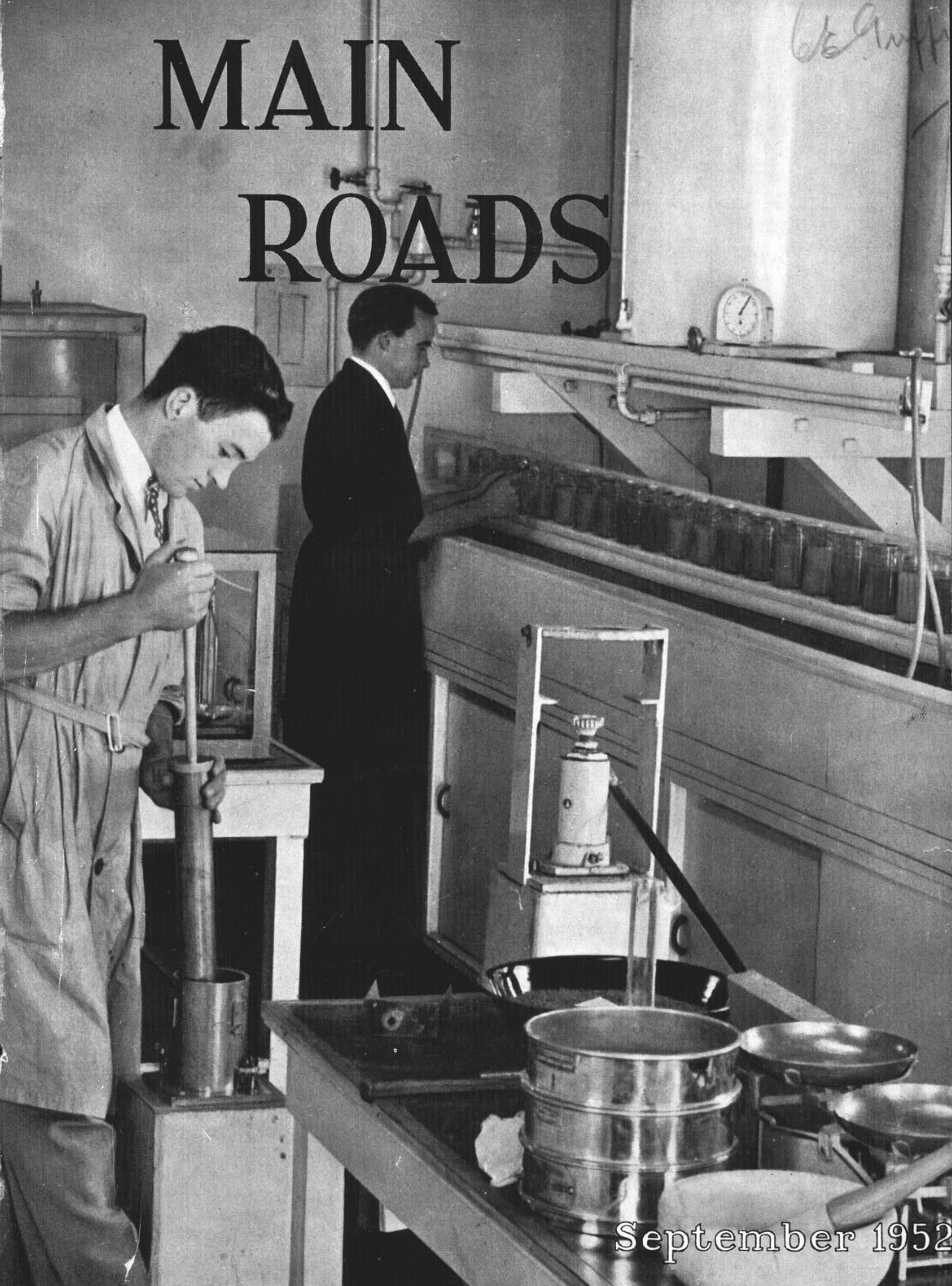
MAIN ROADS



September 1952

MAIN ROADS.

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

Vol. XVIII, No. 1. *Sydney, September, 1952.* *Price: Two Shillings.*

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, 8/-; Post Free.

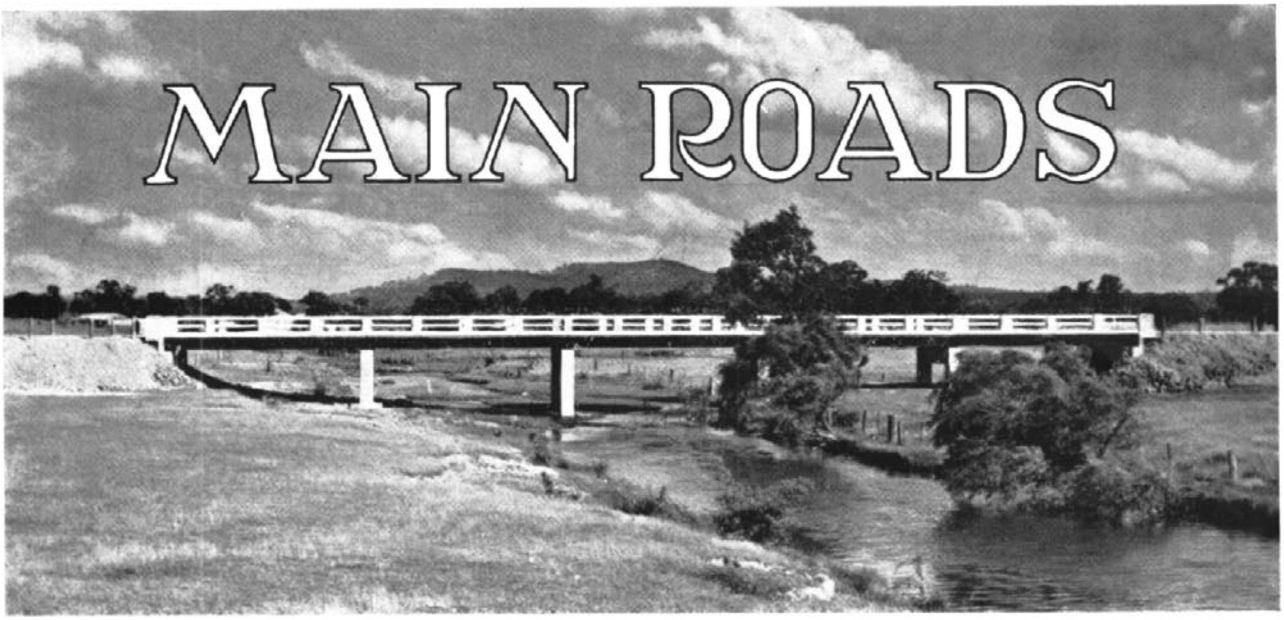
Cover Page.

Interior of Laboratory at Glen Innes Divisional Office. H.O. 3353.

Next Issue: December, 1952.

*94330

MAIN ROADS



H.O.243

Vol. XVIII, No. 1. *Sydney, September, 1952.* 1

Decentralisation of Materials Testing

Until recently, the Department of Main Roads conducted all its materials testing at a central laboratory located in its Head Office building, Sydney. When this system was established, testing was limited in volume, and was confined principally to materials and tests that required special heavy or costly apparatus.

With the development of the testing of subgrade soils, materials for gravel pavements, etc., the volume of testing has greatly increased, whereas the new tests undertaken require relatively cheap and portable apparatus. A few years ago the position was reached when about 75 per cent. of the laboratory's work was with these new tests, and this percentage was steadily rising.

Under these conditions the centralising of the testing work in one laboratory was no longer satisfactory. Samples of soil and gravel are heavy and, from a simple economic point of view, if sufficient tests are being conducted in one area to keep even one operative and the necessary testing equipment fully employed, it is cheaper to send him and his equipment to the area than to transport tons of samples annually to the central laboratory. There are other disadvantages of centralisation of equal or greater importance. The first of these is time. Many tests are required urgently to enable work to proceed or to keep control of quality. The extra time for transport of samples from remote areas to a central laboratory and in the communication of results is often an important indirect element of cost. Also it was found that an appreciable percentage of samples forwarded long distances by rail and/or road were damaged in transit. The replacement of samples is not only costly in itself but, where time is important, the indirect cost of the resulting delay may be serious. Moreover, operatives in a central laboratory seldom come into contact with the works for which the tests are conducted, nor do field engineers have the opportunity for frequent contact with laboratory procedure.

Increased testing of soils and gravels involves a much increased volume of field investigation and sampling work. This is best carried out by officers experienced in the work, and who gain special skill from their experience, preferably aided by training in geology. The establishment of country laboratories with smaller field of operation makes it possible for suitably trained officers not only to be responsible for field testing laboratories, but at the same time take an active part in field investigation and sampling, especially of soils and gravels.

*94330—1

It was decided, therefore, to decentralise testing work. A start has already been made, and the broad outlines of the final scheme decided. Briefly, the ultimate objective is to operate laboratories as follows:—

(1) A central laboratory attached to Head Office which will carry out all testing for the metropolitan area and vicinity; all testing of materials manufactured or purchased in Sydney for despatch to country areas; certain special tests, involving expensive little-used apparatus, for all Divisions; and certain testing for research and investigation.

(2) A laboratory at Newcastle for general testing required in the Division centred on Newcastle, and for the testing of materials manufactured or purchased in Newcastle for despatch to other Divisions.

(3) A laboratory in each other country Division for general testing for the Division's work.

(4) Laboratories at certain important permanent Local Offices for control of materials during use.

(5) Portable laboratories (usually hut-type) attached to temporary Local Offices on large construction works for the same purpose.

(6) Mobile laboratories (caravan-type) for special testing work in remote locations.

The progress already made is as follows:—

(a) A laboratory has been established at Cooma and staffed, and has been in operation for some time. In addition to testing for the road works being carried out by the Department of Main Roads and the Snowy River Council in connection with the Snowy Mountains hydro-electric scheme, this laboratory also carries out general testing for the South Coast Division. This laboratory is not intended to be permanent.

(b) Permanent divisional laboratories have been established at Grafton and Glen Innes and the building for the permanent laboratory at Newcastle is completed.

Testing Laboratory Divisional Office, Grafton.

0.3390.

H.O.2500

Main Roads Materials Laboratory, Cooma.

(c) Divisional laboratories are operating in temporary premises at Parkes, Deniliquin, Chatswood, and Yass. Provision for permanent laboratory premises is made in the new Divisional office building being constructed at Deniliquin, and arrangements are in hand for permanent laboratory buildings at Tamworth and Yass.

(d) Portable laboratories are operating on construction works at Wentworth, Bendemeer and Bateman's Bay. The Bendemeer laboratory is also undertaking some general testing for the North-western Division pending construction of the Tamworth laboratory.

Preliminary arrangements for a number of additional laboratories are in hand, and these will be established as soon as the buildings can be erected and the necessary technical staff trained.

Though substantial progress has thus been made, completion of the decentralisation of testing is likely to take several years more. There are difficulties in securing buildings and equipment, but the controlling factor is the time required to train testing staff. At the present time about half of the Department's testing is being conducted in country laboratories. Though the decentralisation thus appears to be about half accomplished, this is not really the case. Owing to inadequate space and insufficient staff, the Department's central laboratory cannot meet all the requirements for testing in Divisions not yet equipped with laboratories, and a similar position applies in some Divisions already equipped. The objective cannot be regarded as completed until all the country laboratories have been established, equipped, and staffed to an extent that will enable them to meet all normal testing needs. From this point of view decentralisation has been only about one-third completed.

It is hoped that the decentralisation of routine testing of soils, gravels, etc., will result in closer collaboration between testing and engineering staffs, better exploration for and sampling of natural materials, and quicker test results and interpretations.

Wayside Inns of Early New South Wales

Closely interwoven with the history of roads in New South Wales is the story of the roadside inn. As roads developed, inns began to dot the way, providing not only a haven for the traveller, but a common meeting place for isolated settlers. These inns were usually located at intervals of from fifteen to thirty miles apart and served the coaches as "change-stations." The country inn became an essential part of Australian life of the time, a focal point of activity. The bustle of the coaches arriving and departing provided a constant excitement. The "long room" in the more pretentious establishments served every purpose from banquet hall to law court, while the inn yard became the scene of auction sales, travelling shows and other entertainments.

Inns in Antiquity.

In the earliest times when the peoples of the earth were yet nomad tribes, inns were unnecessary and unknown. But as these tribes settled and began to form themselves into productive communities with national characteristics, so they graduated towards civilisation with all its attendant needs, amongst them the need for communications.

Sea travel had from the first been more general and more highly developed. The Persian kings, however, recognised the importance of land communications for strengthening their central power. To this end, they set about the clearing of the tracks that were the only link between countries and even towns. Post houses were built every fifteen miles where the traveller could obtain a bed for the night and fresh horses for the morrow.

The Romans emulated and developed the Persian example. By the time of the Empire, Rome had become the sovereign city of the known world, connected with every province by a vast and excellent network of roads. Truly, all roads led to Rome. Hostelries and drinking places, firstly for the accommodation of soldiers and later of civilians, began to spring up along the roads. The stages of travel were well regulated so that the end of each day's journey found the traveller at a station, "mansio," where he could find lodgings and fresh horses. These posting houses were in reality great Imperial inns, which were under the management of state officials, "frumentarii." In order to gain admission and procure the services of the "Master of Posts" the traveller had to be furnished with a warrant, "epistola evictionis," which might be conferred as a privilege by a person of power. For those who were unable to obtain a warrant, there remained only the mediocre inns, run by private individuals.

After the fall of the Roman Empire commerce and trade languished, travel became dangerous and inns declined. The monasteries took upon themselves the burden of hospitality, which was not lifted until the rise of the guilds, and the need for marketing produce stimulated commerce, and with it, travel.

English Inns.

In England, inns owed their origin to the Roman conquest, one of the most fundamental effects of which was the systematic laying of roads. Once these were made the country began to stir with life, and wherever there was life there was the inn, usually built near a market place. The typical good-class inn of medieval times was galleried, and consisted of a building enclosing a courtyard and entered only by a low and narrow archway which was closed at nightfall by strong, bolt-studded doors.

The advent of coaches gave the inns their greatest impetus and established them as an integral part of the English scene, reflecting always the temper and tastes of the time. There is perhaps no more characteristic picture of nineteenth century England than the English inn—the cheerful commotion of the courtyard, the sound of the bugle heralding the mail coach, the constant arrivals and departures, the conviviality of the tap-room, in all, the throb of life.

The Early Inn of New South Wales.

The rapid development of inns in New South Wales in the middle of the nineteenth century was due to the expansion of settlement, and in particular, to two closely related factors—the discovery of gold in 1851 and the resultant impetus to coach travel. Gold had been discovered by Edward Hargraves at Ophir, near Orange, and in a short time a series of gold rushes swept the colony. This, in turn, greatly stimulated the coaching trade. Travel became more general and widespread, and the number of inns was multiplied to meet the new demand.

A world of difference existed between the inns of the towns and more settled areas and the real "outback" inns. These were often a copy of the early house of the country—a hut of thick wooden slabs cut from ironbark. The chimney, which was made of clay or brick to provide an open fireplace, took up the whole of one side. Often with a few prosperous years, more spacious and comfortable quarters would be built and the original hut converted into a kitchen or outbuilding.

The vicissitudes of the traveller at one of these primitive hotels is graphically recorded in 1849 by Mrs. Perry, who often accompanied her husband, Bishop Perry, on his journeyings: "The inn to-night was worse than last night; besides the amazing gaps between the slabs, the door of the room, which was, as usual, the door of the house, was about a foot too short, both top and bottom. There was no milk, no butter, nothing but excessively bad salt beef, bush tea, black sugar—but happily, good bread. Our bedroom was a very narrow skillion with a black earth floor, all hills and dales, which stuck to our feet and dirtied the bottom of one's clothes. The window was a square hole in one of the slabs. Glass or anything else to supply its place was never thought of."

On the other hand, press advertisements of the time paint a rosier picture of the accommodation offered in the towns. In 1849 the proprietor of the "Tamworth Inn" at Tamworth states that he, "thankful for the distinguished patronage that he has already received, has the honour to inform travellers that he has now made his final arrangements, and he flatters himself that his accommodation, coupled with that desideratum—clean beds, are not to be surpassed, if equalled, by any other inn on the road, and for which only the lowest remunerating price will in future be charged, L.W. having purchased directly of the importers largely of both foreign wines and Spirits which he reduces with VERY LITTLE AND CLEAR WATER ONLY—he is assured by connoisseurs that these, as well as his ales and porters are the real thing, and not the Colonial rubbish supplied by second-rate Sydney and Maitland merchants."

In 1851 the "Apsley Inn" at Walcha was opened with the following statement in the local press: ". . . the stabling will be found perfect, having that most necessary adjunct, a sober, steady and attentive groom. The undersigned is about to erect a large room or hall (brick building) where public meetings, dinners, etc., may be held. Whilst the comforts of gentlemen frequenting the house will be scrupulously attended to, attention to those of the weary labourer and traveller will not be neglected."

Amongst the attractions of the "New Golden Fleece Inn" at Scone, its proprietor in 1850 announced a "horse and bullock paddock and extensive stockyards capable of accommodating four lots of fat cattle at one time of 200 head each. Cattle stopping will avoid the necessity of driving through the town after dark, the cattle can also leave before daylight in the morning, thus avoiding great injury to the cattle and inconvenience to the drivers. These yards will be at the service of customers free of charge."

The keenest rivalry existed between neighbouring inns, who vied with each in providing spectacular amenities for their clients. Competition reached great heights in Hay when the proprietor of the "Red Lion Hotel" engaged a tight-rope walker who attracted large crowds by walking across a rope tied between two gum trees on opposite sides of the river. This remarkable spectacle inspired the proprietor of a rival hostelry to engage another exponent of the art who regularly wheeled a man in a wheelbarrow over a similar rope tied between gum trees.

By the latter half of the nineteenth century such a multiplicity of inns existed in New South Wales as to defy enumeration. The ensuing part of this article will tell of a number of early inns in Sydney and on the main roads radiating from Sydney.

Early Inns in Sydney.

A close link between roads and inns existed in early Sydney when the inns became the starting-points and terminals on the coach runs. (An account of coaching in New South Wales appeared in the December, 1951, issue of "Main Roads.")

The "Rose and Crown," which stood on the south-east corner of Castlereagh and King streets, was the starting point both for the coach run to Parramatta, which was commenced by James Watsford in 1820, and of the later Parramatta run establised by Richards and Ireland in 1832. Thomas Rose, the proprietor, was particularly assiduous in the promotion of coaching, for which he was rewarded in 1825 by a grant of 600 acres of land "in consideration of his public-spirited and successful exertions in establishing coaches in the colony."

Another popular coaching inn was Hart's "George and Dragon" Family Hotel, Mail Coach Office and Livery Stables, in Hart's Buildings, Pitt-street. From here ran the mail coaches to Parramatta and Liverpool in the 1830's.

Departing coaches would call at several inns in George-street, including the "Duke of Wellington," opposite the Post Office, and Polack's "London Tavern," and Ayton's "Woolpack Inn," on Brickfield Hill, where more passengers were taken up.

Old Inn on the Hume Highway near Marulan, now occupied as a station homestead.

H.O 3117.

H.O. 35

The former Railway Hotel, Campbelltown. Built 1860.

Inns Along the Roads from Sydney.

Outside Sydney the earliest inns were naturally to be found on the routes of the three earliest roads, to the west, to the south, and to the north.

On the road from Sydney to Parramatta at the Liverpool Road turn-off stood Ireland's "Speed the Plough" Inn. This curious name is an abbreviation of the Irish expression, "God Speed the Plough." The inn was built in the early 1820's and soon became a popular "change-station" for coaches between Sydney and Parramatta. The site of the old inn is still known locally as "Ireland's Corner."

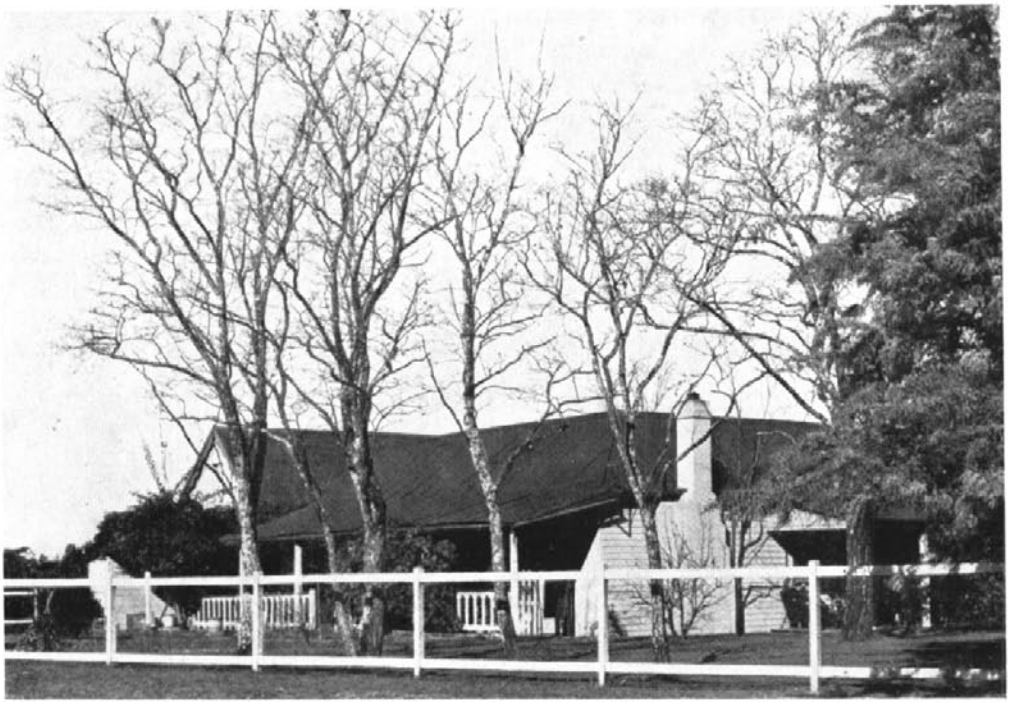
Numerous innkeepers have hung their signs along the streets of Parramatta, and of these two of the most celebrated were Nash's "Woolpack" Inn, which occupied the site of the present court-house on the corner of George and Marsden streets; a hotel established in later years on the opposite corner now bears the name "Woolpack," and the "Red Cow," which stood in George-street. Formerly known as the "Freemason's Arms," the "Woolpack" was taken over by Andrew Nash in 1821, from which time its fame and name date. It was not only the mail coach terminus, but the meeting place of isolated settlers and the scene of balls, banquets, concerts, dinners, lectures and every form of entertainment.

A like popularity was enjoyed by the "Red Cow," a long, low building with a wide front verandah and delightful garden. These two inns became the social centres of Parramatta.

On the Great Western Highway, four miles from Parramatta, can still be seen standing on the northern side of the road at a golf course a building that was formerly a wayside inn. This is the "Fox under the Hill" (see illustration). Its old-fashioned stairs and windows and sloping roof gave the inn an English air. The hostelry is said to have derived its name from

H.O. 705

The Fox Under the Hill, 4 miles west of Parramatta—Great Western Highway.



The former Pilgrim Inn, Blaxland, Blue Mountains.

H.O. 2754.

the Lawsons of Veteran Hall, Prospect, one of the family having let loose a fox under the hill and then set up a hunt to find it.

On the Blue Mountains, "with the exception of two or three small inns, there are no houses, or cultivated land: the road, moreover, is solitary; the most frequent object being a bullock-waggon piled up with bales of wool . . ." Such was the impression formed by Professor Charles Darwin when he travelled to Bathurst in 1836. Included among the "two or three small inns" were the "Pilgrim Inn" at Blaxland, "Buss Inn" at Woodford, and the "Weatherboard Inn" at Wentworth Falls.

The "Pilgrim Inn," which still stands on the old route of the Great Western Highway at Blaxland (see ilustration), was built in 1826 and is typical of its time and type. The structure is one-storied, partly stone, but mostly weatherboard. Features of the building are the verandahs, the cedar fittings, the paved courtyard at the back, the large well and spacious stables.

"Buss Inn" was the name of the picturesque old building, now known as "Woodford House," which stands on the northern side of the Great Western Highway at Woodford (see illustration). The original part of the building dates back to the middle of the

Buss Inn, now known as Woodford House, Great Western Highway, near Woodford.

H.O 2757.

1820's and served as a military station for the convict guard. In the sixties it was opened as a hotel by one Buss, and became a stopping-place for coaches.

The earliest inn on the Blue Mountains was at Wentworth Falls, or Weatherboard, as it was formerly called. The inn is said to have been constructed soon after 1815 on the site of Governor Macquarie's camp on his historic trip to Bathurst. The "Weatherboard Inn" became a recognised stopping place on the road over the mountains. During his journey to Bathurst in 1836, Professor Darwin records, "In the middle of the day we baited our horses at a little inn called the 'Weatherboard'." A later traveller, Mrs. Louisa Meredith, noted in 1839 ". . . we drove briskly on, our destination for the night being the 'Weatherboard' inn (so named from its being built, like many houses in the Colony, wholly of wood, the walls consisting of thin boards lapped over one another, nailed to upright slabs or posts, and lathed and plastered within)."

At the foot of Mount York, by the side of the old line of road to the west, stands a quaint old building called "York House." This was the once prosperous and much-frequented "Collits' Inn," which was built by Pierce Collits in the late 1820's (see illustration). The inn enjoyed a brisk trade as the terminus of the second day's travel from Sydney to the west, local post office, and meeting place for the surrounding district. The construction of Mitchell's new road down Victoria Pass in 1832 threw into disuse that part of the road upon which "Collits' Inn" stood, and gradually its custom declined until it was converted into a private dwelling.

Westward again from "Collits' Inn" is Hartley, which was first settled in the early 1820's, though it was not until 1838 that the town of Hartley was established. At the bridge over the Lett River stood the "Coaches and Horses," erected in 1843, which offered such refinements as wax candles, clean linen, good food and an attentive ostler. The traveller's expenses at this inn were: bed 2s., ostler 1s., supper 2s., breakfast 2s., spirits 6d., horse 8s. It was the gold rush to Orange in 1851 that provided the greatest fillip to Hartley's development. In its heyday the town boasted no less than twelve inns, but with the extension of the railway beyond Mount Victoria in the 1870's, Hartley's prosperity declined.

The town of Liverpool, on the Hume Highway, was first laid out in 1810 soon after Governor Macquarie's visit there on one of his early tours of inspection of the colony. By 1814 direct roads between Liverpool and Sydney and Liverpool and Parramatta were being completed. Of accommodation in Liverpool the *New South Wales Calendar and Directory* for 1832 states, "there are several inns in the town, the 'Union,' kept by Forbes is a very commodious one, from which the mail sets out for Campbell Town; the coaches to Sydney start from the 'Ship Inn,' which is also very comfortable." The "Ship Inn" stood in Macquarie-street.

Further south, where the Hume Highway crosses Stonequarry Creek, the site of Picton was chosen for a village by Governor Macquarie in 1820: "I also examined a most eligible situation on the North Bank of this Creek for a Township whenever this desirable part of the Country is settled." The earliest inn at Picton dates from 1837, when the proprietor of "The Sun Inn" was authorised to open at Redbank, now Upper Picton. In 1839 there appeared another, the "George Inn," which has been modernised and still stands on the eastern side of the Hume Highway at the southern end of the township of Picton.

Berrima came into existence as a result of the new line of road which was built in 1830 to avoid the Mittagong Range. In the same year the town of Berrima was laid out by Surveyor Hoddle. The town's future seemed assured when "Sir Richard Bourke selected Berrima as the proper position for the erection of a Court House and Jail on a sufficiently extensive scale to form the grand depot for the reception of prisoners from the whole of the southern districts for many years to come" (*Sydney Gazette*, 12th April, 1838). As well as the historic gaol and courthouse in Berrima may still be seen the "Surveyor General Inn" (see illustration), named after the famous explorer

Collits' Inn, now known as York House, at the foot of Mt. York, Blue Mountains. Built 1823.

H.O.3124.

Surveyor-General Inn, Hume Highway, Berrima. Built 1834.

H.O. 2968.

and surveyor, Sir Thomas Livingstone Mitchell. It bears the sign, "Australia's Oldest Licensed Inn, Est. 1834."

A short distance south of Berrima, on the Hume Highway, stood a two-storied building, the "Three-Legs-of-Man" Inn, which was built in 1838 and demolished in 1918. The name still applies to a creek adjacent to the site. There has been great controversy over the origin of the name, "Three-Legs-of-Man," which is the arms of the Isle of Man. The symbol of the three legs was found on a fourteenth-century pillar cross near Maughhold on the Isle of Man. It is now generally assumed that the motif was a sun symbol brought from Sicily to the Isle of Man by the Vikings.

To the north the earliest settlement was at Windsor. As early as 1794 the first settlers were allotted their grants along the banks of the Hawkesbury River and South Creek by Lieutenant-Governor Major Grose. These formed the nucleus of the settlement of Windsor, then known as Green Hills. In 1796 Governor Hunter gave instructions for a road to be laid from Parramatta to the new settlement. Governor Macquarie, in 1810, visited Green Hills and renamed it Windsor.

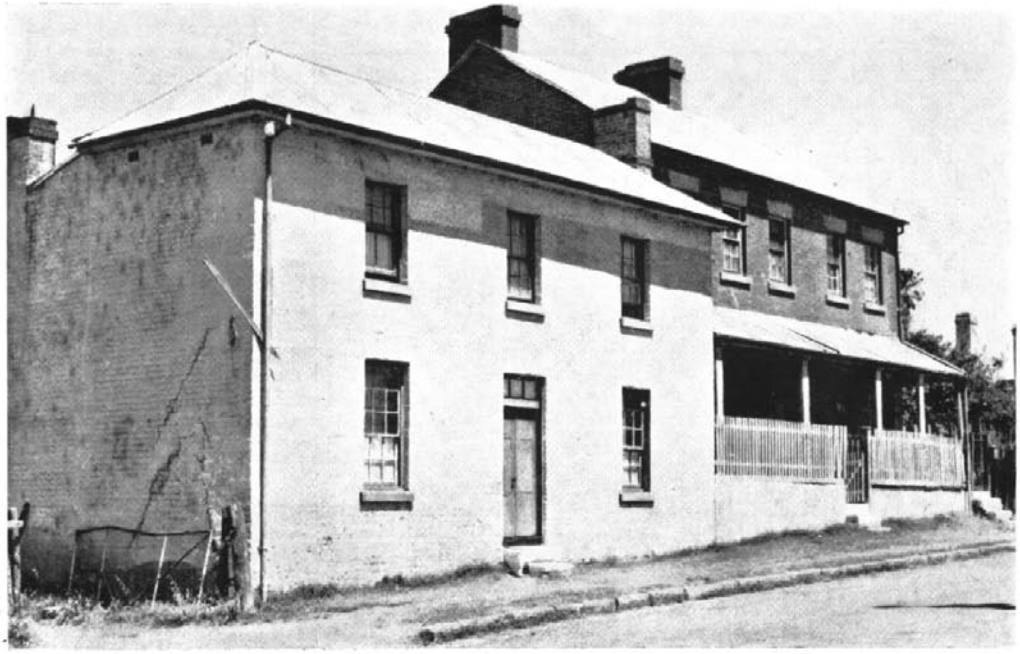
Here may still be found many relics of the early days of the town. One of the most celebrated is the "Royal Hotel," on the corner of George-street and Callaghan-street, which was erected in the 1820's as a private residence by a Mr. Fitzgerald. Later the house became the quarters of the military officers and, later still, a public house under its present name (see illustration). W. C. Wentworth, soon after its erection, notes that it "is by far the best building in the town, and may be pronounced, upon the whole, the most splendid establishment of the kind in the colony." The thick walls, the colonnade in the front of the building with its strong wooden pillars and stone flagging, the fine staircase with cedar balustrades, the roomy cellar and the spacious stables and out buildings all combine to make the "Royal Hotel" one of the finest examples of early Australian architecture.

Another famous inn of Windsor was the "Currency Lad," which still stands in Macquarie-street (see illustration). The origin of this strange name is explained

Royal Hotel, Windsor. Built in 1820's.

H.O. 3495.

Currency Lad and Sportsman (later named Travellers Rest). Formerly licensed Inns, Windsor.



by Edward Gibbon Wakefield in his "Letter from Sydney" (1829). It seems that the term was first used by an Englishman, "who, in the pride of his John Bull breed—distinguished the Emigrant from the Native Population of New South Wales by nicknaming the one Sterling and the other Currency." The "Currency Lad" was built about 1816. Its name was later changed to the "Jim Crowe Hotel" to avoid confusion with the "Currency Lass," which had been opened at South Creek. After a time the inn was converted into a temporary police station, and then, in 1846, into a post office. The building is now used as a private residence.

Richmond's history is nearly as old as that of Windsor. It, too, was marked out at the time of Governor Macquarie's visit in 1810. In the township, on the corner of the main road (Main Road No. 184) and Bosworth-street stands what was once the famous "Black Horse Hotel" or "Honeymoon Cottage," as it was often known from the number of honeymoon couples who came here from Sydney. It is now converted to use as a petrol station. The bridal chamber was one of the inn's showpieces. The inn was built in 1818, and in 1819 a licence was issued to "Paul Randall, at the sign of the 'Black Horse Prince' in Richmond . . . to keep a common Ale House or Victualling House and to issue and sell Beer, Ale, Cyder and spiritous liquors, in the house wherein he dwelleth and not elsewhere for one whole year from the twentieth day of this present month of February and no longer . . ." The thick walls and low-ceilinged rooms bear testimony to the age of the inn.

Wiseman's Ferry Hotel. Built in early 1820's.

From Windsor a line of road was projected to the north. By 1828 the section to the Hawkesbury River had been completed. At the point where the road crossed the river was the hostelry of Solomon Wiseman, who had previously kept an inn in Bligh-street, Sydney, from 1813 to 1817. Wiseman obtained a licence for premises at the site of the present town of Wiseman's Ferry in 1821 and a grant of land in 1823. Later he opened a ferry service across the river. This old two-storied stone building with its stone-flagged passages and old-fashioned window seats with recessed shutters may still be seen standing on the right-hand side of the road at the entrance to the township of Wiseman's Ferry (see illustration).

The era of intensive railway construction which began in 1855, and the appearance of the motor vehicle in the early part of the present century abolished the sovereignty of the horse coach. And so the need for the roadside inn at regular intervals along the road to serve the coaches gradually disappeared, until to-day but few of these historic relics of the past remain.

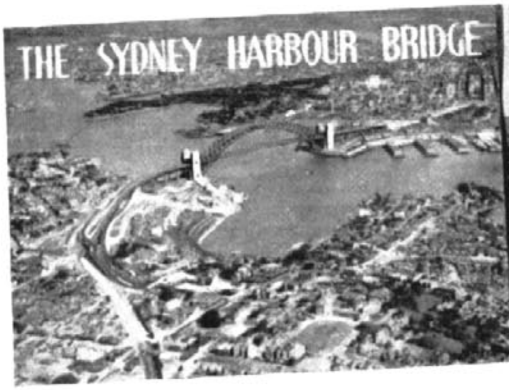
Acknowledgments:

Material for this article has been obtained from—

The Public Library, New South Wales.
The Mitchell Library, New South Wales.
The Royal Australian Historical Society, Sydney.

J.M.E.

Sydney Harbour Bridge Brochure



H.O. 3554

Since the opening of the Sydney Harbour Bridge in 1932 many inquiries have been received for information concerning the construction and maintenance of the structure. To meet this demand the Department has produced a brochure entitled "The Sydney Harbour Bridge."

The brochure tells the story of the building of the bridge, maintenance and toll collecting operations and financial arrangements. It is illustrated with photographs of the construction and maintenance operations.

Copies of the brochure may be obtained at a cost of 2s. 6d. per copy, post free, on application to the Department's Head Office, 309 Castlereagh-street, Sydney.

SYDNEY HARBOUR BRIDGE ACCOUNT

Income and Expenditure for period 1st July, 1951, to 30th June, 1952

Income.

	£
Road Tolls ...	578,574
Contributions—	
Railway Passengers	116,716
Tramway and Omnibus Passengers	27,606
Rent from Properties	13,941
Miscellaneous	62
	£736,899

Expenditure.

	£	£
Cost of collecting road tolls		52,937
Provision for traffic facilities		7,604
Maintenance and minor improvements		76,885
Alterations to archways		231
Administrative Expenses		2,496
Loan Charges—		
Interest	221,400	
Exchange	21,300	
Sinking Fund	66,500	
Management Expenses	1,970	
		311,170
Miscellaneous		1,274
		£452,687

Design of Kerb Alignment at Street Corners

This article describes a new design for the curving of footway edges at street corners, using a two-centered curve. The design was prepared following experiments conducted with double-decker buses kindly made available by the Department of Road Transport and Tramways, Sydney.

Street intersections may be classified broadly into two types according to the nature of the turning traffic, namely:—(a) intersections where turning traffic is light and comprised chiefly of passenger cars, and (b) intersections where turning movements are heavy, and commercial vehicles form a large percentage of the total of all traffic turning. Residential areas and small community shopping centres contain the bulk of intersections of Class (a), while the intersection of two main roads, a main road and sub-arterial road, bus routes, and important streets within industrial areas mainly constitute Class (b).

Factors Affecting Design: The principal factors to be considered in designing the rounding of a kerb at a corner are as follows:—

(i) The shape of the curve should permit a vehicle of normal size to turn left within the path prescribed by traffic regulations, and without encroachment upon the lanes provided for opposing traffic.

(ii) Sight distance at any point should be adequate for a driver approaching the intersection to see other traffic approaching so that he may control his vehicle and avoid collision.

(iii) The passage of pedestrians across the road should be as short as possible and approximately at right angles to the general line of traffic flow.

It will be seen that there could be some conflict between requirements for motor vehicles and for pedestrians; the design described herein to a large degree meets the needs both of vehicles and of pedestrians.

Vehicles Adopted for Design Purposes: The turning requirements of motor vehicles at intersections depend on: (1) the characteristics of the vehicle making the turn, i.e., its wheel base, overall dimensions, and minimum turning radius, (2) the actions of the vehicle operator in making the turn, and (3) the turning speed of the vehicle.

From considerations of vehicle characteristics, two "design vehicles" were selected as representative of the main vehicle groups, viz.:—a commercial vehicle having a wheel base of 17 feet 6 inches, overall length 27 feet 6 inches, width 8 feet and minimum turning radius 40 feet, and a passenger vehicle of 12 feet wheel base, overall length 19 feet, width 6 feet and minimum turning radius 28 feet. The commercial design vehicle has similar characteristics to those of double-decker omnibuses in use in New South Wales.

Consideration was given to semi-trailer and trailer combinations, but although their overall dimensions are, in general, greater than those of the commercial design vehicle, their minimum turning radii are smaller, and consequently they can be accommodated by a design based on the turning path of the selected commercial design vehicle.

Turning Requirements of Vehicles: The path traced by a vehicle when turning may be wholly transitional or consist of a transition and a circular curve, depending upon the driving habits of the operator. The length of transition described by the vehicle is dependent upon vehicle speed and the time taken by the driver to turn his steering wheel from straight to full-lock or to the position required by him to make the turn. From observations of these actions by the drivers of double-decker buses, it was found that for a normal 90 degrees turn at a street intersection, the time occupied in turning the steering wheel from straight to full-lock is about 6 seconds and the average turning speed of the vehicle is about 5 miles per hour. For a passenger car, the corresponding time appears to be about 2.8 seconds at a speed of 10 miles per hour. Higher turning speeds are possible for both commercial vehicles and passenger cars, but those stated are considered to be averages suitable for design purposes.

When a vehicle turns at low speed on a curve of given radius its rear wheels should track inside the front wheels by a radial distance which can be found geometrically, and is expressed by the formula $R-\sqrt{R^2-L^2}$, where R = radius of turn in feet at the outer

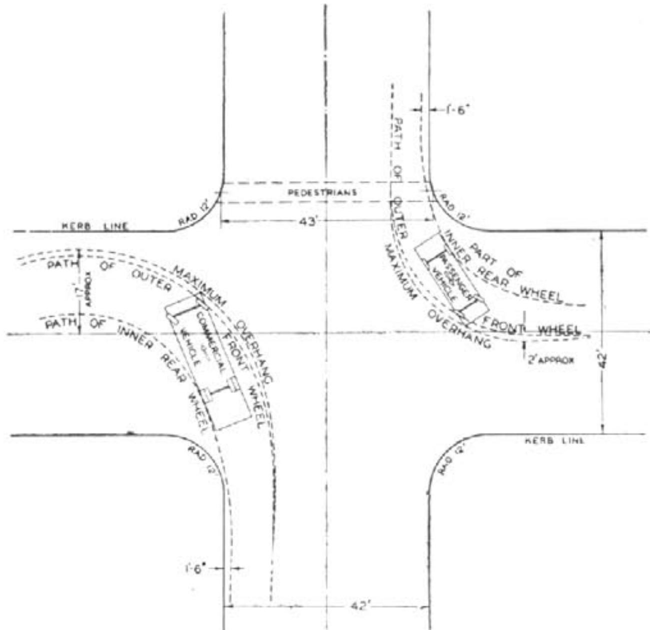


FIG 1

front wheel and L = wheel base of the vehicle in feet. This was confirmed by observation up to radii of 80 feet and for low speeds.

It was found from observation of the path of the commercial design vehicle making 90 degree turns of small radius that a curve of approximately lemniscate shape is followed in practice.

Using this information, paths were plotted showing the trace of the front and rear wheels and the maximum front overhang of the two design vehicles when turning through 90 degrees at full-lock. By placing a trace of these paths over the plan view of an intersection layout, the effect of kerb design on a vehicle turning left or right from one street to another may be studied.

An example of the use of the calculated vehicle paths is shown in Figure 1 where the inadequacy of a 12-feet radius is illustrated by the fact that both the commercial and the passenger vehicle are not capable of turning left from the kerbside lane without encroachment upon the lane of opposing traffic in a side street assumed to have a carriageway 42 feet wide. The inadequacy of a small radius turnout is illustrated also in Figure 2, where a double-decker bus is shown turning left from the second lane from the kerb and across the lane of opposing traffic in the side street.

Fig. 2.

The Left-hand Turn at Intersections: At the intersection of two four-lane carriageways there are four forms of left turning movement to be considered, viz., a turn from the kerbside lane of one street either to the kerbside or to the second lane from the kerb in the intersecting street, and a turn from the second lane from the kerb in one street either to the kerbside lane or to the second lane in the side street.

A left turn from the second lane from the kerb should not be used to fix the shape of turnout curve for the following reasons:—

(a) When turning left out of a "through" road it is desirable that a driver should use the kerbside lane for his deceleration manoeuvre and ultimately make his turn from that lane so as to leave the second lane from the kerb free for other traffic.

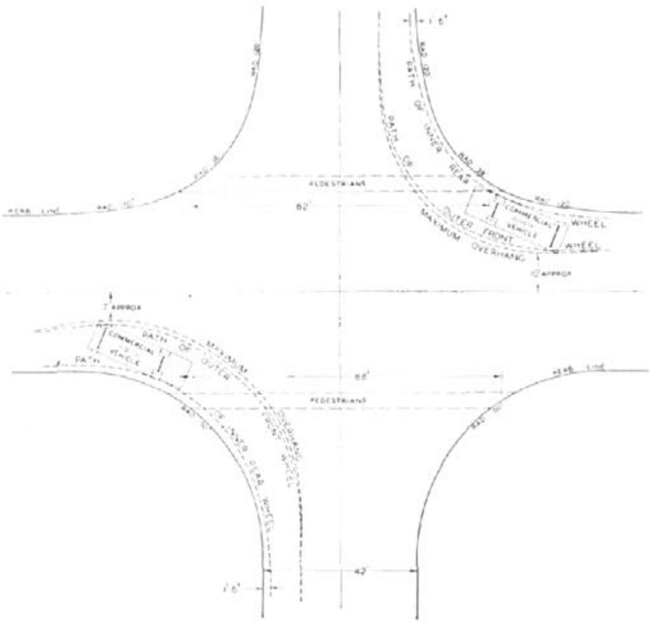


FIG. 3

(b) On many bus routes, stopping places are located near an intersection where the bus turns left, so that the left turn is commenced from the kerbside lane.

(c) The New South Wales traffic regulations require that a vehicle turning left from one street to another should keep as near as practicable to the left boundary of the carriageway.

Adoption of the kerbside lane for the commencement of a left turn leaves two alternatives to consider, i.e., whether provision should be made for a vehicle to turn into the kerbside lane or the second lane from the kerb in the side street.

Commercial vehicles are able to turn left from kerbside lane to kerbside lane when provided with a simple curve of 50 feet radius, or, alternatively, a three-centred compound curve of approximately 120 feet, 40 feet and 120 feet radii, as shown in Figure 3. Either of these layouts provide adequately for the commercial vehicle, but they have two important disadvantages as follows:—

(a) pedestrians are required to traverse a distance of 82 feet in one case and 88 feet in the other in crossing a carriageway whose normal width is 42 feet, and

(b) small wheel base vehicles might be encouraged to turn with little or no reduction in travelling speed from the regulation maximum of 30 miles per hour in built-up areas. This could readily be achieved on a radius of about 100 feet from the second lane in one street to the second lane in the other street, and would create a serious hazard for pedestrians stepping from the kerb to cross the road. It has proved in practice to be a hazard also to the vehicle, particularly where the crossfall of the intersecting street is adverse to the direction of turning.

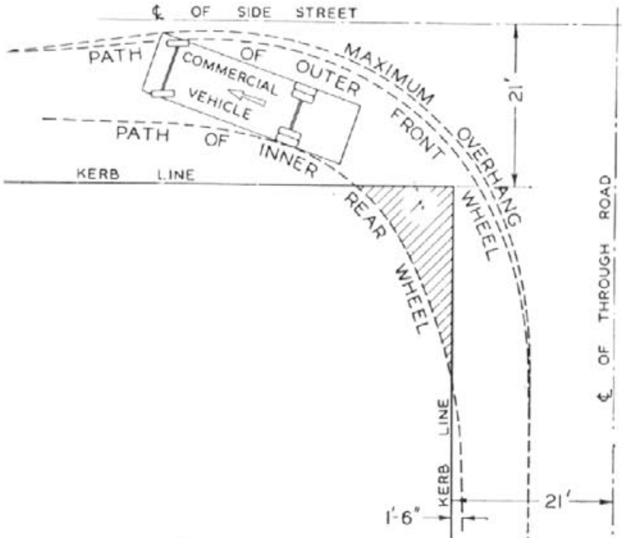


FIG 4

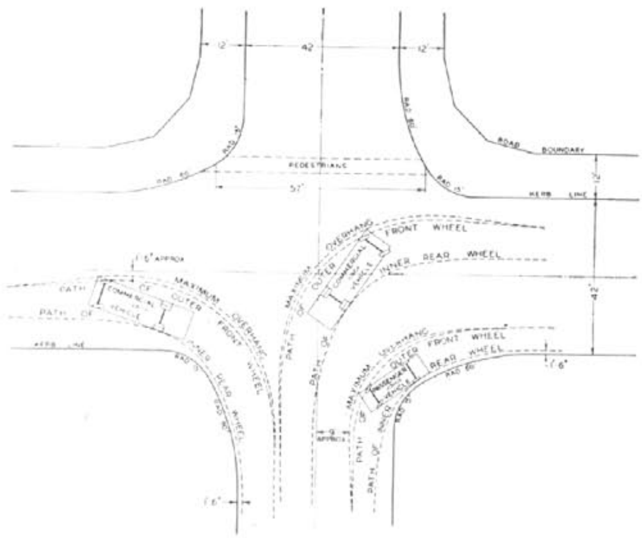


FIG. 5

From consideration of pedestrian safety, therefore, it would appear that a design for the curving of footway edges at street corners should not provide for all vehicles to turn left from kerbside to kerbside lane.

In turning left from the kerbside lane to the second lane from the kerb, the commercial design vehicle would trace a path as indicated in Figure 4. The portion of footway area shown hatched is that which would require to be removed in order to permit such a turn. From an examination of this area it is apparent that a symmetrical kerb layout is not essential if it is desired to design for minimum turning conditions. When making this turn, the transition of the inner rear wheel of the design vehicle approximates to a radius of 60 feet at the commencement of its path so that the provision of a 60-feet radius curve at the kerb should guide a commercial vehicle into a correct path when starting the turn. Once this is accomplished, the shape of the remainder of the kerb will have little effect on the vehicle's path, and an ease to the alignment of the intersecting street may be made in as short a length as possible.

On this basis a standard two-centered compound curve has been designed having radii of 60 feet and 15 feet, as shown in Figure 5, the 60-feet radius section being for the purpose of guiding commercial vehicles into the second lane from the kerb, while the 15 feet radius section accommodates the turning path of a passenger vehicle in a turn from kerbside lane to kerbside lane. With this layout the normal path of pedestrians across the intersection in the case of a carriageway normally 42 feet wide is 57 feet. (The equivalent symmetrical layout would involve a radius of 35 feet with a corresponding crossing distance for pedestrians of 73 feet.)

A two-centered compound curve has a further advantage over a symmetrical curve in that the area of road pavement required at an intersection is kept to a minimum. In comparing pavement areas on a normal four-way square intersection, it was found that the area saved by adopting the two-centered layout was approximately 150 square yards in the case of the three-centered curve of 120 feet, 40 feet and 120 feet radii, approximately 170 square yards for the simple 50 feet radius curve, and approximately 50 square yards for a curve of 35 feet radius.

In order to examine the 60-15 compound curve layout with regard to aesthetics, models were constructed so that the unsymmetrical layout could be viewed from all aspects. It was concluded that the lack of symmetry would not be detected by casual observation by the road user.

Construction of Trial Intersections: From these considerations it was concluded that the 60-15 feet compound curve layout should provide a suitable compromise between the needs of the motorist and the pedestrian. Intersections in accordance with the layout (Figure 5), therefore, were constructed for trial purposes on main roads in the Sydney district. Figure 6 illustrates the

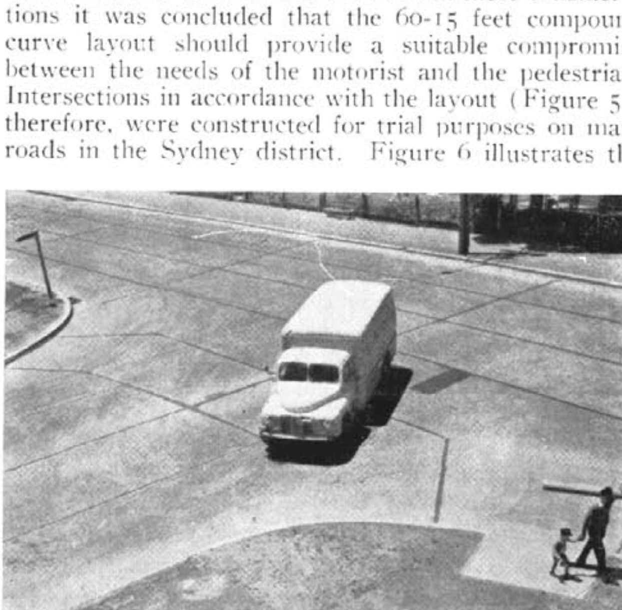


Fig. 6.

intersection of Burwood-road with Canterbury-road, Belmore, Main Road No. 167, which has been reconstructed in accordance with the layout described above.

Fig. 7.

Observation of traffic movements since reconstruction indicates that left-hand turns are being made as anticipated and that large wheel base vehicles do not encroach upon the lanes of opposing traffic when turning. The series of four photos in Figure 7 shows an omnibus stopped adjacent to the kerb of the main road and then turning left into the second lane from the kerb in the side road. It may be noted that the inner rear wheel follows the kerbline in accordance with the design theory. From observation of left-turning manoeuvres by several buses whose drivers were not aware of the tests, it was found that the average position of their outside front wheel from the left-hand kerb was approximately 18 feet, or 3 feet from the road centre line, when completing the turn.

Figure 8 shows the intersection of Wentworth-road with State Highway No. 2, Hume Highway, at Enfield, where an 18-degree skew intersection has been constructed in accordance with the new standard. The photo. illustrates that there are no unusual features in the appearance of the junction when viewed from the road user's normal viewing height.

Fig. 8.

General Application of Compound Curve: The two-centered compound curve layout has now been adopted by the Department of Main Roads in built-up areas at the intersection of the following:—

(a) two main roads,
(b) a main road and sub-arterial road, and
(c) a main road and a side street carrying bus traffic or a large percentage of lorry traffic.

Figure 9 illustrates a geometric construction for the compound curve at a square intersection. The layout is suitable for angles of skew in the side street of up to 30 degrees. (Details for skew layouts are given in the D.M.R. Standard Form No. 499.)

For angles of skew greater than 30 degrees, it is desirable that the layout should, if practicable, be replanned to make the angle of intersection within 30 degrees of a right angle. If replanning is impracticable because of interference with buildings, etc., the intersection on the existing site should preferably be designed to incorporate traffic islands to channel turning movements, and to reduce unnecessary pavement areas which might induce vehicles to wander or make speedy and dangerous turns. Islands serve also as a refuge for pedestrians.

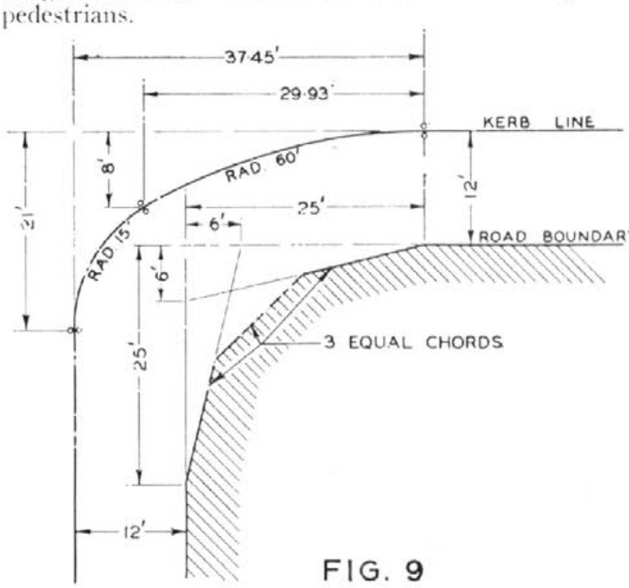


FIG. 9

Turnouts to Residential Streets: In the determination of a suitable layout for corners at the intersection of a main road with a side street in residential or local shopping areas, the following factors have been considered:—

(a) the total turning movements of all vehicles are, in general, numerically low;
(b) commercial vehicles form a small percentage of the total of all vehicles turning;
(c) side street carriageway widths may be less than 42 feet; and
(d) land acquisitions for corner cut-offs should be kept to a minimum.

By the use of similar design methods to those outlined above, it has been found that where the width of the carriageway of the side street is 30 feet or greater, a true circular curve of 15 feet radius will permit the passenger design vehicle to turn left from the kerbside lane into the second lane from the kerb. For carriageway widths of less than 30 feet, however, or where the side street is not at right angles with the main road, the kerb radius requires modification, as shown in

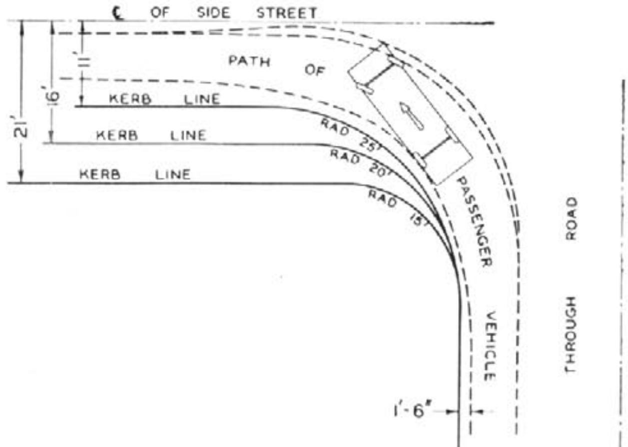
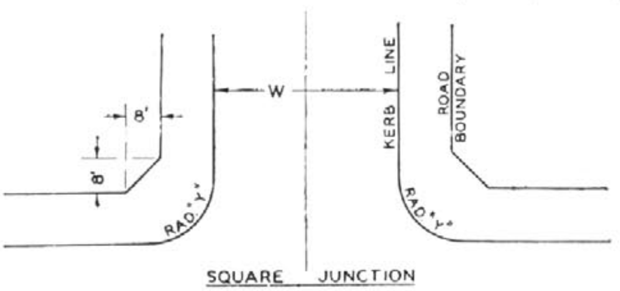
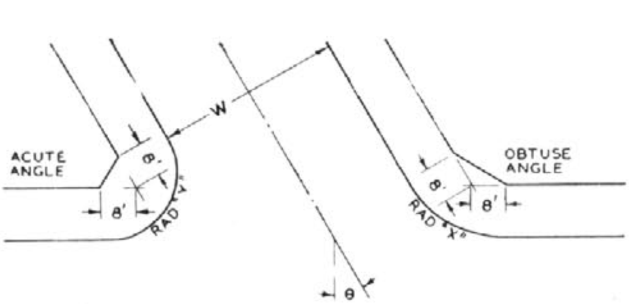


FIG. 10





RADIUS OF TURNOUT TO SIDE STREETS IN RESIDENTIAL & LOCAL SHOPPING AREAS

Angle of Skew θ	Width of Carriageway in side street "W"	Kerb Radius Obtuse Angle Side "X"	Kerb Radius Acute Angle Side "Y"
0°- 5°	30' AND OVER	15'	15'
	22' TO 29'	15'	20'
	LESS THAN 22'	15'	25'
6°- 12°	32' AND OVER	15'	15'
	22' TO 31'	15'	20'
	LESS THAN 22'	15'	25'
13°- 20°	34' AND OVER	20'	15'
	22' TO 33'	20'	20'
	LESS THAN 22'	20'	25'
21°- 30°	34' AND OVER	25'	15'
	20' TO 33'	25'	20'

FIG. II

Figure 10 and detailed in the table in Figure 11, if the passenger design vehicle is to turn left without encroachment upon the lanes of opposing traffic in the side street.

Although the commercial design vehicle cannot turn left from the kerbside lane without crossing the side street centre line, it is possible for it to turn safely in a carriageway 42 feet wide from a position about 7 feet from the kerb, as shown in Figure 12.

Figure 11 illustrates the standard layout which has been adopted by the Department of Main Roads for the intersection of a main road with a side street in residential and local shopping areas.

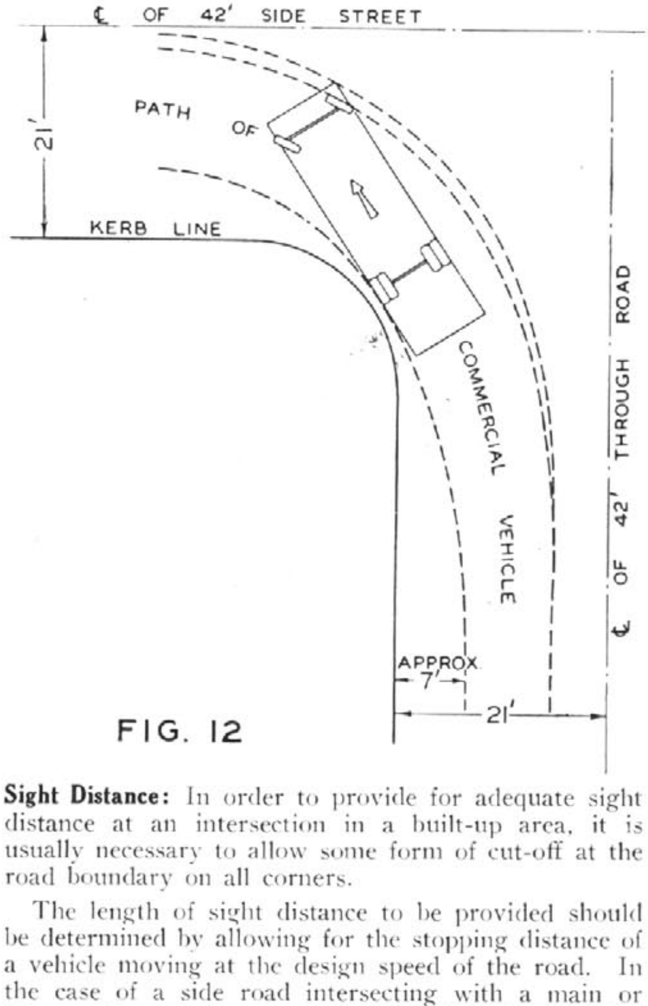


FIG. 12

Sight Distance: In order to provide for adequate sight distance at an intersection in a built-up area, it is usually necessary to allow some form of cut-off at the road boundary on all corners.

The length of sight distance to be provided should be determined by allowing for the stopping distance of a vehicle moving at the design speed of the road. In the case of a side road intersecting with a main or "through" road, however, it is considered reasonable to assume that some extra caution will be exercised by a driver in approaching the intersection along the side road, and a stopping distance calculated from two-thirds of the main road design speed is adopted. On this basis the method of determining the extent of cut-off required is illustrated in Figure 13.

Where a road is 66 feet wide and the footway width is 12 feet, the desirable minimum cut-off at a minor side road intersection is 8 feet measured from the corner along each boundary line. This cut-off is suitable for kerbline radius of from 15 to 20 feet.

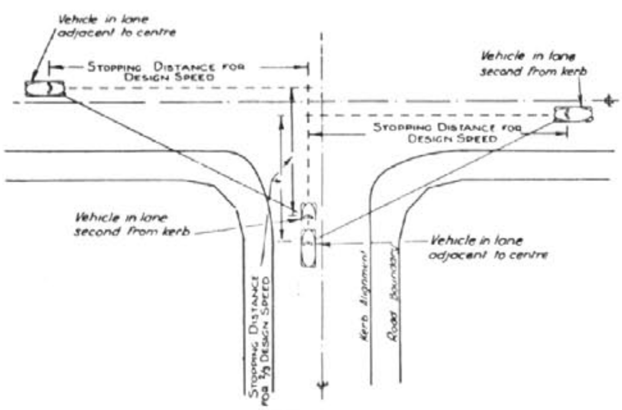


Fig. 13.

In the case of a road where there is substantial turning commercial traffic, and the 60-15 compound curve is used, a three-chord cut-off is desirable in order to maintain a minimum footway width of 12 feet. For a square junction the three-chord cut-off is as shown in Figure 9.

Supervision of Tests: The field tests with buses referred to herein were carried out under the personal supervision of Mr. R. J. Spowart, Assistant Design Engineer.

Acknowledgment: The Department of Main Roads is indebted to the Department of Road Transport and Tramways for its assistance in making available the omnibuses necessary for the investigation into vehicle turning paths, and for the tests conducted at the experimental intersection.

PAYMENTS FROM THE ROAD FUNDS

For period 1st July, 1951, to 30th June, 1952

	Amount Paid. £
County of Cumberland Main Roads Fund—	
Construction and Reconstruction of Roads and Bridges	1,034,973
Acquisition of Land and Buildings for Road Widening	46,374
Maintenance and Minor Improvements of Roads and Bridges	914,034
Interest, Exchange and Repayment of Loans	87,343
Other Expenditure	268,897
Total	£2,351,621
Country Main Roads Fund—	
Construction and Reconstruction of Roads and Bridges	2,413,081
Acquisition of Land and Buildings for Road Widening	24,558
Maintenance and Minor Improvements of Roads and Bridges	3,936,258
Interest, Exchange and Repayment of Loans	151,073
Purchase and Repair of Plant and Motor Vehicles	1,145,374
Other Expenditure	329,952
Total	£8,000,296
Developmental Roads Fund—	
Construction and Reconstruction of Roads and Bridges	166,714
Other Expenditure	1,872
Total	£168,586
Summary All Funds—	
Construction and Reconstruction of Roads and Bridges	3,614,768
Acquisition of Land and Buildings for Road Widening	70,932
Maintenance and Minor Improvements of Roads and Bridges	4,850,292
Interest, Exchange and Repayment of Loans	238,416
Purchase and Repair of Plant and Motor Vehicles	1,145,374
Other Expenditure	600,721
Total	£10,520,503

Some Steep Grades on Main Roads in New South Wales

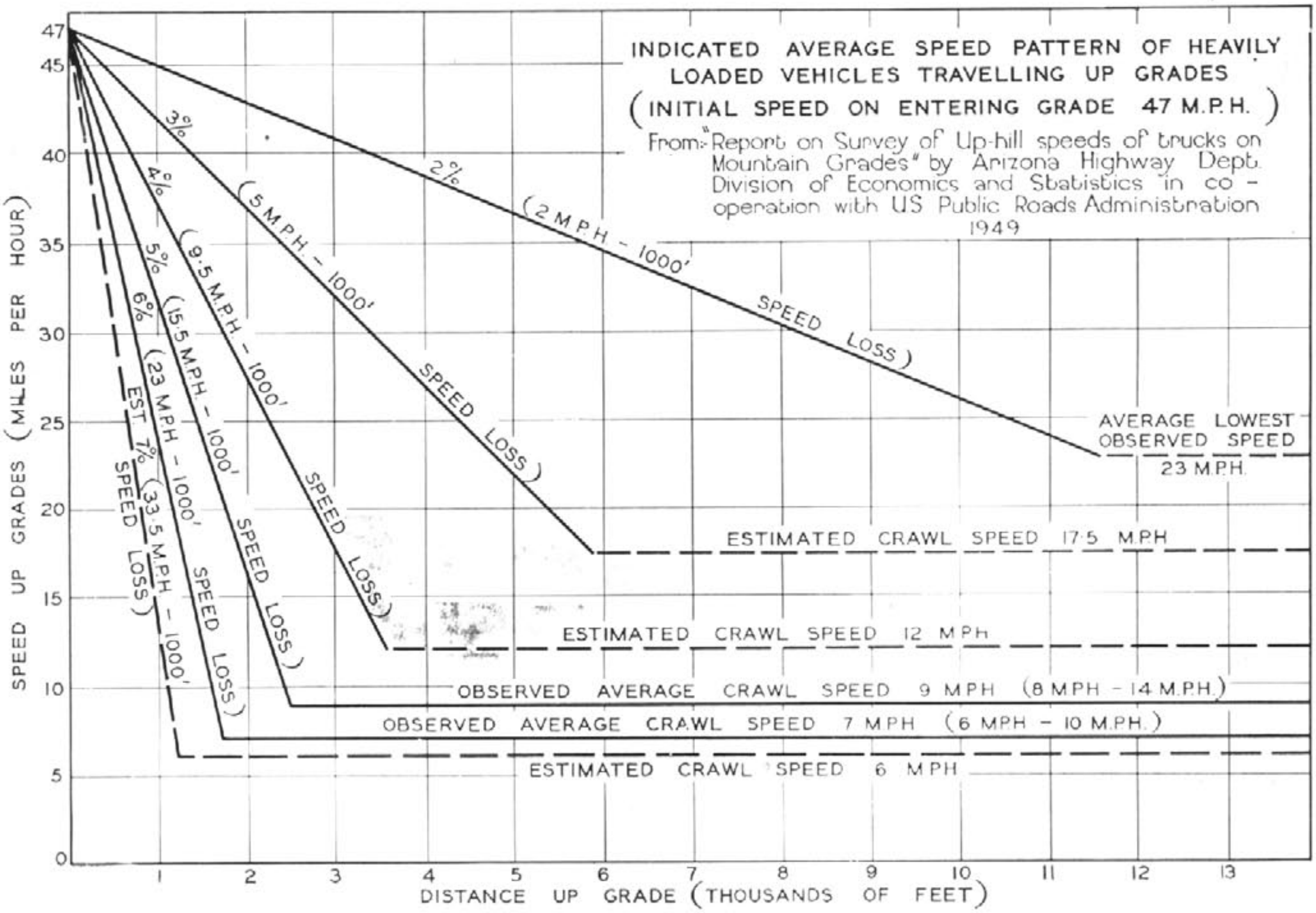
Steep grades on roads have always attracted public interest, as evidenced by the many cases where hills have been given names such as Devil's Pinch, the Big Hill, Macquarie Pass, and so on, and by the enquiries regarding grades received from the public from time to time.

Eastern New South Wales includes much mountainous country and there are various mountain passes, some of the most important being those linking coast and tablelands. These were mainly constructed during the last century, and although widened and improved in various respects, still generally have the grades to which they were originally built. Only in a few cases has some grade improvement been practicable.

During the last 25 years, as the motor vehicle has developed increased power and better performance, views regarding desirable grades on arterial roads have been changing. At first, the outlook regarding grades was mainly influenced by the hill climbing capacity of the early cars, and by safety when going downhill. During more recent years as the use of commercial vehicles has expanded, the needs of the heavy commercial vehicle have tended more and more to determine the desirable form of design for rural arterial roads, in respect not only of grades, but also in respect of width and pavement strength.

The commercial vehicle is underpowered as compared with an average car, because its power-weight ratio is lower than that of a car. For this reason, commercial vehicles are considerably slowed down when climbing steep grades, sometimes to little more than walking pace. The extent to which this occurs varies with such factors as the speed at which the grade is approached, the steepness and length of the grade, the weight of the load carried, and the performance characteristics of the vehicle itself.

The slowing-down of heavy vehicles climbing long grades on two-lane roads either reduces the speed of following vehicles, or results in overtaking, which manoeuvre on a steep grade involves risk unless there



is ample visibility between vehicles travelling in opposite directions. The impatience of drivers of light vehicles blocked by heavy vehicles in this way sometimes leads to this risk being taken, with occasionally unfortunate results.

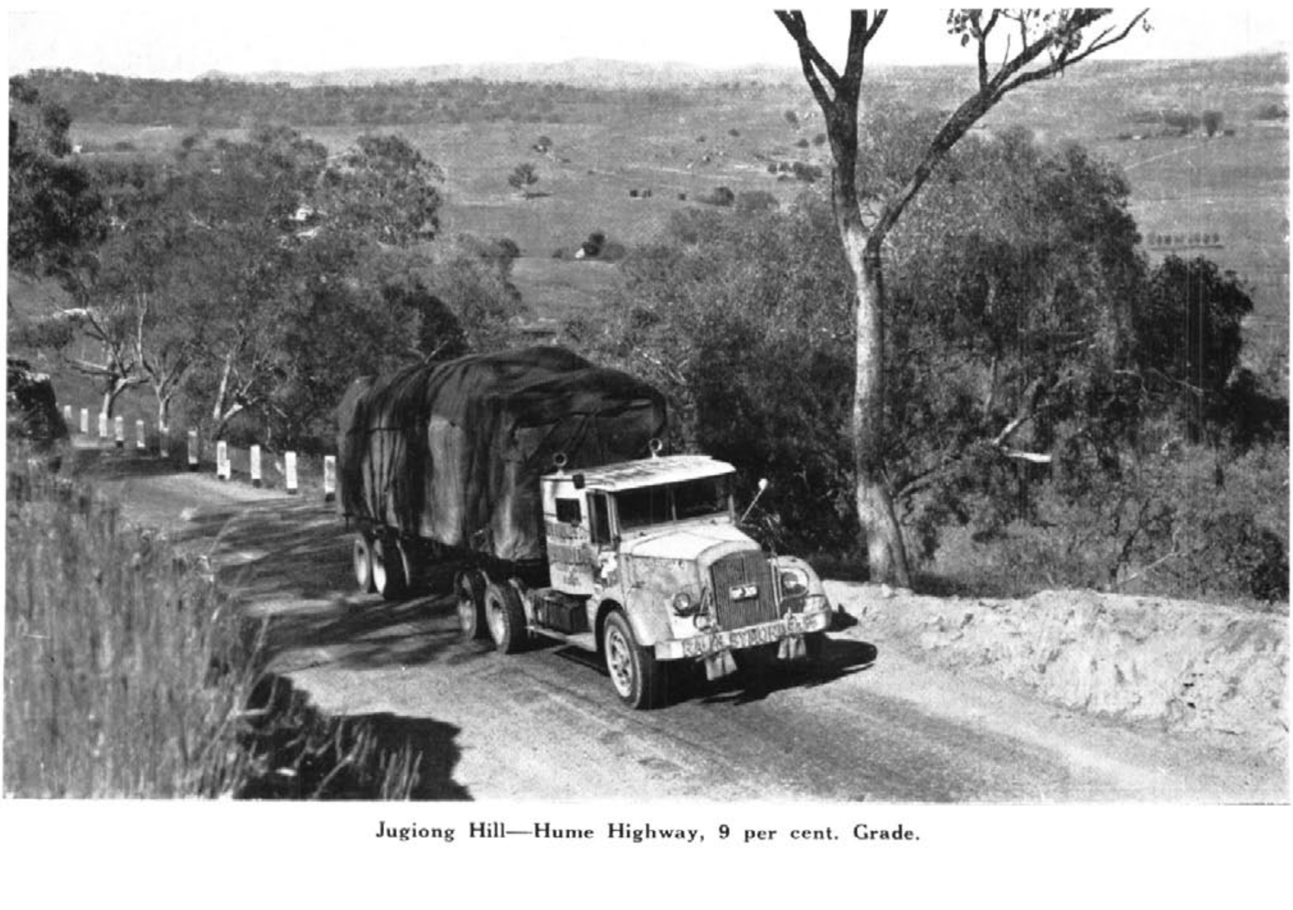
Where it is economically impracticable to build a new road without steep grades, or where old steep roads cannot be rebuilt, at least for the present, an alternative means of improvement of two-lane roads which may sometimes be possible is to widen the roadway along the steep portion to a width sufficient for three lanes of traffic. In this way space is provided to permit slow-moving lorries proceeding uphill to move over to the left and thus enable faster moving vehicles to overtake them in greater safety. This solution is finding application in the United States of America, and will be applied on main roads in New South Wales wherever practicable and justified by traffic needs. Unfortunately some of the steepest existing grades on arterial roads in this State are situated on ground having a steep side-slope, often liable to landslips. In such circumstances the widening of the roadway to provide a third traffic lane is likely to be impracticable.

If a comercial vehicle approaches a steep grade at fair speed, its momentum will carry it up the grade a certain distance without marked speed reduction. On short steep grades, therefore, the need to provide a third traffic lane does not arise.

On longer lengths of steep grades speed of heavy trucks falls off rapidly and the vehicle eventually reaches a "crawl" speed on which it continues in low gear until the grade eases off. The Fig. on Page 17 shows the manner in which speed loss occurs on up-grades of various values travelled by heavily loaded vehicles which enter the grade at a speed of 47 m.p.h. The approximate average sustained speed of fully loaded double-decker omnibuses in climbing grades are as follows:—

Grade.	Speed in m.p.h.	Gear.
Level	31.7	Top.
1 per cent.	31.7	..
2 per cent.	28.8	..
3 per cent.	19.3	3rd.
4 per cent.	18.7	..
5 per cent.	15.7	..
6 per cent.	13.0	..
7 per cent.	11.8	2nd.
8 per cent.	11.6	..
9 per cent.	11.3	..
10 per cent.	10.3	..

The table herewith gives details of some of the steep grades on main roads in New South Wales. There are many other steep grades on main roads, but these usually are not sufficiently long, or not on sufficiently heavily trafficked roads, to have attracted general public interest, although often of local significance. In this regard, the local significance of grades is largely relative—for example, a short length of steep grade on the western slopes or plains becomes a local feature of



31209.

Jugiong Hill—Hume Highway, 9 per cent. Grade.

interest, whereas an equal grade on, say, the north coast, might be overlooked on account of the existence of much steeper lengths in the vicinity. While many of the grades listed are of long standing, others are on roads constructed during more recent years but situated in locations where the terrain has rendered a combination of good alignment and easy grades economically impracticable. In such cases a substantial degree of preference has been given to good alignment as being generally more important than easy grades from the road safety viewpoint.

Grades are expressed in percentages, i.e., in rise in feet per each 100 feet horizontal measurement along the road.

Details of some steep Grades on Main Roads in New South Wales

Name of Grade.	Main Road. No.	Main Road. Name.	Location.	Approximate Average Grade and Length.	Steepest Section.
Bulli Pass	1	Prince's Highway ...	At Bulli	9.50% for 2.50 m. ...	14.8%.
Dignam's Hill	1	Prince's Highway ...	Narooma–Cobargo ...	7.64% for 4,850 ft....	9% for 2,800 ft. 10% for 550 ft.
Jugiong Hill	2	Hume Highway	Eastward from Jugiong ...	9.00% for 0.50 m....	9.0%.
Big Cut	2	Hume Highway	"Big Cut" 4 miles from Tumblong towards Tarcutta.	9% for 1,600 ft. ...	9%.
Tarcutta Range ...	2	Hume Highway	Northern approach to Tarcutta Range.	8% for 3,000 ft. ...	8%.
Brown Mountain ...	4	Monaro Highway ...	Bemboka–Nimmitabel ...	5.88% for 11.68 m.... 9.50% for 0.70 m....	12.5% for 528 ft.
Sawyer's Hill	4	Monaro Highway ...	Adaminaby – Kiandra, Elevation 4,950 ft.	5.14% for 1.55 m. ... 3.80% for 2.55 m. ...	....
Bullock Hill	4	Monaro Highway ...	Kiandra–Tumut, Elevation 4,950 ft. (approx.).	5.40% for 0.70 m. ...	....
Mt. Talbingo	4	Monaro Highway ...	Kiandra–Tumut	8.60% for 4.50 m. ...	10.0% for 1,200 ft.
Victoria Pass	5	Great Western Highway...	At Mt. Victoria	8.00% for 0.75 m. ...	12.0%.
Boddington Hill ...	5	Great Western Highway...	Boddington Hill	8.5% for 1,500 ft. ...	....
Broula Hill	6	Mid-Western Highway ...	West of Cowra	5.70% for 1.00 m. ...	10.2% for 930 ft.
Carcoar Hill	6	Mid-Western Highway ...	At Carcoar	7.50% for 0.50 m. ...	10.2% for 635 ft.
Fitzgerald's Hill ...	6	Mid-Western Highway ...	East of Blayney	9.00% for 0.76 m. ...	10.0% for 1,400 ft.
Liverpool Range ...	9	New England Highway ...	Murrurundi–Willow Tree	7.00% for 1.00 m. ...	8.5% for 1,200 ft.
Sugarloaf Hill	9	New England Highway ...	26 m. south of Tamworth	5.57% for 1.14 m. ...	9.0% for 1,800 ft.
Moonbi Range No. 1 and No. 2.	9	New England Highway ...	Between 17 m. and 20 m. north of Tamworth.	5.30% for 3.30 m. ...	9.0% for 5,280 ft. 9.0% for 1,584 ft.
Devil's Pinch	9	New England Highway ...	Between 14 m. and 16.4 m. north of Armidale.	4.90% for 2.40 m. ...	7.0% for 3,300 ft.
Ben Lomond Range ...	9	New England Highway ...	Guyra–Glen Innes ...	8.00% for 0.64 m. ...	8.0% for 1,930 ft.
Bolivia Hill	9	New England Highway...	Deepwater–Tenterfield ...	7.79% for .7 m. ...	8% for 1,650 ft.
Little Bolivia	9	New England Highway ...	Deepwater–Tenterfield ...	8% for ¼ m. ...	8% for 1,400 ft.
Enfield Hill	11	Oxley Highway	29 m. east of Walcha ...	9% for 0.6 m. ...	12% for 1,580 ft.
Boggy Creek Range (western slope).	11	Oxley Highway	Between 22.21 m. and 26 m. east of Walcha.	2.05% for 3.69 m. ...	16% for 1,300 ft.
Boggy Creek Range (eastern slope).	11	Oxley Highway	Between 26 m. and 29 m. east of Walcha.	3.6% for 2.5 m. ...	10% for 1,480 ft.
Big Hill	12	Gwydir Highway... ...	East of Glen Innes ...	8.70% for 4.75 m. ...	20.5% for 210 ft.
Waterloo Range ...	12	Gwydir Highway... ...	Glen Innes–Inverell ...	7.2% for 1 m. ...	8% for 2,000 ft.
Richmond Range ...	16	Casino–Tabulam	25 m. west of Casino ...	8.50% for 1.50 m. ...	9.4% for 2,000 ft.
Clyde Mountain ...	51	Bateman's Bay–Braidwood.	Braidwood – Bateman's Bay.	9.00% for 3.30 m. ...	12.0% for 200 ft.
Big Hill	75	Armidale–Kempsey Road	42.3 m. to 49.3 m. east of Armidale.	6.5% for 7.0 m. ...	....
Dorrigo Mountain ...	76	Bellingen–Dorrigo ...	9 m. west of Bellingen ...	6.40% for 7.20 m. ...	11.6% for 150 ft.
Macquarie Pass ...	88	Cross Roads–Albion Park	Between Albion Park and Robertson.	7.00% for 4.75 m. ...	9.2%.
Nundle–Hanging Rock...	105	Nundle–Barry Road ...	2.5 m. to 5.0 m. from Nundle.	10.5% for 2.5 m. ..	(i) 16% for 132 ft. at 3.8 m. (ii) 16% for 330 ft. at 4.3 m.
Crescent Street to Belgrave Street.	159	Sydney Road	Manly	8.66% for 1,793 ft....	12.2% for 300 ft.
Foley's Hill	162	Mona Vale Road ...	Warringah	8.64% for 0.77 m. ...	10.0% for 1,800 ft.
Tumbledown Dick ...	162	Mona Vale Road ...	Warringah (Up) ... ... (Down) ...	8.90% for 0.39 m. ... 4.02% for 0.94 m. ...	9.9% for 1,485 ft. 10.0% for 735 ft.
Spit Hill (south) ...	164	Spit Road	Mosman	8.00% for 0.50 m. ...	9.0% for 499 ft.

Details of some steep Grades on Main Roads in New South Wales—*continued*

Name of Grade.	Main Road.		Location.	Approximate Average Grade and Length.	Steepest Section.
	No.	Name.			
Spit Hill (north) ...	164	Battle Boulevarde ...	Manly	7.90% for 0.35 m. ...	8.7% for 100 ft.
Gladesville Road to Fig Tree Bridge.	166	Joubert Street	Hunter's Hill	7% for 1,392 ft. ...	10% for 558 ft.
Denham Street to Lamrock Avenue.	172	Bondi Road	Waverley	5.86% for 2,387 ft. ...	10% for 576.6 ft.
Wiseman's Ferry Hill ...	181	Windsor–Wiseman's Ferry	At Wiseman's Ferry ...	10.00% for 1.00 m. ...	15.0% for 300 ft.
Kurrajong Hill	184	Richmond – Kurrajong Heights.	Kurrajong – Kurrajong Heights.	8.40% for 1.70 m. ...	13.3% for 1,620 ft.
Mt. Tomah (eastern approach).	184	Kurrajong Heights–Bell...	At Mt. Tomah	8.10% for 1.00 m. ...	12.0% for 800 ft.
Mt. Tomah (western approach).	184	Kurrajong Heights–Bell...	At Mt. Tomah	8.50% for 1.00 m. ...	11.0% for 3,000 ft.
Bald Hill	185	Lawrence Hargrave Drive	Between Helensburgh and Stanwell Park.	10.4% for ½ m. ...	14.8%.
Burragorang Hill ...	259	Burragorang Hill... ...	Between Camden and Burragorang River.	5.90% for 2.75 m. ...	8.3%.
Barrengary Mountain ...	261	Moss Vale–Nowra ...	Between ~~Nowra and~~ Kangaroo Valley & Moss Vale	8.60% for 4.00 m. ...	11.0%. → eastern approach
Cambewarra Mountain...	261	Moss Vale–Nowra ...	Between Nowra and Kangaroo Valley ~~and Moss Vale.~~	~~9.40% for 2.75 m.~~ ... 6.5% for 3.2 m	~~13.2%.~~ 12.3%. → " "
Araluen Mountain ...	271	Braidwood–Moruya ...	North of Araluen ...	9½% for 2¼ m. ...	10¾% for 1½ m.
Tantawanglo	275	Bega–Bombala	Between Candelo and Bombala.	6% for 8 m. ...	13% for 1,000 ft.
Collector Hill	283	Collector–Gunning ...	Near Collector	9¼% for 4,500 ft. ...	14% for 1,400 ft. 25% for 160 ft.
Mt. Kosciusko	286	Jindabyne–Mt. Kosciusko	The Creel – Kosciusko Summit.	3.11% average grade throughout.	8.21%.
Forest Road to Culwalla Street.	315	Belmore Road	Kogarah	8% for 4,615 ft. ...	11.7% for 460 ft.
Roseville Chase ...	328	Babbage Road	Ku-ring-gai	4.80% for 1.01 m. ...	7.7% for 1,300 ft.
Yarara Gap	331	Holbrook–Jingellic ...	....	8.90% for 0.66 m. ...	13.9% for 680 ft.
Belah Street to Robertson Place.	339	Old South Head Road ...	Vaucluse	8.26% for 2,500 ft....	10.6% for 391 ft.
Artillery Hill (National Park).	393	Loftus–Waterfall ...	3 m. from Loftus... ...	8.00% for 0.75 m. ...	12.0%.
	510	Capertee–Glen Davis ...	10 m. from Capertee ...	10.25% for 0.38 m. ...	10.5% for 680 ft.
Balgownie Hill	513	Mount Ousley Road ...	Between top of Bulli Pass and Wollongong.	6.2% for 3 m. ...	8.9%.
Lithgow Hill	516	Bell–Lithgow	East of Lithgow	10.00% for 0.91 m. ...	12.5% for 500 ft.

Tender Accepted by Department

The following Tender (exceeding £1,000) was accepted by the Department during the period 1st April to 30th June, 1952 :—

Work.	Name of accepted tenderer.	Amount.
Supply, delivery and installation of approximately 2,168 lineal feet of rubber conveyor and elevating belting 18-inches wide at Aggregate Plant, Metropolitan Maintenance Depot, Granville.	The Goodyear Tyre & Rubber Co.	£ s. d. At rates estimated to total 4,390 0 0

H.O. 3

A view of the Broken Hill-Silverton-road after construction.

Reconstruction of Broken Hill—Silverton Road

PURPOSE OF ROAD.

The road connecting Broken Hill (730 miles by road west from Sydney) to Silverton and Penrose Park has recently been reconstructed and bitumen surfaced—a total length of slightly over fourteen miles.

Silverton, while now a small town, was the site of the first discovery of silver-lead ore in Western New South Wales and for a time had a much larger population than it has now; the discovery of the richer deposits of ore at Broken Hill resulted in the growth of Broken Hill to a city, having to-day a population of about 32,000 persons, and in Silverton becoming much reduced in size.

Penrose Park is a park area of about fifty acres established by Broken Hill mining companies adjacent to Silverton and alongside Umberumberka Creek, for the benefit of the residents of Broken Hill. The park is rabbit-proof, and developed with tree planting, lawns, tennis courts, sports ovals and running tracks, and attracts large numbers of persons, traffic at week-ends rising to over 800 vehicles per day.

Broken Hill, while essentially a mining town, is also the social and commercial centre for a large area of country devoted to sheep raising, and extending into South Australia and Queensland. It is situated in arid country having an average annual rainfall of nine inches. It is isolated from rivers and other natural recreational features, and is thus dependent on man-made facilities for recreation. The existence of Penrose Park, and the availability of access to it, are therefore of special value to the people of Broken Hill.

Umberumberka Creek, adjacent to Penrose Park, is the source of portion of Broken Hill's water supply. The reservoir provides a beautiful expanse of water in an arid and sparsely timbered area; downstream of the dam in summer there is delightful shade, and protection from hot sun and boisterous winds.

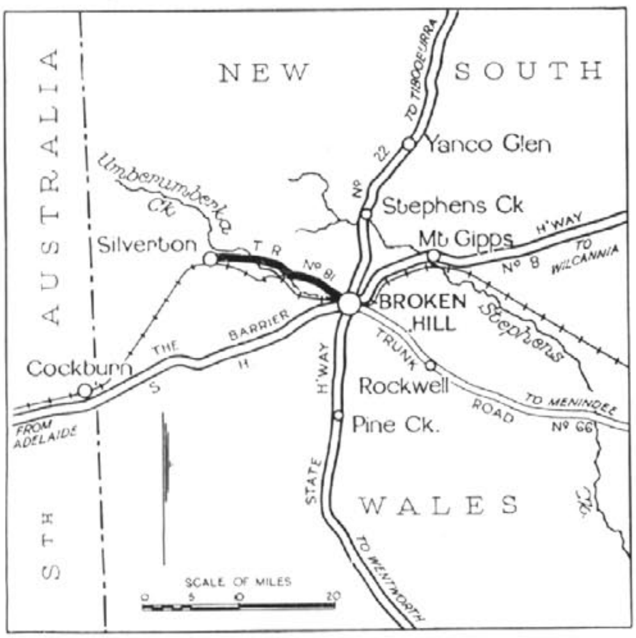
Communication with Silverton in the early days was by road from the Darling River settlement of Menindee, the headquarters of the Bourke and Wills Expedition. Menindee at the time was served by paddle steamers and barges which worked up and down the Darling River from South Australia to as far north as Brewarrina. From Menindee the road to Silverton skirted the present site of Broken Hill and in general followed the location of the present road.

NATURE OF ROUTE.

Of the fourteen miles between Broken Hill and Silverton, two miles are within the City of Broken Hill, the first mile being through residential areas, and the

Portion of Penrose Park, near Silverton.

second mile passing through a regeneration area of about half a mile width, where trees have been planted and natural grasses and shrubs are being re-established within a rabbit and stock-proof fence. On leaving the regeneration area the road follows slightly undulating red soil and gravel country mostly in a basin with rising ground on each side, crossing numerous low-lying points which form waterways in time of rain. The country is almost treeless until Silverton is approached where a belt of timber indicates the location of Umberumberka Creek which, like other creeks in this region, is normally dry.



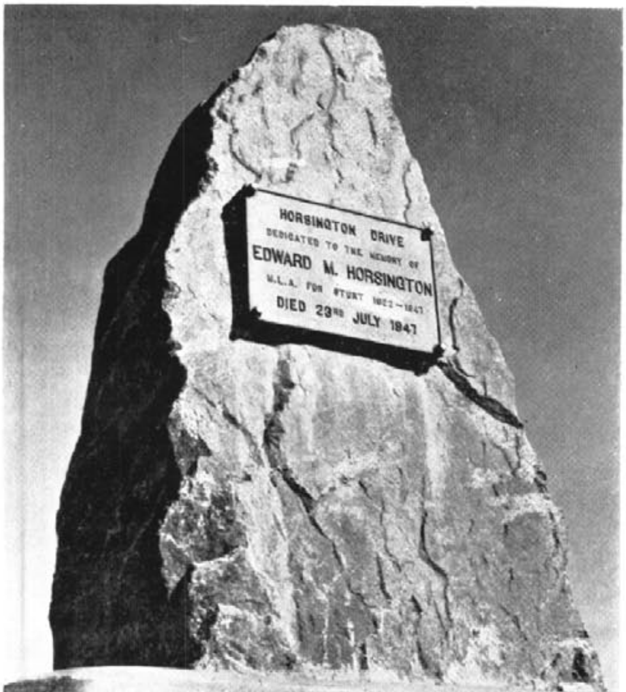
THE ROADWORK.

The construction work and bituminous surface on that part of the road within the City of Broken Hill was carried out by the Broken Hill City Council by day labour. In 1948, the road within the city boundary was named Horsington Avenue in honour of the late Mr. E. M. Horsington who had for twenty-four years been the Member of the Legislative Assembly for the State Electorate of Sturt, which includes the Broken Hill area. A plaque has been placed on the southern side of the road near the city boundary in honour of Mr. Horsington.

The twelve-mile length from the city boundary to Silverton was carried out by the Department of Main Roads by contract. The work comprises formation twenty-six feet wide, and pavement eighteen feet wide. Smaller watercourses have pipes and larger watercourses have causeways. The pavement is six inches thick of secondary limestone, surface treated with bitumen.

The first eight miles from the city boundary was carried out during 1940-41 by Messrs. Worsley and Johnson. On account of the war, operations were then suspended. In 1948 a contract to complete the road was let to Messrs. Lance Farrant & Co., but difficulties in carrying out the work under the conditions prevailing delayed completion until 1951. Meanwhile wear on the gravel on the first length constructed made re-sheeting necessary, and this was carried out by the Department by day labour.

The bitumen surfacing work from the city boundary to Silverton and Penrose Park was carried out by



.3574.

Memorial Plaque erected on the Broken Hill-Silverton-road, to the Memory of the late E. M. Horsington, M.L.A.

contract by Messrs Construction Services Pty. Ltd., the aggregate being supplied by the Australian Blue Metal Co. Ltd., from their Broken Hill quarry.

COSTS.

The work on the Broken Hill-Silverton road has cost approximately £56,000 made up as follows:—

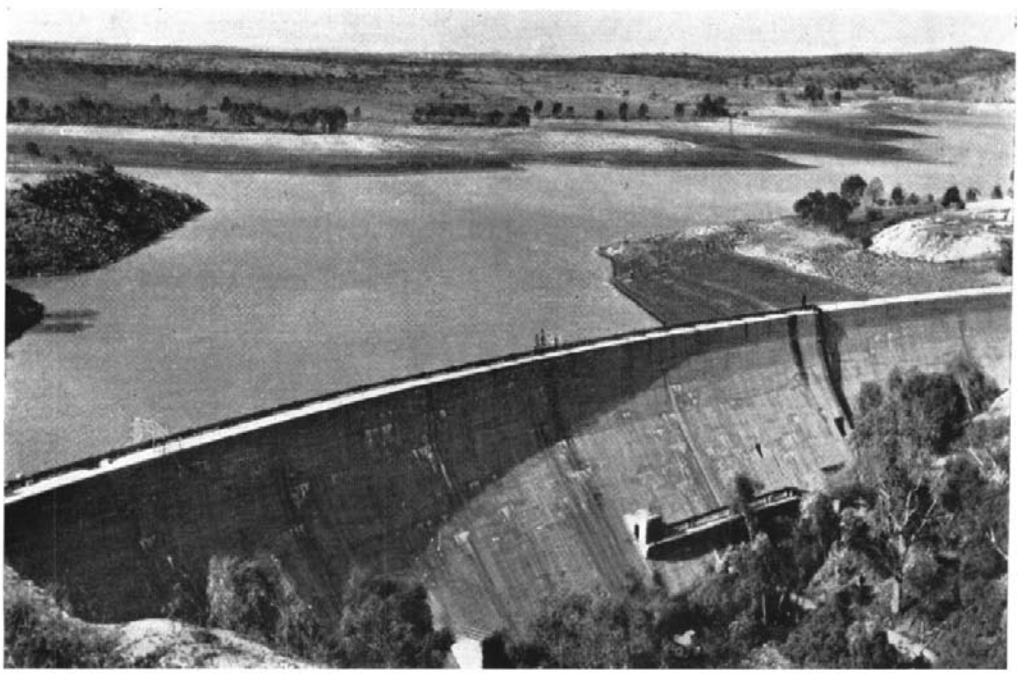
Section.	Recon-struction.	Bituminous Surfacing.	Total.
	£	£	£
O.OM. to 2M.1042 ft. (City of Broken Hill).	5,674	3,509	9,183
2M. 1042 ft. to 13M. 3292 ft. (including spur road 1082 ft. to Penrose Park).	27,667	19,492	47,159
	33,341	23,001	56,342

On the section within the City of Broken Hill, the Broken Hill City Council met £2,476 of the cost and the Department of Main Roads £6,707. The Department met the full cost of all work outside the city boundary.

SUPERVISION.

Earlier work was carried out under the general supervision of the Department's former Supervising Engineer, Mr. E. F. Crouch, and the later work under the Department's Assistant Maintenance Engineer, Mr. F. I. Peterson. The Public Works Department's District Engineer, Broken Hill, was in immediate charge of the reconstruction and bituminous surfacing work.

H.0.3597.



Umberumberka Reservoir.

Petrol Consumption on Gravel and on Bitumen Surfaces

It is well known that the total cost of vehicle operation is higher on gravel than on bitumen or concrete road surfaces. An exact comparison is difficult because of the many variable factors influencing costs and the number of accidental events that can affect the cost of operating any single vehicle. Statistical examination of the cost figures for a large number of vehicles is the only way to obtain a reliable total cost comparison.

On the other hand, the important item of additional fuel cost can be determined by direct experiment and the accuracy is good under favourable conditions. In this connection it must be remembered that fuel is consumed not only in driving the vehicle forward against road friction, internal friction and air resistance, but in accelerating the vehicle after stopping or slowing down, in driving the vehicle uphill and in overcoming the additional friction introduced when cornering. To determine the additional fuel used in overcoming the additional road friction on gravel, as compared with bitumen, it is necessary to eliminate or correct for these other resistances, which is by no means easy on many test courses. In addition, the effects of temperature, humidity, etc., on engine performance and efficiency have to be taken into account. As a consequence, presumably of these difficulties, experiments conducted overseas by different observers were not in agreement.

There exist in New South Wales several areas peculiarly favourable for such experiments, and it was decided that the Department should conduct some careful experiments to determine the true effect of nature of surface on fuel consumption. The test course selected was on the 36-mile straight on State Highway No. 7 across the Bogan-Macquarie Rivers flood plain from Nevertire to Nyngan, New South Wales. This plain is only approximately 600 feet above sea level, though the water in the rivers still has to flow several thousand miles to the sea. The river gradients (only inches per mile) give some indication of the extreme flatness of this area which was the basic reason for its selection. The road used runs from south-east to north-west, the approximate direction of the greatest slope of the plain, and is provided with a bituminous surface for approximately half its length commencing at the south-east end. The north-west half is unsurfaced gravel. Traffic on the road is light. Two test sections were selected, separated by an interval of 3 miles, as follows:—

Section 1—Bitumen Surface.

Length: 5 miles.

General Grade: $2\frac{1}{2}$ feet per mile.

Maximum deviation from straight grade $\pm$ 1 foot.

Section 2—Gravel surface.

Length: 5 miles.

General Grade: 2 feet per mile.

Maximum deviation from straight grade $\pm$ 2 feet.

Accurately placed mileage markers were available at each one-quarter mile along the test lengths and approaches.

Horizontal and vertical curvature did not influence the results. The almost negligible grades were corrected by running each test in opposite directions and averaging the results. The two forward and two backward runs on both lengths could be completed quickly and, therefore, the effects of ambient temperature, humidity, etc., on engine performance were practically eliminated. Effects of starting, etc., were eliminated by running vehicle up to test speed on the straight approach to the test length. There only remained the factors inseparable from vehicle movement, road and internal friction and wind resistance. Effects of variations in the latter were reduced to a minimum by restricting tests to days of light, steady winds when the system of running in two directions would balance out the greater part of the error.

For the observations special glass funnels consisting of two bulbs were constructed. The upper bulb held petrol sufficient for about mile of running at test speed and the lower for about 4 miles. Two marks were etched on the funnels, one on the glass tube between the upper and lower bulbs and one on the glass stem below the lower bulb. The volume between the two marks was determined in advance of the tests. The funnel in use was carried in the vehicle, a standard type of sedan car, and provision was made by tubing and taps to draw petrol from either the normal fuel tank or the special funnel at will. The vehicle was equipped with good "speed" and "distance" speedometer dials. It was warmed up to normal operating temperature, by cruising at approximately test speed, before each test run.

For each test run the funnel was filled and the vehicle run up to and controlled at the desired speed, as read on the speedometer, on the straight level approach well in advance of the test length proper. For this run up the car's normal fuel supply was used and approximately $\frac{3}{4}$ mile before reaching the start of the test length the supply was switched to the funnel. The top and bottom marks of the funnel were thus both passed by the petrol surface level while the car was on the test length proper. When the lower mark was passed the supply was


H.O.486.

Test course on Mitchell Highway between Nevertire and Nyngan.

switched back to the fuel tank and the speed maintained till the final reading was made. The normal procedure was:—

1. Run Gravel S.E.
2. Run Bitumen S.E.
3. Run Bitumen N.W.
4. Run Bitumen N.W.

On one or two occasions, however, when traffic interfered during run 2, it was more convenient to adopt the sequence 3, 4, 1, 2.

During each of the four runs the following readings were made:—

(*a*) Speedometer distance dial—
  (i) when vehicle passed last mileage marker before petrol reached top mark of funnel;
  (ii) when petrol passed top mark;
  (iii) when vehicle passed next mileage marker.

By interpolation it was then possible to determine the mileage at which petrol passed mark and eliminate errors due to rate of speedometer distance dial. As was to be expected, this rate varied appreciably with ambient temperature, speed and type of road surface.

(*b*) Speedometer distance dial—
  (i) when vehicle passed last mileage marker before petrol reached lower mark of funnel;
  (ii) when petrol passed lower mark;
  (iii) when vehicle passed next mileage marker.

By similar interpolation the mileage at which petrol passed second mark was determined. The distance run with the known volume of petrol was thus accurately found.

(*c*) A stopwatch was started at the mileage marker in advance of that used for the first reading for (*a*) above, and the time of passing each fourth marker thereafter noted, the last reading being made after the last reading for (*c*). The average speed for the full run and the average speed over each mile section of the run was thus found. These readings could not interfere with readings for (*a*) but could clash with readings for (*b*). No attempt was made to make two readings simultaneously. The readings for (*b*) were given preference and the reading for speed deferred till the first marker after completion of (*b*) making the last speed section $1\frac{1}{4}$ or $1\frac{1}{2}$ miles, in lieu of 1 mile, in such cases.

Runs were rejected—

1. if traffic interfered;
2. if average speed over any section differed over 2 per cent. from the average speed for the run;
3. if the wind conditions appeared to change before the set of four runs were completed, or if any one of the following runs of the set of four was rejected (*i.e.*, results were accepted only if the full set was completed in a minimum of time with no appreciable change in wind or weather conditions).

One difficulty in such experiments is that it is not practicable to make each of the four runs at exactly the same speed owing to inevitable errors in reading the speed dial and to slight differences in the speedometer rates on bitumen and on gravel at high speeds. This was overcome by conducting a calibration set of runs, one in each direction on the bitumen surface, at various speeds and determining the petrol consumption at each speed. This calibration was carried out on two successive mornings with similar weather conditions and steadily rising temperatures, in the order 30, 40, 50 and 60 miles per hour (approximately) the first day, and the reverse order the second. This procedure largely balanced out the effects of temperature, humidity, etc., on engine efficiency. From these observations the following relation was derived applicable from 30 to 60 miles per hour for the vehicle and other conditions involved:—

$$Cv = C_{30}(1 + 0.0058(V - 30) + 0.000133(V - 30)^2).$$

Where:—

Cv = petrol consumption at V miles per hour.

C_{30} = petrol consumption at 30 miles per hour.

For the comparison of the consumption on the two surfaces the observed consumption on the bituminous surface was adjusted to the equivalent consumption at the speed of the comparison test run on gravel by the above equation before the comparison was made. It is considered that this method was of adequate accuracy for the small corrections involved.

The tests were mainly conducted in dry weather with the surfaces in the following condition:—

Bitumen Surface.

Surface treatment with ½-inch maximum size round river gravel aggregate (mainly quartz) some years old. Condition generally satisfactory with good, even, stone cover but surface worn rather smoother than average generally and slick, from slight excess of binder, in scattered patches comprising approximately 5 per cent. of test length.

Riding generally satisfactory with slight vibration from minor irregularities on about 20 per cent. of length and about three noticeable "bumps" per mile.

Surface was clean and dry, even for the comparisons with wet gravel, and was definitely a better-than average bituminous surface.

Gravel Surface.

A quartz residual ridge-gravel with high stone content (up to ¾-inch maximum size generally) and a slightly clayey soil mortar.

In normal dry condition, as tested, about 25 per cent. moderately corrugated (approximately 30-inch pitch and ½-inch depth) and produced severe vibration at 30 miles per hour, about 25 per cent. was smooth with loose mulch of stone and sandy material (average ½-inch thick), and about 50 per cent. was smooth and firm with scattered potholes (6 inches to 12 inches diameter and 1 inch to 2 inches deep, about 20 per mile of test length struck by car wheels during test runs).

When tested wet the corrugations were as above, the loose material was packed firm by traffic, the potholes were full of water and half the previously smooth, clean surface was soft and cutting under traffic. On about 25 per cent. of whole length the test car cut into surface to a depth of up to ½ inch.

Rating of this surface would be fair to good, dry and poor to fair wet.

The bulk of the tests were conducted under dry conditions and runs were duplicated at 30, 45 and 60 miles per hour approximate speeds with the results shown in Table I. The two sets at each speed were conducted on different days and the slight differences in consumption on the bitumen are due principally to differences in wind and weather. In the case of the gravel surface the figures suggest that the surface was in better condition for the second set than for the first. This is very probable because the first sets were run after a long, dry spell and the second soon after the surface dried out after rain.

TABLE I.

Approx. speed m.p.h.	Petrol consumption galls./mile.			% increase gravel over bitumen.
	Actual on Bitumen.	On Bitumen adjusted for speed difference.	Actual on Gravel.	
30	0.0419	0.0419	0.0431	3
30	0.0416	0.0416	0.0431	1½
45	0.0454	0.0456	0.0467	2
45	0.0451	0.0455	0.0462	1½
60	0.0518	0.0515	0.0545	6
60	0.0521	0.0524	0.0542	3½

It will be noted that the change in consumption difference with speed is not simple. From 30 to 45 miles per hour there is no change or a slight decrease in the excess consumption on gravel, as theory would lead one to expect if extra wheel slip does not occur. That there was no appreciable difference in wheel slip on the bitumen and on the gravel at these speeds was brought out by the observations (*a*) and (*b*) above. From these the rate of the speedometer distance dial was computed for both surfaces and found to be nearly the same. This was not the case at 60 miles per hour, however, where the difference in speedometer rates was approximately 2 per cent. indicating that that much extra wheel slip was taking place on the gravel surface. This was confirmed by the behaviour of the car during the test runs. A marked tendency to tail sway was observed on the gravel surface at 60 miles per hour, but not on the bitumen at that speed nor on either surface at 45 miles per hour or 30 miles per hour.

During the tests heavy overnight rain produced the wet conditions described above and it was possible to make one good test of four runs at 30 miles per hour under fully wet conditions and a less satisfactory test at 60 miles per hour. The former showed an increase of 10 per cent. in petrol consumption for wet gravel over dry bitumen at 30 miles per hour and the second suggested the lower figure of 7 per cent. at 60 miles per hour. This difference is about what theory would predict in the absence of extra slip, and there was no evidence of extra slip at 60 miles per hour on the gravel under wet conditions.

In actual car operation petrol is also used for overcoming inertia of vehicle in starting and accelerating and for hill climbing, etc. This extra petrol will be more or less independent of the nature of the surface and, by comparison with average consumption of petrol over a period for the vehicle this extra petrol was estimated at approximately 30 per cent. of the total consumption. We are, therefore, led to the conclusion:—

1. That as compared with the better-than-average bitumen surface travel on a dry gravel surface at the same speed would increase the total petrol consumption of the vehicle by about 1½ per cent. unless the speed is so high (over approximately 50 miles per hour) that dangerous and uncomfortable slipping of rear wheels occurred on the gravel. At such higher speed the difference in consumptions would increase somewhat.
2. That the difference will be noticeably greater in wet weather if the gravel is soft and liable to cut wet. With the actual surface tested (fair to poor wet, cutting to ½-inch on 25 per cent. of its length) total consumption for the same normal driving speed would be about 6 per cent. higher on the gravel.

A greater petrol consumption on gravel than on bitumen was expected, but the magnitude found for the difference was less than expected. Considering the frequency of wet weather and the average standard of road surface in New South Wales it means that the difference in consumption on bitumen and gravel, due solely to the nature of the surface, is 2 per cent. or less. Many people believe from their experience that the difference is much greater and quote their own records of consumption. These records are, however, influenced by a variety of factors eliminated in the tests described above. Thus there is marked correlation in many areas between the standard of road construction and the nature of the surface and, on the whole, the bitumen roads may have better grading and alignment than the gravel roads. Under these circumstances the average petrol consumption on gravel may well be higher than on bitumen, but the extra petrol would be consumed in acceleration, in hill climbing, and in cornering rather than in overcoming increased surface friction. It might also be mentioned that examination of fuel records of cars operating in the area surrounding the test lengths, where roads are flat, and mostly straight, with little traffic to cause congestion, failed to disclose any significant difference in consumption for travel on gravel or on bitumen surfaces.

The work described in this report was carried out by the Department's Materials and Research Engineer, Mr. A. T. Britton.

Reconstruction of Main Roads linking Coalfields and Lake Macquarie

Shires of Kearsley and Lake Macquarie

Located only 25 miles by road from the centre of the densely populated South Maitland Coalfields, Lake Macquarie is ideally situated as a recreational area for the Coalfields community, and this fact has prompted the initiation of the reconstruction and surfacing by the Kearsley and Lake Macquarie Shire Councils of the Main Roads connecting the two areas.

The direct link between Cessnock and Toronto, Main Road No. 220, is joined at Mulbring, 10¼ miles from Cessnock, by Main Road No. 195, serving Kurri Kurri, Weston, Abermain and adjacent centres of the Coalfields, while at the other end of this road system the traffic is dispersed to various parts of Lake Macquarie by Main Roads Nos. 217 and 325 to the north, and Main Road No. 217 southwards to Wangi Wangi and Rathmines, and other centres along the western shores of the Lake.

The following programme of work was prepared for the progressive reconstruction and surfacing of these roads:—

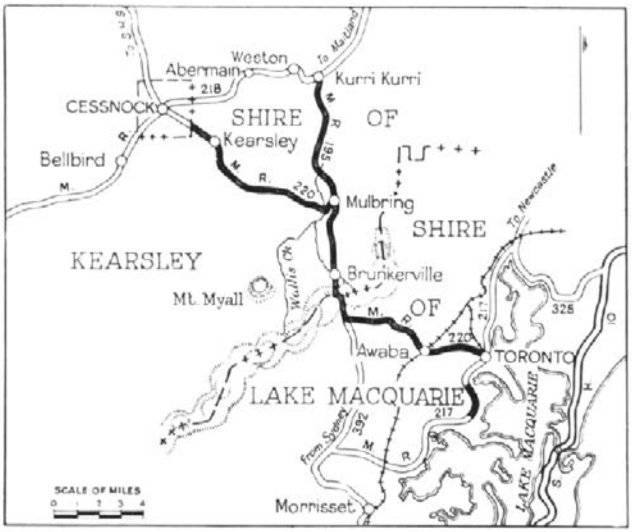
Main Road No. 195—From Kurri Kurri to Main Road No. 220 at Mulbring.

Main Road No. 217—From its junction with the Awaba-Rathmines Road to Wangi turnoff.

Main Road No. 220—From Cessnock to Toronto.

The Department undertook to carry out the necessary survey and design on behalf of the Councils, and in order to avoid delay it was decided that work would proceed in convenient short sections, as plans became available.

In September, 1945, when the survey for reconstruction was placed in hand, the alignment over the greater part of the road between Cessnock and Toronto, Main Road No. 220, was of a very low standard. A section 6¼ miles in length, leading from Cessnock, had been reconstructed, and 5¼ miles of this had been surface treated. At the Toronto end a bituminous pavement was in existence for a length of 5½ miles but extensive reconstruction was required to bring the intervening 13 miles to a satisfactory standard, and it is on this section that work has been proceeding during the last three years.



Construction commenced on the section in Kearsley Shire between 6.20 miles and 8.0 miles from Cessnock in March, 1949, and in June, 1949, a start was made on the section between Mulbring at 10.32 miles and the Lake Macquarie Shire Boundary at 15.75 miles. Work was considerably delayed by heavy rains and floods in June, 1949 and again in June, 1950 when severe damage was caused to roads in the Kearsley Shire. It was necessary to divert plant and labour from the road construction to urgent flood damage repairs. At these times also, heavy traffic and a "coal lift" resulting from the flooded Highway and railway in the vicinity of Maitland, severely damaged sections of the road under construction, which further retarded progress. Since that date, work has proceeded on both sections, and in addition, the previously reconstructed section between 5.23 miles and 6.20 miles from Cessnock has been reconditioned in preparation for tar surface treatment.

Section of completed work, Main Road No. 220, Shire of Kearsley.

The section between Mulbring and the Lake Macquarie Shire boundary has now been reconstructed and tar surfaced, except for a short section approaching the bridge over Brunkerville Creek, and it is anticipated that the surfacing of the length from 5.23 miles to 8.0 miles will be completed at an early date. Construction of the section between 8.0 miles and 10.3 miles has commenced.

Estimates have been approved for the reconstruction and surfacing of Main Road No. 220 from the Kearsley Shire Boundary for a distance of 3.69 miles in Lake Macquarie Shire linking up with the existing bituminous pavement leading into Toronto, and work will proceed on this section as soon as funds become available. Work has not yet commenced on Main Roads Nos. 195 and 217.

The cost of the work is being met by the Department of Main Roads and the Joint Coal Board, the latter body meeting that portion of the cost normally borne by the Councils. To date grants amounting to £44,883 and £15,940 have been made to Kearsley and Lake Macquarie Shires respectively, to meet the Department's share of the cost of the work in those Shires.

Main Road No. 220 has been designed for a speed of 50 m.p.h. with pavement and formation widths of 20 feet and 28 feet respectively. The heaviest earthworks occur on the section from 6.2 miles to 10.32 miles, where 31,700 cubic yards at an estimated average of 7,700 cubic yards per mile were moved. The largest single cutting contained 5,500 cubic yards consisting mainly of medium shale. No new bridges were required, but many old timber culverts have been replaced either by reinforced concrete pipe or box culverts.

Gravel used in the pavement was conglomerate and that for the northern section of the work was brought from an established quarry in Cessnock. A similar material was obtained from a roadside quarry in the Lake Macquarie Shire for use on the section between Mulbring and the Lake Macquarie Shire boundary.

The reconstruction works are being carried out by the Councils by day labour. Bituminous work completed to date has been carried out partly by Council and partly under contract. The B.H.P. By Products Pty. Ltd., supplied the $\frac{3}{4}$ in. and 7/16 in. gauge crushed slag used as aggregate and also sprayed the binder which was applied in two coats, consisting of No. 1 and No. 2 tars at rates of application of 0.2 gallons and 0.3 gallons per square yard respectively. The preparation of the gravel pavement prior to surfacing, loading, hauling and spreading of the aggregate etc., was carried out by Council by day labour.

At present work on Main Road No. 220 is well advanced, and when completed a continuous length of bituminous pavement will extend from Cessnock to Toronto.

Concrete Pavement Construction

Trial Section of Changed Design

A trial section of concrete pavement 1,812 feet long and 23 feet wide has recently been built by the Department of Main Roads on the Hume Highway on the fringe of the metropolitan area between Yagoona and Bass Hill. The section involves: (1) Uniform thickness slabs; (2) use of contraction joints, and (3) omission of expansion joints. It thus conforms with current practice in some parts of the United States. The trial section forms part of a longer length of concrete pavement being built generally in accordance with the Department of Main Roads normal practice. A detailed comparison of the Department's normal design and construction details with those on the trial length is set out hereunder.

Department's Normal Practice.

The Department of Main Roads' usual design of reinforced concrete pavement provides for a 7 inches thick slab with outer pavement edges increased to 9 inches over the last 2 feet 6 inches; the nominal concrete mix is 1 : 2 : 3 by volume. The pavement is built on a sub-base of sand 3 inches thick. The slab is reinforced with steel mesh, and with ½-inch diameter edge bars extending fully around each slab. Longitudinal joints are deformed in order to obtain mutual support from adjacent lanes of concrete. Through each longitudinal joint so formed ⅝-inch diameter steel rods 5 feet long are spaced at 6 feet intervals to tie adjacent slabs together. Expansion joints are spaced 50 feet apart. Each expansion joint is filled with a bituminous strip; ¾-inch diameter steel dowel rods 3 feet long pass through each expansion joint at approximately 18-inch intervals. The dowels are dipped for half their length into hot bitumen and provided with a hollow cardboard cap to allow for movement of the slab. Where construction joints are formed other than at expansion joints clean ¾-inch diameter rods, of similar dimensions to those previously described, are inserted 18 inches apart across the joint.

Expansion joints are constructed by holding the bituminous filler between two slotted steel bulkheads and inserting the dowels through the filler. This assembly is placed between the side forms in a position perpendicular to the grade line and at right angles to the centre line of the road. After the concrete has

Tamping and screeding; Vibrator attached to Screed.

H.O. 3199.

H.O.3216

Withdrawing "T" Iron.

been placed on both sides of the joint and before the initial set has taken place, the bulkheads are removed and the concrete is well compacted in close contact with the filler, care being taken to maintain a straight joint and to ensure that the dowels remain parallel to the grade line of the road.

In order to provide a suitable space for material to seal the joint and to assist in keeping the joint straight, a small steel channel section is fitted over the top of the filler. When the initial set has taken place and the edge of the joint has been suitably treated with an edging tool, the steel channel is removed, thus leaving a cavity three-quarters of an inch deep and a quarter of an inch wide on each side of the filler.

Expansion joints are sealed by cutting the bituminous filler to a depth of three-quarters of an inch below the surface of the pavement and filling the space thereby provided with a sand-asphalt, which is then covered with an application of a bitumen emulsion and sand. Longitudinal and construction joints are sealed by an application of bitumen emulsion and sand.

Construction joints are formed by holding the $\frac{3}{4}$-inch diameter dowels in a rigid timber bulkhead and compacting the concrete up to the face of the bulkhead, care being taken to maintain the dowels in a plane parallel to the surface of the pavement. When work is recommenced, the timber bulkhead is carefully removed and the face of the concrete thus exposed is roughened to provide a bond for the new concrete.

In order to provide a road surface with a high co-efficient of friction, the concrete, after the initial set has taken place, is dragged with a piece of wet hessian.

H.O.3217.

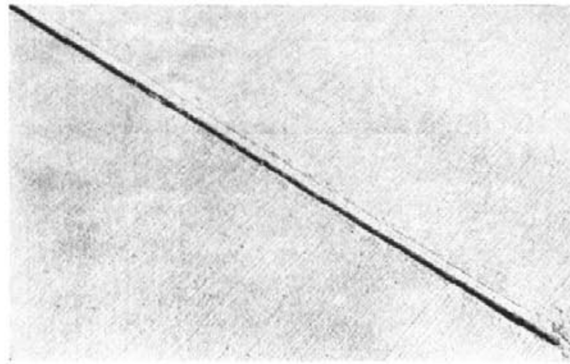
Substituting timber strip for "T" Iron.

Details of the Trial Length.

The trial length of cement concrete pavement is being constructed to a uniform thickness of 8 inches, of a nominal mix 1 : 2 : 3 by volume, on a sub-base of sand 3 inches thick. The slab is unreinforced. Tie bars are placed through longitudinal and construction joints. Expansion joints have been eliminated.

"Dummy" contraction joints to localise pavement cracking have been provided 12 feet apart (there are no dowels at these joints) and construction joints have been formed only at the end of the work each day, or where concreting is suspended for 30 minutes or longer. Clean $\frac{3}{4}$-inch diameter steel tie bars have been provided across construction joints in the same manner as described previously. They are 3 feet long and spaced 1 foot apart as distinct from 18 inches spacing in the case of the normal concrete pavement. The "dummy" contraction joint is 2 inches deep and tapers from three-eighths of an inch wide at the surface of the pavement to a quarter of an inch wide at the bottom of the groove. Longitudinal joints are deformed as in the case of the standard pavement and $\frac{1}{2}$-inch diameter tie bars 5 feet long are placed 3 feet apart in the joint compared with 6 feet spacing in the usual pavement.

The contraction grooves are first formed by inserting a steel "T" section into the wet concrete, after compaction by a vibrating screed and before the initial set has taken place. When the concrete has set sufficiently to permit the withdrawal of the steel without collapse of the sides of the groove, the "T" section is removed and a timber strip cut to the shape of the groove is placed therein. This enables the edges of the groove to be treated with an edging tool and when this is complete and the concrete has taken its initial set, the surface of the slab is finished by drawing wet hessian longitudinally along the slab. When this is done the timber strip is removed and the edges of the groove again tooled where necessary to ensure that a clean smooth concrete joint has been made.



H.O.32/1

Construction joint following removal of Timber Strip.

At the end of the work where the slab does not butt up against an old slab, the last ten contraction joints will be reinforced with $\frac{3}{4}$-inch diameter tie bars spaced 3 feet centre to centre. The transverse contraction joints are continuous across adjacent slabs.

Visiting Road Engineer from the Philippines

Mr. A. Ferrer, B.Sc., Supervising Engineer for Construction (Roads and Bridges), Division of Highways, Bureau of Public Works, Manilla, Philippines, visited Australia from May to August, 1952, under a Nations Technical Development Fellowship. For the greater part of his stay he was attached to the Department of Main Roads, New South Wales, studying engineering and administrative technique both in office and field. He also paid visits to the Country Roads Board, Victoria, and the Department of Main Roads, Queensland.

Tenders Accepted by Councils

The following Tenders (exceeding £1,000) were accepted by the respective Councils during the months of April, May and June, 1952 :—

Council.	Road No.	Work.	Tenderer.	Amount.
				£ s. d.
Apsley S. ...	11	Supply and delivery of 1,100 cu. yds. of screened river gravel to stockpiles at 2¾ m. and 11 m. west of Walcha.	R. C. Barber	2,888 12 0
Berrigan S. ...	...	Win and load 13,600 cu. yds. gravel required for various main roads.	J. G. McMillan	1,190 0 0

Tenders Accepted—*continued*

Council.	Road No.	Work.	Tenderer.	Amount. £ s. d.
Bland S. ...	6	Supply, delivery and spreading 16,800 cu. yds. gravel. Average lead 9 m.	I. N. Miller	4,395 0 0
Bogan S. ...	61	Construction of pipe culverts between 54 m. and 59 m.	W. A. Rowley	1,045 14 0
Carrathool S. ...	244	Supply and delivery 7,580 cu. yds. loam. Average lead $7\frac{3}{4}$ m.	Humphreys and Simpson...	2,084 0 0
Do ...	1,026	Supply and delivery 14,800 cu. yds. gravel. Average lead $2\frac{1}{2}$ m.	J. Thorne	3,543 6 8
Do ...	6	Supply and delivery 17,200 cu. yds. gravel. Average lead 4.6 m.	do	5,430 16 8
Condobolin M. ...	57, 61, 230	Supply, delivery and spreading 3,900 cu. yds. gravel.	Giltrap and Atkinson ...	1,142 10 0
Coolamon S. ...	243	*Supply and delivery 440 cu. yds. aggregate*	W. E. Granger	1,156 10 0
Coonabarabran S.	396	Priming with tar, including supply of primer	B.H.P. By-Products Pty. Ltd.	1,688 10 6
Gunning S. ...	241, 249	Supply and delivery 4,200 cu. yds. gravel	L. Delbroux	1,260 0 0
Hastings S. ...	1,094	Construction of low level bridge over Hastings River at Double Crossing.	A. Gam	16,047 10 6
Jemalong S. ...	377	Supply and delivery 9,632 cu. yds. gravel at various *locations. Average haul 16.6 m.*	J. Thorne	6,381 4 0
Jerilderie S. ...	...	Winning, and loading approximately 28,760 cu. yds. loam for use on various main roads in the shire.	Tatnell Bros.	2,396 13 4
Lachlan S. ...	231, 371, 423, 501	Supply, delivery and spreading 10,500 cu. yds. gravel *at various locations.*	Bulldozer Hire and Repair Service.	3,518 7 6
Manning S. ...	111	Operation of Forster-Tuncurry Ferry	C. A. Blows and Son ...	1,089 0 0
Marthaguy S. ...	111, 333	*Supply and delivery 15,220 cu. yds. gravel between* Nevertire and Warren and north of Warren.	Bulldozer Hire and Repair Service.	5,066 7 6
Mitchell S. ...	240, 543	Winning and loading 24,900 cu. yds. gravel and sand.	F. W. Hall	9,088 0 0
Murray S. ...	388	*Winning, loading and hauling loam from 7 m. to 9.6 m.* and 10.3 m. to 11.8 m. from Deniliquin.	D. D. McCallum	2,236 13 8
Patrick Plains S.	181	Construction of Bridge over Monkey Place Creek ...	L. White	6,185 12 4
Stroud S. ...	10	Construction of bridge over Cromarty Creek	E. W. Milligan	5,275 5 0
Timbrebongie S.	347	*Supply, delivery and spreading 5,600 cu. yds. loam.* Average haul 1 m.	Hutchison and Walsh ...	1,236 13 4
Do	89	Supply, delivery and spreading 3,125 cu. yds. gravel and 1,875 cu. yds. loam. Average haul 1 to 2 m.	J. M. Wooden	1,382 16 3
Tumbarumba S.	85	*Construction of bridge over Manus Creek*	W. A. Winnett	20,405 6 10
Urana S. ...	125, 131, 323, 385	Ploughing and loading 25,776 cu. yds. gravel... ...	Tatnell Bros.	2,040 12 0
Walgett S. ...	12, 18, 127, 329	Supply of 31,054 cu. yds. gravel and sand clay for re-sheeting pavement and shoulders.	Bulldozer Hire and Repair Service.	17,315 5 3
Waradgery S ...	14	Winning, loading and rough spreading of approximately 4,576 cu. yds. loam.	A. E. and J. L. Clark ...	1,706 0 0
Do ...	14	Re-sheeting with loam 18 m. to 19.85 m.	Vincent Murphy and Sons	1,700 0 0
Do ...	14	*Winning, loading and spreading approximately* 4,004 cu. yds. loam.	A. E. and J. L. Clark ...	1,481 0 0
Weddin S. ...	237	Construction of Box Culvert and approaches 6.2 m. from Grenfell.	M. Kallas	2,284 18 0

•

DEPARTMENT OF MAIN ROADS DMR NEW SOUTH WALES

MAIN ROADS STANDARD SPECIFICATIONS, DRAWINGS AND INSTRUCTIONS.

NOTE: Drawings are prefixed by letter "A", instructions are so described; all other items are specifications or forms. Year of revision, if within last 10 years, is shown in brackets.

Form No.

ROAD SURVEY AND DESIGN.

A 478 } Specimen drawings, country road design.
A 478A }
A 478C Specimen drawing, flat country road design.
A 478B Specimen drawings, urban road design.
A 1645 Stadia reduction diagram.
355 Design of two-lane rural highways. (Instruction.)
369 Design of urban roads. (Instruction.)
288 Design of intersections. (Instruction,) (1952.)
402 Design of acceleration and deceleration lanes. (Instruction.)
499 Design of kerb-lines and splays at corners. (Instruction,) (1952.)
A 1614 Widening at points of "A" sight distance.
A 83 Earthwork quantity diagram.
Manual No. 2—Survey and design for main road works.
A 1640 Mould for permanent mark block.

STREET DRAINAGE.

243 Integral concrete kerb and gutter and vehicle and dish crossing, and drawing. (A 134A.)
245 Gully pit and drawings: with grating (A 1042); kerb inlet only (A 1043); with grating and extended kerb inlet (A 1352) extended kerb inlet (A 1353).
A 190 Gully grating.
A 1418 Concrete converter.
A 3491 Perambulator ramp.
A 3536 Mountable type kerb with reflectors.

CULVERTS.

138 Pre-cast concrete box culvert (1947) and drawing: 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).
206 Reinforced concrete culvert (1948) and instruction sheets. (A 304, A 305, A 306, A 359.)
A 1012–20 Single cell reinforced concrete box culvert: 6 in. to 1 ft. 3 in. (A 1012); 1 ft. 4 in. to 3 ft. (A 1013); 4ft. (A 1014); 5 ft. (A 1015); 6 ft. (A 1016); 7 ft. (A 1017); 8 ft. (A 1018); 9 ft. (A 1019); 10 ft. (A 1020).
A 1021–30 Two cell, reinforced concrete box culvert: 6 in. to 1 ft. 3 in. (A 1021); 1 ft. 4 in. to 3 ft. (A 1022); 4 ft. (A 1023); 5 ft. (A 1024); 6ft. (A 1025); 7 ft. (A 1026); 8 ft. (A 1027); 9 ft. (A 1028); 10 ft. (A 1029); and with concrete wearing surface-10 ft. (A 1030).
A 1031–41 Three cell, reinforced concrete box culvert: 6 in. to 1 ft. 3 in. (A-1031); 1 ft. 4 in. to 3 ft. (A 1032); 4 ft. (A 1033); 5 ft. (A 1034); 6 ft. (A 1035); 7 ft. (A 1036); 8 ft. (A 1038); 9 ft. (A 1040); and with concrete wearing surface-7 ft. (A 1037); 8 ft. (A 1039); 9 ft. (A 1041).
25 Pipe culverts and headwalls, and drawings: single rows of pipes: 15. in. to 21 in. dia. (A 143); 2 ft. to 3 ft. dia. (A 139); 3 ft. 6 in. dia. (A 172); 4 ft. dia. (A 173); 4 ft. 6 in. dia. (A 174); 5ft. dia. (A-175); 6 ft. dia. (A 177); Double rows of pipes :15 in. to 21 in. dia. (A 211); 2 ft. to 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 ft. to 3 ft. dia. (A 216). Straight headwalls for pipe culverts: 15 in. to 24 in. dia. (A 1153).
A 1 Joint for concrete pipes.
A 142 Inlet sump for pipe culvert 3 ft. dia. or less. (1947).
139 Timber culvert (1950) 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).
A 1223 Timber culvert 20 ft. roadway. (1949.)
A 3472 Timber culvert 22 ft. roadway. (1949.)
303 Supply and delivery of pre-cast reinforced concrete pipes.

BRIDGES AND FERRIES.

18 Data for bridge design. (1948.)
371 Waterway calculations. (Instruction.)
300 Pile driving frame, specification for 25 ft. and drawings for 50 ft. (A 209); 40 ft. (A 253); and 25 ft. portable (A 1148).
A 3693 Pontoon and pile driving equipment.
164 Timber beam bridge (1947) and instruction sheets, 12 ft. (A 3469); 20 ft. (A 70) (1949); and 22 ft. (A 1761) (1949).
326 Extermination of termites in timber bridges. (Instruction.)
350 Reinforced concrete bridge. (1949.)
495 Design of forms and falsework for concrete bridge construction. (Instruction.)
314 Regulations for running of ferries. (1948.)
A 4 Standard bridge loading. (Instruction, 1948.)
A 26 Waterway diagram. (1943.)
A 1886 Arrangement of bolting planks. (1948.)
A 45 Timber bridge, standard details. (1949.)
A 1791 Timber beam skew bridge details. (1949.)
A 3470 } Low level timber bridge, for 12 ft. and 20 ft. between kerb (Instruc-
A 3471 } tion.) (1949).
A 1216 Running planks.
A 1207 Reinforced concrete pile—25 tons. (1945.)
A 1208 Reinforced concrete pile—35 tons. (1945.)
A 1621 Reflector strip for bridges.

FORMATION.

70 Formation. (1949.)
513 Subsoil and subgrade drainage. (Instruction.)
A 1532 Standard typical cross-section.
A 1149 Flat country cross-section, Type A.
A 1150 Flat country cross-section, Type B.
A 1151 Flat country cross-section, Type D1.
A 1152 Flat country cross-section, Type D2.
A 1476 Flat country cross-section, Type E1.
A 1101 Cross-section one-way feeder road.

Form No.
A 1102 Cross-section two-way feeder road.
A 114 Rubble retaining wall.

PAVEMENTS.

71 Gravel pavement. (1949.)
228 Reconstruction with gravel of existing pavement.
254A Supply and delivery of gravel.
72 Broken stone base course. (1947.)
216 Telford base course.
68 Reconstruction with broken stone of existing pavement to form a base course.
257 Haulage of materials.
65 Waterbound macadam surface course.
230 Tar or bitumen penetration macadam surface course, 2 in. thick.
66 Tar or bitumen penetration macadam surface course, 3 in. thick.
125 Cement concrete pavement, and plan and cross-section. (A 1147.)
A 380 Galvanised iron strip for deformed joint.
A 381 Bituminous filler strip for transverse expansion joint.
493 Supply of ready mixed concrete.
266 Asphaltic concrete pavement.

SURFACE TREATMENT.

301 Supply and application of binder. (1950.)
122 Surfacing with tar. (1949.)
145 Surfacing with bitumen. (1949.)
93 Re-surfacing with tar. (1949.)
94 Re-surfacing with bitumen. (1949.)
466 Fluxing of binders for bituminous flush seals and reseals. (Instruction.)
351 Supply and delivery of aggregate.
354 Road-mix resealing. (1949.)
397 Fluxing for tar road-mix reseal. (Instruction and chart.)
A 1635 Fluxing chart for bitumen road-mix reseal.
167 Resheeting with plant-mixed bituminous macadam by drag spreader. (1951.)

FENCING AND GRIDS.

141 Post and wire fencing (1947) and drawings: plain (A 494); rabbit-proof (A 498); flood gate (A 316).
143 Ordnance fencing and drawing. (A 7.)
144 Chain wire protection fencing and drawing. (A 149.)
246 Location of protection fencing. (Instruction.)
224 Removal and re-erection of fencing.
A 1705 Plain wire fence for use in cattle country.
A 3598 Wire cable guard fence.
A 1301 Motor traffic by-pass 9 ft. wide.
A 1875 Motor traffic by-pass 20 ft. wide.

ROADSIDE.

A 1337 Concrete mile post, Type A.
A 1338 Concrete mile post, Type D.
A 1366 Standard lettering for mile posts.
A 1367 Timber mile post, Type B1.
A 1368 Timber mile post, Type B2.
A 3497 Timber mile post, Type B3.
A 2815 Concrete kerb mile block.
A 1420 Steel mould for concrete mile posts.
A 1381–3 } Tree guards, Types A, B, C, D, E, F, and G.
A 1452–5 }
Manual No. 4—Preservation of roadside trees.

MATERIALS.

296 Tar. (1949.)
337 Residual bitumen and fluxed native asphalt.
305 Bitumen emulsion. (1949.)
349 Light and medium oils for fluxing bitumen. (1948.)
A 27 Slump cone for concrete.
A 178 Mould for concrete test cylinder.
76 Design of non-rigid pavements. (Instruction.)
Manual No. 3—Materials.

TRAFFIC PROVISION AND PROTECTION.

121 Provision for traffic (1947) with general arrangement, (A 1323), and details (A 1325) of temporary signs. (1947.)
252 Supply and delivery of guide posts.
253 Erection of guide posts. (Instruction.)
A 1342 Temporary warning sign, details of construction.
A 1346 Iron trestle for road barrier.
A 1341 Timber trestle and barrier.

PLANT.

A 1414 Gate attachment for lorries with fantail spreader.
A 1450 Half-ton roller with pneumatic tyres for transport.
A 2814 Two-berth pneumatic tyred caravan.
A 2828 Multi-wheeled pneumatic tyred roller.
A 2976 Fantail aggregate spreader.
A 3530 Benders for steel reinforcement.
A 3547 Steel bar cutter.

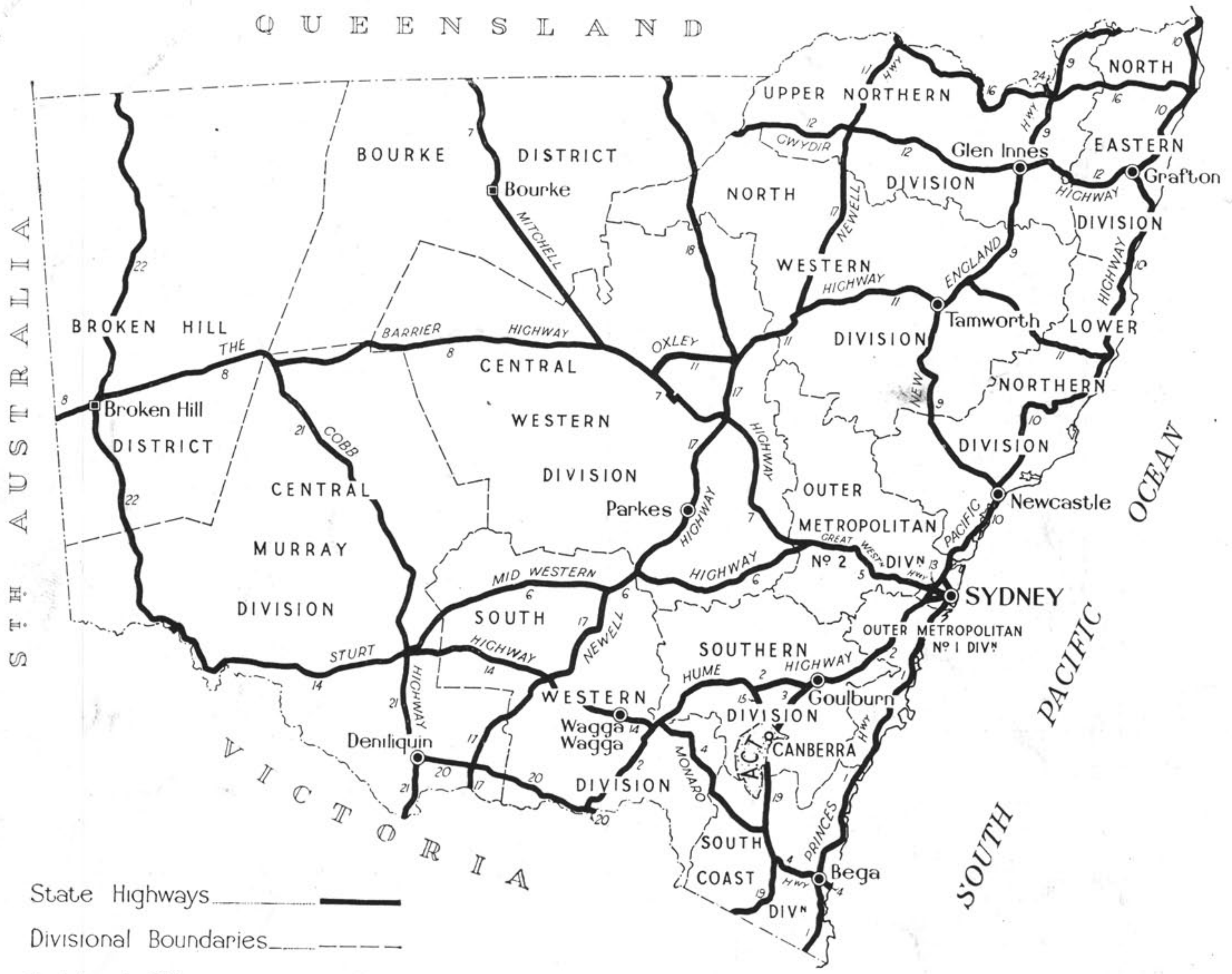
CONTRACTS.

24B General conditions of contract, Council contract. (1950.)
342 Cover sheet for specifications, Council contract. (1950.)
64 Schedule of quanities form.
39 Bulk sum tender form, Council contract. (1946.)
38 Bulk sum contract form, Council contract.
193 Duties of superintending officer. (Instruction.)
274 Ferry contract agreement form.
498 Caretaking and operating ferry.

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

Sydney: A. H. Pettifer, Government Printer—1952.

State Highway System of the State of New South Wales



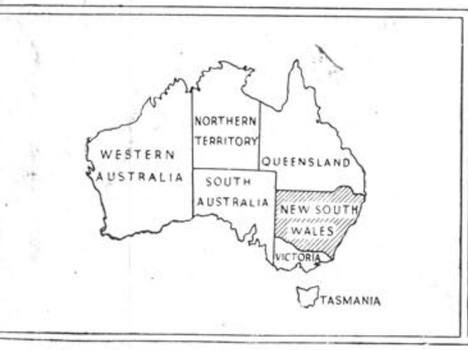
State Highways

Divisional Boundaries

Divisional Offices

SCALE OF MILES

40 20 0 40 80 120 160 200



Area of New South Wales, 309,433 square miles.
Lenth of public roads within New South Wales, 126,272 miles.

MILEAGE OE ROADS CLASSIFIED UNDER THE MAIN ROADS ACT, AS AT 1st JULY, 1951.

State Highways	6,533
Trunk Roads	4,089
Main Roads	12,698
Secondary Roads (County of Cumberland only)	59
Developmental Roads	2,859
	26,238
UNCLASSIFIED ROADS, in Western part of State, coming within the provisions of the Main Roads Act	2,705
TOTAL	28,943