites, permanent bench marks must be established, well clear of all works or traffic. Where convenient, the mark should be cut on the projecting root of a tree, and a shield of bark removed from the tree trunk, with a distinguishing number well cut into the solid wood. Where convenient to any previous railway survey, the datum for the railway survey shall be adopted.

Deviations.

Where it is necessary to deviate from an existing surveyed road, the grade line shall first be approximated with a line run with a clynometer, and the line traversed with a prismatic compass and 100-ft. chain. After the traverse line is plotted the centre line to be adopted must be designed to follow the grade traverse as closely as possible, using the minimum radius for curves, and avoiding all unnecessary earthwork. This line is then to be pegged out and levelled on the ground, observing the angles with the prismatic compass, and setting out the curves by offsets from the tangent lines, the centre line to be ranged out, pegged, and marked as before specified.

Road Deviation Plan.

Plans of road deviations, drawn to a scale of not less than 1,000 feet to an inch, must accompany the sectional drawings.

These plans must show the distances from all adjacent corners of the intersection of the centre line of the road with the allotment boundary lines.

Sections.

All longitudinal sections shall be plotted on section paper, of pattern supplied by the Board, to a scale of 400 feet to an inch horizontal and 40 feet vertical. The surface levels shall be inked in, and the proposed grade levels written in pencil, with the depths of cuttings or banks also shown in pencil. The gradients are to be expressed in feet per hundred. On deviation surveys, where the cross fall exceeds 5 degrees, the cross section may be taken by carefully observing the slopes right and left with a clynometer.

Water Ways.

At all bridge sites and creek or river crossings reliable flood levels must be obtained, and indicated on the sections. The catchment area and approximate slope of same must be indicated, together with the size and type of the culvert deemed suitable.

W. CALDER,
Chairman.

APPENDIX J.

COUNTRY ROADS BOARD.

INSTRUCTIONS TO SHIRE ENGINEER FOR PREPARATION OF SPECIFICATIONS FOR WORKS IN THE SHIRE OF

Complete specifications should be accompanied with General Conditions of Contract, Schedule of Quantities, and a detailed estimate of the cost of each item in the schedule, also the plans and sectional drawings.

All contracts for work under the authority of the Board will be bulk sum contracts, for the purpose of comparison, and to enable the Board to see how the bulk is arrived at, the various items of work will be scheduled generally as follows, viz.:—

A. Grubbing and clearing at per 100 lineal feet.
B. Formation and grading, including excavating or boxing out the metal bed, providing additional filling where required, or disposing of surplus material, excavating mitre drains, &c., at per 100 lineal feet of formation.
The cubical contents of all breast cuttings or banks over 1 foot in height or depth must be expressed in cubic yards, written on the section, to enable the contractor to estimate the lineal costs of the whole contract.
C. Side drains to be paid for at per 100 lineal feet.
D. Fencing to be paid at per 100 lineal feet.
E. Road metal to be at per cubic yard in metal bed, and the specification must state where, when, how, and by whom the same will be measured.
F. Rolling at per day of eight hours.
G. Culverts complete, at per culvert.
H. Rough pitching, at per square yard.

General Description.

The general description must definitely and fully describe the locality of the work, the commencing and terminal points, how its alignment is defined and marked on the ground, and briefly the nature and general description of the same, and in all cases a locality plan, accompanied with an estimate, must be supplied.

Formation and Grading.

The formation width shall be feet from table drain to table drain, with a cross fall of inches, except in cuttings or embankments exceeding 4 feet in depth or height, where the width may be reduced to 20 feet, with a cross fall of 12 inches from the centre of metal after being rolled to the table drain both ways. The batter slopes will be generally 1 to 1 in cutting, and 1½ to 1 in filling.

The minimum formation width for steep hillside cuttings exceeding 15 degrees side slope generally shall be 18 feet, and 20 feet for slopes of from 5 to 15 degrees, but all sharp curves of less than 200 feet radius shall be formed for a width of 25 feet in the centre of the curve, and gradually tapered off to the general widths at the tangent points. For slopes of less than 5 degrees the formation width will be the same as for flat country.

Metal Bed.

The metal bed shall be excavated or boxed in for a width of feet true to line and grade, with a cross-fall of ¾ inch to the foot.

Where the metal bed rests on a foundation of bad clay or spongy material, an additional 6 inches will have to be excavated, and replaced with that depth of good dry loam, sandstone, or other suitable material, and well rolled for the full width of the bed.

In all cases the metal bed must be thoroughly rolled, and all soft places, hollows, or irregularities made good with approved dry loam as the rolling proceeds. After the metal bed has been rolled, and before the first layer of stone is spread, any damage or ruts caused by traffic of any kind must be made good, and the metal bed re-rolled at the cost of the contractor.

Metalling.

The stone used must be of the best basaltic rock or other approved stone, from quarries approved of by the Board, to be crushed and screened so that all the stones will have passed through 2½-in. holes. About 15 per cent. of the dust and screenings must also be taken out, by using a screen with ½-in. holes. The metal must be spread on the road bed in two layers of even thickness, using wooden blocks to gauge the depth, and each layer must be thoroughly and separately rolled. The metal must not be dumped on the metal bed, but must be tipped on to and spread from iron sheets or dumping boards, and the whole must be shovelled into place, so as to insure a thorough mixing of coarse and fine material, spread to the required total thickness of inches, or it may be spread from waggons specially constructed for the purpose, and approved by the Engineer.

Binder.

After the metal has been well rolled, the stone, dust, and screenings must be evenly spread direct from the drays, and on no account tipped on the metal, the men turning their hands, and spreading backwards and forwards, so as to secure a perfectly even coat. The binder should be applied if possible immediately after or during rain, and well rolled, and in places, where water and suitable carts are available, full advantage should be taken to sprinkle the metal and binder during the rolling. In places where good setting quartzite sand or suitable gravels are available, either may be used in lieu of stone dust or screenings

as a binder, but special precautions must be taken to prevent any clay, loam, soft rock, casing, or vegetable earth being used or mixed with the metal or binder used. In the event of the metal not being rolled as soon as spread, all ruts must be kept constantly raked in, and any hollows filled with new metal until the the road has been rolled.

Gravelling.

In places where suitable stone is scarce, and good surface quartzite gravel is obtainable, it may be used in lieu of metal, but if the gravel should contain more than 20 per cent. of gritty loam it must be screened, and all large water-worn stones over 2 inches in their greatest dimension must be broken down, and the gravel must be free from vegetable matter, surface earth, loam, clay, or other extraneous matter. The gravel should be spread and rolled in two layers of a total depth of 10 inches before rolling.

Rolling.

If a suitable steam or motor roller is not available, the metal should be rolled with a 4 to 6 ton horse roller, having a forecarriage, for a period of hours for every 1,000 feet length of the contract, and the metal, after being trimmed, together with the water-tables on each side for a width of 3 feet from the edge of the metal must be thoroughly rolled in two layers with the most suitable roller available, loaded to required weight, and the rolling must proceed until the metal has been thoroughly consolidated to the satisfaction of the Engineer. All depressions or irregularities must be made good with clean metal as the rolling proceeds. No rolling to be done except in the presence of the Engineer or Inspecting Officer. After the stone dust and toppings are spread, the road must be again rolled.

Maintenance.

After the metal is spread, measured, and rolled the road must be thrown upen to traffic, after which and for a full period of two months after the Engineer has certified that the contract works have been completed the contractor shall constantly keep all wheel ruts raked in, and shall leave his work in perfect condition.

On completion the road surface should be even and true to alignment and grade, and with a uniform cross-fall as specified, and the surface of the metal should be perfectly smooth, without any loose stones, and *should shed water.*

Maintenance Metal.

At convenient places there should be stacked on the roadside heaps of metal, amounting to at least 20 cubic yards for every 1,000 feet in length of the contract, such heaps to be trimmed for measurement.

Tender forms will be supplied by the Board.

W. CALDER,
Chairman.

APPENDIX K.

COUNTRY ROADS BOARD.

GENERAL INSTRUCTIONS AND HINTS TO MUNICIPAL ENGINEERS FOR PREPARATION OF SPECIFICATIONS FOR WORKS OF MAINTENANCE AND FOR CARRYING OUT GENERAL REPAIRS ON MAIN ROADS.

As the provisions of the Country Roads Act for financing the cost of " Maintenance " of main roads differ considerably from those relating to the cost of " Permanent Improvements," the former being paid for out of the Country Roads Board Fund, and the latter out of the Country Roads Board Loan Account, it is necessary that municipal engineers in particular, and municipal officers generally, in dealing with the accounts, should have a clear conception as to the precise meaning of the respective terms, in order that the accounts and records relating to expenditure under each heading may be kept absolutely distinct.

The term " Maintenance," by which is ordinarily meant the repair or upkeep of a road, is defined in Section 3 to mean—

> " All works of every description which are in the opinion of the Board calculated to keep the carriage-way of any main road and any drain draining such carriage-way in the same state of utility as it was in at the time it was declared to be a main road, or in the same state of utility as it was in as the result of any permanent improvements which have been effected to it under the provisions of this Act."

While the term " Permanent Improvement " is defined to mean—

> "All works of every description exclusive of maintenance which are in the opinion of the Board calculated to increase the utility of the carriage-way of a main road, and shall include drains for draining such carriage-way."

Consequently, any expenditure on works which will have the effect of increasing the utility and efficiency of a road, over and above its state of efficiency at the date of its declaration as a main road, cannot, broadly speaking, be considered as " Maintenance."

It, therefore, follows that until the roads have been properly constructed or re-constructed, any expenditure in " Maintenance " must be confined to keeping the road up to the standard of efficiency that existed at the date of its declaration, however unsatisfactory that may have been, and that any works which will have the effect of improving the condition of the road to any marked degree, *e.g.*, improving gradients, strengthening or widening the road crust, widening or improving dangerous curves or angles, must be regarded as " Permanent Improvements," while works such as re-forming or re-surfacing with road machines, filling holes or ruts, clearing scrub or vegetation from the formation, will be regarded as " Maintenance."

This being the case, it follows that, in the majority of shires, very little, if any, of the " Maintenance " work is likely to be carried out under contract, except it be for the supply and delivery on the roadside of materials for maintenance.

Where contracts of this nature are contemplated, or where the work of maintenance is considered of sufficient magnitude to justify the letting of a contract, full particulars, including an estimate of the cost of the work, with a locality plan showing the exact location of the proposed work, must be submitted for the approval of the Board.

On approval of the proposals, tenders may be invited, or if deemed more expedient, the work may be carried out by day labour, with the use of the shire plant and tools.

Where it is intended to use the shire's road-making plant, the estimate submitted must clearly indicate the amount proposed to be charged by the council for hire, including depreciation.

Maintenance Metal.

Where rock-breaking machines are employed, all metal for works of maintenance must be of approved stone, of a homogeneous nature, crushed, screened, and graded through a revolving screen, so that no stone shall exceed 2 inches (2″) in its greatest dimension.

From 15 to 20 per cent. of the screenings and stone-dust should be taken out, to be afterwards used as a binder. If practicable, and in order to avoid re-handling, the stone should be carted direct from the crusher, from elevated storage bins, or from the railway trucks, and spread on the road.

Where local conditions, or other circumstances, do not admit of this, it is advisable to cart the maintenance metal to the road during the summer, when the roads are dry and hard, and to stack the different grades of material separately at convenient intervals on the sides of the roads for use at the proper season, preferably after the autumn rains, when the conditions of weather and road-surface will facilitate the setting of the new material. The quantity of metal thus provided for maintenance will depend upon the amount of traffic on any particular road, but 40 to 50 cubic yards per mile will meet average needs.

Where hand-broken metal is used, or the available road stone is not of a hard nature, the gauge of the metal may be increased to 2½ inches.

Under special circumstances, other suitable binding materials may be used, such as gravel, particularly ironstone gravel, or other approved clean grit, but under no circumstances must clay, sods, loam, or other earthy material be used as a binder on broken stone roads.

Patching Repairs.

Ruts, holes, and depressions should be promptly filled directly they appear. Where depressions are to be filled, the patches should be cut out or " scored " around the edges with a pick, the old metal, grit, and dust removed, and the new material put in, rolled or punned with a rammer, and bound with stone chippings or gravel. Metal patches should not be left more than 1 inch above the adjoining road surfaces, the finer materials and chippings being used to taper off the edges of the patch.

A hand rammer should form part of the equipment of men employed upon road maintenance.

In a recently constructed road particularly, ruts and holes should be constantly raked in and repaired until the metal has thoroughly set. Should ruts and holes be left unattended to during the period of consolidation, and before the road crust has set and formed a seal, water will lodge in the depressions, percolate to the sub-soil, and render this (the foundation) incapable of sustaining the weights transmitted to it by the road crust.

General Surface Renewals and Metal Sheeting.

When the crust of a metal or gravel road has become much worn, showing signs of breaking up and disintegrating, it is advisable to effect the complete renewal of the crust by a continuous coating or sheeting of the road surface.

In such a case, the regularity of the bedding or foundation destined to receive the new coatings is an indispensable condition in order to secure satisfactory results.

This is the time to remedy any defects or irregularities in the surface, gradients, or contour. Should the crown be excessively high, this may be reduced by picking or scarifying. The old material removed from the crown may be spread upon the haunches or shoulders of the road.

Should there be a fair depth of metal on the road, and only a thin coat of 3 or 4 inches be necessary to renew the surface, and bring it to the standard cross section, it is generally advisable to scarify the old surface, to remove irregularities and fill depressions before spreading the new material, or at least the haunches of the metalled construction should be "scored" in order to provide a bond for the metal.

Where the crust has become so worn that a thick coating of metal is required, scarifying is generally undesirable, as it would tend to injure and weaken the foundation. Where the required thickness of a new coating exceeds 6 inches, it is not advisable to spread this in one layer, but in two separate layers of 3 to 4 inches; the successive layers should be separately rolled, and the finer graded material used for the finishing coat.

Whatever material is used for re-surfacing should be of uniform size, quality, and texture. "Pockets" of fine or weak material in the road crust will cause uneven wear, and ultimately holes will form.

Binding.

The binding material should be preferably stone chippings of the same stone as that used in the crust, but ironstone, or other approved gravel, may be used for the purpose. It should be used only in sufficent quantity to fill the interstices between the stones, thus locking and binding the stones in position, and at the same time providing a seal against the entrance of surface water.

The loads of binding material should not be dumped on the metalled road, but spread evenly over the surface from the cart, then rolled, and, if appliances be available, the binding should be worked in with water sprinklers and brooms.

Gravel.

In localities where a suitable road stone is not obtainable, and good gravel is at hand, this may be used in lieu of metal. The gravel should be clean, moderately coarse, and free from any excess of clay, loam, surface earth, vegetable or other extraneous matter, and should not contain more than 20 per cent. of fine sand. It should be screened, and all stones exceeding 2 inches in greatest dimension broken down. Gravel containing an excess of clay, loam, or fine sand will rut, and become "puggy" in wet weather.

Earth Roads.

In the case of earth roads, all ruts and hollows should be filled, and the road surface brought to the required grades and cross fall at the proper season, that is, while the soil is still moist, and before the road surface has become dry and dusty. Earth roads require a higher crown than is desirable for macadamized and gravelled roads. This height of crown will depend upon local conditions, but usually a cross fall of 1 inch to 1 foot will be found sufficient. On gradients, the cross fall should be greater than on level roads, or the surface water will form runlets down the centre of the road, instead of finding its way to the side drains. The cross fall should therefore be greater than the longitudinal fall.

It should be borne in mind that, if the surface of an earth road is to wear evenly, the surfacing material should be of a uniform nature. Under no circumstances, therefore, should the surface be made up, or holes filled, with sods, roots, organic matter, or worn-out materials such as sand, dust, or mud cleaned from the side drains. Any new material required should be taken from shallow burrow pits on the road sides. The work of re-forming and grading can be performed most satisfactorily and economically by means of drags or road grading machines. If the road surface is in very bad condition, it may be scarified with disc ploughs and rolled.

Side drains should not be too deep, and should be formed so that their cleaning and maintenance may be effected by road machines.

Filling Holes in Sand and Gravel Roads.

Where holes containing mud or water exist in the surface of roads formed with sand or gravel these should not be filled with new materials until the wet or muddy material has been removed, and a drain about 6 inches in width cut from the bottom of the hole with a fall to the side drain. The hole and drain may then be filled with new material, and rolled or punned with a rammer.

Rolling.

The use of road rollers for consolidating metal or gravel roads, both in construction and maintenance, cannot be too strongly advocated. By the use of an effective roller the road is fit for traffic the day it is finished. The road surface is at the same time made smooth and compact enough to shed the surface water and preserve the road bed from injury, whereas if the metal is left to be consolidated by traffic, the process of consolidation is slow, and much discomfort and damage is occasioned to road users compelled to travel over the loose material. Where metal is spread on a road without being finished by binding and rolling, traffic will avoid the loose material, and travel along the water-tables, which, in consequence, will be tracked and deformed. In short, the road should be made *for* and not *by* the traffic.

The setting qualities of the stones are also impaired by the wearing and rubbing together of their edges, when spread without being rolled, with consequent waste of material, and also before the crust has become smooth and compact, rain and surface water will pass between the loose stones instead of being shed to the side channels, the foundation soil will become sodden, and heavy vehicles will force the metal into the soft sub-soil, which will be forced up and intermixed with the metal, resulting in permanent injury unless the defect is remedied.

Where the revenue of a municipality will not warrant the expenditure upon a self-propelling roller, a convenient and useful horse-drawn roller, weighing from 4 to 5 tons, can be purchased for about £135.

The acquisition of an efficient roller will be fully justified on the score of expediency, comfort, and economy resulting from its use.

Drainage.

It should be remembered that, apart from heavy traffic, water is the greatest factor in the destruction of roads.

A good sound road cannot be obtained where the road bed is surcharged with moisture, and badly drained, or the surface drainage defective.

Attention to the drainage, both of the surface and the sub-soil of a road, is therefore a matter of paramount importance, and every means should be adopted that will tend to preserve a dry road bed and render the road surface capable of quickly shedding the surface water to the side drains.

Where necessary, the side drains should be straightened, the water-tables re-formed, and the haunches of the road sloped, to obtain the proper contour. All table and side drains should be cleared of obstructions, and made effective, with regular and continuous falls to their outlets.

Drain Outlets.

Drain outlets and culverts should be kept effective and clear of obstructions, and be provided as frequently as the configuration of the ground will admit. Water should not be allowed to run along the water-tables or side channels further than is necessary, nor be allowed to stand in the side drains and soak beneath the road bed.

Catch Water Drains.

On sidlings, or in wet clay soils, it may be found advisable to cut catch-water or berm drains on the upper side of the road.

Side Drains.

As noted under "Earth Roads," it is not advisable to make side drains too deep, especially in loose or friable soils, where continued erosion will render them a source of danger.

Erosion may be arrested by "breaks" of stones, fascines of scrub, or, in special cases, by turfing.

Culverts and Bridges.

The decking of all culverts and bridges should be carefully examined periodically, and placed in thorough repair.

In order to facilitate prompt repairs, it is desirable to store, in convenient localities, a sufficient quantity of decking planks of suitable material, length, and sizes.

Where repairs are needed to bridges originally decked with local timber, specifications may provide for the use of the best local material, but, in the case of re-decking, only the best timber obtainable should be used. The hand-railings, and particularly the end posts of bridges and culverts, should be painted *white* as a guide to travellers at night.

Clearing Fallen Timber and Cutting Logs.

The whole width of the formation of roads should be kept clear of saplings, scrub, ferns, and other vegetation, which, if allowed to grow, will keep the road surface wet, and tend to weaken and disintegrate the surface.

In forest areas, where fallen timber obstructs the road, logs should be cut clear of the formation or the edges of cuttings and embankments, so that the sawn ends do not project over the roadway, and no claims for the removal of fallen timber should be recognised unless this is done.

Loose Stones.

Loose stones should be raked or gathered from the metalled surface periodically, and stacked on the roadside for use in repairs, but should not be re-used for surface patches until broken down to a gauge of 1½ inches.

Width of Tires.

All vehicles used for carting stone or other road materials should have 4½-in. tires, in the case of drays, or 5-in. tires, in the case of horse-drawn waggons, and 9-in. tires, in the case of waggons drawn by tractors.

Where, owing to special local conditions, any departure from the foregoing instructions may, in the opinion of the Engineer, be desirable or expedient, such variation may be approved by the Board after investigation of the special circumstances, at the request of the Council or the Engineer.

W. CALDER,
Chairman.

20th January, 1914.

APPENDIX L.

COUNTRY ROADS BOARD.

Duties and Responsibilities of Patrol Men Employed on Main Roads.

1. All patrol men employed by councils on main roads should be responsible directly to the shire engineer, or, in his absence, to such other officer appointed by the council, and all patrol men employed by the Board shall be responsible directly to the engineer appointed by the Board.

2. It must be clearly understood that their first and most important duty at all times and under all conditions of weather, is the care and preservation of the section or sections of road placed under their charge. During wet weather particularly they should patrol their sections, paying particular attention to those portions which are known to be most subject to damage by water, keeping all waterways and culverts clear of obstruction, and diverting water from the roadway when necessary.

3. Any man who relinquishes his employment without giving at least one week's notice to the engineer shall be liable to forfeit one week's wages, and any man who absents himself from his section (except in case of illness or other emergency) shall be liable to a fine of one day's pay and subsequent dismissal.

Hours of Duty.

4. The hours of duty shall not exceed forty-eight (48) per week, and shall be as follows :—

Week days—7.30 a.m. to noon, and 1 to 5 p.m.
Saturdays—7.30 a.m. to 1. p.m.

These hours must be actually worked on the road, and do not include time occupied in going to or returning from work.

Equipment (Tools).

5. When men are employed directly by the Board, their equipment will be supplied by the Board, or by councils when employed by them. The men will be held responsible for all tools supplied by the Board or the councils, and any man leaving his employment must deliver, where directed, all equipment entrusted to him before payment of his wages. Repairs to tools will be paid for by the Board or the councils on production of receipts.

Horses and Drays.

6. When the conditions of employment require it, patrol men may supply their own horse and dray for which they will receive an allowance of 4s. 6d. per day, or 2s. 6d. for half a day, when the horse and dray are in use on the road, or they may hire a horse and dray when required, for which payment at the above rates will be allowed. If the engineer considers that a horse and dray has been unduly or unnecessarily in use, he shall disallow the charge. All drays in regular use on road works must have 4½in. tires, and both the horse and dray must be subject to the approval of the engineer.

Materials for Repairs.

7. As far as practicable, material for repairs, such as metal and gravel, will be delivered and stacked in heaps on the roadside for the use of men, but where this is not done it is expected that the best available material, either from the roadside or from reserves or other stated localities, will be used.

Patrol men are expected to interest themselves in locating the position of deposits of material suitable for repairs, such as sand, gravel, or stone, and report same to the engineer.

Material must only be taken from private property under the authority of the engineer acting for the council or the Board.

Heaps of stone or other road materials must not be stacked at curves or angles of roads where they would be a source of danger to traffic.

Earth Roads.

8. When the road or any section of it is not metalled or gravelled, a higher crown is necessary, and the chief duty of patrol men on such sections is to preserve the crown by promptly filling in all ruts, holes, and depressions appearing in the road surface with clean new material taken from the road side, so that no part will retain water, and thus become water soaked.

The side drains and water tables must be kept clear, so that they will discharge water quickly, but on no account must the material taken from the water tables, such as sand, dust or mud, or any sods, organic matter, or worn-out material be used for filling ruts or depressions, or be spread on the road surface. Such detritus removed from the water tables should be so disposed, clear of all traffic, that it may not be scattered or washed back into the channels.

Gravelled Roads.

9. When holes or depressions containing mud or water exist in the road surface, they should not be filled until the water has been drained off, and the muddy material removed. The hole or depression and trench should then be filled with clean new gravel. Should any of the gravel stones be of a greater dimension than 2 inches, and water-worn, they should be broken, and then placed in the bottom of the rut or depression, and the smaller sized material placed on top, and then " punned " with a rammer. Loose water-worn gravel stones exceeding 2 inches in size must be raked off and treated as above.

Metalled Roads.

10. As in the case of gravelled or earth roads, it is of the first importance that holes or depressions appearing in the road surface be promptly filled in. Patrol men should therefore carefully observe their sections during wet weather, and mark any places where there is a tendency for the water to lie in pools, so that they may be attended to as soon as possible.

Where such depressions are to be filled or patched, they should be first cut out or " scored " around the edges with a pick, the dust or grit removed, and the new metal put in and rolled, or where no roller is available, thoroughly " punned " with a rammer. The patch should be then covered with a layer of stone chippings or gravel, and again rolled or " punned." The new patch should not be left more than 1 inch above the adjoining surface, the finer materials being used to taper off the edges of the patch.

Where there is a tendency for the earth formation or shoulders alongside the metal bed to become worn below the surface of the metal, it should be filled or rounded up with material taken from the roadside, clear of the formation.

All loose stones must be raked or otherwise removed from the road, and stacked clear of the formation for future use, but should not be used for surface repairs until broken down to a gauge of $1\frac{1}{2}$ inches.

For patching repairs, the smallest metal should be used, preferably of $1\frac{1}{2}$in. to 2in. gauge, and for shallow depressions, stone chippings or screenings may be used where no roller is available.

Binding.

11. Should no suitable binding material, such as chippings, clean gravel, or sand be available, it is better to leave the macadam without binding, depending entirely upon extra rolling or ramming to consolidate the work.

Rolling.

12. Where a roller is used, the rolling should commence from both sides, working gradually, and finishing in the centre, so that a perceptible crown will be given to the road.

Side Drains and Water Tables.

13. On no account must water be allowed to run along the travelled portion of the road surface, consequently the road must be kept to such a curvature that it will quickly shed the water to the water tables. The water tables must be kept straight and clear of obstructions such as grass, leaves, stones, sand, and mud.

Water should not be allowed to run along water tables further than is necessary, nor be allowed to stand in the drains and soak beneath the road bed. If the side drains and water tables should show a tendency to become too deep, especially in loose and friable soils, the erosion must be immediately arrested by use of " breaks " of stones, facines of scrub, or, in special cases, by turfing. Where the erosion has been excessive or dangerous, it must be stopped by laying bushes in the drain with the heads up stream.

All inlets and outlets of culverts must be kept effective and clear of obstruction.

Bridges and Culverts.

14. Patrol men must pay particular attention to all bridges and culverts, and carefully observe the effects on them of every flood, and, should any defect occur, report same at once to the engineer.

All broken or loose planks that may occur in the decks must be repaired instantly they are discovered, and any necessary precautions taken to prevent accident and restore traffic.

All drift wood must be removed, and kept clear from the piles or under framing of the bridges.

Water, earth, or manure must not be allowed to accumulate on the decks of bridges or culverts, and all projecting spikes in deck planks must be driven home.

As a precaution against damage by fire, all scrub, boughs, and rubbish must be kept clear of any wooden bridge or culvert. On the occasion of heavy floods, bridges must be given special attention, so that they are not endangered by the accumulation of *débris*. The maximum height of the flood must be indicated by either permanently marking on the bridge or driving a peg in the bank of the stream.

Approaches to bridges must be kept in good order, and care taken to see that the junction of the timber deck with the road is free from holes or depressions.

Fences.

15. Any defects in guard fences are to be made good, or, if extensive repairs are needed, such should be reported to the engineer.

Clearing Saplings and Fallen Timber.

16. The whole width of the road formation must be kept clear of saplings, scrub, ferns, and other vegetation.

In forest areas, where fallen timber obstructs the road, all logs must be cut clear of the formation or the edges of cuttings and embankments, so that the ends do not project over the roadway.

Destruction of Trees.

17. Patrol men are required to pay particular attention to the preservation of growing trees on the roadside, and any case of injury to or destruction or removal of timber from the road must, with the name of the offender, be immediately reported to the engineer.

Width of Tires and Damage to Roads.

18. Any breach of by-laws relating to width of tires, damage to water tables by bullock waggons, or any dragging of logs along any road, must be immediately reported to the engineer.

Careless Use of Fire.

19. Patrol men are cautioned against lighting fires for clearing off rubbish during the summer months. and must be careful to properly extinguish any camp fires, whether lighted by themselves or other persons,

Time-books and Records.

20. Each patrol man will be supplied with a time-book, in which he will record the time worked each day, the nature of the work performed, and the materials used. He must also particularly note any matter or circumstance which he considers a source of danger to the travelling public, or which is likely to cause damage to the road.

In the event of an accident happening on his section, he must at once report the circumstances to the engineer, and record all the available facts in his time-book.

The time-book must be forwarded to the engineer at such regular intervals as directed.

APPENDIX M.

COUNTRY ROADS BOARD.

COUNTRY ROADS ACT, VICTORIA No. 2415.

Explanatory Memorandum.

The above Act was passed in December, 1912, and practically came into operation when the Board was appointed in April, 1913.

The object of the Act is to bring about an improvement in the condition of the principal highways of the State, and to insure that such improvement shall be maintained by the adoption of a system of continuous maintenance.

The Act provides for the appointment of a Board of three members, in which is vested powers similar in all respects to but wider than those possessed by municipal councils under the Local Government Acts, but the jurisdiction and control by the Board is confined to such roads as are declared to be main roads under the Act.

The first duty of the Board is to investigate the road conditions throughout the whole of the State, with a view to determining, after consultation with the municipal authorities, what roads are to be main roads. The responsibility of determining what roads shall be main roads is intrusted to the Board, but the municipal authorities have the right of appealing to the Minister of Public Works against its decision, and, in the event of such an appeal, the decision of the Minister is final.

There is nothing in the Act in the way of a direction to the Board as to what character of roads shall be main roads other than that the Board must be of opinion that they are "of sufficient importance." The Board is, therefore, expected to exercise its discretion after considering the matter from the points of view—

1*st*. As to whether they are main arterial roads, carrying extensive traffic, or likely to carry extensive traffic between centres of population, or from one district to another.

2*nd*. As to whether they are subject to considerable traffic from rural districts to the railway system.

3*rd*. As to whether they are developmental, that is, that their construction is likely to lead to increased settlement or increased production.

As soon as the routes which are to be main roads are determined upon they are gazetted as such, and the responsibility for their construction and continued maintenance then devolves upon the Board, conjointly with the municipal authorities. Generally speaking, all works, whether of construction, re-construction, or maintenance, will be carried out by the municipal councils, but power is reserved to the Governor in Council to direct that any works may be carried out by the Board. This latter power is intended to be exercised only in cases where the work is of such magnitude as to be beyond the capabilities of a municipality, or where several municipalities are concerned in the same work, or where a municipality neglects or refuses to carry out any work.

All works, whether of construction or maintenance, are to be carried out to the satisfaction of the Board, which means that the Board shall decide as to the nature and method of construction generally, such as width of formation, grades, width and thickness of metal, or gravel, and materials to be used.

For the carrying out of permanent works, such as the construction or re-construction of main roads, and bridges thereon, the State Government has undertaken to borrow a sum of £2,000,000, to be expended over a period of five years, at the rate of £400,000 per annum. One-half of this £2,000,000 is to be refunded by the municipalities, the refunds to extend over a period of 31½ years, at the rate of 6 per cent. per annum, 4½ per cent. being interest, and 1½ per cent. sinking fund.

The cost of all works of construction is in the first instance to be paid by the Board, and at the end of each financial year the Board is required to apportion half of the cost amongst the municipalities benefiting by the expenditure, and on this apportionment of cost the instalments of interest and sinking fund payable annually by municipalities will be calculated.

For maintenance works a special fund has been created under section 38. It consists principally of fees for the registration of motor cars and traction engines, as set out in the second schedule of the Act, all fines under the Motor Car Act, rents from Water Frontages and Unused Roads, repayments by municipalities, and such other sums as Parliament may provide.

The Board must notify each municipality every year the amount it must expend in maintenance on each of the main roads in its territory, and this cost, in the first instance, will be paid by the Board, but the municipalities are required to refund half of the expenditure in the subsequent year. Consequently, municipalities, when framing their estimates in October, need make no provision therein for works on any of the roads declared to be main roads, except such sum as may be necessary as a refund to the Board on account of the council's proportion of expenditure incurred in the previous year, of which the councils will be duly notified.

The works of maintenance, as in the case of construction, are to be carried out to the satisfaction of the Board.

If any municipality be in default in the payment of its instalments the Board has power to levy a rate on the rateable property in the municipal district sufficient to meet the amount of instalment due.

Briefly, the Act is designed to insure a proper and uniform standard of construction and maintenance of the principal highways of the State, and to provide funds for that purpose, in connexion with which the State undertakes to provide one-half, and requires the municipal councils to be responsible for the other half.

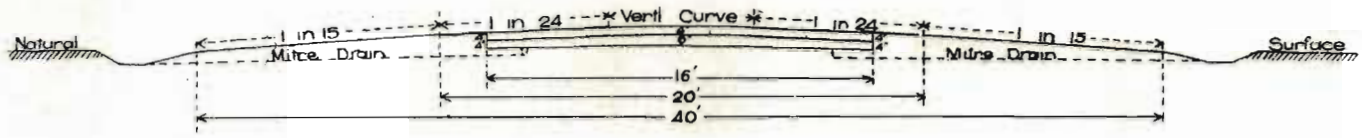
By Authority: ALBERT J. MULLETT, Government Printer, Melbourne.

COUNTRY ROADS BOARD

TYPE CROSS SECTIONS

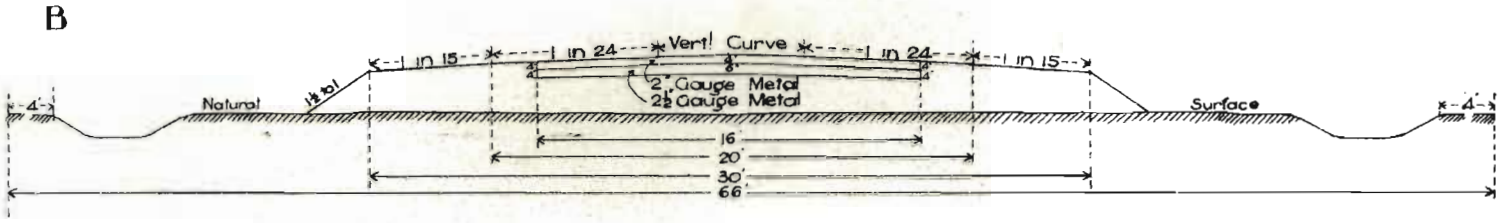
Scale. 8' to 1"

A



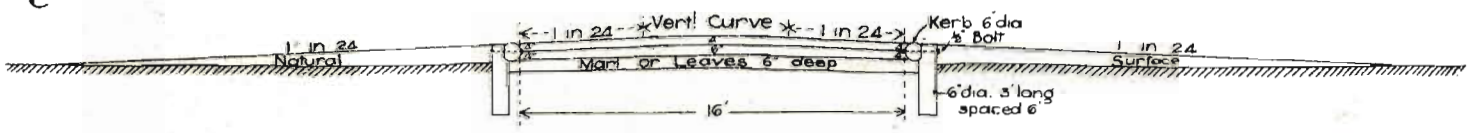
Formation on Level Ground

B



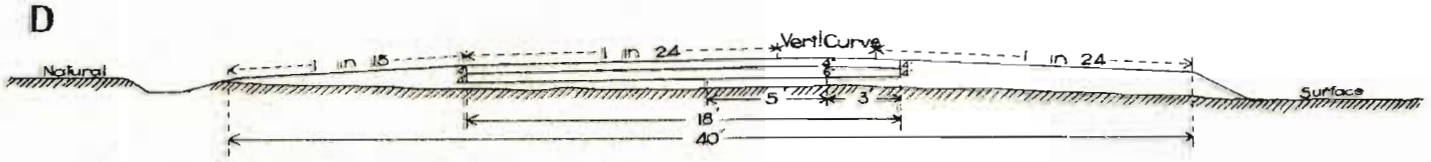
Formation on Swampy Ground

C



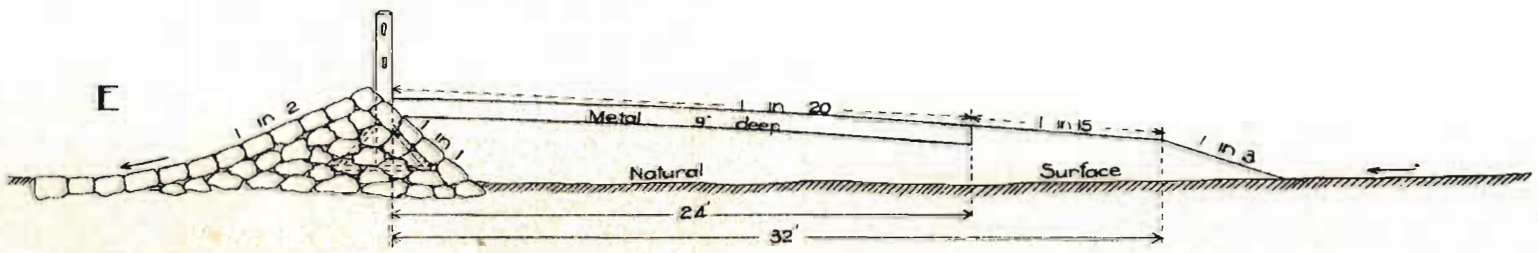
Formation on Sandy Ground

D



Banking for all curves of less than 300' radius

E



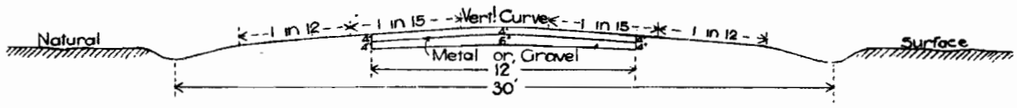
Formation for Flood Crossing
showing raised sill to prevent scour

COUNTRY ROADS BOARD

TYPE CROSS SECTIONS

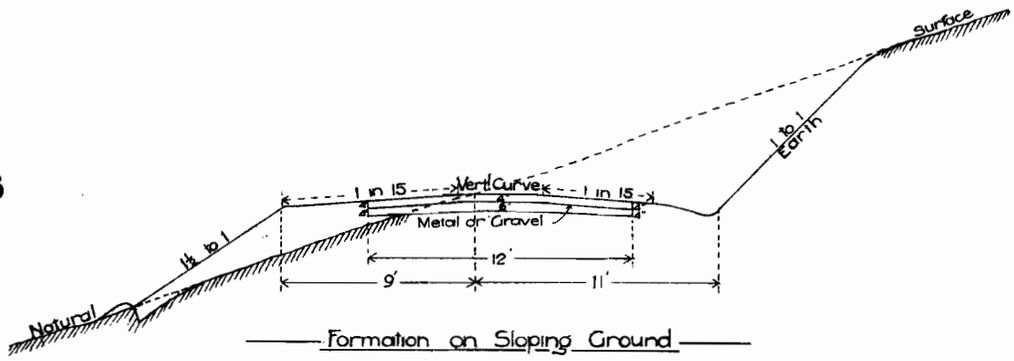
Scale. 8′ to 1″

A



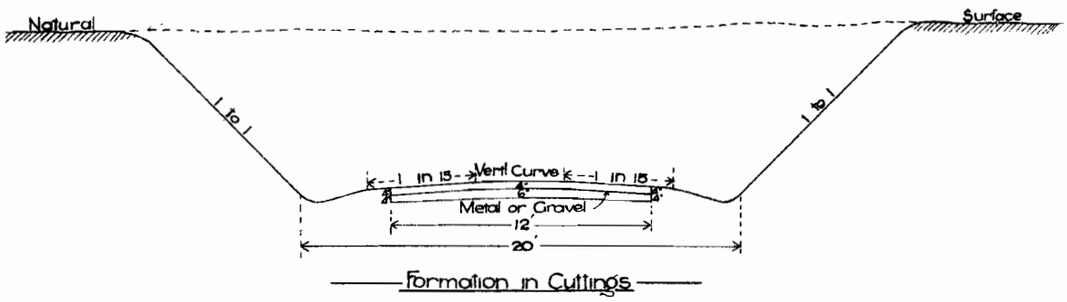
Formation on Level Ground.

B



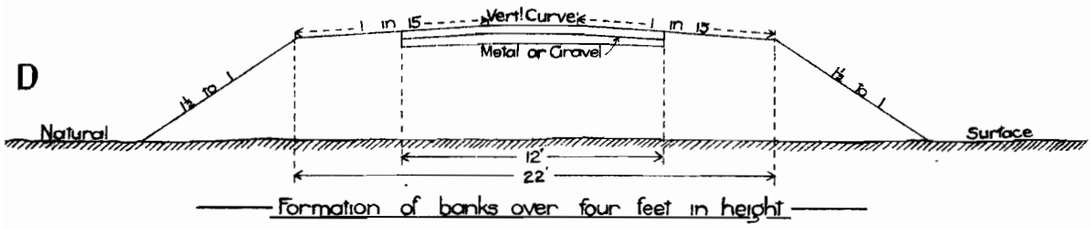
Formation on Sloping Ground

C



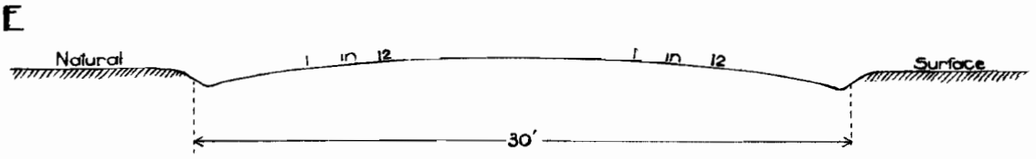
Formation in Cuttings

D

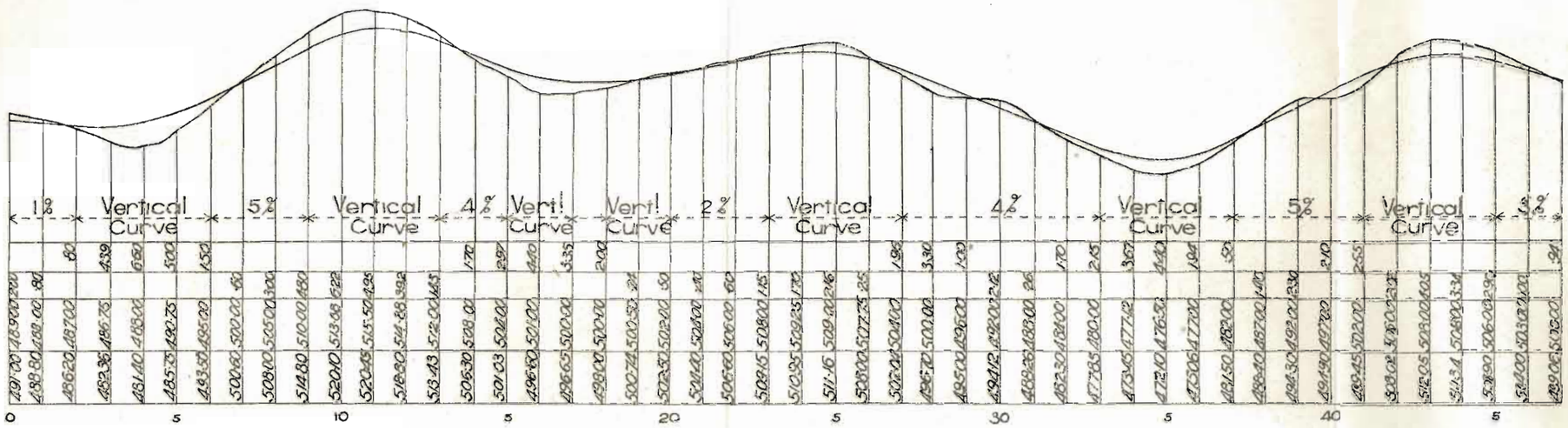


Formation of banks over four feet in height

E



Formation of Earth road on Level Ground

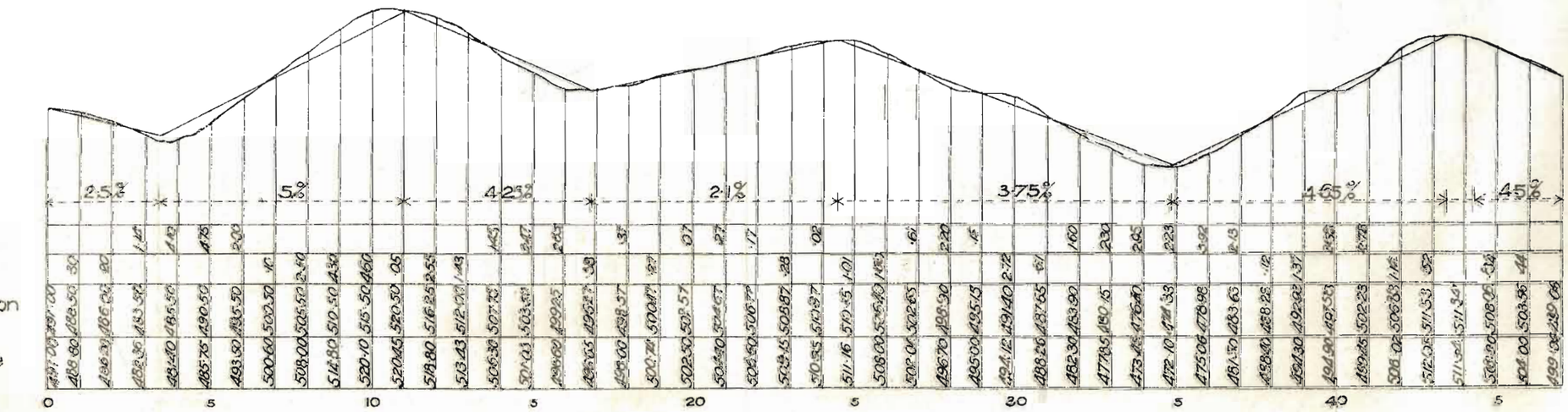


LONGITUDINAL SECTION SHOWING ROAD GRADED WITH ROLLING GRADIENTS
BY THE USE OF VERTICAL CURVES

d = ½ (Algebraic difference of Tangent grades expressed in feet per 100) x (length of curve expressed in stations of 100')

$d' : d :: t'^2 : t^2$

$d' = \frac{dt'^2}{t^2}$



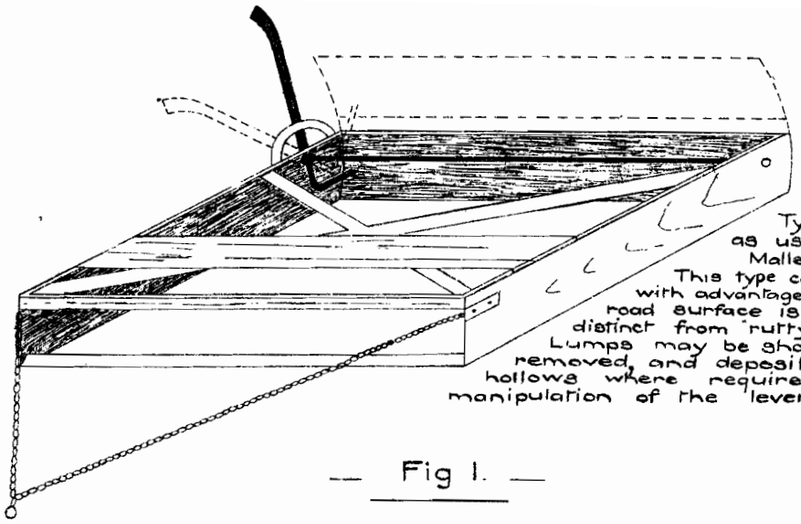
LONGITUDINAL SECTION SHOWING OLD METHOD OF GRADING WITH STRAIGHT
GRADE LINES TERMINATING AT SHARP ANGLES OR RISES AND DIPS

Example

$d = \frac{1}{2}(5\% - (-3\%)) \times (4)$

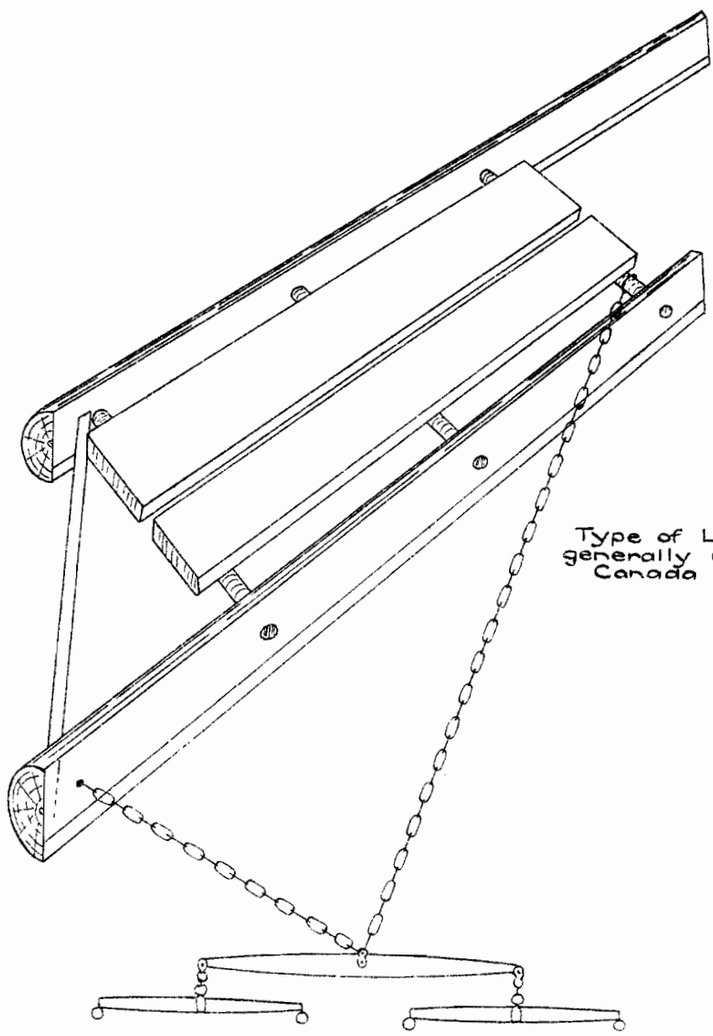
$d = \frac{1}{2}(8) \times (4) = \frac{32}{8} = 4'$

$d' = \frac{4 \times 1^2}{2^2} = \frac{4}{4} = 1'$



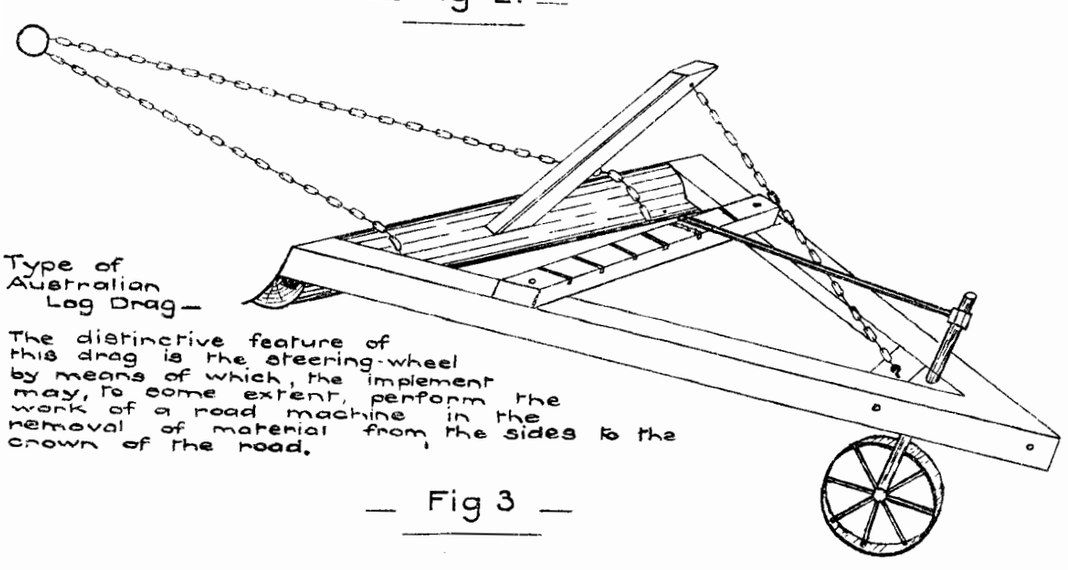
Type of Box Drag as used in the Mallee District— This type can be used with advantage where the road surface is uneven as distinct from 'rutty'. Lumps may be shorn off, removed, and deposited in hollows where required, by manipulation of the lever.

— Fig 1. —



Type of Log Drag as generally used in Canada & U.S.A.

— Fig 2. —

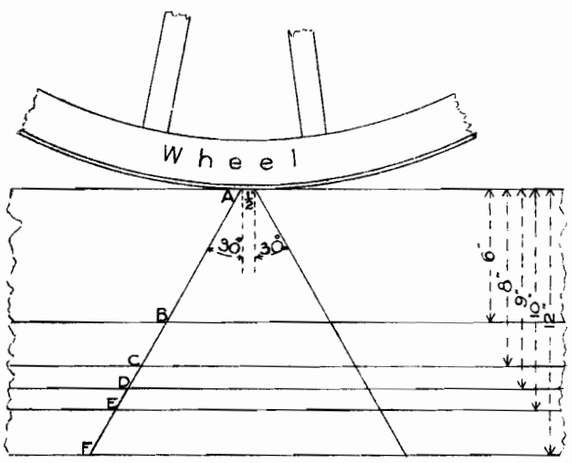


Type of Australian Log Drag—

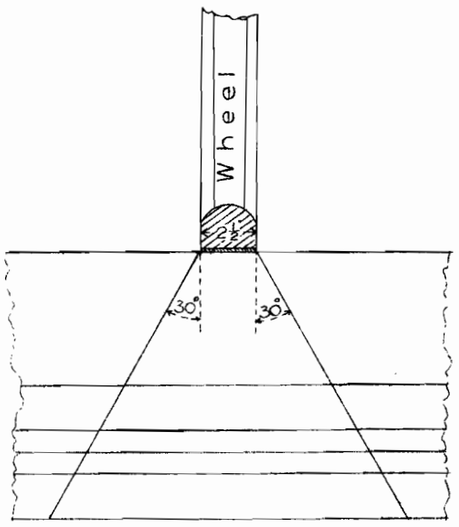
The distinctive feature of this drag is the steering-wheel by means of which, the implement may, to some extent, perform the work of a road machine in the removal of material from the sides to the crown of the road.

— Fig 3 —

DIAGRAMS ILLUSTRATING THE EFFECT OF INCREASED THICKNESS OF ROAD CRUST IN REDUCING PRESSURE ON FOUNDATION SOIL.



Long! Section

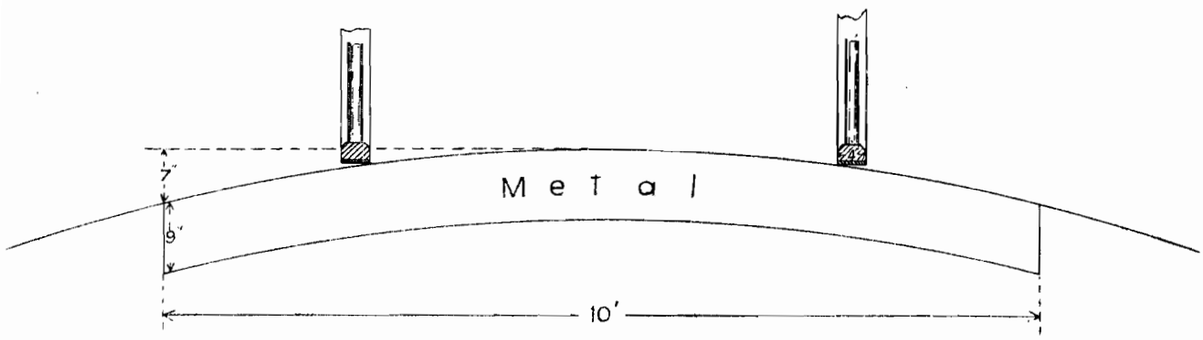


Cross Section

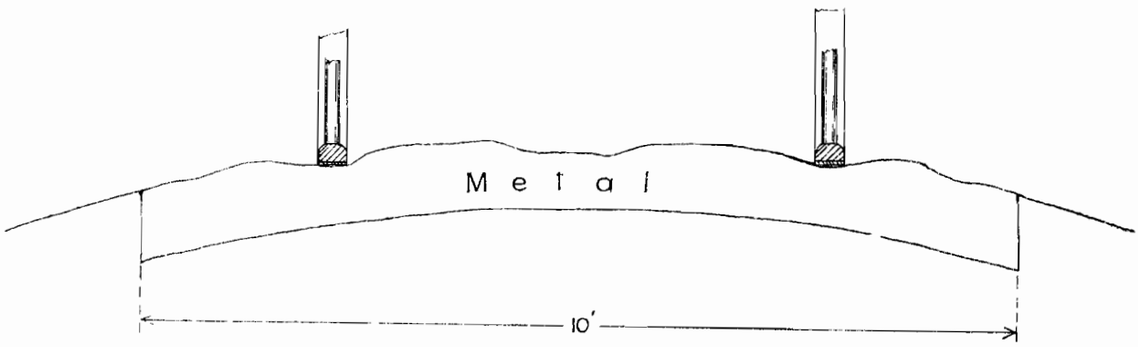
	Area acted upon in sq inches	Pressure in lbs per sq inch	Pressure in tons per sq foot
A	1·00	2240 0	144·00
B	50·97	43·94	2·82
C	84·35	26·54	1·70
D	104·23	21·49	1·38
E	126·18	17·75	1·14
F	175·53	12·76	·82

Note. By increasing the depth of metal from six inches to nine inches (one third) the pressure on the road bed is reduced by one half.

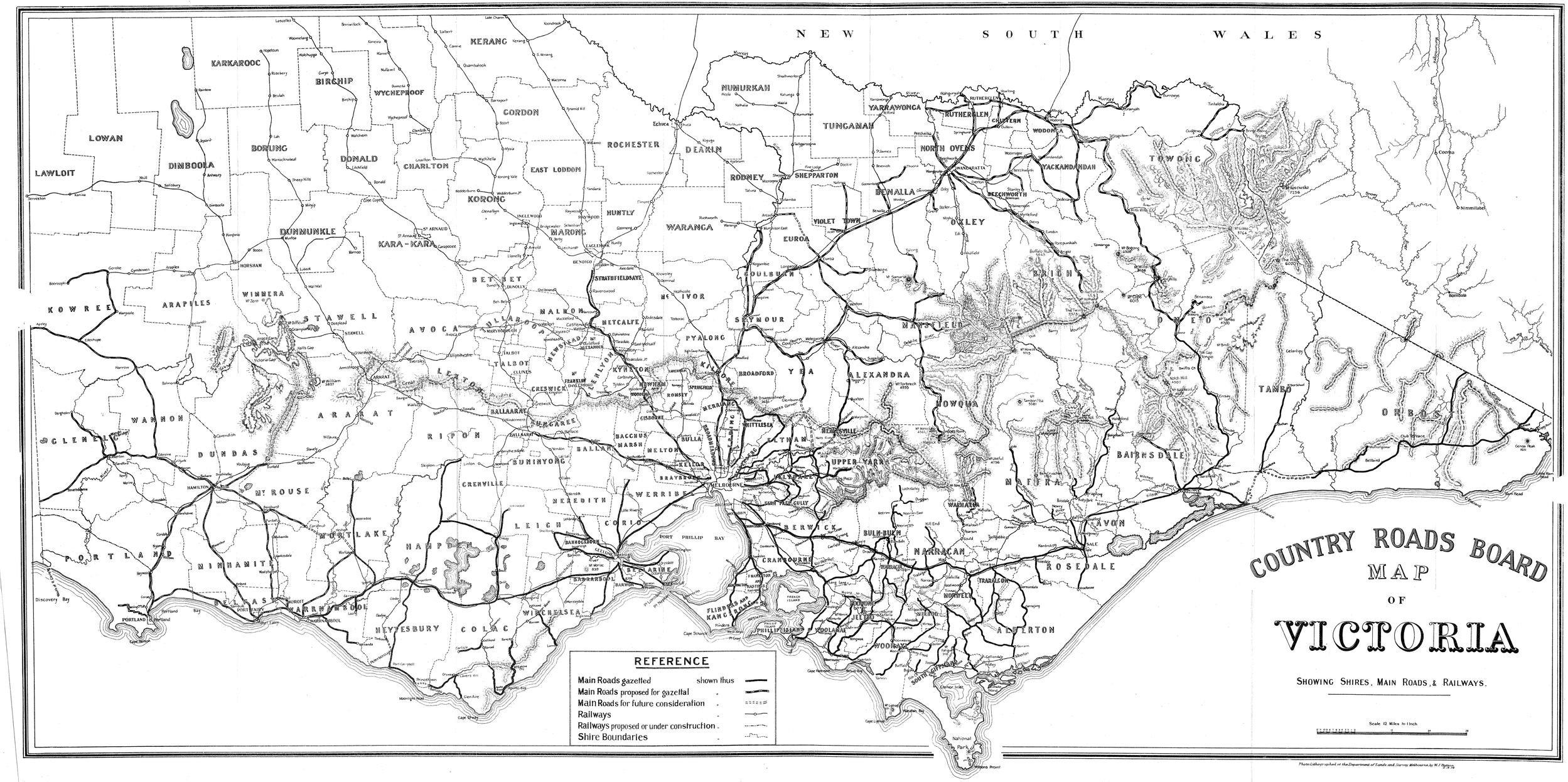
DIAGRAM SHOWING EFFECT OF TRAFFIC ON NARROW ROAD WITH HIGH CROWN



NEWLY FINISHED ROAD WITH HIGH CROWN.
NOTE UNEVEN BEARING OF TYRES ON SURFACE.



THE RESULT OF TRAFFIC CONCENTRATED ON CENTRE OF ROAD.
THREE TRACKS FORMED BY WHEELS AND HORSES.



COUNTRY ROADS BOARD MAP OF VICTORIA

SHOWING SHIRES, MAIN ROADS, & RAILWAYS.

REFERENCE

Main Roads gazetted	shown thus
Main Roads proposed for gazettal	-
Main Roads for future consideration	-
Railways	-
Railways proposed or under construction	-
Shire Boundaries	-

Scale 12 Miles to 1 Inch

Photo-Lithographed at the Department of Lands and Survey, Melbourne, by W. J. Stevens