MAIN ROADS

A Record of the activities of the Department of Main Roads, N.S.W.

Orchards and Dehydration Plant near Wirrimah on the Bendick Murrell—Wirrimah Developmental Road in the Shire of Burrangong.

SEPTEMBER **1948**

MAIN ROADS.

Issued Quarterly by and with the Authority of the Commissioner for Main Roads.

Vol. XIV, No. 1. *Sydney, September, 1948.* *Price: One Shilling.*

CONTENTS.

Additional copies of this journal obtainable from the—

Department of Main Roads,

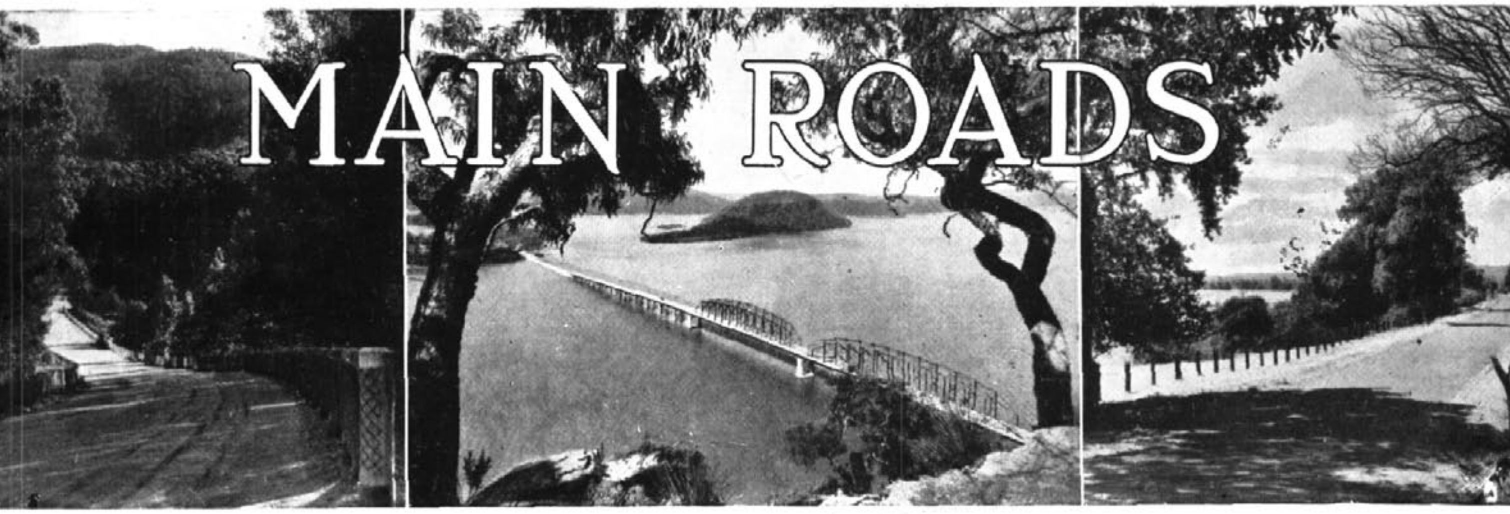
309 Castlereagh Street, Sydney, New South Wales, Australia.

Box 3903 G.P.O. Telephone: M 6231. Telegrams: "Mainroads" Sydney

Annual Subscription, 4/-; Post Free.

Next Issue December, 1948.

*93254



Vol. XIV, No. 1. *Sydney, September,* 1948. 1

Types of Road Surface in New South Wales.

COMPARISON WITH THE UNITED STATES OF AMERICA.

•

The type of surface or pavement existing on the roads of a country is to some extent a measure of the progress made in road improvement. It is not in any way a complete measure of progress because other essentials of a good road include adequate drainage, width, alignment, grading, strength of pavement, etc., to suit the nature and volume of traffic, and the achievement of an efficient and safe standard in these respects is often of more importance than the provision of a higher type of surface. This applies particularly in areas of rugged topography, as in eastern New South Wales. Bearing these qualifications in mind, it is of interest to see the trend of pavement types in New South Wales, and to compare with the position in the United States of America. Such a comparison is based purely on mileage of pavement surface types and disregards completely all other factors. For example, the large traffic volumes on many roads in the United States have called for standards of width, alignment, grading, etc., far superior to those provided in New South Wales, but these essential features are not disclosed in a comparison which relates only to surface types.

Figure 1 shows pavement types in New South Wales, excluding the Western Division, as at 1931, 1936 and 1946 in respect of proclaimed main roads, and shows separately, (a) State Highways, (b) State Highways and Trunk Roads, and (c) State Highways, Trunk Roads and ordinary Main Roads. The Western Division has been excluded since details of the pavement types in this area of the State for 1931 and 1936 are not available. It will be noted that the improvement in pavement types is to some extent masked by the increase in the mileage of the main roads system during the years, from 13,822 miles in 1931 to 17,125 miles in 1946, due to the addition to the system from time to time of roads not previously included in it. The diagrams indicate a steady expansion in the mileage of roads having a dustless bituminous surface or better, and a large reduction in the mileage of earth surfaces. The change is greatest on the State Highways, but is significant on each class of main road.

Figure 2 aims at comparing the position on rural roads generally in New South Wales with the position in the United States of America as a whole. In addition, two American States, California and North Carolina, are shown separately. These two States have climatic and topographical conditions resembling in some degree those of New South Wales, and their distribution of primary and secondary industries is somewhat similar to that in New South Wales.

The New South Wales figures only approximately represent the rural road system of the State as, of roads in towns, only those in the Sydney metropolis are excluded.

It will be noted that in the United States, 46.3 per cent. of all rural roads have a gravel surface or better, and that the corresponding figure for New South Wales is 31.3 per cent. In the United States 17.9 per cent. of all rural roads have a dustless surface, and the corresponding figure for New South Wales is 4.8 per cent.

It will be noted also that pavements in the United States coming under the general classification of dustless, are to a much larger degree than in New South Wales, of high type bituminous or cement concrete construction.

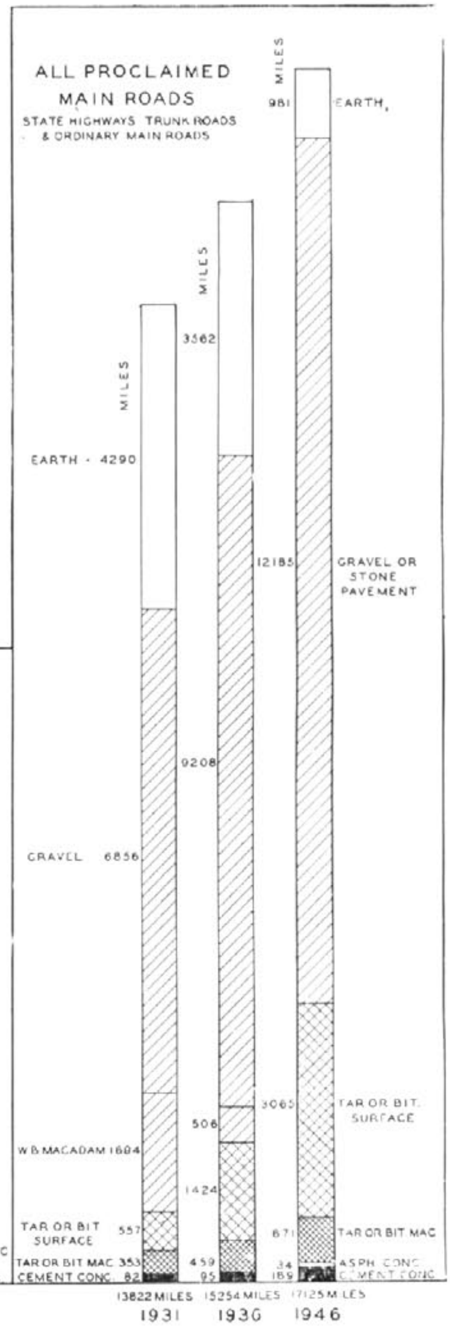
The average population per square mile in the United States is approximately five times that of New South Wales and the number of motor vehicles in the United States per 1,000 persons is one and three-quarter times that of New South Wales.

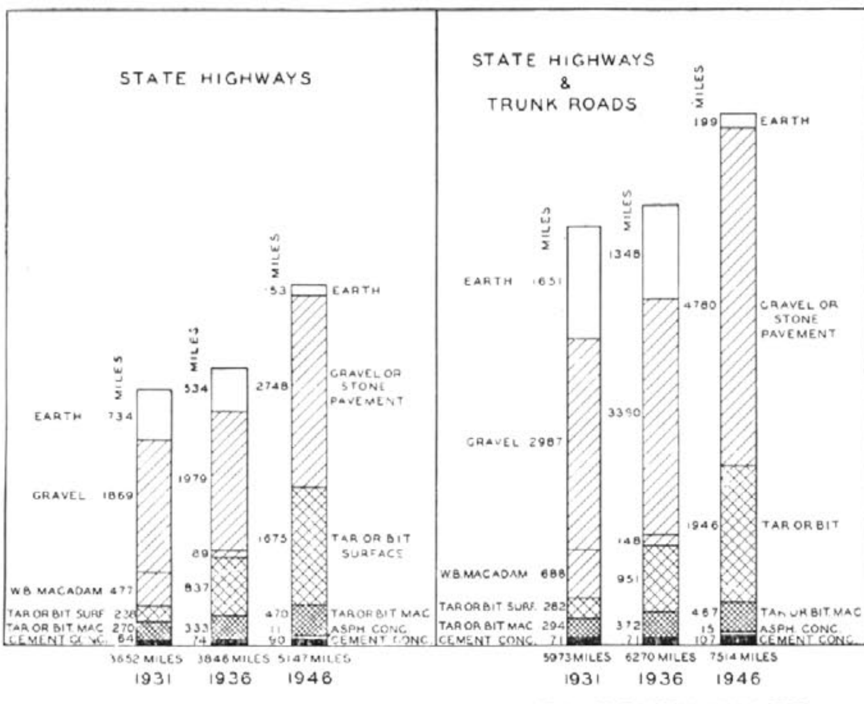
Comparison of New South Wales with California and North Carolina discloses the following figures:—

State.	Percentage of roads having a gravel surface or better.	Percentage of roads having a dustless surface.
New South Wales	31.3	4.8
California	48.8	36.7
North Carolina	33.7	18.7

New South Wales compares with California and North Carolina on an area, population and motor vehicle basis as follows:—

State.	Area sq. miles.	Population.	Motor Vehicles per 1,000 persons.
New South Wales	309,433	2,985,144	129
California	158,762	8,756,000	326
North Carolina	52,712	3,532,000	171





NEW SOUTH WALES
(EXCLUDING ROADS IN WESTERN DIVISION)

FIG. 1

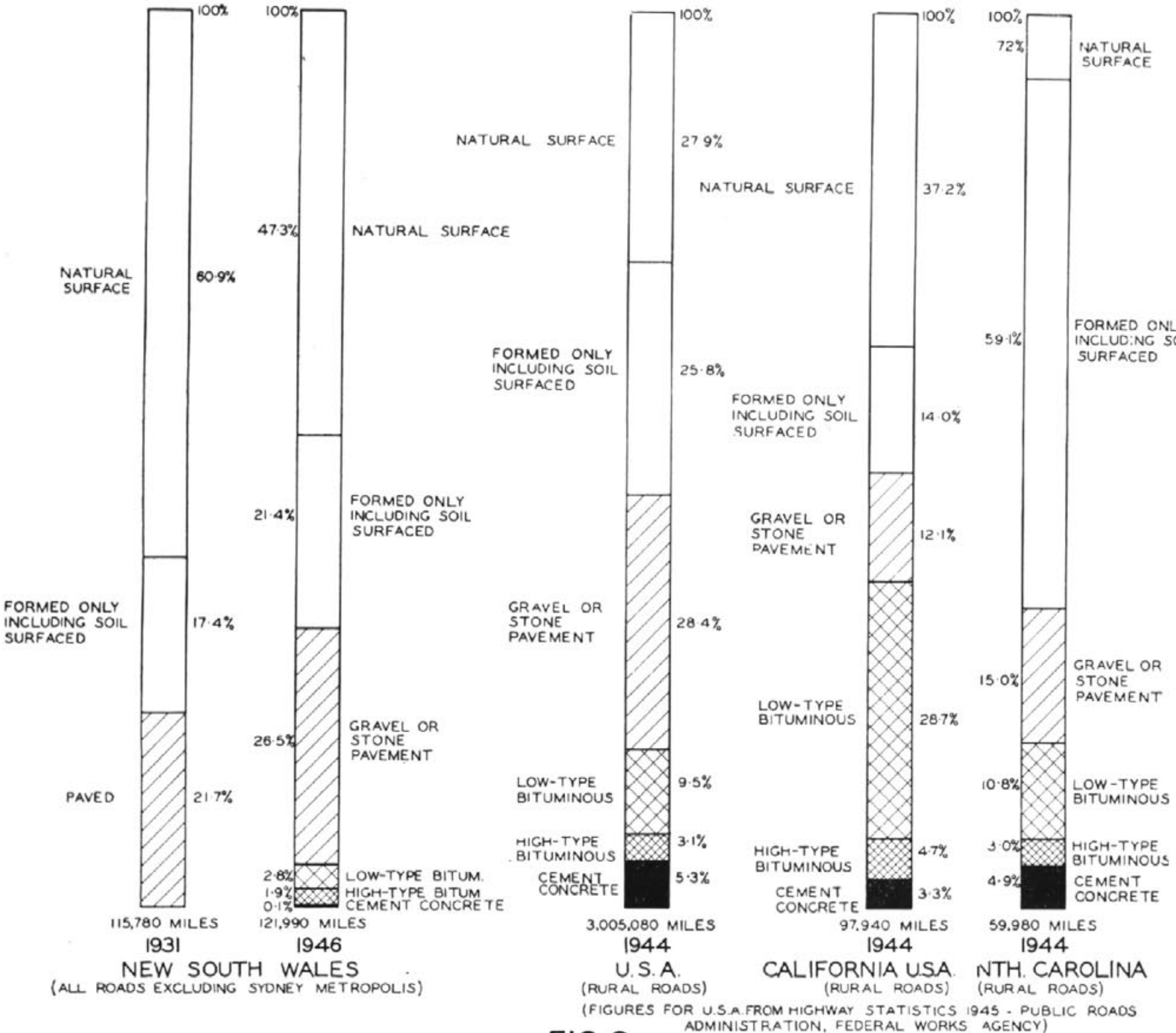


FIG. 2

SYDNEY HARBOUR BRIDGE ACCOUNT.

Income and Expenditure for the period 1st July, 1947, to 30th June, 1948.

Income.	£	*Expenditure.*		£
Road Tolls	352,514	Cost of Collecting Road Tolls		21,500
Contributions—		Maintenance and Minor Improvements		44,500
Railway Passengers	131,000	Alterations to Archways		13,100
Tramway Passengers	16,670	Administrative Expenses		1,300
Omnibus Passengers	9,684	Loan Charges—		
Rent from Properties	9,400	Interest	£257,000	
Miscellaneous	350	Exchange	32,000	
		Sinking Fund	66,000	
		Management Expenses	1,143	
				356,143
		Miscellaneous		750
	£519,618			£437,293

Note: The figures in this Statement are subject to adjustment upon completion of accounts for the year.

Some Examples of Agricultural Development Following Developmental Road Construction.

Dubbledah to Goolhi: Developmental Road No. 1112: Shire of Liverpool Plains.

Emerald Hill in the Shire of Liverpool Plains is the centre of a rich district of grazing and wheat-growing land converted from natural forest during the past thirty years. The Emerald Hill area is served by a road leading from Trunk Road No. 72 about 10 miles north of Gunnedah westward through Emerald Hill to Turrabeile Creek, a distance of about 20 miles.

The route was proclaimed a Developmental Road (No. 1112) in 1928 and since then £13,340 has been spent on general improvements which include clearing, forming, gravelling, the provision of culverts and causeways. Before its construction, the road was in a very rough condition and, passing as it does through undulating black soil country, was quite impassable to traffic during wet weather.

The western end of the road is near the "Napperby" and "Goolhi" estates, big holdings producing heavy crops of wheat and running large flocks of sheep. "Napperby" estate has already been subdivided for soldier settlement, and "Goolhi" estate will be subdivided in the near future.

Locality map.

D.R. 1112. Unconstructed length.

The fat lamb industry is now firmly established and barley and fodder crops are steadily increasing. The district is an important resting and fattening area for stock intended for the saleyards at Gunnedah, about 11 miles to the south. When the proposed abattoirs are established at Gunnedah in the near future, the district will become even more important for supporting stock. Considerable quantities of timber are hauled over the road from the Karringle State Forest to the railway and sawmills at Gunnedah.

A vastly improved and varied production has taken place since the construction of the Developmental Road.

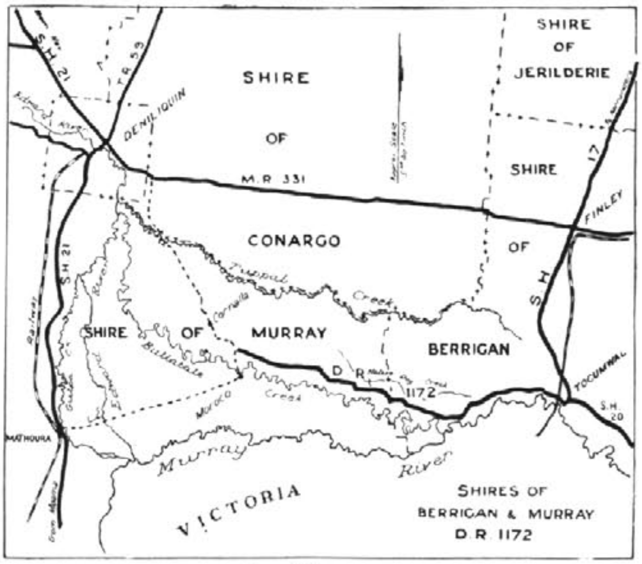
D.R. 1112. Constructed section.

Tocumwal towards Deniliquin: Developmental Road No. 1172: Shires of Berrigan and Murray.

This road serves a district adjacent to the Murray River. The country near the river and its anabranches is low and subject to flooding. It is well suited for wool growing and with irrigation could be intensely cultivated. Much of the land could readily be used for fat lamb raising. Poor access to the railway and Tocumwal-Finley State Highway prevented the development of dairying, citrus growing and vineyards.

Prior to 1937 there were isolated efforts to improve the road system. A Government grant to the Shire of Murray was used for the construction of nine timber beam bridges on the Mathoura-Moroco and Deniliquin-Moroco roads.

The road leading westward from State Highway No. 17 at Tocumwal passes for 14 miles through the Shire of Berrigan and 14 miles through the Shire of Murray. About 4 miles were constructed as Main Road No. 212 before its deproclamation as such, about 3 miles being built with a raised formation. With a grant of £1,750 made to the Shire of Berrigan by the Government in 1935, another length of raised formation was constructed with causeways. The remaining length—about 9 miles in the Shire of Berrigan and 14 miles in the Shire of Murray—was virtually unformed. Means of access were poor under the most favourable conditions. In wet weather the road was impassable and

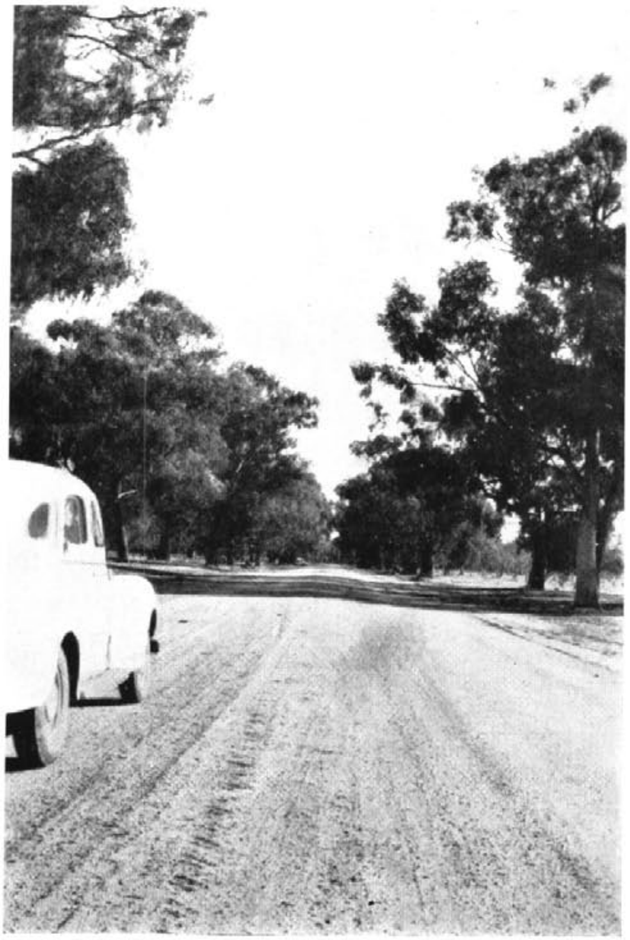


Locality map.

in time of flood it remained impassable for weeks after the flood waters had subsided.

To bring the road to a trafficable condition it was proclaimed a Developmental Road (No. 1172) in

D.R. 1172. Unformed section 20 m. west of Tocumwal.



D.R. 1172. Constructed length 4 m. west of Tocumwal.

August, 1937, and since then in the Shire of Berrigan 3 miles 71 chains have been cleared and formed with 24 feet formation and 16 feet pavement. Two 3-cell and two 1-cell reinforced concrete box culverts have also been provided. The total cost was £2,940.

The outbreak of war prevented any further construction. The Berrigan Shire Council is now preparing plans for the construction of a new bridge at 6.2 miles. The previous bridge, a five-span structure, was severely damaged by the 1946 flood. In the Shire of Murray work is proceeding on the construction of formation, loam pavement and culverts for 3 miles at the Mathoura end of the road. The estimated cost is £1,970.

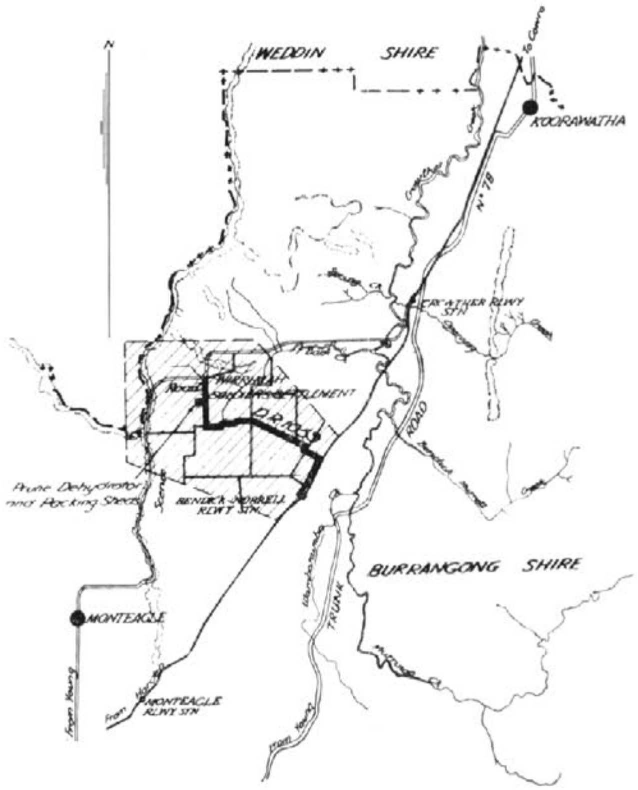
The road passes through about 3,000 acres of State Forest. Round timber, piles, girders, milling timber and firewood are cut and hauled easterly to Tocumwal and westerly to Mathoura. Since the building of the road there has been an increase in the timber traffic. The district was severely affected by the prolonged drought conditions which occurred during the latter part of the war period. There is evidence already, however, that agricultural development is being stimulated by the construction of the road, and steady progress is likely.

Grazing land 6 m. west of Tocumwal served by D.R. 1172.

Bendick Murrell to Wirrimah: Developmental Road No. 1059: Shire of Burrangong.

The Wirrimah Soldiers' Settlement is about five miles from Bendick Murrell Railway Station on the Harden-Cowra railway. The settlement is about 7,000 acres in area, and is occupied by 26 settlers engaged mainly in fruit growing. In this industry, careful transport of the fruit is essential; jolting over rough roads causes spoilage and consequent loss to the grower.

Access to the Wirrimah Settlement was by a rough, stony track. During wet weather, watercourses formed across the track that became liable to erosion after the rain. The poor road was an important factor retarding the growth of the district, mainly because of damage to soft fruit during transport.

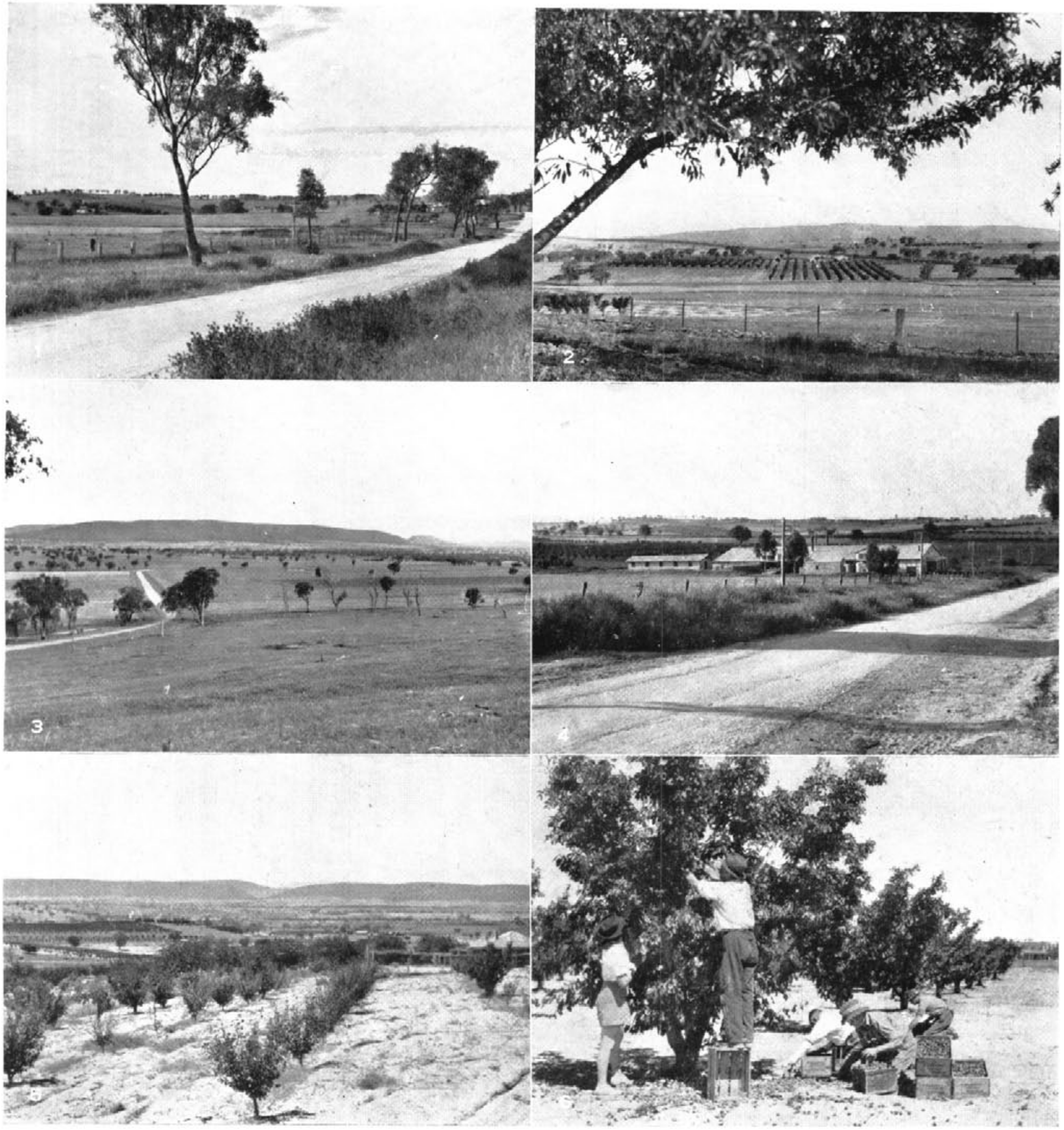


Locality map.

With the assistance of successive grants up to 1941, the Burrangong Shire Council was able to reconstruct the route to practically all-weather standard. The road has been formed 24 feet wide with a 12 feet gravel pavement. The damaging effect of the watercourses has been corrected by the construction of concrete and stone causeways.

At the present time the annual output of the area is approximately 550 tons of prunes and 40 tons of fresh fruit. In 1934 the output was only 300 tons of prunes. Even allowing for increased productivity of the trees due to ageing, much of the greater output can be attributed to the road because of the encouragement to settlers to make fresh plantings. The improved transport has considerably reduced the loss of soft fruit during carriage to the dehydrator and railway.

The road is used for hauling wood fuel to the dehydrator as well as for the general traffic of the district. The country to the west of the Wirrimah Settlement is used for wheat growing and the growers avail themselves of this road to bring the grain to the silos at Bendick Murrell.



D.R. 1059. Bendick Murrell to Wirrimah.

1. Constructed section approaching Wirrimah.
2. Orchards in the vicinity of Wirrimah.
3. Road near Bendick Murrell wheat silos.
4. Dehydration plant at Wirrimah.
5. Prune orchards, Wirrimah Soldiers' Settlement.
6. Prune picking, Wirrimah Soldiers' Settlement.

Barham to East Barham Sawmills: Developmental Road No. 1011: Shire of Wakool.

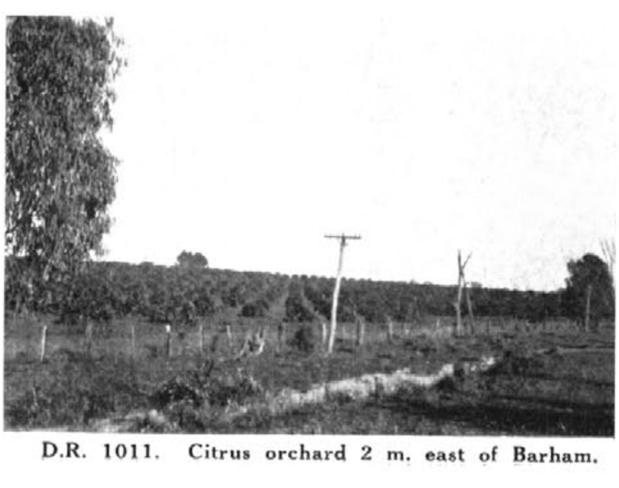
State Forest No. 625 is situated east of Barham on the Murray River and produces about 2,400,000 super feet of Murray River Redgum (hardwood) per annum for milling. The mill employs about 44 men and, in addition, 26,000 sleepers were cut in 1947.

The country between Barham and the State Forest has been largely devoted to soldier settlement. The only means of access through the settlement was a track through black soil country used mainly for hauling timber. During wet weather the track became impassable.

In 1927 under a State-Commonwealth grant the Wakool Shire Council constructed the road from Barham East Sawmills to Barham at a cost of £5,620. The construction included long lengths of high fill and sanding of sections of clayey material.

Grazing land at East Barham served by D.R. 1011.

Since the building of the road, considerable development has occurred. In 1927, 127 acres of citrus fruits were planted. This had increased to 500 acres by 1947 with an annual yield of 150,000 bushels valued at £50,000. Dairying has been established and four new dairies are expected to be in production during 1948. The income from butter fat is £3,600 per annum. Wool growing and fat lamb raising are also becoming features of the district's development, and further progress is likely.

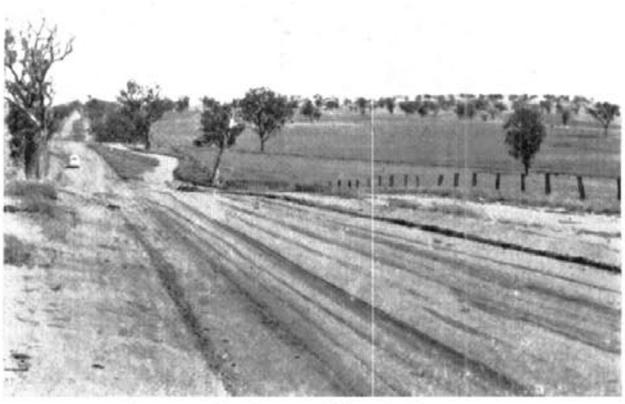


D.R. 1011. Citrus orchard 2 m. east of Barham.

Road connecting the Jingellic-Tumbarumba and Wagga Wagga-Tumbarumba road: Developmental Road No. 1191: Shire of Tumbarumba.

In 1939 the Crown acquired the station property of Munderoo West, in the Shire of Tumbarumba, for the purpose of subdivision for closer settlement. The station was subdivided into twelve farms ranging in area from 840 to 1,030 acres and allotted to settlers. The country, situated in a fertile valley, is suitable for dairying and fat lamb raising. The settlers have put in hand intensive schemes of pasture improvement and as a result large quantities of fertiliser are transported over the railway and road systems. A butter factory is established at Jingellic to the south at the junction of Main Road Nos. 278 and 282 on the Murray River, to which cream is taken from the farms. Other farm produce is taken to the railway to the north, either to Rosewood or Wolseley Park sidings.

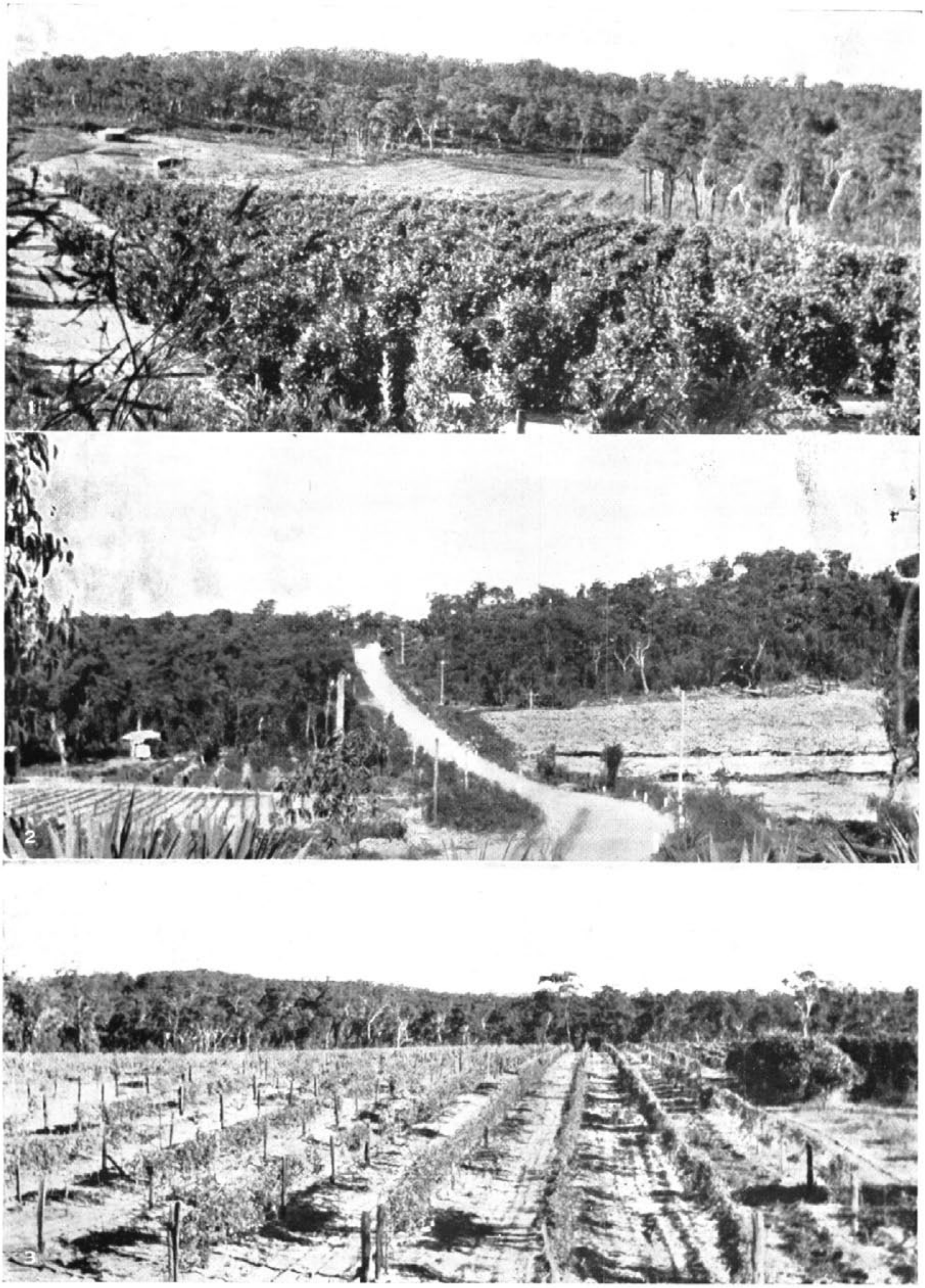
The subdivision of Munderoo West, provided for a road approximately 10¾ miles long connecting the Jingellic-Tumbarumba road (Main Road No. 278) to the south with the Tumbarumba-Wagga Wagga road (Main Road No. 284) to the north. Some clearing and forming of the road was done between 3¼ miles and 5 miles from the southern end under a closer settlement grant, but nothing further was done. No satisfactory road outlet was available therefore, either to the railway, or to the point where the cream was picked up by the Jingellic butter factory.



Grazing land served by D.R. 1191.

After a review of all the circumstances, the Department considered that the formation of a road would greatly assist the proper development of the district. Accordingly the road was proclaimed a Developmental Road in December, 1939.

In planning the work to be done, it was found that all the farmers sent cream to the butter factory and therefore, if work was commenced at the southern end at Main Road No. 278, the immediate benefit would accrue to the greatest number. Funds were allocated on this basis, and two miles of light construction were completed by contract on the 5th February, 1942, at a cost of £1,320.



D.R. 1160. Calga to Kulnura.

1. Orange orchard at Kulnura.
2. Clearing preparatory to Citrus Tree and Passion Fruit Vine Planting.
3. Passion Fruit orchard at Kulnura.

The intervention of the war prevented any further work being done and an allocation of funds to proceed with work to 3¾ miles was withdrawn. Funds have since been reallocated and work is again proceeding. When it is completed there will be a good road for 5 miles north of Main Road No. 278. During the winters of 1946 and 1947 the cream lorry from Jingellic could not proceed past the two mile peg, and settlers north of this point had to transport their cream to the pick-up place. The saving in time and effort for these people will therefore be appreciable.

Between the 5 mile and 8 mile the present road is only a bush track, but it is through sound country and provides a fair dry weather road.

Calga to Kulnura: Developmental Road No. 1160: Shire of Gosford.

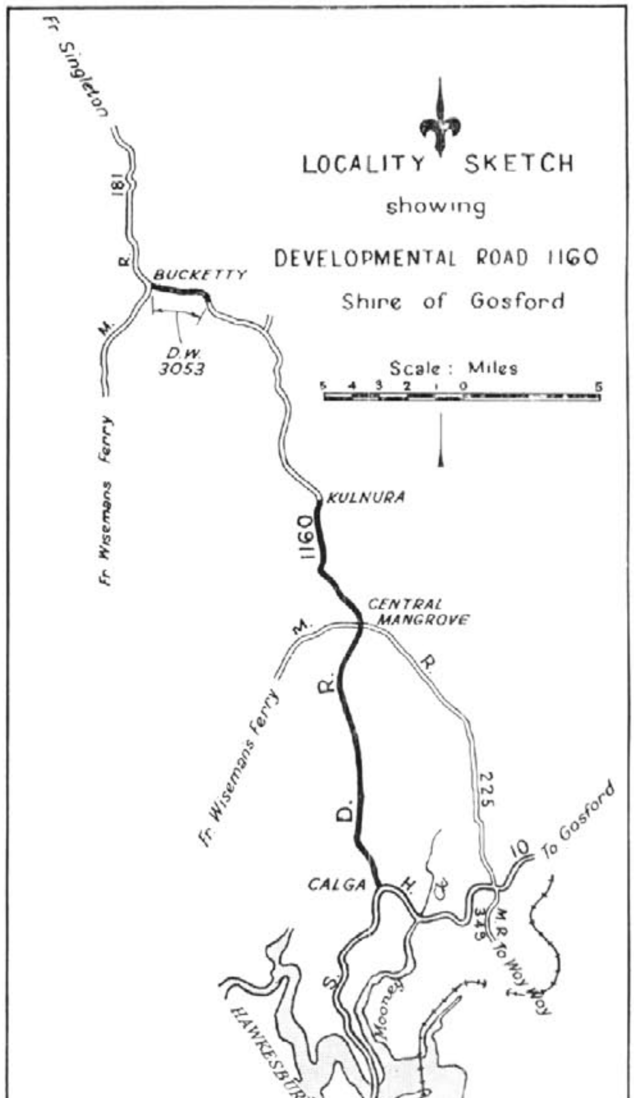
Calga is situated on the Pacific Highway about 10½ miles north of the Hawkesbury River. From Calga a road proceeds northward along "Peat's Ridge" via Central Mangrove and Kulnura to Bucketty on Main Road No. 181 (Wiseman's Ferry-Wollombi Road). Main Road No. 225 (Mangrove Mountain road) is crossed at Central Mangrove.

The district lends itself particularly to citrus orchards and access had previously been obtained only by indifferent tracks leading from Main Road No. 225.

In 1935, the Calga-Kulnura section was proclaimed as a Developmental Road.

Construction for the first two miles was carried out by the Erina Shire Council in 1937-38 with Developmental Road funds. The remaining section of 14½ miles to Kulnura was completed as an Unemployment Relief Work in 1940.

D.R. 1160. A length of constructed road 7 m. south of Kulnura.



Since the construction of the Developmental Road, there has been a substantial increase in the area under orchards, and additional areas are still being cleared and brought under cultivation. Where orchards were previously established, the new road has facilitated the delivery of fruit to the packing shed in good condition.

The road north from Kulnura to the Wiseman's Ferry-Wollombi road (Main Road No. 181) at Bucketty has been constructed by the council for about 10 miles, but there remains a gap of 2½ miles at the northern end that requires completion. This last section was proclaimed a Developmental Work (No. 3053) in October, 1946. Funds have been provided for its construction and the work is to be undertaken by the Kearsley Shire Council.

Bridge Maintenance.

ORGANISATION AND METHODS USED BY THE DEPARTMENT OF MAIN ROADS.

There are 3,895 bridges on the Main Roads system of New South Wales, and 31 bridges on declared Secondary Roads, their maintenance and replacement being partly or wholly financed from the Main Roads Funds. In addition, there are 59 bridges not on Main Roads, and formerly known as "National" works, which are entirely financed from the Main Roads Funds, and 25 bridges on the borders of the State partly financed from Main Roads Funds.

For the Department's purposes, a bridge is defined as any structure where the width of waterway between the inside faces of abutments at the underside of the superstructure is 20 feet or over or, where the abutments consist of driven piles, the centre to centre of the abutment piles is 20 feet or over. It will be apparent that this definition results in many reinforced concrete culverts being regarded as bridges.

The cost of bridge maintenance and construction on Main Roads is shared between the Department of Main Roads and Councils on the following basis*:—

	Department. %	Council. %
Maintenance—		
State Highways in the Country and all Main Roads in the County of Cumberland	100	Nil
Trunk Roads in the Country	75	25
Other Main Roads in the Country ..	66 2/3	33 1/3
Construction—		
State Highways and Trunk Roads in the Country, and all Main Roads in the County of Cumberland	100	Nil
Other Main Roads in the Country	75	25

*NOTE.—In the County of Cumberland, councils contribute indirectly to bridge maintenance and construction, together with other main road work, by means of a rate levy of 7/16 of a penny in the £ on the U.C.V. of land.

In the country, the Department's assistance is generally limited to bridge widths sufficient to carry two lanes of traffic.

The greater part of the mileage of the Main Roads system is under the care and control of Councils, whose responsibilities include bridge maintenance on the lengths under their control. The bridges maintained by the Department comprise bridges on roads maintained by the Department, bridges on the borders of New South Wales, bridges which are a State responsibility on roads other than Main Roads, and the Sydney Harbour Bridge, the last mentioned not being financed from Main Roads Funds.

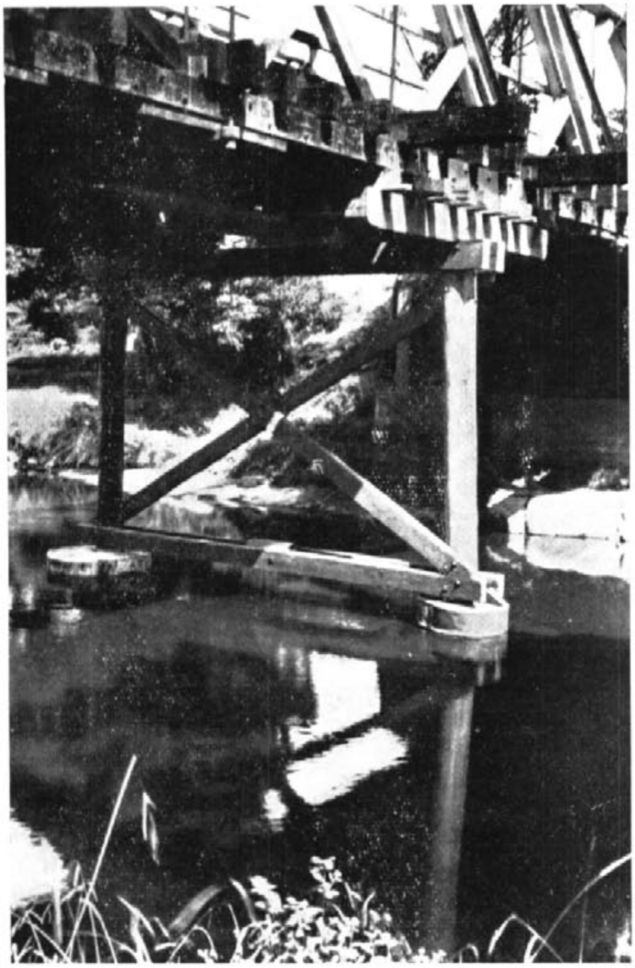
Grouped according to their type of construction, the bridges maintained directly by the Department are as follows:—

Steel	98
Reinforced concrete (includes stone bridges)	199
Timber	620
	917

Bridges maintained by Councils at the partial or complete cost of Main Roads Funds are as follows:—

Steel	175
Reinforced concrete (includes stone bridges)	849
Timber	2,069
	3,093

Timber painting gantry.



Temporary central support under a timber truss span.

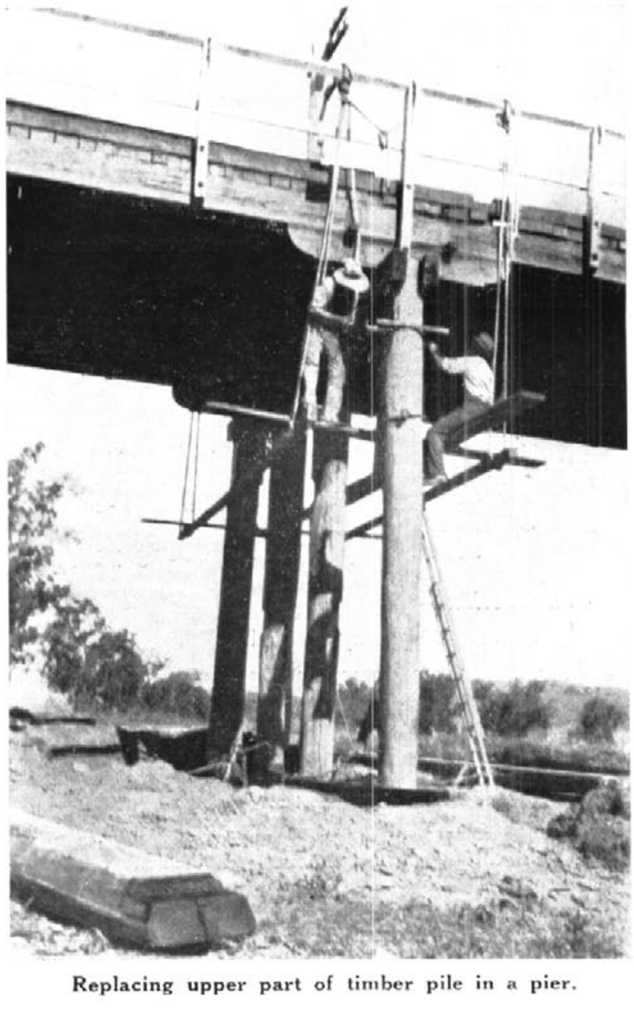
The majority of the bridges on Main Roads in New South Wales consist of beam spans. Bridges maintained by the Department include 26 structures having one or more steel truss spans, and 129 having one or more timber truss spans. In addition, there are several arch spans. The Sydney Harbour Bridge, although maintained by the Department of Main Roads, is not maintained from Main Roads Funds. Bridges maintained by Councils include 62 structures having one or more steel truss spans, and 50 having one or more timber truss spans.

During the war years bridge maintenance by the Department could not receive the attention normally necessary owing to shortage of manpower, and the need to divert the Department's repair gangs to defence works in the Northern Territory, in Queensland and in New South Wales. Much the same applied to works under the control of Councils. The replacement of old worn out structures was also necessarily much reduced in volume. As a result, at the end of the war there was a large accumulation of urgent maintenance and replacement work awaiting attention. Progress with this has been severely handicapped by shortages of labour, timber, cement, steel and paint, and many urgent works are still untouched.

Inability to undertake replacements when due has made it necessary in some cases to carry out extensive and uneconomic temporary repair work—essential, however, to avoid breakdown of the road transport system.

Organisation of Bridge Maintenance Work.—For purposes of administration, the work of the Department is divided among twelve divisions and two districts (Bourke and Broken Hill), each in charge of a Divisional or District Engineer. To each division and district is allocated one or more bridge repair gangs as necessary, each under a foreman reporting to an engineer at the divisional or district office. There are 24 bridge repair gangs each comprising about six workmen. The average number of bridges cared for by each gang is thus about thirty.

Each bridge repair gang moves from job to job in accordance with a prearranged annual programme. The gang is equipped with a standardised set of hand tools, tackle, traffic warning signs and lights, etc. Typical equipment lists are given at the end of this article. Heavy materials, such as timber, are delivered to the site before the gang arrives. Each gang is supplied with a motor truck for movement of gang and equipment



Replacing upper part of timber pile in a pier.

between jobs, and for transport of stores, etc., as required.

Methods.—Every bridge is carefully examined at least once each year. Periodically in the case of timber bridges, the members are bored to determine the condition of the members. The results of borings are recorded on diagrams of the structure in such a way as to enable the extent of any renewal work required to be readily assessed.

Bridge inspection work underwater is carried out by experienced divers equipped with all necessary diving gear. Underwater inspection is especially necessary in the case of timber piers in tidal waters, on account of presence of *teredo navalis* or shipworm, and of Limnoria. Divers are also frequently used to assist bridge gangs where underwater repair work is required.

Where a timber bridge has reached a stage requiring renewal of members, estimates are prepared, financial provision is made in the annual maintenance programme and orders are placed for the materials required. Under present conditions materials cannot sometimes be obtained until as much as a year after the placing of orders, which renders difficult the organisation of the repair work in advance.

When renewal work is carried out on a timber bridge, all timber likely to require renewal within the next few years is replaced by new material in order to avoid the need for frequent costly dismantling of the structure and interference with traffic. At the same time painted work is repainted, bolts tightened, etc.

In the case of renewal of members of timber truss bridges, standard instructions are supplied to foremen setting out the procedure to be followed to avoid mishap.

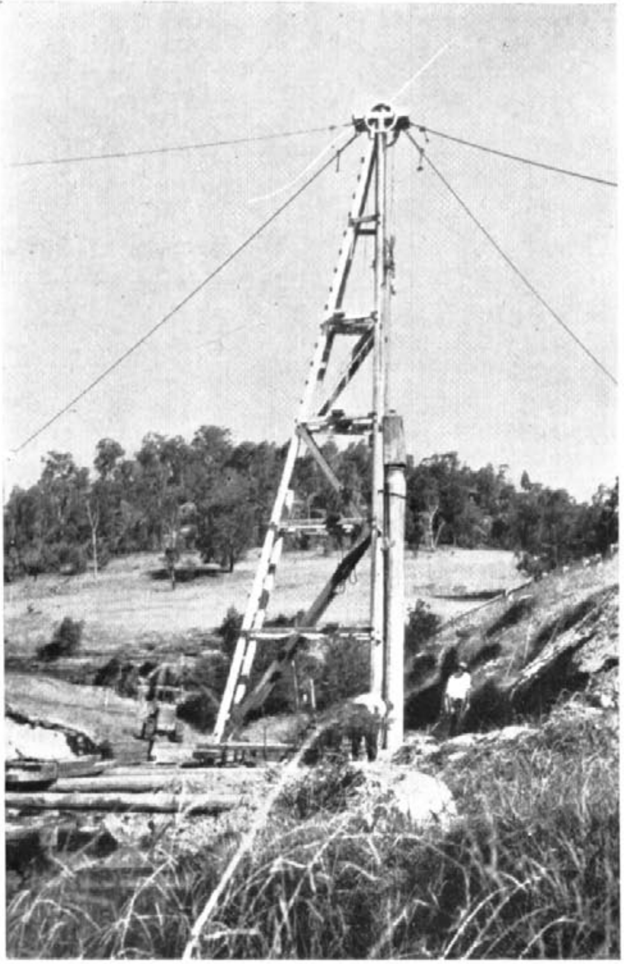
Standard instructions are also issued describing the methods to be followed in order to prevent or eliminate attack of timbers by termites.

In cases where most of the members of a timber truss bridge are deteriorated and the provision of a new structure is not practicable immediately, two methods of temporarily strengthening the structure are available. One of these is by the introduction of struts or "toms" under the trusses. These, however, are liable to cause blockage of the stream in time of flood. The other method is to use wire ropes and turnbuckles to "undertruss" each truss, in effect causing the lower chord of each truss to act as a trussed beam.

The Bailey Military Bridge has also been used to carry loads temporarily where an old structure was failing, the Bailey trusses being placed inside the old trusses.

Running planks two inches thick, placed longitudinally are often attached to the deck of an old timber bridge awaiting renewal in order to provide smooth

Undertrussing of span.



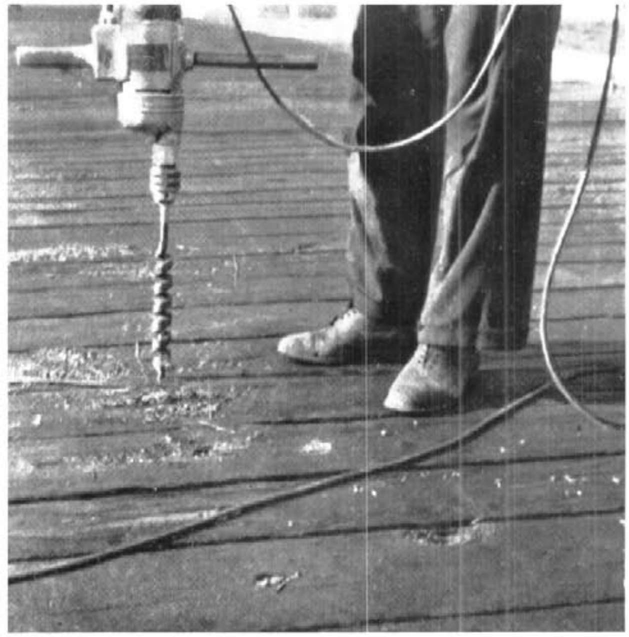
Driving a timber pile.

riding conditions for traffic and to reduce impact on the structure resulting from irregularities in the surface of the old deck.

A feature of timber bridge repair work during recent years has been the use of small power drilling units to replace the hand auger. The type most commonly used is petrol driven with a flexible shaft, but where electric power is available, a motor driven drill may be used. On works involving the use of an air compressor, pneumatic drills are adopted.

The foregoing describes methods applicable mainly to timber bridge maintenance work, because timber bridges predominate, and because the life of timber is limited and repairs are frequent. The Department's bridge repair gangs include all types of structure within their work, however. In the case of steel bridges, cleaning, scraping and painting are carried out at intervals of about six to twelve years, depending on distance from the sea and climatic conditions. In the arid western portion of New South Wales, corrosion of steel is slight. Some of the older steel bridges have been equipped with new reinforced concrete decks in place of old macadam covered buckle-plate decks.

Normally, in preparing surfaces of steel bridges for repainting, any areas showing signs of rust or other



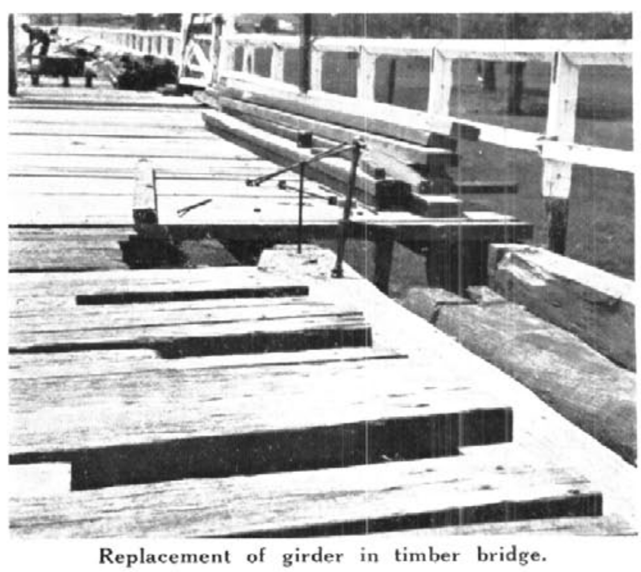
Electric auger boring decking.

deterioration are scraped, either by hand or by mechanical de-scaling machines.

Steel bridges in the coastal areas require a higher standard of protective coating than those inland. In the case of the older bridges near the coast, this is secured by sand-blasting to remove the old film completely prior to re-priming and repainting. Two recent examples are the bridge over the Nepean River at Penrith, and the bridge over South Creek at Windsor.

The maintenance of the Sydney Harbour Bridge is carried out by the Department by a special organisation set up for that purpose, and will form the subject of an article in an early issue of this journal.

Reinforced concrete bridges away from the coast have required little maintenance attention except where damaged by traffic or by river scour, or where faulty



Replacement of girder in timber bridge.

workmanship has been disclosed. Coastal bridges subject to the effect of salt water and salt air have to a small extent suffered by corrosion of steel reinforcement. Remedial work has been necessary only in a few cases, and has taken the form of removing surface concrete which has been loosened by corrosion of the underlying steel, cleaning rust from the steel, and restoring the surface concrete. The best means of cleaning steel is by sand blasting and the best means of restoring the surface concrete is by cement gun, which applies mortar in thin dense layers by the force of compressed air. For best results, layers should average about one-quarter of an inch in thickness, and should not exceed half an inch. It will be seen that the building up of, say 2 inches, requires about 6 or 8 applications.

Engineers engaged on reinforced concrete bridge design from time to time inspect the older reinforced concrete bridges, in order that any faults which may have become apparent may be avoided in future designs. Design officers also inspect works under construction when conveniently situated.

TYPICAL EQUIPMENT LISTS FOR BRIDGE REPAIR GANGS.

List "A."

For a bridge repair gang consisting of a working foreman, one bridge carpenter, three bridge carpenters' labourers. (For additional numbers more tools will be required.)

1 motor truck, 2½-4 tons capacity with power take-off.
1 ladder, 15 ft. long.
1 ladder, 20 ft. long.
1 extension ladder.
Assorted staging planks.
1 hand winch—capacity 1 ton off barrel.
200 ft. ½ in. wire rope.
200 ft. ⅝ in. wire rope.
400 ft. 2½ in. hemp rope.
200 ft. 1½ in. hemp rope.
2 ¾ in. x 12 ft. wire rope slings with thimble each end.
2 single blocks for wire rope.
2 double blocks for wire rope.
2 treble blocks for wire rope.
4 single blocks for hemp rope.
3 double blocks for hemp rope.
2 snatch blocks for each type.
2 1½ in. x 5 ft. turnbuckles.
2 1 in. x 4 ft. turnbuckles.
2 bottle jacks—10 ton capacity.
1 wallaby jack—2 ton capacity.
1 wallaby jack—4 ton capacity.
1 traversing jack—20 ton capacity.
1 petrol-driven drill.
2 5 ft. carpenters' cramps.
2 3 ft. carpenters' cramps.
1 56-lb. anvil.
1 forge with blower.
1 set blacksmith's tools.
1 set stocks and dies.
1 7-lb. sledge hammer.
2 10-lb. sledge hammers.
1 14-lb. sledge hammer.
1 3-lb. Gympie hammer.
Augers—screw and bullnose.
Chains: ½ in.—2 6 ft., 2 8 ft.
⅝ in.—2 6 ft., 2 8 ft.
1 6 in. leg vyce.
1 5 in. bench vyce.
1 light timber trolley with 12 in. wheels.
1 heavy timber trolley with 18 in. wheels.
1 5 ft. cross-cut saw.
1 6 ft. cross-cut saw.
1 grindstone.
1 1 ft. 6 in. Clyburn spanner.
1 2 ft. Clyburn spanner.
1 12 in. hacksaw with blades.
1 15 in. hacksaw with blades.
2 adzes.
2 axes.
1 broad axe.
6 steel wedges, 20 in. x 6 in.—1½ in. to ½ in.
1 1 in. drift, 2 ft. long.
1 ¾ in. drift 2 ft. long.
2 6 in. spike punches.
2 1¼ in. x 6 ft. crowbars, pointed one end chisel other.
2 1¼ in. x 5 ft. crowbars, pointed one end claw other.
4 ⅝ in. deck hooks, 3 ft. long, with round handle and hooked end.
1 tool box.
1 blow lamp—1 pint capacity.
1 24 in. steel square.
1 pair bolt cutters—capacity up to ¾ in.
Ratchet brace and drilling post and twist drills, ⅝ in., ¾ in., ⅞ in. and 1 in.
1 14 in. Stillson wrench.
1 24 in. Stillson wrench.
2 cantilever hooks.
3 jiggers.
Spanners, 2 ⅜ in., 2 ⅝ in., 2 ½ in., 4 ¾ in., 4 ⅞ in., 4 1 in., 2 1¼ in.
Shackles (screwed)—2 ⅝ in., 2 ¾ in., 2 ⅞ in.
Ambulance chest.
2 picks (muck).
2 shovels, round mouthed, short handle.
Files—2 10 in. bastard, 2 16 in. rough, 2 mill saw fine.
Cold chisels—2 1 in. x 8 in., 2 ¾ in. x 6 in., 2 round nose ¾ in. x 6 in.
Bolts, nuts and washers (assortment).
2 trestles.
2 pipes, 1½ in. x 5 ft.
1 metallic tape, 100 ft. long.

List "B."

The following additional equipment should be on hand in a central location for use by bridge repair gangs as required:—

1 pile-driving machine—35 ft.—with 35 cwt. monkey, tripper, &c.
1 portable pile-driving machine—30 ft.—on wheels, with 35 cwt. monkey, tripper, &c.
1 winch for above (if steam with boiler).
1 hand-winch.

Portable grinder and brush (petrol driven) as in Kopsen drilling unit.
1 portable welding plant for Metropolitan, Newcastle and Grafton.
1 oxy-acetylene torch.
2 pile rings—14 in. dia. 2½ in.—1 in.
2 50-ton hydraulic jacks.

List "C."

Equipment required by a foreman and labourer engaged in examination and testing of condition of bridges:—

1 motor truck 1 ton capacity.
200 ft. hemp rope 2½ in. circumference.
100 ft. hemp rope 1½ in. circumference.
100 ft. hemp rope 2 in. circumference.
1 ladder 15 ft.
1 extension ladder.
Staging planks.
3 single blocks for hemp rope.
1 snatch block for hemp rope.
2 wallaby jacks—2 tons capacity.
Supply bolts, nuts and washers.
Steel wedges—2 20 in. x 6 in. x 1 in. to ½ in.
Crowbars—1 4 ft. x 1⅛ in., 1 5 ft. x 1¼ in.
Spanners—2 ½ in., 2 ⅝ in., 2 ¾ in., 1 1 in., 1 1¼ in., 1 Clyburn 24 in.
2 White Ant respirators and blowers.
½ cwt. 7½ in. deck spikes.
½ cwt. 8 in. deck spikes.
¼ cwt. 10 in. deck spikes.
Screw augers, 2 ½ in.
Also 2 braces and bits ⅜ in. and ½ in.
1 handy billy tackle with double and treble blocks for 2 in. circumference hemp rope.
1 cross-cut saw, 4 ft.
1 metallic tape, 100 ft. long.

The Danger from Straying Stock.

Live-stock straying on main roads and other thoroughfares creates serious hazards to motor traffic, particularly at night. For the two years ended the 31st December, 1947, official accident statistics for New South Wales disclose that 214 motor vehicle accidents were attributed to straying stock. Five persons were killed and 100 injured in the two year period. It is common knowledge that many cases occur where stock are lightly struck or just missed by vehicles, and accident just avoided.

The most frequently noted patterns of accidents involving travelling stock appear to be as follows:—

(i) Vehicle striking or swerving to avoid an animal standing or lying on the road pavement.

(ii) Animal suddenly moving from roadside to pavement in the path of the oncoming vehicle and striking it or causing violent swerving and braking.

Cows and calves are chiefly involved in group (i), and horses and sheep in group (ii).

The menace of straying live-stock is particularly acute in some dairying districts in coastal areas. The elimination or substantial reduction of the hazard is practicable. The prime responsibility in the matter lies with the stock owner, either to refrain from turning stock loose on to fenced public roads, or to take all necessary steps to prevent stock from straying and to recover them promptly when they do stray.

To provide for the case that an owner does not control his stock as required, Shire and Municipal Councils have been or may be given certain powers under Section 426 of the Local Government Act, 1919, to round up and lodge in a pound all stock found straying in public road reserves. Subsection (1) of Section 426 provides that a Municipal Council may impound straying stock found at large in any public place or trespassing on any land vested in or under the control of the Council. Any animal found in a Municipality trespassing on any public land which adjoins a public road may also be impounded by the Council.

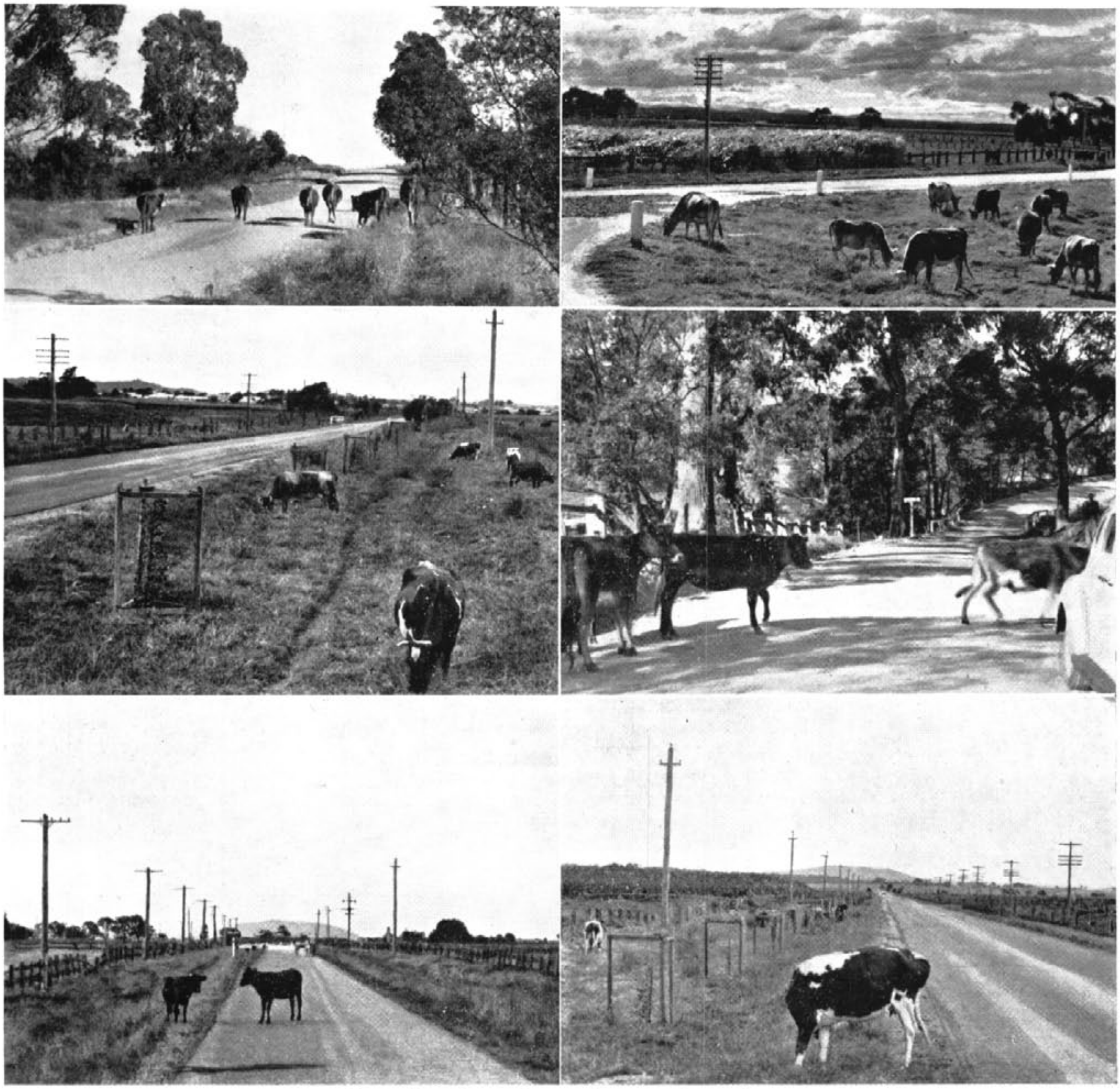
Similar powers are given to Shire Councils, but are restricted—

(a) to areas where Texas or tick fever is prevalent, or where there is reason to apprehend danger of animals being affected by such fever;

(b) to villages, towns or urban areas; and

(c) outside villages, towns or urban areas—to public places (other than roads) which are sufficiently fenced, and to lands vested in or under the control of the Council which are sufficiently fenced, and to roads which are sufficiently fenced on both sides.

An amendment of the Local Government Act in 1945 provided that the provision of Section 426 (i) may be extended by proclamation to the whole or any part of the area of a Shire. In such cases the limitations (a), (b) and (c) abovementioned will not apply.



Examples of straying stock on main roads.

In those parts of the State where unfenced properties, usually relatively large holdings, flank the road reserves the presence of live-stock on or near the road formation must be expected, and it is therefore necessary for the drivers of motor vehicles to keep a very sharp lookout. Fortunately, however, it is most commonly the case that the unfenced roads are in open country where sight distance is at least adequate for the usual speed of travel.

It will be seen that, as in most actions and movements to promote road safety, the co-operation of a number of parties is required to correct hazardous conditions arising from straying stock. The benefits of such co-operative action are likely to be so substantial in improved road safety as to call for a maximum effort in ridding roads of what at present can be regarded only as an unnecessary hazard to life and limb.

Items of Interest.

AUSTRALIA'S FIRST ROAD.

When the original settlement was established in Sydney in 1788, the first road built was from Dawes Battery along the west of Sydney Cove and skirting the Cove about the present foot of Grosvenor-street, to cross the Tank Stream by a small wooden bridge, then rising to Governor Phillip's residence at the site of the present Government Architect's building in Phillip-street.

CENTRE-LINE MARKING OF MAIN ROADS.

The total mileage of centre-line marking or re-marking carried out on main roads during the financial year 1947-48 was 2,004 miles. The use of approximately 14,000 gallons of paint was required for the work. The mileage quoted includes the Hume Highway from Sydney to Albury (360 miles), the Pacific Highway from Sydney nearly to Stroud (125 miles), the Prince's Highway from Sydney to Bateman's Bay (180 miles), the New England Highway from Hexham to the other side of Glen Innes (317 miles) and the Mitchell Highway from Sydney to Narromine (283 miles). These mileages represent the miles of marking and not necessarily the total road distance.

Arrangements have been made to adopt the uniform system of traffic centre lining which is now to apply throughout Australia. As set out in the 22nd Annual Report of this Department, this will consist of a broken line, and where passing is not allowed—a full line placed on the side from which passing is prohibited. The change over will be to a one-colour two line system instead of the two-colour three line system which has operated up to the present. The alteration in this State will be made gradually as existing lines require repainting or new lines are established.

ALLOCATION OF MOTOR VEHICLE AND PETROL TAXATION FOR EXPENDITURE ON MAIN ROADS.

Half the motor vehicle tax collected in the County of Cumberland (Metropolitan area) is spent in the County of Cumberland. The remaining half, together with the whole of the motor vehicle tax collected in the area outside the County of Cumberland is spent outside the County of Cumberland.

As a result of this method of distribution approximately 25 per cent. of the proceeds of motor vehicle taxation collected in the State is spent in the County of Cumberland and approximately 75 per cent. in the Country area. The proceeds of petrol taxation allocated for expenditure on main roads is proportioned for expenditure as between the County of Cumberland and the portion of the State outside the County of Cumberland in the same ratio as are the proceeds of the motor vehicle taxation.

ROAD DESIGN IN RELATION TO SAFETY.

The principal aim in the design of roads is to provide that when the road is constructed traffic is enabled to proceed safely up to the permissible maximum speed. Road Safety requires the provision of suitable general alignment and grades, adequate and consistent curvature, adequate visibility, adequate width of shoulders and pavements, suitable camber of the pavement and banking and widening on curves, convenient and efficient intersections and junctions. These features are determined for the speed and volume of traffic likely to use the road.

Important contributions also to road safety are the provision and maintenance of road signs (e.g., warning signs, directions signs, information signs), guide and fender posts and protection fencing and also the traffic centre lining of roads.

In the final analysis "Safe Roads" are only so if safely used, and the success of all efforts depends on the co-operation of the road user who in the main, holds the last opportunity of avoiding accidents.

TRAFFIC OVER PEAT'S FERRY BRIDGE.

Peat's Ferry Bridge on the Pacific Highway over the Hawkesbury River was opened to traffic on 5th May, 1945, prior to which date traffic was transported by vehicular ferries. The total number of vehicles which used the bridge during the financial year ended 30th June, 1948, was 516,882 comprising 442,923 cars, utilities and motor cycles and 73,959 lorries, or an average of 1,412 vehicles per day. This figure is 28 per cent. higher than the maximum number transported annually on the ferries, which was during the financial year ended 30th June, 1940, when the total was 402,695 or an average of 1,100 vehicles per day.

LABOUR STRENGTH ENGAGED ON MAIN ROAD WORKS.

The number of men employed directly on Departmentally subsidised road works by both the Department, Shire and Municipal Councils in June, 1948, was 5,078.

The Design of Subsoil and Subgrade Drainage.

Provision of an effective drainage system is an essential feature of all road construction. The need for measures to prevent damage by surface water is so apparent that suitable provision is invariably made in road design and construction. The need for subsoil and subgrade drainage may be less obvious, however, and, further, the precise form it should take is not always apparent prior to the construction of earthworks. For these reasons it tends sometimes to be neglected. Such neglect can have serious consequences later, particularly where bituminous or other high class pavements are constructed, or where embankments and cuttings are built on steeply sloping ground. The object of this article is to describe suitable methods of subsoil and sub-grade drainage, and the circumstances which call for their use.

Prior to design of a road, a thorough investigation of ground water conditions should be made and provision where necessary for subsoil and subgrade drainage should be indicated on road plans. Without proper investigation the design of subsoil drainage is haphazard and the success of any works undertaken is at least doubtful. As such drainage works are costly the investigation should be complete and, if possible, made during a wet season or after heavy rains when the ground water is likely to be standing at its highest level and the worst conditions may be observed. Investigation may be modified to some extent in cases where only low class construction is proposed and the repair of weaknesses found during or after construction will not be expensive. In some cases, too, it will be inadvisable to incur high expenditure for drainage facilities when ground water conditions are likely to be altered materially as a result of construction, consolidation of the subgrade and pavement, clearing of timber from the roadside, etc.

The most important facts to be determined by investigation are the nature of the subsoil, the location and depth of the water-table* or "free water" surface, and the direction of flow, if any, of the ground water, which is normally roughly parallel to the ground surface.

Free water can be located by test holes or by auger borings. In boring with an auger the upper portion of the soil may be wet from capillary water but no water is seen on the samples. When, however, the water-table is reached, water will be seen on the samples or will show in the hole. In the larger test holes, in cuttings, or where the water-table reaches the surface of the ground the free water zones are indicated by springs or seepage. In heavy clay soils this seepage may be very slow.

There are various types of sub-drain that have been used for different purposes, as follows (see Figure 1):

(a) *The "French" drain.* This consists of a trench backfilled with coarse broken rock, usually to 3-inch maximum size. As the only path for flow of water along the drain is through the voids, the discharge accommodated is not very great and the hydraulic efficiency low. It is unsuitable in roadwork for all except very minor drains carrying very little water, e.g., shoulder drains. The relatively large size of rock is necessary to provide sufficient voids for the flow, but large voids may permit washing in of soil, thereby tending to fill the voids and choke the drain.

(b) *The farm drain.* This consists of an open-jointed pipe laid in a trench backfilled with soil. This is suitable for farm use as it does not interfere with cultivation, but it may not be so satisfactory for road work. It prevents fields remaining waterlogged, but it does not function like an "intercepting drain" as ground water can pass over and round the pipe. Also, especially in heavy soils, entry of water into the pipe is slow, and serious damage could be done to a road before there was any appreciable removal of water by the drain.

(c) *Intercepting drains.* These consist of trenches in which an open jointed pipe is laid, the trench being filled with pervious material. This pervious material may be rounded gravel or crushed rock, the best grading being 95% passing ¾-inch sieve, 95% retained No. 10 sieve, the bulk of material being between ¼-inch and ½-inch sieve. The voids in such material are ample for the downward flow of water, but are not large enough to choke readily with soil.

The top of the drain may be sealed with impervious material to make a "sealed top" or may be filled with pervious material to form a combined surface and subsoil drain. The latter, with various types of porous topping, is sometimes used in airports, but is rarely used for roadwork where the surface waters would usually bring in fine material to silt up the drain. It is only permissible in roadworks where all the neighbouring surfaces are paved or well-sodden with good grass. The sealed top is usually made of

---

* Throughout this article the term "water-table" is used to denote the free water surface and not the formed gutter or table drain.

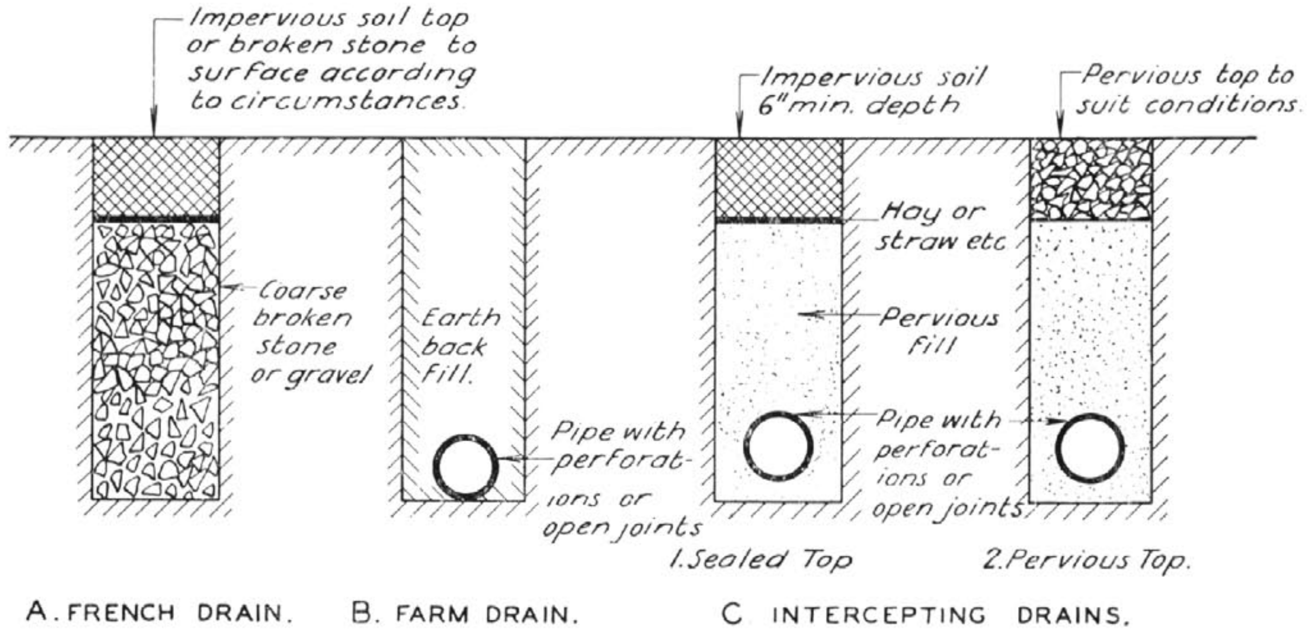


Figure 1. Types of Drains.

well rammed impervious soil at least six inches thick. A layer of hay or straw, old bags, or other suitable material should be placed on top of the pervious fill before placing the impervious top. This is to prevent the entry of the topping soil into the pervious fill; although it will eventually decay the soil will by then have consolidated and, as there is little downward flow of water, silting should not occur.

Sealed-top intercepting drains are the best type for most subsoil and subgrade drainage for roadworks. Where, however, the drain is placed under the road pavement, the seal at the top is not necessary and it is advantageous for the pervious filling to be brought up to the underside of the pavement in order to intercept moisture in or under the pavement.

The internal diameter of the pipe will depend on the amount of water to be dealt with and should not be less than three inches. The flow can be estimated after field investigations from the slope of the water surface, the permeability of the soil, and the depth of free water surface*, or judged by experience in similar conditions. Pipes should be laid to grades steep enough to prevent silting. A grade as low as 0.5% may be adopted but a minimum of 1% is desirable.

Drains consist of ordinary clay pipes with joints left open to collect water. Alternatively, perforated iron pipes may be used. Perforated pipes are provided with openings on one side of the pipe only and are laid with closed joints. Pipes may be laid in either of two ways as follows (see figure 2):—

* See "Engineering Properties of Soil," by Hogentogler.

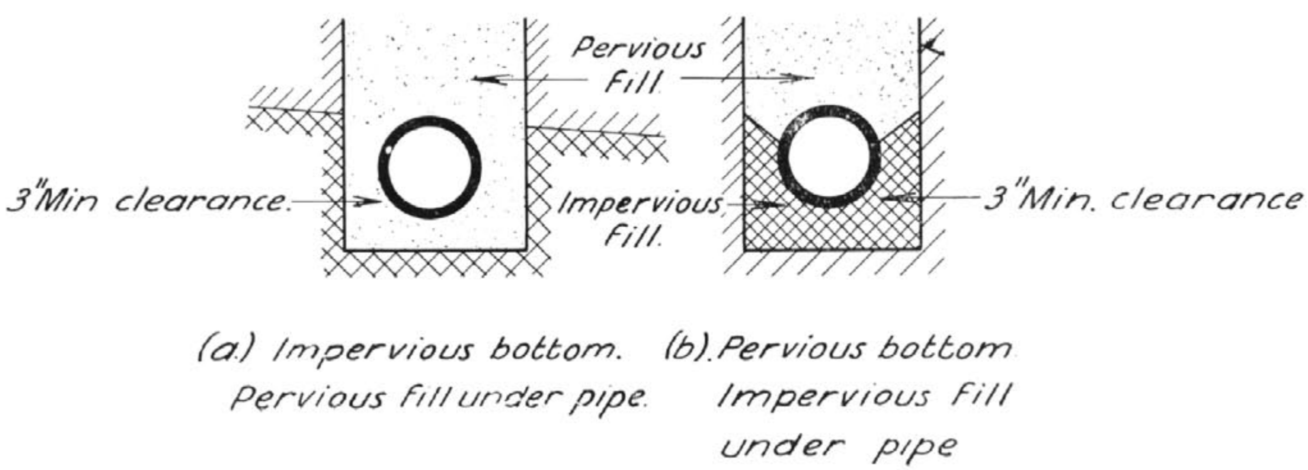


Figure 2. Details of Pipe Laying.

(*a*) The best practice is to take the drain down into an impervious zone,* the top of the pipe being placed level with the top of the impervious zone. In this case the excavation is carried about three inches below the level of the bottom of the pipe, and the spaces under and around the pipe are back-filled with pervious material. This allows the water to enter the pipe when it accumulates to a lower level in the pervious fill. Perforated pipes used with this form of construction should be laid with perforations down. Pipes are thus less liable to silting and perforations less liable to become blocked by the surrounding pervious materials.

(*b*) Where there is no impervious zone at a suitable depth and the ground below the pipe is pervious, the spaces under and around the pipe to about two-thirds of its height are back-filled with impervious soil. Were construction (a) employed in such circumstances, water collected elsewhere might flow out of the pipe and defeat the purpose of the drain. All pervious intrusions in impervious materials should be located and dealt with in this manner. Perforated pipes used with this form of construction should be laid with perforations up.

The outlets of all pipes should be carefully placed to avoid possible blockage and should be provided with wire guards to prevent nest building in the pipes by small animals and birds. Frequently the outlet section of the pipe is in a position where the seepage of water could cause damage. A pipe with sealed joints and with ordinary earth backfill should be used for such sections. Sometimes a watertight bulkhead of impervious soil should be constructed round the pipe in such cases to shut off water percolating through the pervious fill in the collecting area. To protect the outlet a headwall of stone or concrete may be provided and its position should be marked with a peg or post to permit it to be readily located during subsequent maintenance. The high (or dead) end of a pipe should be fitted with a metal cap, or suitably blocked, to prevent backfill material from entering the pipe.

Continued functioning of the drains is most important and every precaution should be taken in their construction to obtain the greatest efficiency and the longest possible life.

Sub-soil drainage problems can be divided into two main classes depending on ground-water conditions, as follows:—

1. Sidehill seepage, in rolling or hilly country, where the water is percolating downhill and the water-table has a definite slope.

2. Level water-table, in flat country and swamp, where there is little or no movement of ground water and the water-table is practically level and merely rises and falls in wet and dry seasons.

In the first case the method of draining subsoils consists of intercepting the water above the area to be drained. The drain, by removing the flowing ground water, lowers the water-table on the downhill side of the drain.

In the second case, the method is to lower the water-table by drains placed in or adacent to the area to be drained, but such lowering can only be brought about if there is an outlet for the drains lower than the desired lower level of the water-table. In very flat country this difficulty is often insurmountable except at prohibitive cost.

PROTECTION OF PAVEMENT.

In moist soils capillary water will rise above the level of the free water, often in sufficient quantity to make the soil soft and unstable. The maximum height of rise varies from a few inches in coarse sand to over a hundred feet in very fine clay. In clay, however, the rate of capillary movement is very slow and water in quantities sufficient to cause damage is not in practice raised to very great heights. The actual distance through which water will be raised in sufficient quantities to soften the subgrade is best determined by experience with the actual soil involved, but such experience is often not available. In its absence it may be assumed that with average soil detrimental softening will be avoided if the water-table is kept from two to four feet below the pavement. There are considerable variations between apparently similar soils, and variations from these figures may be required.

It is sometimes stated that subsoil drainage is of little benefit in heavy clays as the pores are so small and the capillary forces so great that water cannot be withdrawn by gravity. In many cases, however, drainage does not aim at the removal of all water but at the maintenance of existing stable conditions by preventing the entry of seepage water in wet periods, and for this purpose intercepting drains are very satisfactory. Where the soil is wet and unstable and an attempt is made to improve its bearing power by drainage success may not always be achieved in heavy clays. In the United States a centrifugal test on a small sample, applied force about 1,000 g., is used to indicate whether such drainage is practicable or otherwise.

Softening of subgrade by water is rare in fills over a few feet in height, as the water-table is usually below the original ground level. Troubles of this nature may occur in cuttings, especially box cuttings, as well as in surface formation and low embankment where the water-table is close to the ground.

* In this case the terms "pervious" zone and "impervious" zone are used in a relative sense, an impervious zone being a layer that is much less permeable than the adjacent material (e.g., sandstone or other rock of a porous or fissured nature would be "impervious" relative to an overlying sand but "pervious" in comparison with dense layers of clay or shale). Impervious zones usually consist of the native country rock or heavy dense clay subsoils.

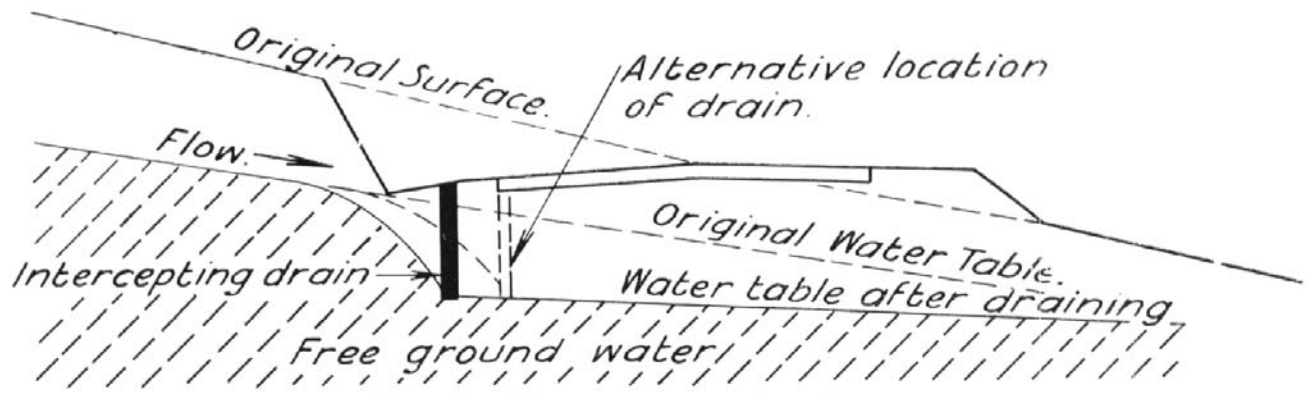


Figure 3a. Sideways seepage, no impervious zone.

In the case of a road in side cutting, the ground water is normally entering the area under the pavement from the high side. If the ground water rises too high and capillary rise damages the subgrade, the water can easily and effectively be lowered by the installation of an intercepting drain on the high side of the road. The water-table on the downhill side will be no higher than the top of the pipe (see figure 3a). If there is an impervious zone within this depth or within, say, one foot of the bottom of the trench designed on this basis, the drain should be taken into this impervious zone. The ground water will then be completely intercepted by the drain (see figure 3b).

Such intercepting drains may be placed either under the table drain, under the shoulder, or under the edge of the pavement, and are effective in all these positions. Under the table drain the impervious top is liable to be disturbed by scour, and the water in the table drain may then enter the pervious fill carrying silt with it to choke the intercepting drain. This location is therefore usually unsuitable. It is expensive to disturb the pavement on existing roads and, even on new work, except with gravel or other cheap pavement, it is usually better to keep the drain in the under the shoulder, but in the event of future atten-shoulder and clear of the pavement area. Slightly greater excavation is required to place the drain tion being required the pavement is not disturbed. On the other hand, if the drain is under the edge of the pavement, there will be no doubt that the pavement itself is drained.

If, in through cuttings, the direction of underground drainage is practically parallel to the road, it is usually necessary to install drains on both sides of the road to intercept water that would otherwise seep in from each side. In addition if, owing to the grade of the road, the surface is falling more rapidly than the water-table, it is usually necessary to install transverse drains to intercept water that would otherwise flow down between the two side intercepting drains. Usually a single drain above the danger area is adequate, but more may be required, especially with steep grades and wide roads. These transverse drains will discharge via the side intercepting drains. No standardised treatment can be laid down for such conditions, the location in every case being determined from the water-table levels and direction of flow of ground water.

It may be found in some cases that the underlying rocks contain water-bearing layers that require special drainage provision. The treatment of this must be based again on local conditions.

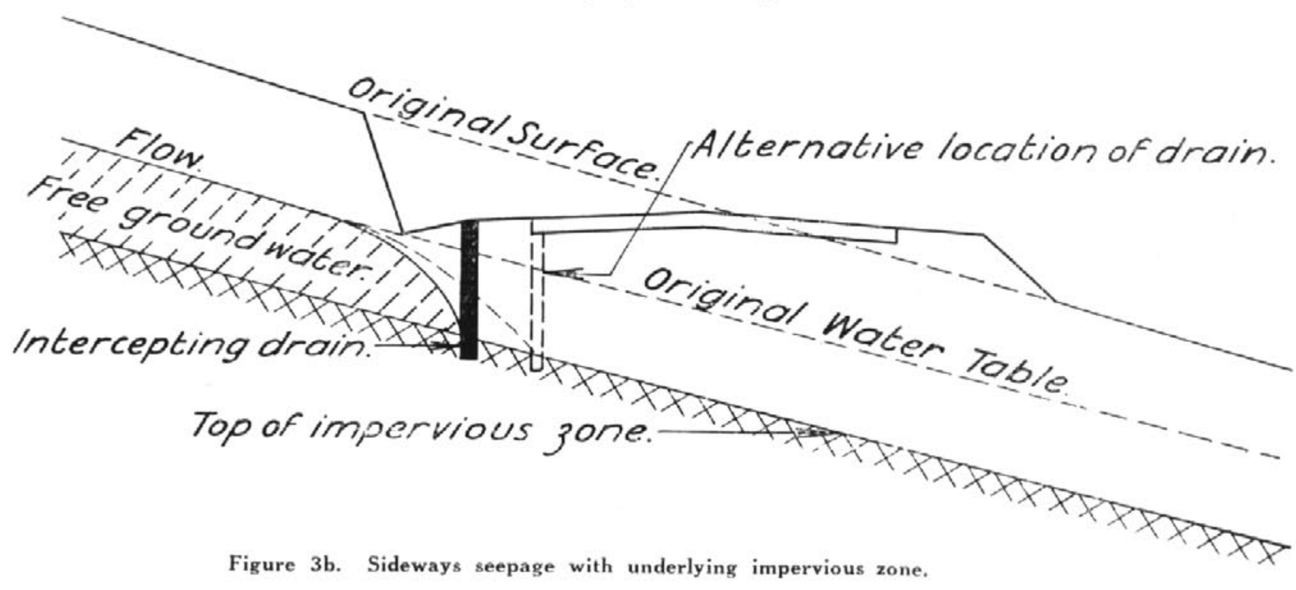


Figure 3b. Sideways seepage with underlying impervious zone.

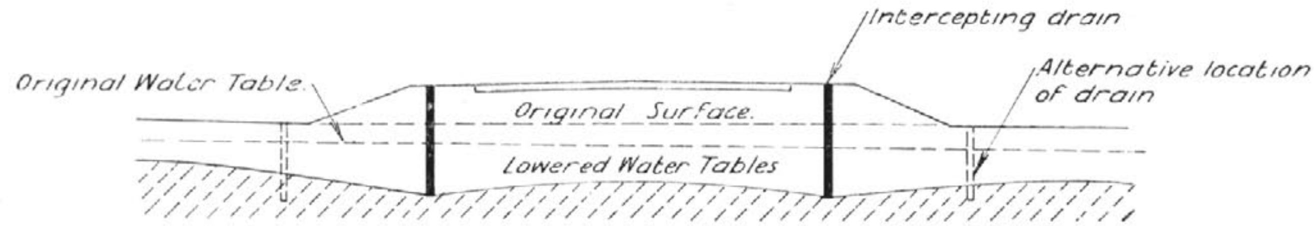


Figure 4. Flat country conditions.

In flat country and swamps the road is usually in a light fill and where the water-table is close to the original surface of the ground softening of the subgrade by capillary water may become serious. The difficulty in this case is to provide an outlet for the drains. If such an outlet is available, the trouble can be effectively met by the construction of an intercepting type of drain in each shoulder to lower the water-table (see figure 4). Alternatively, drains can be constructed beyond the toe of the fill as shown in broken lines; this method is cheaper but is not so effective in soils of low permeability. The more frequent solution in this case, however, is the cutting of open ditches parallel and adjacent to the embankment.

DRAINAGE OF SUBGRADE.

Provision for the discharge of any water passing down through the pavement and collecting on the subgrade should not be overlooked. There are two principal cases that require attention—subgrade of clay soil, and rock cuttings. If the subgrade is of pervious soil the small quantity of water passing through the pavement will not collect in the road base. Subgrade drainage is especially necessary if a gravel or similar pavement is sealed with bitumen or tar as the ordinary surface treatments develop cracks and porous spots which allow water to enter, while the generally impervious roof practically prevent evaporation.

Where the subgrade is properly shaped to a suitable camber, or super-elevation, the water will tend to flow to the pavement edges and with the usual narrow pavement width can be removed by ordinary "shoulder drains" discharging into the water-table or other drain or over the side of a fill. Such drains only convey a very small quantity of water and the French drain has proved satisfactory for the purpose. Pipe drains are less suitable on account of the small cover and consequent danger of breakage under traffic. Care should be taken in such cases that there is adequate provision for entry of water into the drain. As a pavement of gravel, etc., is much less pervious than the French drain, it is necessary to make the inlet area considerably greater than the cross section of the drain. On very wide roads it may be necessary to adopt special measures such as transverse French drains across the whole width of subgrade at frequent intervals, or a porous sub-base to allow of free discharge of water.

In the case of rock cuttings, the rock surface left by excavation is very irregular and water tends to accumulate in the depressions. Much trouble has been caused in "through" rock cuttings as there is no natural outlet for water accumulating in hollows in the floor of the cutting. In such cases it is usually desirable to provide a subsoil type of drain along both sides of the pavement to provide an outlet. In all cases, moreover, the depressions in the rock surface must all be drained by cutting a small trench filled with broken stone to form a French drain discharging into the side drains or over the side of the fill in side cuts.

SLIPS.

Subsoil drainage is often the cheapest and most satisfactory method of preventing slips. The best principle is again to reduce the moisture content of the danger area by the installation of intercepting drains to collect the ground water above the area it is desired to protect.

Figure 5 shows how this method would be applied to the most common case of slides, i.e., fill slides on sideling ground. The removal of the ground water greatly increases the safety of the fill. The drain is placed above and close to the fill, but its exact position

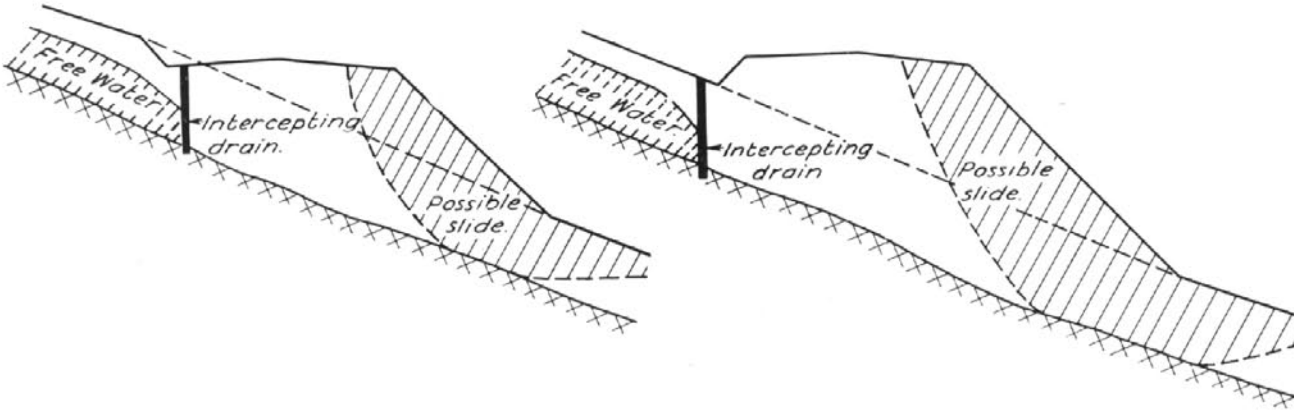


Figure 5. Prevention of fill slides

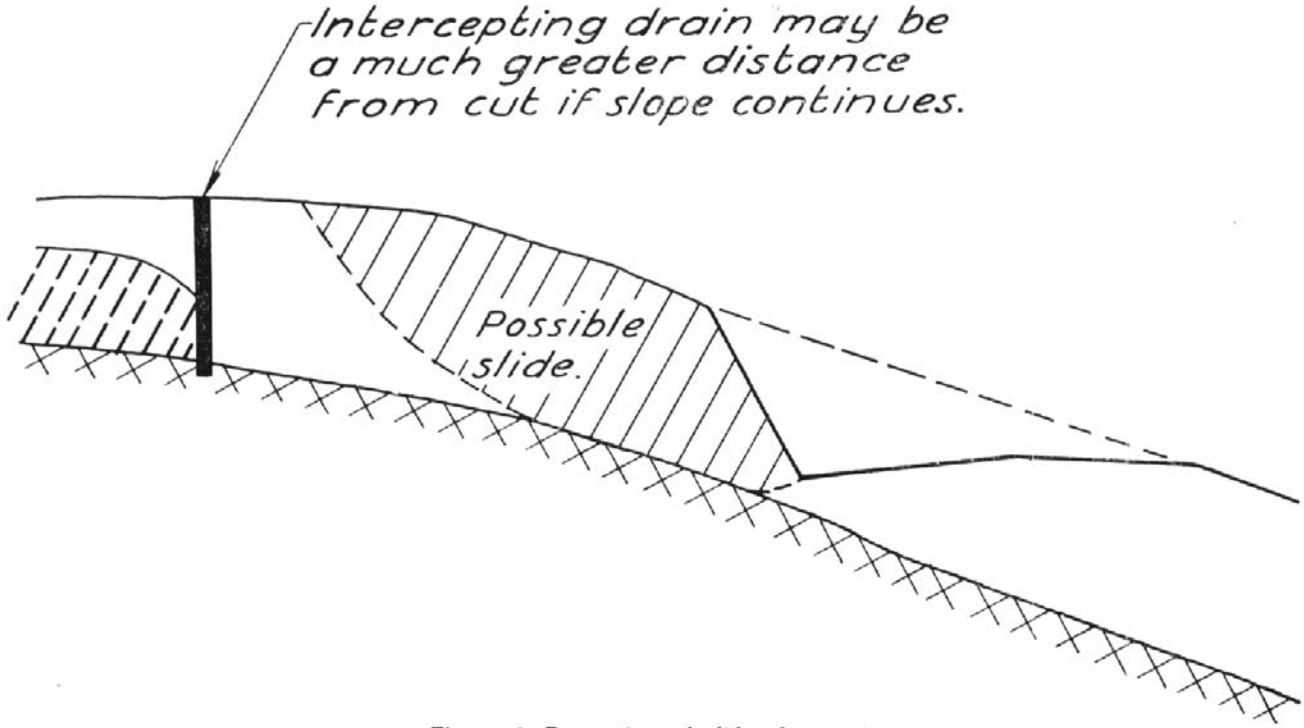


Figure 6. Prevention of slide above cut.

is unimportant, the one selected being that for minimum depth and cost.

Some serious cases of fill slides are largely due to water discharged below the fill through pervious seams and layers in the country rock. Special attention must be paid to the collection and interception of this water.

Figure 6 shows how the method would be applied to prevent a similar slide above the cut.

Wool Transport in the Vicinity of Bourke Railway Station.

Reconstruction and Widening of Pittwater Road Manly to Narrabeen.

The reconstruction and widening of Pittwater Road between Manly and Narrabeen, which links the intervening centres of Brookvale, Deewhy and Collaroy, have now been undertaken, the war years having caused a delay in their commencement. Sections of the old road have reached the end of their economic life, and there had been a substantial increase in traffic partly due to normal traffic growth, but also due to the use of buses instead of trams. The abandonment of the tram service in September, 1939, has facilitated the adoption of a modern type of road design.

From Manly to Brookvale the old road consisted of bituminous macadam construction of varying width. From Brookvale to Deewhy was of bituminous macadam supplemented by a 20 feet wide concrete slab. From Deewhy to Narrabeen over the greater part of the length there was a 20 feet width of concrete only.

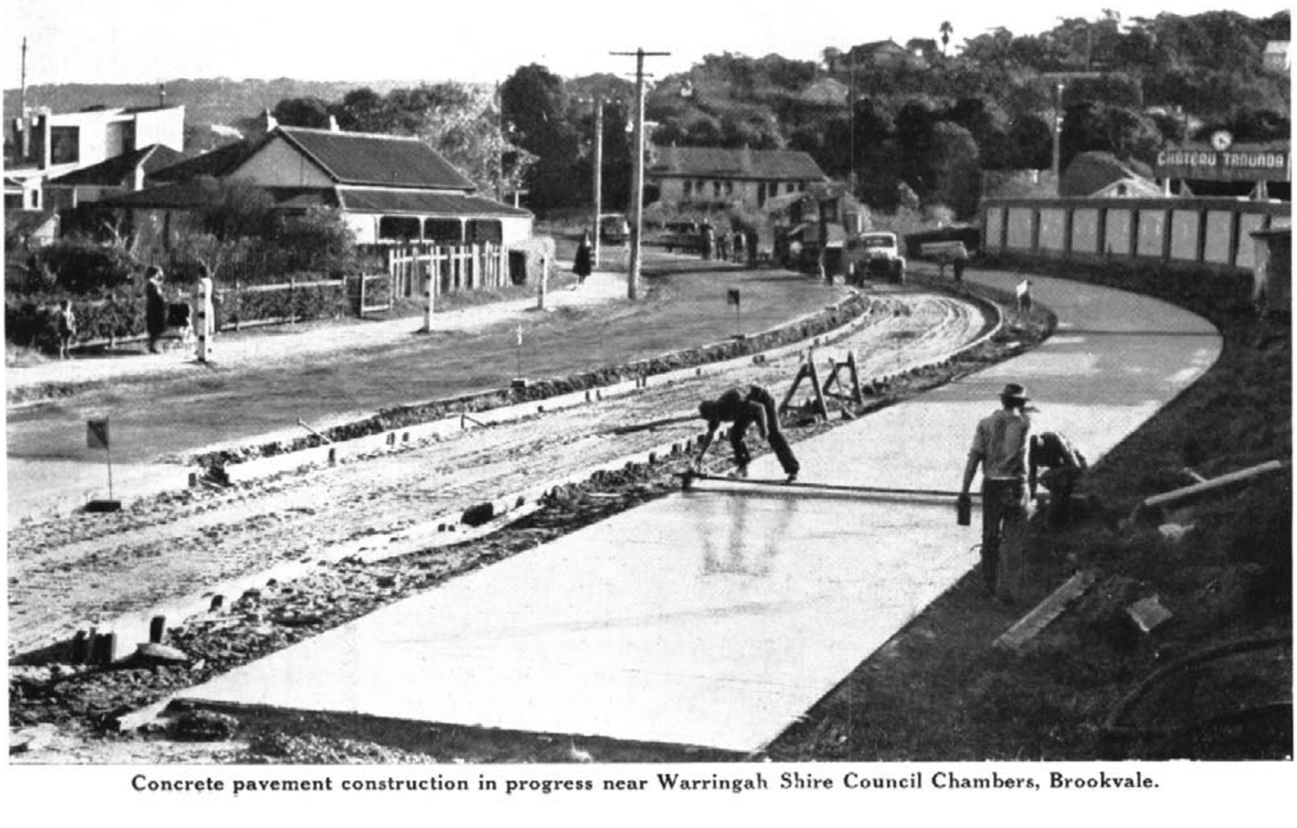
The new road is to provide generally dual carriageways, each 33 feet wide, divided by a kerbed medial strip five feet wide. Each carriageway will be paved with concrete to a width of 23 feet, providing for two lanes of moving traffic in each direction. The remaining ten feet width adjacent to the outer kerbs on each side will be constructed in macadam to provide a parking lane, except that at shopping centres and bus stopping places the paving will be of concrete.

Where the road is bounded by a public park, as on the western side over much of the length between Manly and Brookvale, the parking lane will be omitted.

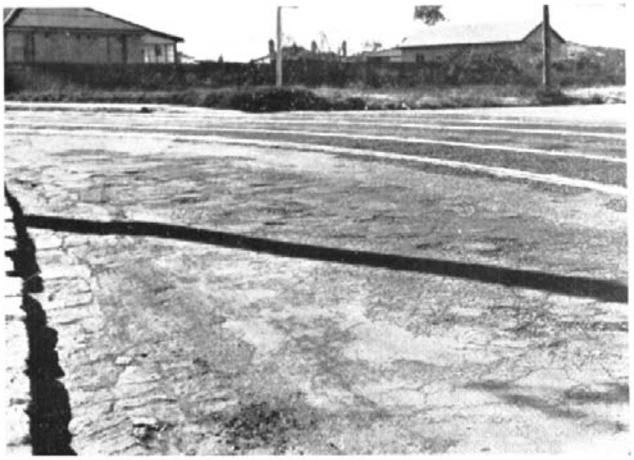
In the vicinity of Brookvale, the existence of buildings will prevent the immediate provision of full-width dual carriageways. The work now in hand is being so carried out, however, as to enable the ultimate design to be readily achieved as soon as buildings can be removed.

Details of Pavement.

The concrete pavement is 6½ inches thick of 1: 2: 3½ concrete, increased to 9 inches thickness



Concrete pavement construction in progress near Warringah Shire Council Chambers, Brookvale.



Typical section of the old paved road.

along the outer edges. It is reinforced with steel bar mat near its lower surface, and provided with steel edge bars and dowels.

The kerb surrounding the medial strip is of the low sloping type which can be safely mounted by a vehicle in emergency. It will be studded with reflector buttons at frequent intervals.

Bridges.

Associated with the work is the construction of bridges over Manly Lagoon and over Narrabeen Lake, in replacement of old timber structures. The new bridges are to be of reinforced concrete design and contracts have been let for their construction. The bridge over Manly Lagoon is to be 120 feet long, and that over Narrabeen Lake 168 feet long, the amount of accepted tenders for which are £1,689 and £11,827 respectively. Several new small structures will also be required.

Work on Manly-Brookvale Section.

Operations were commenced on the Manly-Brookvale section in 1947 by the Department of Main Roads by day-labour. Progress has been retarded due to labour shortages and other post-war difficulties, but a substantial length has been completed and is in use by traffic.

Public utility service alterations.—Extensive alterations and additions to public utility services were first necessary. These included the laying of approximately 2,790 linear feet of 15-inch water main and 3,400 linear feet of 12-inch water main in the western footway and the laying of 2,610 linear feet of 6-inch water main in the eastern footway. In addition, a duplicate 8-inch gas main, approximately 4,000 feet long had to be laid in the western footway and seventeen poles carrying 11,000 volt electricity supply mains had to be relocated. Approximately 10,200 feet of tramway tracks had to be removed from the existing road. Considerable difficulty was experienced by the public utility authorities in obtaining labour and materials for carrying out these alterations and the progress of the road work was impeded from time to time. In order to expedite the road work, much of the excavation for the trenches carrying water and gas mains was carried out by the Department's organisation, and assistance was also given to the Department of Road Transport and Tramways in the removal of the tram tracks. A skimmer shovel and a mobile crane were used from time to time in the removal of the old rails.

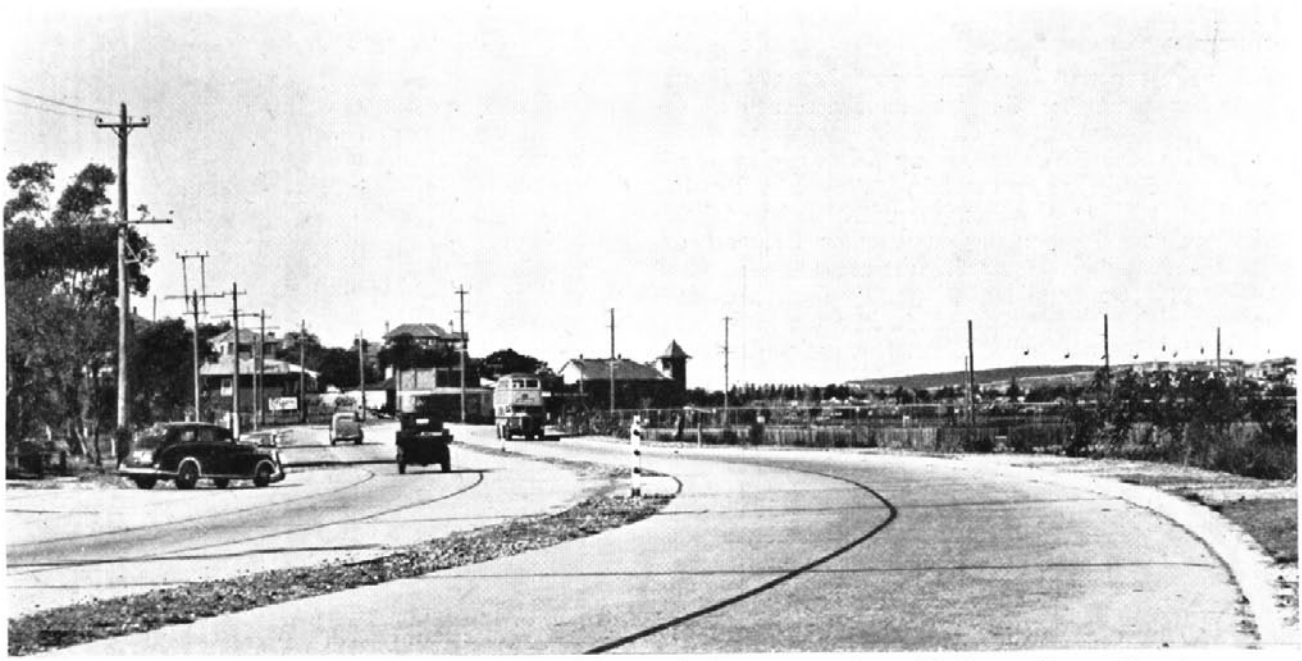
Earthworks and Drainage.—The total quantity of earth filling involved was approximately 33,000 cubic yards of which a total of 18,000 cubic yards was available from excavation on the work, including 4,000 cubic yards of sandstone rock. Filling required from outside the work, therefore, comprised 15,000 cubic yards. In addition, 9,000 cubic yards of filling will later be required for the approaches to the new bridge over Manly Lagoon.

Beach sand two miles from the work was the most suitable material readily available for filling, and this was loaded with a ⅜-cubic yard shovel. Excavation on the road was carried out using a ⅜-cubic yard skimmer shovel. Loosening of sandstone was necessary by drilling and blasting, and special precautions had to be taken during blasting operations owing to the close proximity of houses and telephone and power lines.

Consolidation of sand filling was effected by placing in layers and inundating each layer. Water was obtained from water mains where practicable, and also from a creek adjacent to the road on the western side, pumping directly on to the fill with a 6-inch centrifugal pump. Spreading of the filling was expedited by the use of a bulldozer mounted on a 40-h.p. tractor, which also assisted the consolidation. Trafficking of the filling by lorries as the layers were placed materially aided consolidation. Prior to the construction of the concrete pavement, the completed fill was again thoroughly inundated.

The construction of the embankment entailed the erection of 380 linear feet of retaining wall where the filling was subject to scour from the adjacent creek. Sandstone masonry was adopted, 430 cubic yards of good quality sandstone being quarried in the vicinity of Oxford Falls, 3½ miles distant.

Vibrating screed at work.

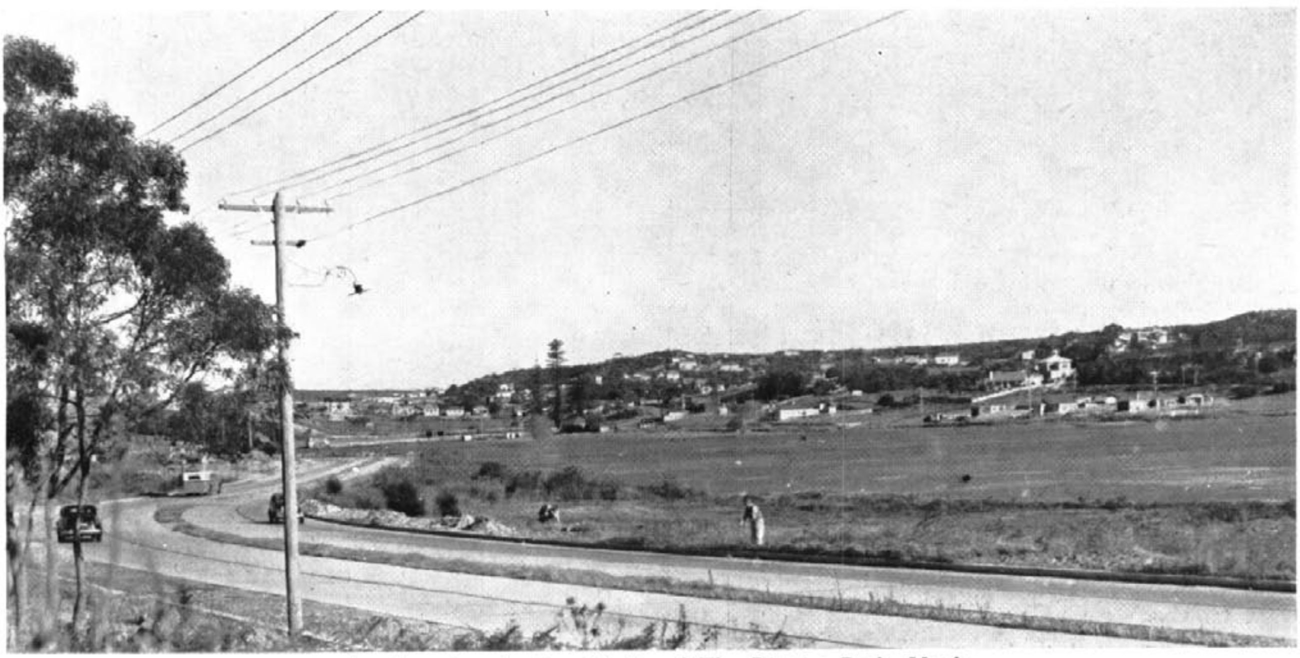


General view of completed pavement (medial zone kerbing not yet in position) near Kentwell-road.

Drainage works included four reinforced concrete box culverts, and 5,890 linear feet of reinforced concrete pipes varying in size from 12-inch to 60-inch diameter.

Concrete pavement construction.—Aggregate consisted of washed river gravel and sand. These were loaded into lorries in their correct proportions at a stock-pile site by means of three track-mounted mechanical bucket loaders, each fitted with its own measuring box. Cement was added to the lorries and the dry materials then transported to the site of the work and dumped into the hopper of a 27-cubic feet concrete paver, which deposits mixed concrete directly on the roadway.

Use of Vibrating Screed.—Shortly after construction of the pavement commenced, a vibrating hand screed was substituted for the transverse and longitudinal hand screeds previously used. The vibrating screed consists of a board 3 inches thick with one vibrating unit bolted to the centre for lengths up to 12 feet 6 inches, and two vibrating units bolted to the centre for lengths between 12 feet 6 inches and



Another view in the vicinity of The District Park, Manly.

20 feet. Handles at each end of the board enable the operators to stand upright.

After the concrete has been spread between forms by hand to a height of approximately 1 inch above finished level, the first or consolidating pass is made transversely with the screed. Any cavities left behind the board are filled and a second pass is made. Finally a third or finishing pass is made with the board held upright or sloped depending on whether a smooth or roughened surface is required. Just prior to the initial set taking place a long-handled wooden float is passed across the slab to remove any slight irregularities. The surface texture is then brought up by twice dragging longitudinally with hessian.

The vibrating screed board appeared on this job to have the following advantages over hand screeding:—

(1) Obviates longitudinal screeding.

(2) Reduces the labour necessary.

(3) Does not require such experienced labour.

(4) Reduces the amount of hand packing.

(5) Enables the finishing to be kept immediately behind the concrete placing, this being most desirable on hot days.

(6) Concrete placing can continue to within a short period of "knock off" time without undue overtime for labour engaged on finishing.

(7) Enables the pavement to be readily shaped as required for crown or guttering by cutting the screed board to the desired template.

Costs.

The following are the unit direct costs of the work carried out, exclusive only of Workers' Compensation Insurance, Pay Roll Tax, Holidays, Depot establishment and maintenance, General engineering and clerical supervision costs.

Earthworks: Borrowed material including excavation of old road pavement, 6s. 7d. per cubic yard (solid measurement).

Trimming and Consolidation of subgrade, shoulders, footpaths, 1s. 3d. per square yard.

Excavation in all classes of materials for storm water drains, 12s. 5d. per cubic yard.

Sandstone retaining walls, £5 12s. 10d. per cubic yard.

Concrete in box culverts, £7 3s. 9d. per cubic yard.

Cement concrete slab 6½"–9" thick, 17s. 3d. per square yard.

Steel reinforcement in place: Edge bars and dowels, £21 15s. per ton; bar mat, £29 2s. per ton.

New separate concrete kerb, 3s. 11d. per lin. ft.

New concrete integral kerb and gutter, 6s. 3d. per lin. ft.

Supervision.

The design and construction of the work is under the general direction of the Department's Metropolitan Engineer, Mr. F. W. Laws. The engineer in immediate charge of construction work is Mr. R. J. Milner.

Policy of Naming State Highways in New South Wales.

In the naming of State Highways the Department has favoured the selection of names associated with either the discovery, early history or development of the roads or of the regions through which the roads pass. Where this has not been possible, then the name selected has been one with some relevant geographic or local significance or one perpetuating the memory of a person or commemorating an event of national importance.

It is fitting that roads which closely follow the routes traversed by the early explorers should bear their names, thus serving to honour and to perpetuate their memory. Names were so selected for the Hume, Oxley, Sturt and Mitchell Highways. The Hume Highway from Sydney to Melbourne, via Albury, closely follows the route taken by Hume on his journey from Appin to Port Phillip in 1824. The Oxley Highway, which extends from Port Macquarie to Bendemeer and from Tamworth westward to Trangie, practically coincides with the route taken by Oxley on his exploratory journey of 1818 from the Pacific Coast to the Warrumbungle Range near Coonabarabran. The Sturt Highway from the Hume Highway at Lower Tarcutta and thence via Wagga to Hay and through northern Victoria to Adelaide lies approximately along the route taken on the historic journey of Sturt, the town of Hay being the point at which his party commenced its boat expedition. The Mitchell Highway, from its junction with the Great Western Highway at Bathurst via Orange, Dubbo and Bourke to the Queensland border at Barringun, follows approximately in the vicinity of the route taken by Sir Thomas Mitchell in his expedition of 1845.

Other State Highways of historical significance are the Great Western Highway from Sydney to Bathurst and the recently named Cobb Highway which runs from Moama through Hay and Booligal to the Barrier

Highway near Wilcannia. There are few roads that would so suitably commemorate the name of the great pioneering firm of Cobb & Co., whose coaching activities of earlier days linked three States of the Commonwealth.

The Prince's Highway from Sydney via the South Coast, and thence through to Melbourne and Adelaide, was named in honour of Edward, Prince of Wales, following his visit to Australia in 1920.

The Newell Highway from the Victorian border at Tocumwal to Boggabilla on the Queensland border was selected as the most appropriate highway to commemorate the life-long association of the late Mr. H. H. Newell, formerly Commissioner for Main Roads, with the development of the road communications of the State.

While it is not the general practice to apply names to Main Roads other than State Highways, except in towns, two interesting examples have occurred recently of naming of ordinary Main Roads which pass largely through rural country, namely, the Wakehurst Parkway and the Lawrence Hargreave Drive.

Wakehurst Parkway, which extends from the vicinity of Seaforth, above the Spit, Sydney, to Pittwater Road, at Narrabeen, has been so named as a tribute to Lord Wakehurst, who, as Governor of New South Wales from April, 1937, to January, 1946, took a great interest in the development of the State and its natural beauty. This is the first road in the State to merit the name "parkway," a term which is applied to a road of exceptional width, including in its width areas in their natural state or developed as strips of park land.

The name Lawrence Hargreave Drive has been applied to Main Road No. 185, previously generally known as the Lower South Coast Road, which extends from the Prince's Highway near Helensburgh and thence through Stanwell Park, Coalcliff and other coastal towns to the Prince's Highway at the foot of the Bulli Pass near Thirroul. The road was given its new name as a result of representations by the Bulli Shire Council, and because Lawrence Hargreave, pioneer in aeronautics, lived in the vicinity of Coalcliff and travelled to and fro along this road to Stanwell Park to carry out his experiments at Bald Hill.

The naming of the State Highways has proved to be of convenience to long distance travellers and has emphasised the importance of the major avenues of road communication. At the same time it has, in a number of cases, provided a further means to perpetuate the names and work of the explorers.

Whenever possible, naming of State Highways which extend to the borders of the State has been carried out in consultation with the road authority of the adjoining State concerned. Thus the name Hume Highway applies from Sydney to Melbourne, the name Prince's Highway from Sydney through Melbourne to Adelaide, the names Pacific and New England Highways from Sydney to Brisbane, and the name Sturt Highway applies from the Hume Highway near Lower Tarcutta continuously to Adelaide, including a length across the north-western corner of Victoria.

The numbers, names and routes of named Highways in New South Wales are as follows:—

No.	*Name.*	*Route.*
1	Prince's Highway	From Sydney south along the coast to the Victorian border and thence to Melbourne and Adelaide.
2	Hume Highway	From Sydney, via Goulburn, Yass, Gundagai and Albury, to the Victorian border, and thence to Melbourne.
3	Federal Highway	From the Hume Highway near Goulburn, to the border of the Australian Capital Territory, and thence to Canberra.
4	Monaro Highway	From the coast at Tathra, thence via Bega, Bemboka, Nimmitabel, Cooma, Adaminaby, Kiandra and Tumut, to the Hume Highway between Tumblong and Tarcutta.
5	Great Western Highway.	From Sydney, via Penrith, the Blue Mountains and Lithgow, to Bathurst.
6	Mid-Western Highway.	From Bathurst, via Blayney, Cowra, Grenfell and Wyalong, to Hay.
7	Mitchell Highway	From Bathurst, via Orange, Molong, Wellington, Dubbo, Narromine, Trangie, Nyngan and Bourke, to the Queensland border at Barringun.
8	Barrier Highway	From the Mitchell Highway at Nyngan, via Cobar, Wilcannia and Broken Hill, to the South Australian border at Cockburn.
9	New England Highway.	From the Pacific Highway at Hexham near Newcastle, via Maitland, Singleton, Muswellbrook, Scone, Murrurundi, Tamworth, Uralla, Armidale, Glen Innes and Tenterfield, to the Queensland border near Mount Lindsay, and thence to Brisbane.
10	Pacific Highway	From Sydney north along the coast to the Queensland border at Tweed Heads, and thence to Brisbane.

No.	Name.	Route.
11	Oxley Highway	From the Pacific Highway near Port Macquarie, via Wauchope and Walcha to Bendemeer, and from the New England Highway at Tamworth, via Gunnedah, Coonabarabran and Gilgandra, to the Mitchell Highway at Trangie.
12	Gwydir Highway	From the Pacific Highway at Grafton, via Glen Innes, Inverell, Warialda and Moree, to the Barwon River at Collarenebri.
14	Sturt Highway	From the Hume Highway at Tarcutta, via Wagga, Narrandera, Hay and Balranald, to the Victorian border near Mildura, and thence across northern Victoria to Adelaide.
17	Newell Highway	From the Victorian border at Tocumwal, via Jerilderie, Narrandera, Wyalong, Forbes, Parkes and Dubbo, to Gilgandra, and from Coonabarabran, via Narrabri and Moree, to the Queensland border at Boggabilla.
21	Cobb Highway	From the Victorian border at Moama, via Deniliquin, Hay, Booligal and Ivanhoe, to the Barrier Highway near Wilcannia.

PAYMENTS FROM THE ROADS FUNDS FOR PERIOD 1st JULY, 1947, to 30th JUNE, 1948.

	Amt. Paid. £
County of Cumberland Main Roads Fund—	
Construction of Roads and Bridges	415,085
Cost of Acquisition of Land for Road Widening	34,987
Maintenance of Roads and Bridges	408,476
Interest, Exchange and Repayment of Loans	*39,393
Other Expenditure	220,696
Total	£1,118,637
Country Main Roads Fund—	
Construction of Roads and Bridges	780,647
Cost of Acquisition of Land for Road Widening	6,926
Maintenance of Roads and Bridges	2,062,046
Interest, Exchange and Repayment of Loans	206,342
Purchase and Repair of Plant and Motor Vehicles	241,820
Other Expenditure	204,399
Total	£3,502,180
Developmental Roads Fund—	
Construction of Roads and Bridges	101,187
Other Expenditure	1,663
Total	£102,850
Summary All Funds—	
Construction of Roads and Bridges	1,296,919
Cost of Acquisition of Land for Road Widening	41,913
Maintenance of Roads and Bridges	2,470,522
Interest, Exchange and Repayment of Loans	*245,735
Purchase and Repair of Plant and Motor Vehicles	241,820
Other Expenditure	426,758
Total	£4,723,667

* Excludes a special payment of £696,096 in the liquidation, prior to the ordinary due date, of outstanding loan liabilities.

Note: The figures in this statement are subject to audit.

Tenders Accepted.

The following Tenders (exceeding £500) were accepted by the Department during the months of April, May and June, 1948.

Council.	Road No.	Work.	Tenderer.	Amount.
				£ s. d.
——	—	Supply and delivery of 5,000 tons of bitumen as required...	The Shell Co. of Aust. Ltd.	78,750 0 0
Jerilderie S.	17	Construction of bridge over Algudgerie Creek, 1 mile South of Jerilderie...	J. H. Galvin ...	1,628 17 10
Murray S.	391	Ferry over Murray River at Barmah. Caretaking and operation.	O. Lawford ...	520 0 0 per annum.

The following Tenders (exceeding £500) were accepted by the respective Councils during the months of April, May and June, 1948.

Council.	Road No.	Work.	Tenderer.	Amount.
				£ s. d.
Berrigan S.	331	Construction of formation and unblended sand-clay base course pavement between Conargo Shire and Finley.	Messrs. Kieselbach & McCallum.	4,863 16 0
Bland S. ...	231	Supply and delivery of 3,200 cu. yds. gravel	G. Broad	800 0 0
,,	57	Supply and delivery of 4,672 cu. yds. gravel	,,	817 12 0
,,	398	Supply and delivery of 4,064 cu. yds. gravel	Miller & Lewington	1,059 9 4
,,	57	Supply and delivery of 4,992 cu. yds. gravel	,,	1,249 12 0
,,	371	Supply and delivery of 5,760 cu. yds. gravel	G. Broad	1,440 0 0
Boomi S.	507	Supply, delivery and spreading 5,160 cu. yds. gravel	Muggleton Bros.	1,350 0 0
Boree S. ...	377	Construction of R.C. Box Culvert at Long's Corner 35.5m. from Orange.	M. Kallas	1,142 18 7
,,	238	Construction of R.C. Box Culvert between 6m. 2,640-ft. and 6m. 3,540-ft. from Eugowra.	,,	666 0 0
Burrangong S.	78	Reconstruction	F. A. Lewington	9,172 11 6
Cobbora S.	1,004	Clearing and grubbing 24-ft. wide, box and pipe culverts, gravel pavement, etc.	A. C. Stephen & Sons	4,245 5 4
,,	77 206	Supply, delivery and spreading 10,438 cu. yds. gravel	,, ,,	954 0 0
,,	77	Supply, delivery and spreading 7,226 cu. yds. gravel ...	W. M. McDonald	1,742 3 6
Coolamon S.	17	Supply and delivery of 4,184 cu. yds. gravel	C. G. Staines & F. L. Grundy.	819 7 4
,,	155	Supply and delivery of 4,001 cu. yds. gravel	,, ,,	766 17 2
Coonabarabran S.	11	Gravel resheeting 5¾m.-7m., 8m.-12m. and 12m.-20m. from Coonabarabran towards Gilgandra.	E. W. Hall	3,013 7 6
Culcairn S.	57	Supply and delivery of 4,700 cu. yds. gravel	T. G. Kirk	1,044 0 0
Harwood S.	10	Replacement of culverts	F. E. Brown ...	1,276 1 5
Hastings S.	1,094	Construction of gravel pavement and subsidiary works from 5m. 1,295-ft. to road terminal at 5m. 4,520-ft.	J. Bowen	1,869 4 0
Holbrook S.	284	Supply and delivery of 2,800 cu. yds. gravel	C. Lea ...	700 0 0
,,	211	Supply and delivery of 3,150 cu. yds. gravel	F. Carstens	879 7 6
,,	331	Construction of Approaches to Bridge over Wantagong Creek.	W. A. Winnett	1,068 18 0
Hume S.	57	Supply and delivery of gravel	C. G. Quast	1,200 0 0
Jemalong S.	56	Supply, delivery and spreading 4,464 cu. yds. gravel between 2m. 48 chns. and 30m. 40 chns. from Forbes towards Cowra.	J. R. Brown ...	892 9 0
,,	236	Supply, delivery and spreading 3,412 cu. yds. gravel between 3m. 4 chns. and 24m. 68 chns. from Forbes towards Grenfell.	J. P. Dean	890 0 0
,,	377	Supply, delivery and spreading 4,816 cu. yds. gravel between 3m. 64 chns. and 33m. 72 chns. from Forbes towards Condobolin.	J. R. Brown ...	2,166 16 0
Jindalee S.	78	Surfacing	B.H.P. By-Products Pty. Ltd.	1,083 12 6
Kyeamba S.	384	Gravel resheeting	C. A. Maloney	702 0 0
,,	57	Gravel resheeting	,,	895 0 0
Lachlan S.	57	Supply, delivery and spreading 4,800 cu. yds. gravel between 24.5m. and 36.25m.	R. E. Scarce ...	1,080 0 0
Lake Macquarie S.	...	Surfacing and resurfacing Main Roads 217, 220, 223 and 325.	B.H.P. By-Products Pty. Ltd.	7,795 6 6
,, ,,	...	Supply and delivery of 3,681 tons of ¾-inch slag and 1,135 tons ½-inch slag for surfacing Main Roads 217, 220, 223 and 325.	,, ,,	1,673 16 10

Council.	Road No.	Work.	Tenderer.	Amount.
				£ s. d.
Liverpool Plains S.	72	Gravel resheeting 15m.–17m. and 30m.–35m. South of Gunnedah and 5m.–6½m., 9m.–12m. and 14m.–18m. north of Gunnedah.	S. J. Bailey	6,312 15 10
Macintyre S. ...	...	Supply, delivery and spreading 15,208 cu. yds. gravel ...	R. G. Gardner ...	3,553 7 4
Macleay S. ...	75	Construction of R.C. Bridge over Midnight Creek and Box Culvert over Figtree Creek.	T. Milligan	5,792 14 9
Murrumburrah S.	387	Surfacing	B.H.P. By-Products Pty. Ltd.	1,083 12 6
Muswellbrook S.	209	Supply and delivery of ¾-inch and ⅜-inch aggregate for bituminous surfacing.	R. C. Barber	612 0 0
Patrick Plains S....	128 213	Surfacing with bitumen between 5.50m. and 6.00m. from Singleton (M.R. L128) and between 15.62m. and 16.57m. from Singleton on Main Road 213.	B.H.P. By-Products Pty. Ltd.	1,195 7 8
Snowy River S.	286	Supply of Aggregate	Blue Metal & Gravel Pty. Ltd.	953 19 2
,, ...	4	Supply of R.C. Pipes	Hume Pipe Co. ...	761 5 4
,, ...	4	Supply of Aggregate	Blue Metal & Gravel Pty. Ltd.	1,412 6 7
Timbrebongie S.	354	Supply and delivery of 9,957 cu. yds. gravel 0m. 64 chns. to 21m. 20 chns.	Torrens & Wooden ...	2,738 3 6
,, ...	342	Supply and delivery of 7,200 cu. yds. gravel 1m. 23 chns. and 23m. 63 chns.	,, ...	1,980 0 0
,, ...	57	Supply and delivery of 10,140 cu. yds. loam between 3m. 26 chns. and 16m. from Trangie.	J. C. Beaumont ...	1,394 5 0
Tumut S. ...	278	Supply and delivery of 2,500 cu. yds. gravel	J. Henrick	1,562 10 0
Upper Hunter S.	105	Construction of R.C. culvert 13¾m. from Scone ...	S. J. Donaldson ...	629 1 8
,, ...	105	Construction of R.C. culvert 3¾m. from Scone ...	,, ...	739 19 8
Waugoola S. ...	56	Supply, delivery and spreading 5,750 cu. yds. gravel 1m. 60 chns.–19m. 60 chns.	Mackie Bros.	1,150 0 0
,, ...	56	Supply, delivery and spreading 7,000 cu. yds. gravel 3m. 73 chns.–26m. 5 chns.	A. J. & E. Mackie ...	1,575 0 0
,, ...	78	Supply, delivery and spreading 4,520 cu. yds. gravel 1m. 75 chns.–15m. 77 chns.	Mackie Bros.	1,130 0 0
,, ...	310	Supply, delivery and spreading 5,400 cu. yds. gravel 2¾m. and 19½m.	A. J. & E. Mackie ...	1,350 0 0
Weddin S. ...	...	Supply, delivery and spreading 10,968 cu. yds. gravel on Main Roads Nos. 236, 237, 239 and 398.	C. J. Gavin	2,682 14 6
,, ...	...	Supply, delivery and spreading 10,438 cu. yds. gravel on Main Roads Nos. 236, 237, 239 and 398.	,, ...	2,565 17 0
Windouran S. ...	21	Forming, boxing, shouldering, loaming and provision of culverts between 25m. 1,266-ft. and 25m. 4,039-ft.	D. L. Hazelman ...	760 9 6
,, ...	21	Clearing, forming, re-forming, provision of culvert and loaming from 10m. 2,500-ft. to 11m. 2,500-ft.	,, ...	583 15 0
Wingadee S. ...	18	Repairs to timber beam bridge over Gulargambone Creek	A. Dorin	566 0 0
,, ...	1,168	Supply, delivery and spreading 7,043 cu. yds. loam between 4m. 3,834-ft. and 16m.	McClellan & Death ...	1,172 1 4
,, ...	205	Supply, delivery and spreading 7,040 cu. yds. loam ...	,, ...	1,232 0 0
,, ...	...	Supply, delivery and spreading 5,000 cu. yds. loam on M.R. 202 and 6,300 cu. yds. loam on M.R. 383.	,, ...	1,559 5 0
,, ...	18	Supply, delivery and spreading 18,920 cu. yds. loam north and south of Coonamble.	,, ...	2,991 10 0
,, ...	129	Supply, delivery and spreading 9,880 cu. yds. loam between 2.63m. and 35.70m.	,, ...	1,482 0 0

Sydney: Thomas Henry Tennant, Government Printer—1948.

MAIN ROADS STANDARDS.

***NOTE:* Numbers prefixed by "A" are drawings, the remainder are specifications unless otherwise noted.**

Form No.

EARTHWORKS AND FORMATION.

70* Formation. (Revised, July, 1946.)
A 1532* Standard Typical Cross-sections.
A 1149* Flat Country Cross-section, Type A. (Revised, 1930.)
A 1150* Flat Country Cross-section, Type B. (Revised, 1936.)
A 1151* Flat Country Cross-section, Type D1. (Revised, 1936.)
A 1152* Flat Country Cross-section Type D2. (Revised, 1930.)
A 1476 Flat Country Cross-section, Type E1. (Revised, 1937.)
A 1161 Typical Cross-section One-way Feeder Road. (1936.)
A 1102 Typical Cross-section Two-way Feeder Road. (1931.)
A 114 Rubble Retaining Wall. (1941.)

PAVEMENTS.

71* Gravel Pavement. (Revised, January, 1939.)
228* Reconstruction with Gravel of Existing Pavements. (Revised, January, 1939.)
254 Supply and Delivery of Gravel. (Revised, August, 1939.)
72* Broken Stone Base Course. (Reprinted with amendments, August, 1947.)
68* Reconstruction with Broken Stone of Existing Pavement to form a Base Course. (Revised, October, 1933.)
296 Tar. (Revised, March, 1939.)
337 Bitumen. (Revised, February, 1939.)
305 Bitumen Emulsion. (Revised, September, 1942.)
351 Supply and Delivery of Aggregate. (Revised, July, 1941.)
65* Waterbound Macadam Surface Course. (July, 1939.)
301* Supply and Application of Tar and/or Bitumen. (Revised, August, 1946.)
122* Surfacing with Tar. (Revised, May, 1940.)
145* Surfacing with Bitumen. (Reprinted with amendments, August, 1947.)
93* Re-surfacing with Tar. (Revised, May, 1940.)
94* Re-surfacing with Bitumen. (Revised, October, 1947.)
230* Tar or Bitumen Penetration Macadam, Surface Course, 2 inches thick. (Revised, December, 1936.)
66* Tar or Bitumen Penetration Macadam, Surface Course, 3 inches thick. (Revised, September, 1936.)
125* Cement Concrete Pavement (April, 1939) and Plan and Cross-section A 1147 (March, 1932).
466 Bituminous Flush Seals and Reseals—Fluxing of Binders. (March, 1947.)

GENERAL.

342* Cover Sheet for Specifications, Council Contract. (Revised, April, 1939.)
24B*General Conditions of Contract, Council Contract. (Revised, January, 1948.)
64* Schedule of Quantities.
39* Bulk Sum Tender Form, Council Contract. (Revised, August, 1946.)
38* Bulk Sum Contract Form, Council Contract.
121* Provision for Traffic (Revised, June, 1947) with general arrangement, A 1323* and details A 1325* of temporary signs. (Revised, January, 1947.)
A 1342* Warning Signs, Details of Construction.
A 1346 Iron Trestles for Road Barriers.
A 1341 Timber Trestle and Barrier.
A 1824 Light Broom Drag. (1941.
A 1924 Pipe Frame Drag.
A 178 Mould for Concrete Test Cylinder.
A 1381-3, A 1452-5 } Tree Guards, Types A, B, C, D, E, F, and G.
197* Hire of Council's Plant. (Revised, April, 1937.)
A 478* Specimen Drawings, Rural Road Design, with drawings A478A* and A 478B*.
A 478C*Specimen Drawing, Flat Country Road Design.
A 1113* Rural Road Plan and Longitudinal Section Form (tracing cloth).
A 1114* Rural Road Cross-section Form (tracing cloth).
A 1115* Urban Road Plan Forms (tracing cloth).
193 Duties of Superintending Officer (instructions). (Revised, July, 1938.)
314 Standard Regulations for Running of Ferries. (Revised, January, 1947.)
A 1645 Stadia Reduction Diagram. (1939.)
355* Instructions for Design of Two-lane Rural Highways (1937).
A 1487* Horizontal Curve Transitions (diagrams).
A 1488*, A 1488A*, A 1488B*, and A 1488C*.—Horizontal Curve Transitions (tables for speeds of 30, 40, 50, and 60 miles per hour).
A 1614 Widening of Shoulders on Crests.
369* Instructions for Design of Urban Roads (1939).
288 Instructions for Design of Intersections (Revised, January, 1948.)
402 Instructions for Design of Rural Intersections (acceleration and deceleration lanes). (1941.)

Form No.

KERBS, GUTTERS, AND GULLY PITS.

243 Integral Concrete Kerb and Gutter and Vehicle and Dish Crossings (Revised, July, 1939) and Drawing. (A134A.)
245 Gully Pit (Revised, May, 1939) and Drawings (*a*) with grating (A 1042); (*b*) Kerb inlet only (A 1043); (*c*) with grating and extended kerb inlet (A 1352); (*d*) extended kerb inlet (A 1353).
A 190 Gully Grating. (1933.)
A 1418 Concrete Converter. (1936.)

FENCING.

142 Split Post and Rail Fencing and Drawing (A 43).
141* Post and Wire Fencing (Revised, December, 1947) and Drawings (*a*) Plain (A 494); (*b*) Rabbit-proof (A 498); (*c*) Flood gate (A 316).
143 Ordnance Fencing (Revised, February 1934) and Drawing A 7 (Revised, November, 1939.)
144 Chain Wire Protection Fencing and Drawing (A 140).
246 Location of Protection Fencing (instruction). (Revised, May, 1940.)
A 1301 Motor Traffic By-pass 9 feet wide. (1936.)
A 1875 Motor Traffic By-pass 20 feet wide. (1942.)

BRIDGES AND CULVERTS.

A 4 Standard Bridge Loading (general instruction). (1948.)
A 4A Standard Bridge Loading (instruction for dead-end Developmental Roads.) (Revised, 1938.)
18* Data for Bridge Design. (Revised, August, 1944.)
84* Data accompanying Bridge or Culvert Designs.
A 26 Waterway Diagram. (Revised, 1913.)
371 Waterway Calculations. (1939.)
A 421 Boring Gear, 2 inches. (1930.)
A 44 Boring Gear, 3½ inches. (1926.)
A 2847 Rod Sounding Apparatus. (1945.)
A 2995 Rod Sounding Apparatus, with tripod (1947).
25* Pipe Culverts and Headwalls (Revised, December, 1939) and drawings, Single Rows of Pipes, 15 in. to 21 in. dia. (A 143*), 2–3 ft. dia. (A 130*), 3 ft. 6 in. dia. (A 172*), 4 ft. dia. (A 173*), 4 ft. 6 in. dia. (A 174), 5 ft. dia. (A 175), 6 ft. dia. (A 177); Double Rows of Pipes, 15 in. to 21 in. dia. (A 211*) 2–3 ft. dia. (A 203*), 3 ft. 6 in. dia. (A 215), 4 ft. dia. (A 208), 4 ft. 6 in. dia. (A 207), 5 ft. dia. (A 206), 6 ft. dia. (A 213); Treble Rows of Pipes, 15 in. to 21 in. dia. (A 210), 2–3 ft. dia. (A 216), and Straight Headwalls for Pipe Culverts, 15–24 in. dia. (A 1153*).
A 1* Joint for Concrete Pipes. (Revised, August, 1933.)
A 142* Inlet Sump for Pipe Culverts 3 ft. dia. or less (Revised, December, 1947.)
138* Pre-Cast Concrete Box Culvert (Revised, February, 1948) and drawings, 9 in. high (A 485*), 12 in. (A 446*), 1 ft. 6 in. (A 447*), 2 ft. (A 448*), 2 ft. 6 in. (A 449).
A 311 Concrete Arch Culvert, 5 ft. high. (1931.)
A 314 Concrete Arch Culvert, 10 ft. high. (1931.)
206* Reinforced Concrete Culvert (Revised, February, 1948) and instruction sheets (A 305, A 359, A 306, A 304).
A 1832 Cast-in-Place Concrete Pipe Culverts. (1942.)
A 309* Concrete Culvert Posts. (Revised, June, 1937.)
300 Pile Drivers, specification for 25 ft., and drawings for 50 ft. (A 209), 40 ft. (A 253), and 25 ft. portable (A 1148).
A 1886 Arrangement of Bolting Planks for various widths of deck. (1943.
A 45 Timber Bridge, Standard Details. (Revised, October, 1947.)
A 1791 Timber Beam Skew Bridge Details. (1941.)
164 Timber Beam Bridge (Revised, April, 1947) and instruction sheets, 16 ft. (A71), 18 ft. (A 68), 20 ft. (A 70) and 22 ft. (A 1761). (Amended August, 1946.)
A 1226 and A 1165 Low Level Timber Bridges, instruction sheets for 16 feet, and 18ft. between kerbs. (1932.)
A 1222, A 1166, and A 1223 Single Span Timber Culverts, instruction sheets for 16 ft., 18 ft. and 20 ft. between kerbs. (1931.)
139* Timber Culvert and drawings, 1 ft. 6 in. high (A 427), 2 ft (A 428), 3 ft. (A 429), 4 ft. (A 430), 5 ft. to 8 ft. high, (A 431). (1928.)
326 Extermination of Termites in Timber Bridges. (Revised, October, 1940).
A 222* Pipe Handrailing Details. (Revised, July, 1947.)
350 Reinforced Concrete Bridge. (Revised, January, 1946.)
495 Design of Forms and Falsework for Concrete Bridge Construction. (September, 1947.)

Standards marked * may be purchased from the Government Printer, Sydney.
Others may be purchased from the Head Office of the Department of Main Roads, 309 Castlereagh Street, Sydney, single copies being free to Councils.

State Highway Sy em
of the
State of New South Wales

Area of New South Wales, 309,433 square miles.
Length of public roads within New South Wales, 126,053 miles.

MILEAGE OF ROADS CLASSIFIED UNDER THE MAIN ROADS ACT, AS AT 1st JULY, 1947.

State Highways	6,501
Trunk Roads	3,731
Main Roads	12,653
Secondary Roads (County of Cumberland only)	81
Developmental Roads	2,805
	25,771
UNCLASSIFIED ROADS, in Western part of State, coming within the provisions of the Main Roads Act	2,309
TOTAL	28,080