CHAPTER VIII.

ELECTRIC POWER GENERATION AND DISTRIBUTION.

This chapter is divided into three major parts. A.—Introduction, which deals briefly with the resources, generation and distribution and future developments, of electric power in Australia ; B.—*The Snowy Mountains Hydro-electric Scheme* ; and C.—*The origins*, development, present situation and new projects of electrical systems in each Australian State and Territory. A Statistical Summary is appended.

It should be noted that the information contained in the chapter relates to situations existing and projects contemplated in 1957 and that it may be considerably affected by changes in policy or plans, or by developments in the projects themselves.

A. INTRODUCTION.

1. **Distribution of Population and Location of Power Resources.**—The geographical pattern of electric power generation and distribution in Australia has been affected by two main influences—the distribution of population, with a resulting distribution of industry, and the location of fuel and water resources.

The Australian population increased between 1939 and 1957 by approximately 2,675,000 to reach a total of 9,643,000. The two principal centres of population and industry, the metropolitan areas of Sydney and Melbourne, make the greatest demands for electric power and their growth has been associated with the development of large deposits of coal located relatively close to the source of demand. This, together with the fact that the major water resources are also located in the south-eastern portion of the Commonwealth, materially influences the distribution of industrial population and the location of major electric power stations.

By far the most important source of energy used in the production of electric power in Australia is coal. At 30th June, 1956, thermal power equipment represented 78 per cent., hydro plant 16 per cent. and internal combustion equipment 6 per cent. of the total installed generating capacity.

Most of Australia is poorly supplied with water, only 15.2 per cent. receiving an annual rainfall of 30 inches or over. This is confined largely to Tasmania and to the narrow coastal strip on the east coast. The possibility of establishing large hydro or steam stations in inland areas is, therefore, strictly limited by the lack of sufficient water for feed and condensing purposes.

The only region on the mainland of Australia where land is high enough to receive reliable winter snowfall, and from which, therefore, reasonably constant water supplies throughout the year can be expected, is the mountain chain which stretches from the high plateaux of south-eastern New South Wales through to the north-eastern highlands of Victoria. The hydro-electric potential of this area is considerable, and plans have been formulated to develop more than 3,000,000 kW within the next 25 years. The two major construction projects in this area are the Snowy Mountains and Kiewa schemes. Other hydro-electric potential does exist on the mainland on the rivers of the coastal areas of New South Wales and Queensland, but the amount there available is only a small proportion of the potential of the Alpine region. In Tasmania, hydro-electric resources have been estimated at about 50 per cent. of the total Australian hydro-electric potential. Whereas on the mainland the chief source of energy is coal, water occupies this position in Tasmania.

2. **Electric Power Generation and Distribution.**—(i) *Ownership of Undertakings.* At the beginning of this century, Australia's electrical undertakings were carried on mainly by private enterprise, but some measure of governmental control was exercised through various electric light and power Acts. This legislation was designed to provide standards of safety, and to define the scope and obligations of the private organizations engaged in producing electric power for sale. A trend towards public ownership commenced during the 1914–18 War and became more pronounced after the 1939–45 War. By 1957, all major generating stations supplying the public were, in varying degrees, under the control of State statutory organizations, constituted with the object of unifying and co-ordinating the generation and distribution of electricity supplies within the various States. There are, however, still a large number of small private and municipal enterprises generating power

for supply to country towns, although central authorities are extending supply to these places wherever practicable. In many areas, however, it has been and remains the practice for central authorities to sell power in bulk to local distributing organizations who undertake local reticulation.

In addition to the private, local government and statutory organizations who generate and/or distribute electricity for sale, there are numerous firms generating power for use in their own establishments, particularly those engaged in mining pursuits remote from the main centres of population. This chapter, however, is concerned mainly with the activities of central electric stations, and the power regularly produced for such internal consumption is, in any case, a relatively small proportion of total power produced.

(ii) *Power Production and Generating Capacity.* In the period between 1938–39 and 1956–57, production of electric power in Australia increased by almost 300 per cent. from 4,688 to 18,377 million kilowatt hours.

Since the 1939–45 War, industry and commerce have expanded rapidly, many new houses have been built and the population has increased by approximately 20 per cent. These factors, together with extension of electricity supplies to rural areas and the increased use of domestic electric appliances, have all contributed to bring about a position where the greatly increased demand for power cannot be satisfied by the existing installed capacity of central generating stations.

At 30th June, 1956, installed generating capacity in Australia totalled approximately 4.14 million kW compared with 1.62 million kW in 1939, an increase of about 156 per cent. In 1955–56, each kW of installed capacity produced an average of 4,027 kWh compared with an average of 3,000 kWh in 1938–39. These figures are based on Commonwealth totals; figures for the States vary, depending on such factors as the distribution of demand, number of consumers, and type of equipment employed.

3. **Future Developments.**—Each central authority has embarked upon constructional programmes to overcome the lag between supply and demand. Industrial and commercial expansion, however, has continued on a high level, and several projects have been commenced or planned in various parts of the Commonwealth for suburban and main railway line electrification. Other fields directly connected with the demand for power, such as house building, must also be taken into account.

An important factor to be considered in respect of future development is the increasing relative importance of the generation of electric power from water resources.

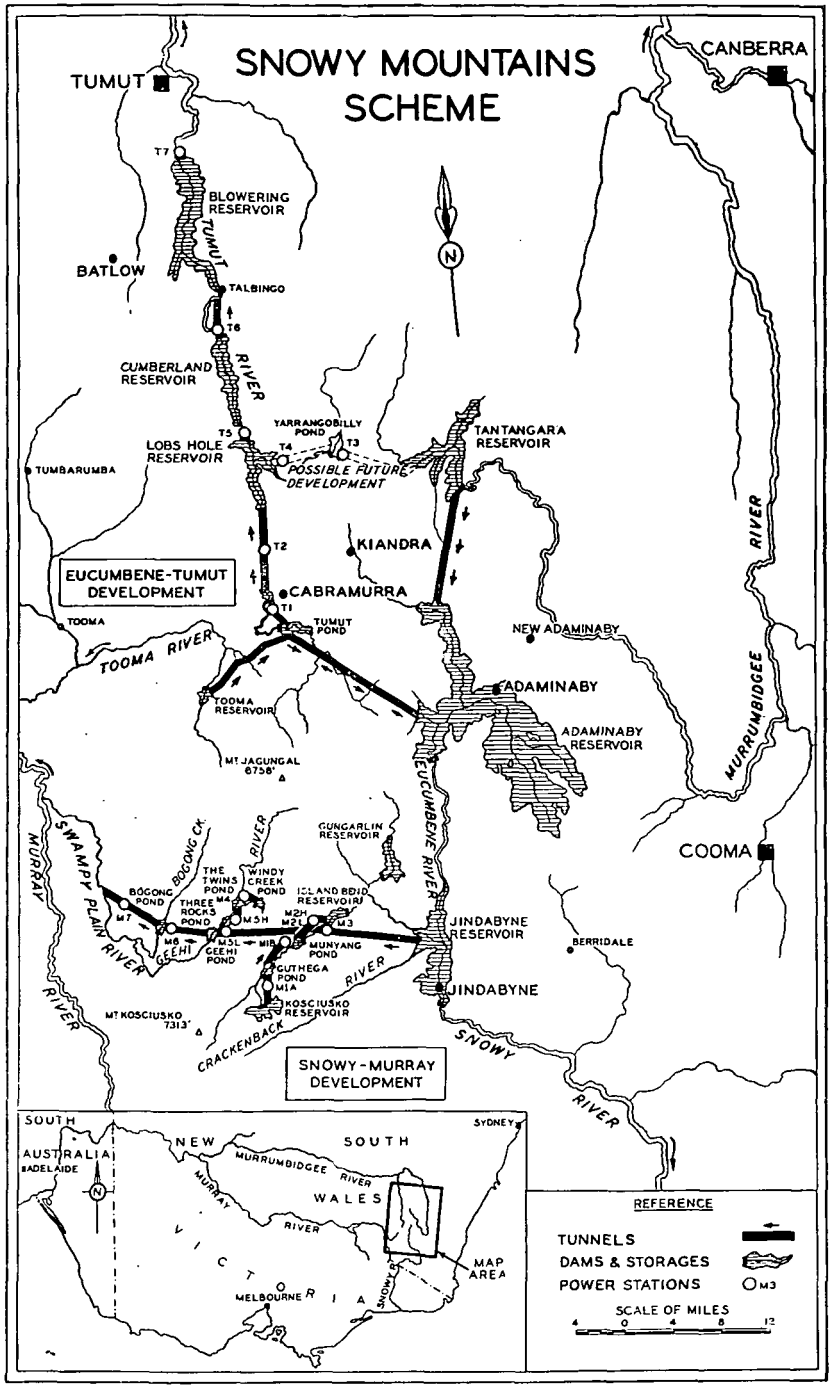
B. SNOWY MOUNTAINS HYDRO-ELECTRIC SCHEME.*

1. **Geography of Area.**—The Snowy country in south-eastern New South Wales is the only part of the continent in which any altitudes exceed 7,000 feet, and in which there is a substantial area over the altitude of 6,000 feet. The precipitation which results from the presence of this barrier on the line of the prevailing winter depressions of Antarctic origin amounts to as much as 120 inches a year in the vicinity of Mt. Kosciusko, the highest point in Australia. The drainage from the snowfields is practically all to three systems—those of the Murray and Murrumbidgee Rivers, which flow inland, and that of the Snowy, which flows southwards to Bass Strait.

2. **Description of Scheme.**—(i) *General.* The proposals at present being implemented by the Snowy Mountains Hydro-electric Authority fall into two groups, Tumut Development and Snowy-Murray Development, each having its associated plans for hydro-electric power production. The features described hereunder may be identified by reference to the map on page 273. It should be remembered that, as the final designs for practically every element of the Scheme have not yet been completed, and in many cases will not be completed for some years, any figures which are now quoted in respect of those elements will undoubtedly be subject to modification in the future.

(ii) *Tumut Development.* The central feature of this part of the Scheme is diversion to, and regulation of, the waters of the Tumut River, a stream which is at present completely unregulated but contributes approximately half of the flow of the Murrumbidgee River at Gundagai below the existing main storage on the Murrumbidgee at Burrinjuck. To the Tumut will be diverted the waters of the Eucumbene, a major tributary of the Snowy, and the headwaters of the Tooma, a tributary of the Upper Murray. The headwaters of the Murrumbidgee itself will also be diverted to the Tumut, principally to secure desirable electric power.

* *See also* Chapter IX.—Water Conservation and Irrigation, Division A, §3, para. 4 of this issue and special detailed article in Official Year Book No. 42, pp. 1103–1130.


SNOWY MOUNTAINS SCHEME
TUMUT
CANBERRA
BLOWERING RESERVOIR
TUMUT
BATLOW
TALBINGO
CUMBERLAND RESERVOIR
RIVER
YARRANGOBILLY POND
TANTANGARA RESERVOIR
LOBS HOLE RESERVOIR
TUMBARUMBA
POSSIBLE FUTURE DEVELOPMENT
KIANDRA
EUCUMBENE-TUMUT DEVELOPMENT
CABRAMURRA
TOOMA
TUMUT POND
NEW ADAMINABY
TOOMA RIVER
ADAMINABY
TOOMA RESERVOIR
ADAMINABY RESERVOIR
MURRUMBIDGEE RIVER
MT JAGUNGAL 6798'
EUCUMBENE RIVER
GUNGARLIN RESERVOIR
COOMA
SWAMPY PLAIN RIVER
BOGONG CK
THE TWINS POND
WINDY CREEK POND
ICELAND BEND RESERVOIR
BOGONG POND
THREE ROCKS POND
JINDABYNE RESERVOIR
BERRIDALE
GEEHI
GEEHI POND
MUNYANG POND
GUTHEGA POND
JINDABYNE
KOSCIUSKO RESERVOIR
MT KOSCIUSKO 7313'
CRACKENBACK
SNOWY
SNOWY-MURRAY DEVELOPMENT
SOUTH AUSTRALIA
ADELAIDE
NEW SOUTH WALES
SYDNEY
MURRUMBIDGEE RIVER
MURRAY RIVER
VICTORIA
MELBOURNE
SNOWY R.
MAP AREA
REFERENCE
TUNNELS
DAMS & STORAGES
POWER STATIONS
SCALE OF MILES
4 0 4 8 12

A major dam is being constructed on the Eucumbene River at Adaminaby, creating an ultimate usable storage of 3.5 million acre feet, and from here, water will be conveyed by a 14-mile tunnel to Tumut Pond, on the upper reaches of the Tumut River, where it will be joined by the waters from the Tooma, diverted by aqueducts and tunnels. From Tumut Pond, the water will be conveyed by another tunnel to power station T1 with an installed capacity of 320,000 kW and by a further tunnel to power station T2 with a capacity of 280,000 kW thence discharging into a smaller storage at Lob's Hole also on the Tumut River.

Between the foot of the Lob's Hole storage and the top of the Blowering storage will be power stations T5 and T6. The total capacity of these stations will be 410,000 kW.

The Blowering storage with its capacity of about 800,000 acre feet, is an adjunct to the Snowy Mountains Hydro-electric Scheme and will be required for the regulation both of the Tumut waters and of the waters diverted into the Tumut. This regulation is essential if the waters impounded are to be fully utilized for irrigation purposes. At the foot of the Blowering Dam will be the last of the Tumut Power stations, T7, with a capacity of some 60,000 kW, but this station will operate only when water is released for irrigation. The State of New South Wales will be responsible for the construction of the Blowering works.

The waters of the Upper Murrumbidgee will be brought from a major storage at Tantangara holding 200,000 acre feet, through 9 miles of tunnel, to the Adaminaby storage and will augment the flow through power stations T1, T2, T5, T6, and T7 on the Tumut River.

The total extra new water which will reach the Murrumbidgee is expected to average 528,000 acre feet per annum.

(iii) *Snowy-Murray Development.* Investigation of this section of the Scheme is not as far advanced as that for the Tumut Development and considerable modifications may be made to the lay-out proposed by the Commonwealth and States Snowy River Committee. In the original lay-out the central feature of this part of the Scheme is the diversion of the waters of the Upper Snowy itself from a major dam to be constructed at Jindabyne on that river, a little below its junction with the Eucumbene and the Crackenback Rivers. This reservoir will have a storage capacity of approximately 1,100,000 acre feet and from it a tunnel approximately 28 miles in length will run right through the Great Dividing Range finally discharging into Swampy Plains River, not far above its junction with the Murray proper.

Into this tunnel will be collected a considerable quantity of water from the very high altitude country of the Kosciusko area and from a number of smaller tributaries of the Murray. The collection from the Kosciusko area commences at the Kosciusko Reservoir at an altitude of 5,765 feet, not many miles below the source of the Snowy. A tunnel will convey water from this reservoir to power station M.1.A. with an installed capacity of 60,000 kW and thence to a pond on the Snowy River, at its junction with the Guthega River.

From the Guthega Pond, a further tunnel and penstock lead to station M.1.B. with a capacity of 60,000 kW (ultimate capacity 90,000 kW), which discharges into a pond at the junction of the Munyang and Snowy Rivers. Construction of this part of the scheme has been completed. Munyang Pond will discharge into a tunnel leading to station M.2.L., with installed capacity of 60,000 kW. This station also receives the flow of a tributary of the Snowy River via station M.2.H. From station M.2.L., the water discharges into a reservoir at Island Bend on the main stream of the Snowy.

From the Island Bend reservoir, a vertical shaft, 1,100 feet deep, will lead to the main tunnel from Jindabyne reservoir previously referred to, passing on its way through power station M3 with installed capacity of 265,000 kW. Into this main tunnel will also be collected waters from the Upper Murray tributary streams previously mentioned.

Of these, the most important is the Windy Creek-Geehi River series. A pond on Windy Creek, a small tributary of the Geehi, situated at an altitude of over 5,000 feet, will provide water through a tunnel to station M4 with an installed capacity of 75,000 kW thence by aqueducts and tunnel to station M5.H. with an installed capacity of 40,000 kW discharging into the M5.L. Intake Pond on the Geehi River.

A vertical shaft will lead this water into the main tunnel, passing through station M5.L. with an installed capacity of 20,000 kW. The combined waters thus collected into the main tunnel will pass through station M6 with an installed capacity of 540,000 kW and then discharge into a pond on Bogong Creek, another of the Upper Murray tributaries. At this point, the water is still at an altitude of nearly 2,000 feet, and the main tunnel will thence continue to station M7 with a capacity of 540,000 kW.

From M7 the total collected waters will flow into the Swampy Plains River at a point some seven miles, in a direct line, above its confluence with the Murray. It will be necessary, however, to provide a further storage on the Murray for the proper regulation of these waters for irrigation purposes.

The total water flowing to the Murray from these works will amount on the average to 722,000 acre feet per annum, but since 280,000 acre feet which now reach the Murray from the Tooma will be, as indicated previously, diverted to the Tumut, the total extra water actually reaching the Murray will be, on the average, 442,000 acre feet per annum.

An integral part of each development is the construction of hundreds of miles of aqueducts to collect and divert water from the many streams in the area into storages and tunnels.

3. **Utilization of Power.**—The total capacity of all stations in the Scheme will be of the order of 3,000,000 kW. By comparison, the present total installed capacity of all the generating stations in the Commonwealth is over 4,000,000 kW.

If, however, the demand for power continues to increase as expected, the major source of power must still be thermal stations. The operation of the whole Scheme is dependent on the appropriate development and integration of these stations, as otherwise there would be a serious loss in ultimate economy ; all economic estimates therefore postulate that thermal capacity will be expanded so as to preserve an appropriate ratio.

It has been estimated with a reasonable degree of probability that the power available from the Scheme will save coal to the order of five million tons annually.

The first call on the power generated under the Snowy Scheme will be by the Commonwealth Government for supply to the Australian Capital Territory of power which it needs in that area, particularly for certain projects with defence significance, and no indication can be given at present as to how great that call will be. It is not likely, however, to amount to more than a relatively small fraction of the total power available, and it has been agreed that the balance will be divided between the States of New South Wales and Victoria in a proportion of two-thirds to New South Wales and one-third to Victoria.

The first power station in the scheme, M.1.B., the Guthega Project, is now producing power. A 132,000 volt transmission line extends from the power station via Cooma to the Australian Capital Territory where it feeds into the main New South Wales transmission network. The construction of the Eucumbene-Tumut diversion tunnel, Tumut Pond Dam, and Power Station T1 is in progress. The construction of the Adaminaby Dam is being supervised by the Public Works Department of New South Wales on behalf of the Snowy Mountains Authority and a contract for this work was let in May, 1956, to a group of American engineering contractors who were already engaged on the construction of the Eucumbene-Tumut tunnel and Tumut Pond Dam for the Authority. Construction of the embankment has been sufficiently advanced to permit closure of the diversion tunnel gates, and storage of water in the reservoir commenced during June, 1957. Power Station T1 will enter the New South Wales network via a 330,000 volt transmission line early in 1959.

C. STATES AND TERRITORIES.

§ 1. New South Wales.

1. **General.**—In Official Year Book No. 39, an account was given in some detail of the origin and development of electricity generation and distribution in New South Wales, describing in particular the growth of the systems of the Sydney County Council, the Department of Railways, the Electric Light and Power Supply Corporation Ltd., the Southern Electricity Supply and the Clarence River County Council (now the Northern Rivers County Council). A description was also given of the legislation which constituted The Electricity Authority of New South Wales and The Electricity Commission of New South Wales as well as legislation existing prior to their constitution. At present, the three main Acts governing electricity supply in New South Wales are:—

(i) The Local Government Act 1919 which lays down the various rights and responsibilities of local government bodies in the establishment and operation of electricity trading undertakings.

(ii) The Electricity Development Act 1945–1957 which established the Electricity Authority of New South Wales as the body responsible for the co-ordination of electricity supply throughout the State.

(iii) The Electricity Commission Act 1950–1954 which constituted The Electricity Commission of New South Wales as the major generating authority and not subject to the provisions of the Electricity Development Act.

2. **Organization.**—(i) *The Electricity Commission of New South Wales.*—The Commission, which was constituted under the Electricity Commission Act 1950, consists of five members of whom one is a full-time Chairman. In its administration, the Commission is directly responsible to the Minister for Local Government.

When the Commission was established, 93 per cent. of the State's power requirements were generated by four bodies—the Sydney County Council, the Department of Railways, Southern Eiectricity Supply (a division of the Department of Public Works) and the privately-owned Electric Light and Power Supply Corporation Ltd. The Electricity Commission Act 1950 and the Electricity Commission (Balmain Electric Light Company Purchase) Act 1950 provided for the acquisition of the power stations and main transmission lines of those bodies. The transfer of the power stations and transmission lines of all these undertakings has now been effected. On 1st July, 1956, the Commission acquired the power station and bulk supply system of the Tamworth City Council, which supplied in bulk to a number of distributing bodies in the north of the State.

The main function of the Commission is the generation and transmission of electricity which it sells in bulk to distribution authorities (mainly local government bodies) throughout a large part of the State, to the government railways and tramways and to certain large industrial consumers. As the major generating authority, it is also responsible for the development of new power sources. An important exception is the hydro-electric potential of the Snowy Mountains region which is being developed by the Snowy Mountains Hydro-electric Authority, a Commonwealth Government body.

(ii) *Other Electricity Supply Authorities.* The retail sale of electricity to the public is, in general, carried out by separate electricity supply authorities—municipal and shire councils, electricity county councils (consisting of a grouping of shire and/or municipal councils) or private franchise holders. At 1st September, 1957, there were 96 of these supply authorities throughout the State of which 31 also generated part or whole of their power requirements. The majority of country power stations are small oil engine plants which are becoming increasingly costly to operate. Consequently, they are gradually being closed down as the main transmission network is extended further afield.

Over the past few years, there has been a distinct trend towards the consolidation of supply areas, many of which have been regarded as being too weak individually to form satisfactory areas for distribution. Generally these consolidations have taken the form of a county district consisting of a number of neighbouring shire and municipal areas grouped for electricity supply purposes only and administered by a county council of representatives elected by the constituent shire and municipal councils.

It is interesting to note that of the 230 shires and municipalities in New South Wales, 179 are included in one or other of the 35 electricity county districts. Twenty-eight of these county districts have been constituted since 1945. The largest of the county councils is the Sydney County Council which at 30th June, 1957, was supplying 386,976 consumers in the Sydney Metropolitan Area. Unlike the other county councils, which are constituted under the provisions of the Local Government Act 1919, the Sydney County Council was specially constituted under the Gas and Electricity Act 1935.

(iii) *The Electricity Authority of New South Wales.*—The Electricity Authority was constituted under the Electricity Development Act 1945–1957, for the stated purpose of promoting and regulating the co-ordination, development, expansion, extension and improvement of electricity supply throughout the State. The Authority, which is a regulatory body only, consists of seven members of whom one is a full time Chairman. Like the Commission, it is responsible to the Minister for Local Government.

The main functions of the Authority are as follows :—

(*a*) *Distribution.* Under the Act the approval of the Authority is required, *inter alia*, for the establishment or acquisition of an electricity trading undertaking by a local government council, for the granting or renewing by such a council of electricity franchise agreements or corresponding

agreements with other councils, and for the giving or taking of bulk supplies of electricity. It also has power to formulate proposals for the establishment of county councils.

In exercising these powers, the Authority is mainly concerned to see that distributing authorities are sufficiently strong to provide an economical, efficient and satisfactory service. Its most important activities in this regard are in investigating supply areas and in making recommendations to the Minister for the consolidation of such areas into county districts. Many of the new county districts referred to earlier have been formed largely as a result of the Authority's advice.

(*b*) *Rural Electrification.* The Authority administers the rural electricity subsidy scheme under which rural electrification throughout the State is progressing very rapidly (*see* para. 4, page 280).

(*c*) *Safety.* The Electricity Development Act 1945–1957 contains provisions for the making of regulations relating to most aspects of safety and these powers are being used more and more extensively. Safety regulations now in force cover such matters as inspection of consumer's installations, licensing of electricians and electrical contractors, approval of electrical appliances, safety of linesmen and overhead line construction.

(*d*) *Generation and Transmission.* The approval of the Authority is required for the establishment or extension of power stations and main transmission lines (with the exception of those of the Electricity Commission). The Authority may, for example, refuse approval for the establishment of a new power station if it is more economical and in the general interest for the supply authority concerned to purchase in bulk from another body.

3. **Generation and Transmission.**—(i) *General.* Except in the Snowy Mountains district and in one or two other areas, New South Wales is lacking in major water power potential and for the generation of electricity the State is, therefore, mainly dependent on steam power stations. During the year ended 30th June, 1956, coal-fired stations generated 93 per cent. of the State's energy requirements, hydro-electric stations 5 per cent. and internal combustion plants 2 per cent.

The proportion of power generated in hydro-electric stations will increase considerably in the future with the development of the Snowy Mountains Scheme by the Commonwealth Government. Nevertheless, coal-fired steam power stations will continue to supply the greater part of requirements for the foreseeable future.

(ii) *Major Generating Stations.* In New South Wales, the generation of electricity has followed the general world trend towards large centralized power stations supplying large areas through inter-connected transmission networks. The greater part of the coal-fired generating plant is now concentrated within the bounds of the major coal-fields, where the big industrial centres and most of the population are also located.

As at 1st July, 1957, the major power stations within the main inter-connected system and their installed capacities were as follows :—*Steam*—Bunnerong " A " and " B " (Sydney), 375,000 kW; Pyrmont " A " and " B " (Sydney), 220,000 kW; White Bay (Sydney), 122,000 kW; Ultimo (Sydney), 80,000 kW; Balmain (Sydney), 107,000 kW; Port Kembla, 64,500 kW; Zarra-street (Newcastle), 65,500 kW; Tallawarra (Lake Illawarra), 120,000 kW; Lake Macquarie, 100,000 kW; Wallerawang (near Lithgow), 30,000 kW; Lithgow, 27,000 kW; Maitland, 20,000 kW; Penrith, 20,000 kW; Liverpool, 20,000 kW. *Hydro*—Hume (near Albury), 25,000 kW; Burrinjuck (near Yass), 20,000 kW. There were also various other steam, hydro and internal combustion stations aggregating 46,150 kW. The total installed capacity of the main inter-connected system was 1,462,150 kW.

It will be seen, therefore, that the greater part of the State's generating plant is concentrated within a hundred mile radius of Sydney—that is, at Sydney itself (five stations), Port Kembla, Newcastle, Maitland, Penrith and Lithgow. The largest single station outside this area is located at Tamworth, capacity 27,000 kW.

(iii) *Interconnected Network.* Over 90 per cent. of electricity consumers in New South Wales are now supplied through the main inter-connected systems. In this network, transmission lines operating mainly at 132,000, 66,000 or 33,000 volts interconnect the various power stations and distribute power to load centres throughout most of the south-eastern portion of the State and the north coast region. At 30th June, 1957, there were in service 915 circuit miles of 132 kV lines (including 65 built for future 330 kV operation) and about 1,600 circuit miles of 66 kV lines. The total installed capacity of the interconnected systems, which includes an aggregated capacity of 62,555 kW for various stations, including the Northern Rivers and Bega Valley County Districts linked with the main system was 1,524,705 kW (as at 1st July, 1957).

(iv) *Separate Systems and Total State Installed Capacity.* There are a number of separate systems and isolated plants which have not yet been interconnected with the main network and which at 1st July, 1957, had an aggregate installed capacity of 107,000 kW. The most notable are the Tamworth and Muswellbrook Coal Company systems. The Tamworth system (27,000 kW), now taken over by the Commission, supplies power to an extensive district in the north of the State through 66,000 volt and 33,000 volt transmission lines. Both the Tamworth and Muswellbrook systems are to be interconnected with the main system in the near future. Some councils along the Victorian border receive bulk supplies from Victorian authorities.

The aggregate installed capacity for the whole of the New South Wales systems and isolated plants was 1,631,705 kW (as as 1st July, 1957).

(v) *Future Development.* Construction is proceeding on new major power stations on the coalfields at Lake Macquarie, near Newcastle (330,000 kW), Tallawarra, near Port Kembla (320,000 kW), and Wallerawang, near Lithgow (240,000kW). These stations are linked with Sydney by 132,000 volt transmission lines, and extensive additions are also planned to the 132,000 volt system to supply increasing loads at various metropolitan and country centres. Sections of a superimposed 330,000 volt system, which will eventually extend from the Snowy Mountains area to Armidale in the north west, are also under construction. A hydro-electric power station on the Hume Reservoir of 50,000 kW capacity, connected to the New South Wales network through a 132,000 volt transmission line between Hume and Wagga Wagga is in part operation and is almost complete. Plans provide for the construction of a hydro-electric power station on the Warragamba Dam of 50,000 kW capacity to be connected to the 132 kV Sydney metropolitan network.

In addition to the power stations mentioned above, which are under construction or planned for the system controlled by the Electricity Commission, a number of local government bodies have plans in hand for the development of independent power stations. Of these the more important are as follows :—The Northern Rivers County Council is extending a steam power station at Koolkhan (near Grafton). Plans provide for an installed capacity of 25,000 kW. The first three units, totalling 17,500 kW, were in operation at 30th June, 1956. The North-West County Council is proceeding with the establishment of a 12,000 kW steam power station on the Ashford coal-field. The New England County Council and the Bega Valley County Council are extending small hydro-electric power stations on the Oakey River (near Armidale), and Georges Creek (near Bega) respectively.

(vi) *Hydro-electricity.* The greater part of the hydro-electric potential of New South Wales is concentrated in the Snowy Mountains Area (*see* Snowy Mountains Hydro-electric Scheme, p. 272). Apart from this area, there are in operation the first of two 25,000 kW units to be installed at the new hydro-electric station at the Hume Dam, the 20,000 kW station at the Burrinjuck Dam, and the 7,500 kW station at the Wyangala Dam. The output of all these stations is dependent on the release of water for irrigation.

Of the remaining hydro installations, the largest is that of the Northern Rivers County Council on the Nymboida River, a tributary of the Clarence. This station has a capacity of 4,600 kW.

The New England County Council has constructed a 2,500 kW hydro scheme near Armidale on the Oakey River, a tributary of the Macleay River, and plans to increase the capacity to 5,000 kW.

The Mullumbimby Municipal Council has in operation two 150 kW hydro units on Wilson's Creek, a tributary of the Richmond River.

The Bega Valley County Council operates a hydro-electric scheme at Brown Mountain, utilizing the headwaters of the Bemboka River. This installation now has a capacity of 1,900 kW and work is in progress on extensions to provide for two further 1,000 kW units.

The Clarence Gorge Scheme is a proposal for combined flood mitigation and hydro-electric generation on the Clarence River about 40 miles from Grafton and 240 miles from Newcastle. In February, 1955, the Clarence Advisory Committee which was set up by the New South Wales Government to report on the scheme recommended, because of economic reasons, against the construction of a dam at the Clarence Gorge either solely for flood mitigation or for the dual purpose of hydro-electric power generation and flood mitigation.

There are also possibilities of relatively large scale developments on the Shoalhaven and Macleay Rivers. Investigations have been made by the New South Wales Government but no concrete proposals have as yet been adopted.

Generally, apart from the Snowy Mountains area, hydro-electric developments are not favourable in New South Wales when compared with coal-fired steam power stations.

4. **Rural Electrification.**—When The Electricity Authority of New South Wales was constituted in 1946, one of its first tasks was the devising of a scheme for subsidizing the cost of rural electrification. At that time only 16,000 New South Wales farms were being served with electricity—less than one-third of those within reasonable reach of public electricity supply systems. In August, 1946, a subsidy scheme was approved by the Government and put into immediate operation. Under this scheme, local electricity suppliers receive subsidies from the Electricity Authority towards the cost of new rural lines. The amount of subsidy is based on the estimated cost of a proposed extension and the number of consumers able to be served by the new lines. In order that the funds available for subsidy purposes might be used to the best possible advantage, the scheme is designed to encourage local electricity supply authorities to construct the more economic extensions first. This has been achieved by fixing a limit to the cost eligible for subsidy. Originally this limit was £250 per consumer when averaged over the cost of the whole extension but the limit was raised to £400 in December, 1953. Some subsidy is paid on higher cost extensions but the excess over an average of £400 is not subsidized.

Between August, 1946, and June, 1957, about 23,800 miles of new distribution lines in rural areas were erected at a cost of over £15,700,000. These lines served 33,700 farms and 23,000 other rural consumers. At 30th June, 1957, the Electricity Authority was committed to the payment of almost £7,165,000 in subsidies of which nearly £2,933,000 had actually been paid. At that time the percentage of farms connected had been raised from 22 per cent. (in 1946) to 69 per cent.

§ 2. Victoria.

1. **General.**—In Official Year Book No. 39, a detailed description is given of the development of electricity generation in the cities of Melbourne, Geelong, Bendigo and Ballaarat up to the time of transfer of control of electricity undertakings in those cities to the State Electricity Commission of Victoria. An account is also given of the events culminating in the establishment of the Commission in 1919, and of the early developments in the Commission's undertakings.

2. **State Electricity Commission of Victoria.**—(i) *Power and Fuel Authority.* Since it began operating in 1919, the State Electricity Commission has expanded and co-ordinated the production and supply of electricity on a State-wide basis to the point where its system now generates almost all the electricity produced in Victoria and serves about 97 per cent. of the population through a supply net-work covering more than three-quarters of the populated area of the State.

Development of Victoria's State electricity system is based on the development of Victoria's extensive brown coal resources for both power and fuel in the Latrobe Valley in eastern Gippsland, with supplementary development of the hydro-electric potential of north-eastern Victoria. Sixty-five per cent. of the State's electricity is generated from brown coal, either used in its raw state or manufactured into higher quality fuel in the form of brown coal briquettes. Ninety-six per cent. of the brown coal and all the briquette fuel are supplied by undertakings which the Commission itself owns and operates. Output of brown coal in 1956–57 from the three open cuts at Yallourn, Yallourn North and Morwell totalled 9,859,549 tons, of which 6,682,629 tons were used in the Commission's own power stations, and 2,418,843 tons were manufactured into 617,989 tons of brown coal briquettes, 29 per cent. of the briquette output being then used for electricity production in metropolitan and provincial steam power stations.

The two functions—generation of electricity and production of fuel—are closely integrated. Apart from the large proportion of brown coal and briquette fuel directly consumed in the power stations, the actual process of briquette manufacture results also in large-scale generation of electricity, since the steam needed for processing the raw coal in the briquette factory is first used to operate turbo-generators in associated power plant which functions as part of the briquette works.

(ii) *Status and Powers.* Constituted by Act of the Victorian Parliament, the State Electricity Commission is a semi-government authority administered since 1921 by a full-time Chairman and three part-time Commissioners. The principal duty of the Commission is

to co-ordinate and extend on an economic basis the supply of electricity throughout Victoria. For this purpose, it is vested with power to erect, own and operate power stations and other electrical plant and installations, supply electricity retail to individual consumers or in bulk to any corporation or public institution, acquire and operate electricity undertakings, develop, own and operate brown coal open cuts and briquetting works, and develop the State's hydro-electric resources. From its own revenues, which it controls, the Commission must meet all expenditure in the operation of its power, fuel and subsidiary undertakings, and all interest and other charges incurred in the service of its loans and other capital commitments.

The Commission is the controlling authority for all electrical undertakings in Victoria. It is responsible for the registration of electrical contractors, the licensing of electrical mechanics, the control of installation methods and material and the testing and approval of electrical equipment and appliances. Incidental to its main operations, the Commission owns and operates the tramway systems in Ballaarat and Bendigo. For the accommodation of its employees at Yallourn, the Commission owns and administers the town of Yallourn and owns large housing settlements in the surrounding area. In the Kiewa hydro-electric works area, it owns the two townships of Mount Beauty and Bogong.

(iii) *Electricity Supply.* At 30th June, 1957, consumers in Victoria served by the State system totalled 761,806. Outside the State system, there were 23,052 other consumers served by local country undertakings. The system supplies all the Melbourne metropolitan area and nearly 1,300 other centres of population.

The Commission sells electricity retail in all areas except part of the metropolitan area, where it sells in bulk to eleven municipal undertakings which operate as local retail supply authorities under franchises granted before the Commission was established. Bulk supply is also being provided at present to several New South Wales municipalities and irrigation settlements bordering the River Murray. Rural electrification is now more than four-fifths completed, the over-all plan to extend the State system to all populated regions of Victoria having made rapid progress during recent years. Consumers served by the State system outside the Melbourne metropolitan area (306,426) have more than doubled, and the number of farms connected to supply (35,852) has more than trebled in the past 10 years. More than two-thirds of the new consumers annually connected to supply are outside the metropolitan area. New farm connexions average about 2,500–3,000 a year.

The Commission's retail consumers totalled 590,906 at 30th June, 1957. Retail supply is administered through the metropolitan branch, seven extra-metropolitan branches (namely Ballaarat, Eastern Metropolitan, Geelong, Gippsland, Midland, North Eastern and South Western) and the North Western Region, which comprises Bendigo branch and the two sub-branches based on Mildura and Horsham (Wimmera) respectively. At 30th June, 1957, there were branch and district supply offices in 75 towns in Victoria.

(iv) *Electricity Production.* Electricity generated in the State system totalled 4,763 million kWh in 1956–57 or 99 per cent. of all the electricity generated in Victoria. The system comprises 22 steam, hydro and diesel power stations with a total installed generator capacity at 30th June, 1957, of 1,136,599 kW. Eighteen of these power stations, totalling 1,109,195 kW, are interconnected, and feed electricity into a common pool for general supply. The major power station in this interconnected system is the brown coal burning power station at Yallourn, which alone generates 44 per cent. of Victoria's electricity. Other power stations in the interconnected system comprise steam stations in Melbourne (Newport, Richmond and Spencer Street), Geelong (two stations) and Ballaarat (two stations); hydro-electric stations at Kiewa (two stations) and Eildon, and on the Rubicon and Royston Rivers (four stations), near Eildon; and three diesel stations at Shepparton, Warrnambool and Hamilton. All are Commission owned, except Spencer Street power station, which remains the property of the Melbourne City Council, although operated as a unit in the inter-connected system. Also linked with the Victorian interconnected system is the hydro station completed in 1957 at Hume Dam on the River Murray. This power station is operated by the Electricity Commission of New South Wales. Output and operating costs are shared equally by Victoria and New South Wales.

In meeting the total demand on the system, which fluctuates throughout the day and from month to month, each group of stations in the interconnected system, whether steam, hydro or diesel, is assigned a predetermined function dependent upon the availability of power from each group and the over-all economics of generation. The various stations are utilized in a combination that will most economically meet the system load at a given time. This procedure results in an arrangement of the system on the following general lines :—

(*a*) Yallourn power station, owing to the low cost of extraction and ample supply of raw brown coal, is a base load station, and is operated continuously at its maximum economic capacity.

(*b*) *Metropolitan and provincial steam stations and provincial diesel stations* situated close to load centres are designed to operate as peak load stations to assist in meeting the heavy, short period load. Pending the completion of extensions to Yallourn power station, a substantial proportion of the base load on the system is carried by Newport power station.

(*c*) Hydro stations are operated in accordance with the availability of water. They are designed to effect, where possible, a saving of the more expensive fuels used in the metropolitan and provincial thermal stations.

Commission power stations not yet connected with the rest of the State system comprise the two steam stations (Redcliffs and Mildura) serving the Mildura region, and two local diesel stations at Horsham and Murtoa which have been acquired as the first step in a large-scale plan to extend the State electricity system to the Wimmera. The stations at Horsham and Murtoa are being connected to the State system in 1958.

(v) *Transmission and Distribution.* The electrical transmission and distribution system n the State supply network at 30th June, 1957, comprised 24,871 miles of transmission and distribution power lines, 11 terminal receiving stations and over 15,000 distribution sub-stations. Main transmission is by 220 kV, 132 kV and 66 kV power lines which supply the principal distribution centres and also provide inter-connexion between the power stations. The 220 kV system connects Yallourn and Kiewa with metropolitan terminal stations. From Yallourn also, there are four 132 kV transmission lines to Melbourne. The 66 kV lines radiate from Melbourne to Geelong and Warrnambool, Ballaarat and Bendigo, and also to Benalla and other main centres in the North East. Further 66 kV lines radiate from Yallourn to main centres in Gippsland.

(vi) *Future Development.* In conformity with its dual responsibility for producing and supplying Victoria's electricity and producing a large proportion of the State's solid fuel, the Commission's developmental programme is in two parts, which are, however, closely dependent one upon the other. The major part of this programme is for the development of the brown coal undertakings at Yallourn and Morwell in the Latrobe Valley and the erection of a large new brown coal burning power station at Hazelwood near Morwell; and the second and lesser part for the development of the hydro undertaking at Kiewa and construction of a high voltage transmission line for the supply of power to be purchased from the Snowy Mountains Hydro-electric Authority. At the same time, the commission will continue its programme of rural electrification, extension of the State system (particularly in western and north western Victoria) and reinforcement of supply by the establishment of a 220 kV power transmission grid designed ultimately to encircle central Victoria, linking all principal power stations and all major centres of distribution.

Yallourn power station is being greatly enlarged. One 100,000 kW extension was completed late in 1956. A second 100,000 kW extension is being built. One of its two 50,000 kW generators came into service in 1957 and the extension is due for completion in 1958. A third extension of 240,000 kW capacity is due for completion in 1962. Enlargement of the power station will require a corresponding expansion in production of brown coal at Yallourn. New dredger plant will increase annual output at the Yallourn open cut to over 12 million tons in 1963. This will complete the Yallourn power generation development, except for the eventual replacement of 175,000 kW of old plant with one generating unit of about 200,000 kW capacity.

At Morwell, six miles from Yallourn, the Commission is developing a second brown coal power and fuel project. The new project will comprise a large brown coal open cut and a major new power station which will operate in association with a large new briquetting plant. Some of the electricity generated at Morwell will be needed to operate the briquette works, but most of the output of the power station will be transmitted through Yallourn to metropolitan terminal stations for general supply through the State network. The power station and two units of the briquetting works are now being built, and the power station will start generating electricity in 1959. In 1961, electricity output for general supply will be 91,000 kW, and briquette production will be over 1,500,000 tons per annum. Annual output of brown coal at the Morwell open cut will increase progressively to about six million tons in 1962.

In order to make the best possible use of the new brown coal open cut already in the initial stages of production at Morwell the Commission is now planning to build at Hazelwood, south of Morwell, a large new brown coal burning power station of 800,000 to 1,000,000 kW capacity in units of 200,000 kW each or larger, the first to be in service not later than 1964.

(vii) *Hydro electricity.* The new hydro station built to operate on the waters of the greatly enlarged Eildon Reservoir was completed in 1957. The electrical installation consists of two large generating sets, each of 60,000 kW capacity, and two small generating sets, totalling 16,000 kW transferred from Sugarloaf power station, the original power station which was demolished when the new Eildon Dam was built. As the primary purpose of Eildon Reservoir is to provide water for irrigation, generation of electricity will be mainly governed by irrigation requirements, but provision has been made for limited operation of the power station in winter when electricity requirements are at their heaviest and there is no irrigation demand for water. Similar considerations apply to the newly completed Hume hydro station. Since it also operates on water released for irrigation, no regular output of electricity can be expected during the non-irrigation months in the winter. At the Kiewa hydro-electric undertaking, where two stations, totalling 87,600 kW capacity, are now in service, work is in progress on a third power station of 96,000 kW capacity, which is due to have the first of its six generators operating in 1960 and the remainder in service by the beginning of 1962. Work is also in progress on the construction of Rocky Valley Reservoir, which is designed to provide the main high level storage for the operation of the Kiewa power stations.

Connexion with the Snowy Mountains undertaking will be made by a new high voltage transmission line which will feed into the Victorian system via Dederang, near Kiewa. It will operate at 330 kV. Two sections of the 220 kV transmission grid (Yallourn-Melbourne and Kiewa-Eildon-Melbourne) are in service and interconnected. Extensions of this new grid are due for completion as follows:—Geelong to Colac (1957); Geelong to Melbourne (1958); Kiewa to Shepparton (1958); Shepparton to Bendigo (1959). Temporarily the Melbourne-Colac line and the Shepparton-Bendigo line will operate at 66kV. They will be activated at 220 kV at a later date. Eventually the 220 kV grid will be continued from Bendigo via Ballaarat to connect with the Melbourne-Geelong-Colac section at Geelong, and will also extend along the Murray Valley to Redcliffs, near Mildura.

3. **Local Country Electricity Undertakings.**—At 30th June, 1957, there were 41 independent electricity undertakings in country centres in Victoria generating and distributing their own local supply. Most of these undertakings were in the far south west, west and north west of the State. Under the State Electricity Commission's rural electrification programme, almost all the independent local country undertakings will ultimately be acquired and absorbed into the State system. For the year 1956–57, the total production of the independent undertakings was 43 million kWh. The number of consumers at 30th June, 1957, was 23,052. The operation of the independent undertakings is governed by the Electric Light and Power Act, 1928, which the State Electricity Commission administers.

§ 3. Queensland.

1. **General.** In Official Year Book No. 39, an account is given of the growth of electricity generation in Queensland, with particular reference to the City Electric Light Co. Ltd. of Brisbane (now the Southern Electric Authority of Queensland), the Brisbane City Council and the Toowoomba Electric Light and Power Co. Ltd.

The first of these organizations supplies a large part of Brisbane's electric power requirements and a considerable rural area in the south-east corner of the State from a modern power station at Bulimba, a suburb of Brisbane. Capacity is 95,000 kW at Bulimba "A" plus 10,000 kW, "packaged plant" at Abermain (near Ipswich) and 90,000 kW at a new generating station known as "Bulimba B". The output from a 3,200 kW hydro-electric unit installed at Somerset Dam near Brisbane is fed into the Southern Electric Authority system. With these plants 613 million kWh were generated in 1955–56 while the total number of the Authority's consumers at 30th June, 1956 was 104,025.

The Brisbane City Council's electrical undertaking and power production in 1955–56 had an installed capacity of 135,000 kW plus a 10,000 kW "packaged" plant erected at Tennyson, units purchased and generated amounted to 548 million kWh, and there were 121,090 consumers connected. Since 30th June, 1955, 30,000 kW of plant at a new power station at Tennyson has been commissioned by the Council.

The Toowoomba Electric Light and Power Co. Ltd., which commenced operations in 1905, has now been absorbed by the Southern Electric Authority of Queensland.

The generation and distribution of electric power in Queensland had, until the last decade, tended to lag behind developments in this field in other States of Australia. The comparatively slow growth in the production and consumption of electricity can be attributed to some extent to the absence, prior to 1938, of a central statutory authority constituted to undertake the functions of co-ordinating, unifying and controlling the production and transmission of electric power. In addition, Queensland's vast area, coupled

with a low population density, made large-scale rural electrification, elsewhere than in the south-eastern portion of the State, which surrounds the major centres of industry and population, an uneconomic proposition.

Before establishment of the Regional Electricity Boards in 1945, no attempts had been made to unify or co-ordinate electricity supplies outside of South Eastern Queensland, and rural electrification, apart from reticulation within certain townships, was practically unknown.

2. **Royal Commission on Generation and Distribution of Electric Power in Queensland, 1936.**—On 5th December, 1935, the Queensland Government appointed a Royal Commission to inquire into and make recommendations on matters relating to the generation and distribution of electric power in Queensland. An account of the results of its investigations and of the alternative proposals put before it will be found on p. 1182 of Official Year Book No. 39.

3. **The State Electricity Commission of Queensland.**—In 1937, the State Government legislated to constitute a State Electricity Commission (legislation administering the generation and distribution of electricity in Queensland prior to the establishment of the Commission is referred to on p. 1181 of Year Book No. 39), which commenced to function during January, 1938, and to it was passed administration of the Electric Light and Power Acts 1896–1938. The Commission's main powers were to secure a proper and efficient supply of electric power, review tariffs, grant licences to supply electricity, secure the safety of the public, and control and advise electrical undertakings generally. It was thus a controlling authority as distinct from an operating authority. In addition, the Commission was empowered to co-ordinate the industry's development throughout Queensland. Between 1938 and 1956, the number of private companies was reduced by absorption and acquisition from 21 to two, while publicly owned undertakings, after amalgamation into Regional Authorities, and the development of 24 new schemes for small Western Queensland towns, totalled 53.

By agreement with the Commission in 1939, the City Electric Light Co. Ltd. became the co-ordinating authority for the provision of electricity in an area of some 10,062 square miles, extending from the New South Wales-Queensland border to Gympie, north of Brisbane. The Company acquired the undertakings at Boonah, Beaudesert, Gympie, Coolangatta, Ipswich, Nambour, Southport, Redcliffe and the Somerset Dam supply and transmission line to Brisbane. Certain restrictions were placed on the Company's dividend rate, namely limitation to the rate on Commonwealth bonds plus 2 per cent. During 1940, a similar agreement was made with the Toowoomba Electric Light and Power Co. Ltd. for the supply of electricity in the Toowoomba, Warwick, Killarney and Allora districts, subsequently being extended to cover a comprehensive area of 9,324 square miles, including Stanthorpe and other districts. Transmission line extensions since that year have made supply available to a number of adjacent districts on the Darling Downs. The City Electric Light Co. Ltd. was converted to a public authority as from 1st February, 1953 by the Southern Electric Authority of Queensland Act of 1952 (*see* para. 5, page 285).

Amending legislation, passed by the Queensland Parliament in March, 1948, changed the constitution of the State Electricity Commission from a body corporate to a corporation sole. On 1st July, 1948, a Commissioner for Electricity Supply was appointed in lieu of the previous Commission of four Commissioners. Since its inception in 1938, the Commission has made considerable progress in its task of developing the State's power resources and promoting a more widespread use of electric power. The degree of utilization of electrical energy in Queensland now compares favourably with other States in the Commonwealth.

4. **Regional Electricity Boards.**—With a view to facilitating the control and development of electricity supply in areas of low population density or those having a predominantly primary producing economy, the Government, in 1945, passed the Regional Electric Authorities Act. This legislation, as later amended, provides for the creation of regions of electricity supply and the constitution of Regional Electricity Boards. The Act provided for transfer to the Boards of local authority electricity undertakings in their regions, and for acquisition by the Boards of privately owned undertakings when purchasing rights fell due. Each Board comprises representatives of local authorities in the region and a representative of the Commission. Financial operations of the Boards are under the control of the Commission.

Soon after passage of the Regional Electric Authorities Act, four regions were defined and four Regional Boards constituted, namely, Wide Bay, Capricornia, Townsville and Cairns. A fifth Board, entitled South Burnett, became an operating authority in October,

1947, but on 1st July, 1951 was absorbed in the Wide Bay Regional Board and the organization is now known as the Wide Bay-Burnett Regional Electricity Board. As power was to be obtained from the Wide Bay Regional Board's station at Howard, the Commission decided that development of the two regions could be planned more effectively by a single authority.

As from 1st March, 1957, a further Regional Board became operative, covering the areas of Mackay, Sarina, Proserpine and adjacent rural areas under the name of Mackay Regional Electricity Board.

Supply throughout this Region will be provided from the central generating station at Mackay and accelerated electrical development of this area is being undertaken. The Townsville Regional Electricity Board's area was extended in July 1957 to include that of the Bowen electricity undertaking. The local authority areas of Thursday Island and Cook were included in the Cairns Regional Electricity Board's area from 1st July, 1956 and 1st July, 1957 respectively.

Activities of the original four Regional Boards in 1955–56 and 1956–57 compared with operations of the stations located in regions in 1945–46, and totals for Queensland as a whole are shown in the following table:—

QUEENSLAND : REGIONAL OPERATIONS.

Region.	1945–46.		1955–56.		1956–57.	
	Units Generated.	No. of Consumers.	Units Generated.	No. of Consumers.	Units Generated.	No. of Consumers.
	m.kWh		m.kWh		m.kWh	
Wide Bay-Burnett ..	13.7	11,467	60.8	25,034	71.8	26,624
Capricornia	19.5	11,196	89.5	19,038	107.6	19,718
Townsville	25.8	11,612	90.8	21,536	104.2	23,325
Cairns	22.7	9,722	80.7	17,067	89.9	18,620
Total	81.7	43,997	321.8	82,675	373.5	88,287
Queensland	**487.0**	**194,429**	**1,582.9**	**335,609**	(*a*)	*b* **349,000**

(*a*) Not available. (*b*) Estimated.

Generator capacity of the four existing Regional Boards installed at 30th June, 1957 was :—Wide Bay-Burnett, 37,500 kW ; Capricornia, 37,500 kW ; Townsville, 38,980 kW ; Cairns, 18,829 kW ; total, 132,809 kW.

5. **Creation of Southern Electric Authority of Queensland.**—A further major step in electrical progress, comparable with that taken when the agreements with the City Electric Light Co. Ltd. and Toowoomba Electric Light and Power Co. Ltd. were first entered into, was taken by the passing of the Southern Electric Authority of Queensland Act of 1952. This Act constituted the City Electric Light Co. Ltd. as a public authority to be known as the Southern Electric Authority of Queensland.

Two Government representatives are included on the Board of the new Authority, whose establishment prepares the way for the complete amalgamation, in due course, of the electrical undertakings serving the south-eastern Queensland area of supply.

An important advantage gained by the creation of this Authority is that on 30th June, 1968, acquisition of the Authority by the State Government can be effected without the necessity of a cash payment, as the Government will have the power to convert the Authority's existing stock to inscribed stock. Furthermore, the replacement of the City Electric Light Co. Ltd. by the Southern Electric Authority as a public body relieves electricity consumers in the Authority's area of supply from the burden of taxation which has hitherto been payable by the City Electric Light Co. Ltd., but will not need to be met by the new Authority. An agreement has been signed between the State Government and the Southern Electric Authority giving effect to the principles contained in the new legislation.

As from 1st July, 1954, the Southern Electric Authority acquired the Toowoomba Electric Light and Power Co. Ltd., thus bringing this company's area of supply under its control. The Southern Electric Authority is now responsible for the electrical supply and development of a consolidated area of 19,386 square miles.

6. **Hydro-electricity.**—Behind the coastal plain of the Cairns-Ingham area is an extensive plateau, the elevation ranging from 2,000 to 3,000 feet, although isolated peaks exceed 4,000 feet. The short coastal streams which rise on the plateau descend rapidly into deep gorges, which they have cut through the old divide. With heavy monsoonal rainfall on their catchments and concentrated fall, these streams represent a considerable potential source of power, but storage, which can in most cases be provided, is essential to control the very variable flow.

The Barron Falls scheme, 14 miles north-west of Cairns, came into operation in 1935. The installed plant operates under a head of 410 feet and comprises three 2,000 h.p. turbines each connected to a 1,320 kW generator. Average rainfall varies from 80–150 inches along the ranges to less than 35 inches in the western portion of the catchment. There is extreme variation from year to year, resulting in great fluctuation of stream flow which, at Kuranda, has varied from a maximum of 117,000 cusecs in 1911 to a minimum of 30 in 1915. Storage to regulate the flow is possible but has not yet been provided. During periods of low flow the supply of electricity is supplemented by fuel plants at Cairns, Atherton and Innisfail. Power is distributed over 22,000 volt transmission lines serving the tableland and extending southward along the coast to Tully.

A small hydro-electric scheme on the Mossman River, 5 miles from Mossman, North Queensland, comprises two 120 h.p. turbines operating under a head of 200 feet.

The development of a hydro-electric power scheme at Tully Falls has now reached an advanced stage, the initial plant installation of 36,000 kW being commissioned in September, 1957. Work is in hand on the installation of a further two 18,000 kW sets, making a total installation of 72,000 kW. Water controlled by Koombooloomba Dam at present under construction on the upper Tully River is diverted, a short distance above Tully Falls, through a tunnel and steel penstocks to an underground power station in the gorge at the foot of the falls operating with Pelton driven generators under a head of 1,485 feet. Power is transmitted to the load centres at Cairns and Innisfail by means of 132 kV transmission lines. Future automatic power plants upstream and downstream from Tully Falls will consist of two 7,500 kW sets under 405 feet head and one 5,400 kW set under 230 feet head. The combined peak load for the three plants will be 69,000 kW. Interconnexion of the Tully scheme with the Townsville area, previously supplied by a thermal station, was completed in 1957 by the provision of a 160 mile duplicate 132 kV transmission line. On present estimates, power from the Tully scheme will be sufficient to supply the interconnected area until 1965, when additional power will be required. A full investigation by the State Electricity Commission of the electricity supply industry in North Queensland is proceeding and the terms of reference include the survey of additional hydro-electric projects.

Other northern schemes which have been investigated include Freshwater Creek (3,900 kW); North Johnstone–Russell Rivers (32,000 kW); Beatrice–North Johnstone Rivers (9,000 kW); South Johnstone River (25,000 kW); extension of Barron Falls scheme (22,000 kW); Herbert River (90,000 kW). The total potential of the plateau region is therefore about 250,000 kW at 50 per cent. load factor.

In the vicinity of Townsville, the Commission, acting on behalf of the Burdekin River Authority, investigated the proposed hydro-electric development of the Burdekin. The Scheme envisaged a power plant immediately below the Burdekin Falls Dam which will operate under an average head of 225 feet. This scheme was linked with a plan to conserve the waters of the river for irrigation and flood mitigation, and surveys undertaken indicate that approximately 80,000 kW could be generated.

South of the Burdekin River, no appreciable hydro-electric development is practicable. A plant of 3,200 kW capacity has been installed to utilize the outflow from Somerset Dam on the Stanley River a few miles above its confluence with the Brisbane River.

7. **New Capacity.**—(i) *Regions.* To provide for development of the electric power resources in the regions, the State Electricity Commission formulated a ten-year programme divided into two five-year periods. In the first, it was planned to erect main transmission systems to connect existing power stations located within the regions and supplement generating capacity by the construction of new stations. Work on this section of the plan in the original Regional Board areas is now virtually complete. In the second, the transmission system will be extended to more sparsely settled areas, the ultimate purpose being the provision of "ring" transmission lines throughout each region and interconnexion between the regions.

A number of new generating stations have been commissioned as follows:—Wide Bay (Burnett Region), of which 15,000 kW was placed in service during September, 1951,

and 7,500 kW in 1954, while a further set of 15,000 kW was installed in 1957. Rockhampton (Capricornia Region) of which 22,500 kW was placed in service during September, 1952 and a further 15,000 kW in May, 1956, with a further 15,000 kW at present in process of installation; and Townsville (Townsville Region) of which 22,500 kW was commissioned in July, 1953, and a further 15,000 kW in January, 1956. Plans are in hand for the installation of a further 15,000 kW at Rockhampton and Townsville. Each of these stations will have an ultimate capacity of 52,500 kW and be steam-operated. In the Cairns Region, construction is well advanced on the Tully Falls hydro-electric scheme and two 18,000 kW turbo alternator sets were commissioned in September, 1957, with a further two 18,000 kW sets to follow shortly afterwards. The scheme is designed for an ultimate installed capacity of 92,400 kW. To augment existing capacity and to cover demands prior to the operation of Tully Falls, the Cairns Regional Board had installed twenty-one diesel units with a total capacity of 14,485 kW.

The Tully Falls scheme (*see* para 6, page 286) is planned to link with the Townsville Regional Electricity Board's system for the purpose of marginal supply, and construction of this inter-connexion was completed by the close of 1957. Investigations are being carried out into the development of a further hydro-electric scheme on the Barron River which, when constructed, would add about 30,000 kW to the available hydro-electric generation capacity in the area.

At Mackay, where supply was first given in 1924, a Regional Electricity Board has now been constructed and a 66 kV transmission line to Proserpine is under construction. The generating capacity of this Regional Board is 9,500 kW, and a further 2,750 kW unit is being installed. At Bowen, the Town Council, which established the service in 1952, has now transferred its area to the Townsville Regional Electricity Board, and transmitted supply will eventually be provided to this area. During 1935, a small (3,800 kW) power house—Australia's first underground hydro station—was placed in service at Barron Falls near Cairns. When the Cairns Regional Board was established during 1946, operation of the station passed to the Board's control and now comprises part of its generating plant, totalling 18,829 kW, supplying an area of approximately 91,000 square miles.

(ii) *Western Queensland.* In Western Queensland, where a number of small isolated generating stations supply power to some of the larger towns, the Commission has evolved a plan to increase and modernize existing capacity. It involves installation of small internal combustion units ranging in size from 100 kW to 600 kW according to the load likely to be experienced, and conversion from direct to alternating current supply. The Government is assisting the scheme by subsidy—a feature of electrical development in Queensland. In general, the assistance provided comprises subsidies of up to one-third of capital cost on annual loan charges, with special subsidies of up to 50 per cent. for authorities in isolated areas.

In addition to improving supplies to the larger western towns, a scheme has been devised for electricity supplies for smaller towns in the western districts, where consumers range from 50 to 200. Subsidies of 65 and 60 per cent. will apply in those cases where the number of consumers supplied is less than 100 and 200, respectively. This plan is now being implemented and at 30th June, 1957, 27 townships in the west of Queensland had been provided with the amenities of electricity. In addition, investigations of the possibility of supply have been carried out at a number of other small centres. The power is being supplied by small oil driven generating sets with automatic controls which can be run with a minimum of operating attendance.

Coal-burning gas producers have been successfully commissioned for public electricity supply purposes in the West. They have been installed at Longreach, Clermont, Dalby, Blackall and Barcaldine and further extensions of their use in Western Queensland is predicted, as lower tariffs and more efficient production of electricity should follow their use.

(iii) *South-eastern Queensland.* To increase the availability of electric power in the south-eastern area of the State, the two major generating authorities, in conjunction with the Commission, have power station projects under construction which are designed to place in service, by 1958, new generating units totalling 400,000 kW. The Southern Electricity Authority is developing a station known as Bulimba "B" on a site adjacent to Bulimba "A". 90,000 kW had been installed to 30th June, 1957, with a further 30,000 kW to be commissioned during 1957–58 and the ultimate capacity may reach 180,000 kW. At Tennyson in the Brisbane area, the Brisbane City Council has constructed a new power station with an initial capacity of 60,000 kW which may be ultimately increased to 180,000 kW. At 30th June,

1957, generating plant of 60,000 kW was in service at this new station. To supplement capacity pending operation of these projects, " packaged " generating units totalling 20,000 kW were obtained from overseas and commissioned early in 1953, one 10,000 kW set having been installed at Tennyson and another 10,000 kW set at Abermain near Ipswich.

The power stations of the two major generating authorities at New Farm and Bulimba are interconnected at 33,000 volts.

§ 4. South Australia.

1. **General.**—An account referring to the companies generating electric power in South Australia prior to the establishment of the Adelaide Electric Supply Co. Ltd., and describing the development of that company's activities, was given in Official Year Book No. 39. Also included in the account was some reference to the early measures of public control over electricity supply in South Australia and the extent to which they were applied, and also to the inquiries into the activities of the Adelaide Electric Supply Co. Ltd. in 1932 and 1935.

Following upon an inquiry instituted by the Government in 1943, relative to measures for increasing electricity supply to the metropolitan area and country districts, the Electricity Act 1943 was passed which, *inter alia*, established the South Australian Electricity Commission. However, until the State assumed full responsibility for the supply of electric power, this body was not able to do much more than exercise the formal functions conferred on it by the Act.

2. **The Electricity Trust of South Australia.**—Early in 1946, a Bill was passed transferring the assets of the Adelaide Electric Supply Co. Ltd. to the newly formed public authority, the Electricity Trust of South Australia, which became responsible for unification and co-ordination of the major portion of the State's electricity supplies. This legislation provided that the Trust should take over the powers vested in the South Australian Electricity Commission under the 1943 Act, which, after establishment of the Trust, would cease to exist. In addition to the powers specified in the Adelaide Electric Supply Company's Acts 1897–1931, the Trust may, *inter alia*, supply electricity direct to consumers within a district or municipality with the approval of the local authority, and by agreement with other persons who generate or supply electricity, arrange to inter-connect the mains of the Trust with those of other persons, and give or receive supplies of electricity in bulk.

3. **Capacity and Production.**—There are three main categories of organizations generating electric power in South Australia, namely :—(*a*) Governmental, which include the Electricity Trust ; (*b*) Local Authorities, e.g., municipal and district councils, and Renmark Irrigation Trust ; and (*c*) Other, including individuals and firms primarily engaged in generating power for sale, firms generating power primarily for their own use but supplying outside consumers, and firms generating power for their own use.

In 1955–56, total installed capacity in South Australia was 320,869 kW, a decrease of 9,409 kW on the year before. The units generated totalled 1,204 million kWh compared with 1,199 million kWh in the previous year.

Of the total installed capacity, the Electricity Trust of South Australia operated plant with a capacity of 269,660 kW. It is thus the most important authority supplying electricity in the State. There were approximately 241,300 ultimate consumers of electricity, of whom 216,424 were supplied by the Trust. Its major steam stations were Osborne " A " (79,000 kW), Osborne " B " (120,000 kW) and Port Augusta " A " (60,000 kW) while the balance of the capacity controlled consists of house sets and regional stations at Port Lincoln and Mount Gambier.

No hydro-electric potential exists in South Australia. Steam generating units comprise 95 per cent. of installed capacity and the balance, 5 per cent., is internal combustion equipment. Until recently, all fuel consumed in the thermal stations was obtained from sources outside the State, and at times power restrictions were necessary owing to the inadequacy of supplies.

4. **Leigh Creek and other New Capacity.**—With a view to reducing the dependence on external sources of fuel, steps have been taken to produce local coal and to install plant to use it. Fairly extensive deposits of low-grade sub-bituminous coal are obtainable at Leigh Creek, about 360 miles north of Adelaide. Under the Electricity Trust of South Australia Act Amendment Act 1946, the Trust was given authority to develop Leigh Creek coal for use in its own undertakings and also for sale to other consumers. Production from the Leigh Creek field commenced in 1944 and in the year ended 30th June, 1956, 436,577 tons of coal were sold. Of this amount, the Electricity Undertaking used 375,126 tons.

In order to cope with the rapidly increasing demand for power, the Electricity Trust is installing two additional 30,000 kW units at Osborne " B " Power Station. These will complete the " B " station which will then have a total capacity of 180,000 kW. Another major work under construction is the power station at Port Augusta with an ultimate capacity of 90,000 kW. This power station, which was commissioned in June, 1954, is located at Port Augusta because of its proximity to the Leigh Creek coalfield and will use Leigh Creek coal exclusively. A new standard guage railway line connecting Leigh Creek with Port Augusta was constructed by the Commonwealth Railways Department. The power station is inter-connected with the Metropolitan Area by two transmission lines which will also supply power at intermediate points. The Trust is to construct a second power station at Port Augusta to be known as Port Augusta " B ". This station will have a capacity of 180,000 kW making the combined capacity at Port Augusta 270,000 kW. In addition, the Trust is building steam power stations at Port Lincoln and Mt. Gambier to replace existing diesel stations. The station at Port Lincoln will have a capacity of 5,000 kW and will burn fuel oil while the station at Mt. Gambier will have a capacity of 16,800 kW and will burn either wood waste or fuel oil.

5. **The Municipal Tramways Trust.**—On 30th June, 1956, the Municipal Tramways Trust power station ceased operations and all power required for traction purposes is now supplied from the Electricity Trust system through converter stations and a 5,500 kW frequency changer. The installed capacity of the power station has been reduced from 19,100 kW to 9,000 kW and will only be used in case of emergency.

§ 5. Western Australia.

1. **General.**—Electrical undertakings in Perth and Fremantle formerly owned by the Perth City Council, the Western Australian Government Electricity Supply, the Fremantle Municipal Tramways and Electric Lighting Board and other metropolitan municipal and road board supply authorities have now been taken over by the State Electricity Commission of Western Australia. For information on the early history of electricity supply in the metropolitan area, *see* Official Year Book No. 39, p. 1189.

2. **Metropolitan Undertaking.**—Statistics relating to activities of the Metropolitan undertaking are shown in the following comparative table.

WESTERN AUSTRALIA : METROPOLITAN UNDERTAKING.
(*Including Bunbury Power Station*).

Particulars.		1938–39.	1955–56.	1956–57.
Plant capacity	kW	57,000	179,000	*a* 49,000 *b* 160,000
Maximum load	kW	33,000	127,000	119,000
Units generated	Million kWh	137	517	533
Coal used per unit generated	lb.	2.77	1.56	1.57
Coal used	tons	168,722	361,164	355,360

(*a*) 40 cycles. (*b*) 50 cycles.

As a result of a separate inquiry conducted at the same time as the early investigations into the proposed new station at South Fremantle, a recommendation was made favouring conversion of the East Perth 40 cycle system to the British and Australian Standard Frequency of 50 cycles per second. The recommendation was adopted and implemented by making the frequency of generation at South Fremantle 50 cycles and installing at East Perth a frequency changer able to convert 25,000 kW of energy from one frequency to the other. Change-over of consumers' plant is nearing completion and only the city area and some inner suburban districts remain on 40 cycles.

3. **Kalgoorlie.**—In Kalgoorlie, the Municipal Council supplies approximately 3,800 consumers with either direct or alternating current. A diesel station of 1,825 kW generating capacity provides direct current to the limit of its capacity. Alternating current is purchased from Kalgoorlie Power Corporation and retailed by the Council to some consumers, while portion is passed through a rectifier to convert it to direct current. Primarily established to supply power to the gold mines, the Kalgoorlie Electric Power and Lighting Corporation operates a steam station of 11,000 kW and maintains a 22kV line of 21 miles to the Celebration mine. Alternating current is also supplied to about 1,400 consumers. The Corporation's undertaking generates approximately 35 million kWh per annum and boilers are fired by Collie coal.

4. **General Pattern of Electricity Supply.**—The pattern of the generation and distribution of electric power in Western Australia consisted until recently of a number of isolated systems each supplying a particular area. Except in the metropolitan area and in the area embraced by the South-West Power Scheme (*See* para 6, below), where in both cases electricity supply is in the hands of the State Electricity Commission of Western Australia, local authorities are generally responsible for the supply of electricity for domestic and industrial purposes. In the area between the Great Southern Railway from Northam to Albany and the west coast, however, the State Electricity Commission has now constructed transmission lines to give central station supply to the towns and their surrounding rural areas. In addition, there are several mining companies which generate electricity for use in their mines. In order to cater for the expected growth in demand, capacity of the State's major generating stations is being increased.

The system in the Metropolitan area has been inter-connected with the Bunbury area by means of a 132,000 volt transmission line.

The main load centre of the State is, of course, the Perth-Fremantle area into which is concentrated the major portion of the State's population and industry. The inter-connexion between the Metropolitan and Country systems is, however, expected to lead to a gradual decentralization of load.

5. **The State Electricity Commission of Western Australia.**—(i) *Origin and Aims.* In order to ensure an organized and co-ordinated future growth of electricity generation and distribution throughout the State, the Government introduced a Bill in 1945 to establish the State Electricity Commission, which, together with an Electricity Bill, became law early in 1946. Under these Acts, the Commission was given power, *inter alia*, to secure the ultimate co-ordination of all State or other electrical undertakings in the State, to construct and operate power stations and transmission lines and purchase as a going concern and carry on the undertaking of any supply authority. Under the Electricity Act, which should be read in conjunction with, and is subject to, the State Electricity Commission Act, no person or organization is permitted to construct or extend an electricity supply undertaking without consent from the Commission. Local authorities are empowered to operate and construct power stations and other works associated with the supply of electricity, provided that authority is first obtained from the Commission and any proposals are not inconsistent with the Commission's plans.

(ii) *New Projects.* Since its inception in 1946, the Commission has proceeded with the task of increasing generating capacity in an endeavour to cater for a greatly increased demand for power. Long-range plans were formulated to inter-connect the south-western portion of the State with the Perth-Fremantle system. One of its most important and immediate problems was to increase the capacity of the generating equipment serving Perth and Fremantle. During the 1939–45 War years, it became evident that the growth of demand for electric power would necessitate provision of additional generating equipment in the metropolitan area as soon as possible. Accordingly, the Government Electricity Supply authority commenced design work for a new station of 50,000 kW capacity. Contracts were let in 1945 and construction commenced on a site selected at South Fremantle, on the coast south of Fremantle proper. Responsibility for completion of this project was given to the Commission under the Act of 1946. As it was considered that an even larger station would be required, provision was made for the installation of two additional units giving an ultimate capacity of 100,000 kW. Steam is furnished by eight boilers designed to use pulverized coal from Collie, which is located about 120 miles from the station. At the end of 1954, four units had been placed in service and the output was being fed into the metropolitan system.

At the East Perth power station, a new 30,000 kW unit has been commissioned and an additional boiler installed. A 25,000 kW unit, commissioned in 1938 (generating 40 cycles) is also available at this station. Older plant with a total capacity of 24,000 kW is also installed, but the usefulness of this plant for standby purposes will be reduced as the 40 cycles load in the metropolitan area is converted to 50 cycles.

6. **South-west Development.**—At the request of the Government, the Electricity Advisory Committee in 1945 submitted a report recommending, amongst other things, that a National Power Scheme for the south-west be proceeded with. The plan provided for acquisition of the existing Collie power station and installation of additional generating capacity, construction of a power station at Bunbury and inter-connexion of the south-west scheme with the metropolitan system. On 12th October, 1946, the State Electricity Commission acquired the Collie power station, which prior to 1946 was owned and operated by the Collie Power Company Limited. At the date of acquisition, the station's installed capacity was 5,000 kW, comprising two steam units. The capacity of the station was increased to 12,500 kW in 1952.

Since 1950, the Commission has acquired a number of electrical undertakings from municipal bodies and private organizations in the south-west area and is proceeding with arrangements for the purchase of others. In August, 1951, the first portion of the South-

West Power Scheme was officially opened at Collie and many of the south-west towns have now been connected by transmission line to the Collie Power Station. When completed, a system of power lines will reticulate electricity over an area of approximately 1,800 square miles. The first 30,000 kW unit and associated boilers at Bunbury Power Station have been placed in service. Work is proceeding as programmed on two similar units and tenders have been called for a fourth unit to give the Station an ultimate capacity of 120,000 kW. The first section was officially declared open on 23rd August, 1957.

Diesel stations of 4,400 kW capacity at Albany serve the towns of Albany, Denmark, and Mount Barker in the extreme south of the State.

§ 6. Tasmania.

1. **General.**—A considerable part of the water catchment in Tasmania is at high level, with a substantial natural storage available, and this has made it possible to produce energy at lower cost than elsewhere in Australia, or in most other countries. Other contributing factors to the low costs are that rainfall is distributed fairly evenly throughout the year, with comparatively small yearly variations. The cheap power has led to the establishment in Tasmania of several large electro-chemical works with high load factor, and as a consequence the system load factor is also very high and at present is 61 per cent.

For information on hydro-electric development in Tasmania prior to the establishment of the Hydro-Electric Commission in 1930, *see* Official Year Book No. 39, pp. 1192–3.

2. **The Hydro-Electric Commission.**—(i) *Present System.* In 1929, the Government passed the Hydro-Electric Commission Act, under which was established the Hydro-Electric Commission and which vests in the Commission, with some minor exceptions, the right to use the waters of the State of Tasmania and authorizes it to develop and reticulate electric power for all purposes. In 1930, this corporate body took over the State hydro-electric undertaking and the business of the Hydro-Electric Department.

The first project undertaken by the Commission was the Shannon Power Development which utilizes 258 feet of the difference in level between the Great Lake (Miena Dam) and Waddamana forebay. A small earthen dam diverts the outflow from the Great Lake through 2½ miles of canal and then by two pipelines to the Shannon Power Station, where 10,500 kW was added to the system in 1934. After passing through Shannon Power Station the water discharges into the Waddamana canals to be used again at the Waddamana Power Stations.

In 1933, it was decided to proceed with the Tarraleah Power Development. In this scheme, the waters of the River Derwent are picked up near Butler's Gorge by a canal and conveyed 14 miles to the pipeline forebay 982 feet above the power station on the Nive River where three 15,000 kW generators were placed in service in 1938. Shortly afterwards two more 15,000 kW units were added and a sixth machine installed in 1951 brought the total installed capacity at Tarraleah Power Station to 90,000 kW. Storage is provided at Lake St. Clair and at Lake King William, an artificial lake created by the 200-ft. high Clark Dam across the Derwent at Butler's Gorge. In the Butler's Gorge Power Station at the foot of the dam, a single 12,200 kW generator was installed in 1951. To increase the security of the system and to permit variable seasonal loading of Tarraleah station, a second canal from Clark Dam to Tarraleah was completed in 1955.

Early in 1939, it was decided to make full use of the Great Lake storage by increasing the peak capacity at Waddamana. War conditions impeded progress, but by the end of the war two 12,000 kW generators had been installed in a new power station, Waddamana "B", adjacent to the original station Waddamana "A". A third unit installed in 1946 and a fourth in 1949 brought the total to 48,000 kW. To enable a full peak capacity to be maintained at both Waddamana stations a duplicate of the original Waddamana canal was constructed during 1947–48.

Between 1930 and 1948, the generating capacity of the system was increased by 121,500 kW but the demand for power continued to increase rapidly and it was obvious that a greatly accelerated construction programme would have to be undertaken. Construction of the Tungatinah Power Development was started in 1948 and the Trevallyn Power Development in 1949.

The Tungatinah scheme draws water from three separate catchment areas located on the Central Plateau between the Great Lake (Shannon–Waddamana) and Lake St. Clair (Butler's Gorge-Tarraleah) catchments and control of practically the whole run-off from the Central Plateau has now been effected.

The principal catchment utilized by the Tungatinah scheme is drained by the Nive River. A 120-ft. high dam at Pine Tier diverts the waters of the Nive through 6½ miles of canal system to the first of a chain of four artificial lakes, created by dams constructed across the outlets from natural marshes and linked by large open cuts. From the southernmost lake, a tunnel and then five steel pipelines lead to the five 25,000 kW generators in

Tungatinah Power Station, 1,005 feet below on the Nive River just upstream from Tarraleah station on the opposite bank of the river. Power was first generated at Tungatinah in mid-1953 with a capacity of 125,000 kW. Water from the smaller Clarence River catchment is brought into one of the lakes in the Tungatinah system by means of a woodstave pipeline 5½ miles in length and the third catchment area utilized is the Lake Echo-Dee River catchment. Regulation of this catchment has been achieved by construction of a dam at Lake Echo to provide the main storage reservoir for the Tungatinah scheme, construction of the Lake Echo Power Station (one 32,400 kW generator) to utilize 568 feet of the difference in level between Lake Echo and Dee Lagoon, and the diversion of water from Dee Lagoon through 2 miles of tunnel to the main Tungatinah system.

The Trevallyn Power Development, the first constructed by the Commission outside the Central Plateau region, was undertaken primarily to meet the requirements of the aluminium industry. The waters of the South Esk River are diverted through 2 miles of tunnel and pipeline to a power station on the Tamar River near Launceston. Three 20,000 kW generators were installed in mid-1955 and a fourth unit has since brought the total capacity of Trevallyn Power Station to 80,000 kW.

(ii) *New Capacity.* The Hydro-Electric Commission is still engaged in the most progressive construction programme in its history. Since 1948, the generating capacity of the system has been increased by 274,600 kW to a total of 447,100 kW and present construction is planned to bring this total to 575,800 kW by 1960. There will still remain very considerable resources for future development as it is considered that at least 2,400,000 kW can be economically developed.

The Wayatinah Power Development, now under construction, will comprise two power stations and headworks to utilize water which is in the main already regulated and which has been used several times. The volume of water available is much larger and the head smaller than in the case of other major stations. All the water which has passed through Tarraleah or Tungatinah stations will be diverted, by a weir across the Nive River below Tarraleah, through 4 miles of tunnel and then steel pipes to Wayatinah "A" Power Station lower down on the Nive River where 83,700 kW will be installed by 1960.

A dam across the River Derwent, just below its junction with the Nive, will create a small lake into which will flow all the water from Wayatinah "A" plus water collected by the Derwent below Clark Dam. One mile of tunnel and one mile of pipeline will lead the water to Wayatinah "B" Power Station on the Derwent three-quarters of a mile below its junction with the Florentine River. The lower station, Wayatinah "B", was constructed first and completed in 1957. Installed capacity is 32,250 kW.

There is every indication that the demand for power in Tasmania will continue to increase. The Commission is conducting extensive surveys and investigation of other schemes with a view to further construction after the completion of the present programme.

3. **Power Usage by Secondary Industry.**—The abundant and comparatively cheap supplies of electricity and other natural resources attracted to Tasmania a number of important secondary industries for which energy costs constitute a significant proportion of the total cost of production. Some of the more important organizations and their continuous power demands when plant is operating are as follows :—Electrolytic Zinc Company of Australasia Ltd., 73,000 kW ; Australian Aluminium Production Commission, 30,000 kW ; Australian Newsprint Mills Ltd., 19,000 kW ; Associated Pulp and Paper Mills Ltd., 14,500 kW ; Australian Commonwealth Carbide Company Ltd., 7,800 kW ; and Goliath Portland Cement Company Ltd., 1,800 kW.

§ 7. Commonwealth Territories.

1. **Internal Territories.**—(i) *General.* The electricity supply undertakings at Canberra in the Australian Capital Territory and at Darwin, Katherine, Tennant Creek and Alice Springs in the Northern Territory are operated by the Commonwealth Government.

(ii) *Australian Capital Territory.* Supply was first established at Canberra during 1915. The Department of the Interior owns steam stand-by plant of 2,100 kW capacity which is operated in conjunction with the New South Wales Electricity Commission's generating equipment. The major portion of the territory's power requirements are supplied in bulk from the New South Wales inter-connected system. Total population served with electricity at 30th June, 1957 was 38,000 and the total number of ultimate consumers was 11,354. Rapidly increasing domestic, government, and commercial load will absorb appreciable amounts of power from the Snowy Scheme.

(iii) *Northern Territory.* At Darwin, supply was established by the Town Council in October, 1934, but later, during April, 1937, responsibility for generation and supply was placed in the hands of the Northern Territory Administration. The power station

is equipped with diesel generating plant of 5,390 kW capacity. Two new 970 kW diesel sets were installed in 1955–56 and an additional 1,380 kW diesel set was installed during 1957, making a total capacity of 6,770 kW. At Alice Springs, the Power Station is equipped with diesel generating plant of 1,462 kW capacity, two 230 kW diesel sets being installed in 1956–57. An additional 520 kW diesel set will be installed during 1957–58, making a total capacity of 1,982 kW.

At Katherine, the power station is equipped with small diesel generating plant of 450 kW capacity and the diesel station at Tennant Creek was closed down in 1957, supply for the township being purchased in bulk from Peko Mines No Liability.

The total number of ultimate consumers served was 3,317 in 1956–57.

In 1956–57, the Department of Works selected a site on the water front of Darwin for a 15 megawatt steam driven generating set. This steam station is being designed to supply Darwin and suburbs when the present diesel station has reached its maximum economical capacity. No construction work has yet been undertaken on the project.

2. External Territories—Papua and New Guinea.—Responsibility for the operation and establishment of electrical undertakings in Papua and New Guinea is vested in the Administration of the Territory of Papua and New Guinea, whose headquarters are located at Port Moresby. The total generating capacity of the diesel engine driven generating sets amounts to 6,805 kW and of the hydro operated sets 3,132 kW. The generating capacity of the power plants at the main centres is—Port Moresby, diesel 2,504 kW, hydro, 3,000 kW; Rabaul, 1,320 kW; Lae, 660 kW; Madang, 410 kW; Samarai, 356 kW; Kavieng, 197 kW; Wewak, 70 kW; Lorengau, 50 kW; Goroka, hydro, 100 kW; Aiyura, hydro, 30 kW; and 309 kW distributed among outstations where generating capacity is between 5 kW and 60 kW. The new hydro-electric scheme at Rouna Falls, 22 miles from Port Moresby, is now completed and in full operation. The townships of Wau and Bulolo are still supplied by the Bulolo Gold Dredging Co., which operates a hydro-electric plant of 5,500 kW. This power is produced mainly to supply alluvial dredges and, in addition, now supplies power to the plywood mill at Bulolo.

The number of ultimate consumers served was 3,584 in 1955–56 and 4,258 in 1956–57.

Vast hydro-electric potential exists in New Guinea and it has been estimated at 15,000,000 kW, but because of the island's location, absence of large load centres and lack of industrialization, only a small proportion could, at present, be economically developed.

In 1950, it was announced that the Commonwealth Government had joined with British Aluminium Co. Ltd. of London to locate and develop large capacity hydro-electric schemes in New Guinea. A new company was formed, known as New Guinea Resources Prospecting Co. Ltd., with a capital of £100,000. The Commonwealth holds 51 per cent. of the shares and has a controlling interest on a board of five members. The agreement for the formation and operation of the Company is administered by the Commonwealth Department of Supply, except in matters requiring compliance with the law of New Guinea, when responsibility for administration rests with the Department of Territories. Surveys and comprehensive investigations are in progress.

The following hydro-electric schemes are now in operation:—Port Moresby—at Rouna on the Laloki River, generating sets have been established with an initial capacity of 3,000 kW, with provision for expansion to 5,000 kW as stage 2, and to 9,000 kW as stage 3. The power station came into operation in January 1957. The present project utilizes only portion of the power available from the Laloki River and the economic ultimate development will be of the order of 40,000 kW. At Aiyura, a 30 kW hydro-electric station, for the Agricultural Experimental Station, was brought into operation in August, 1956.

At Goroka, one 100 kW hydroset is now in operation and a second 100 kW set is on order with provision for a further 200 kW.

Stream gauging and other preliminary investigations for hydro-electric schemes have been carried out at Lae, Rabaul, Madang, Wewak and Highlands Stations.

There are possibilities for major hydro-electric development in the following localities :—Rouna Falls (near Port Moresby), Upper Snake and Busu-Erap-Leron (near Lae), Upper Ramu (near Markham-Ramu divide—80 miles from Lae) and Hathor Gorge (on Purari River) with an estimated average power of 100,000 kW, 150,000 kW, 2 million kW, 250,000 kW, and 3 million kW respectively. These have estimated run-offs of 1,400 ; 6,000 ; 12,000 ; 1,000 ; and 75,000 cusecs respectively.

In an area of 150,000 square miles of the Eastern New Guinea mainland, the power potential has been estimated at 150 kW per square mile which compares favourably with potentials of 170 kW per square mile for Switzerland and 95 kW per square mile for Norway.

D. STATISTICAL SUMMARY, 1950-51 AND 1955-56.

The following table shows statistics for each State separately and for the six States combined for 1950–51 and 1955–56 and relates to :—(i) the numbers and installed capacity of central electric generating stations, (ii) the values of production and output and the

average numbers of persons employed in the generating side of the electricity supply industry and (iii) the amount of electricity generated in both years and the number of ultimate consumers of electricity in 1955–56.

For further statistics of the electricity supply industry (years 1938–39 and 1951–52 to 1955–56), *see* Chapter VII.—Manufacturing Industry.

CENTRAL ELECTRIC STATIONS.

Particulars.	N.S.W.	Vic.	Q'land.	S. Aust.	W. Aust.	Tas.	Total.
1950–51.							
Generating Stations—							
Government .. No.	10	11	..	2	21	2	46
Local Authority „	41	33	36	14	37	..	161
Companies ... „	39	25	9	18	55	1	147
Total	90	69	45	34	113	3	354
Installed Capacity of Generators—							
Steam .. '000 kW	945	568	208	(a)	103	(a)	2,020
Hydro .. „	33	53	4	(a)	..	(a)	284
Internal combustion „	64	22	34	(a)	43	(a)	174
Total	1,042	643	246	(a)	146	(a)	2,478
Persons employed(b) No.	4,076	2,453	1,023	(a)	1,023	(a)	9,815
Value of output(c) £'000	18,949	8,301	4,448	(a)	2,827	(a)	38,761
Value of production(d) „	7,763	3,141	1,207	(a)	858	(a)	14,790
Electricity generated(e) Million kWh	4,251	2,876	1,115	713	470	1,078	10,503
1955–56.							
Generating Stations—							
Government .. No.	22	17	1	7	11	6	64
Local Authority „	32	20	52	16	37	..	157
Companies .. „	24	20	4	19	42	2	111
Total	78	57	57	42	90	8	332
Installed capacity of Generators—							
Steam .. '000 kW	1,463	831	442	(a)	210	(a)	3,251
Hydro .. „	98	117	7	(a)	..	(a)	648
Internal combustion „	100	41	34	(a)	51	(a)	241
Total	1,661	989	483	(a)	261	(a)	4,140
Persons employed(b) No.	5,348	3,007	1,513	(a)	949	(a)	12,111
Value of output(c) £'000	37,877	21,475	9,803	(a)	6,334	(a)	84,788
Value of production(d) „	20,707	11,397	2,982	(a)	2,664	(a)	43,219
Electricity generated (e) Million kWh	6,505	4,628	1,786	1,204	753	1,794	16,670
Ultimate consumers(f) No.	999,165	751,461	335,609	241,300	133,920	105,292	2,566,747

(a) Not available for publication ; included in the total for Australia. (b) Average employment, in generating station, over whole year including working proprietors. (c) Value, at generating station, of electricity produced plus certain earnings. (d) Value added to materials and fuel in the process of generation. (e) Total generated including that generated by factories for their own use. (f) Approximate figures supplied by the electricity authority in each State. An "ultimate consumer" is a person, business, undertaking, etc., that has contracted to receive electric power from a public or private organization supplying this service. The number of ultimate consumers is not synonymous with the number of persons served with electricity because one ultimate consumer may embrace three or four persons, e.g., in a household.

CHAPTER IX.

WATER CONSERVATION AND IRRIGATION.

A. RESOURCES, UTILIZATION AND NATIONAL AND INTERSTATE ASPECTS.

§ 1. Introduction.

Official Year Book No. 37, pp. 1096–1141, contained a special article "The Conservation and Use of Water in Australia" prepared by Mr. Ulrich Ellis of Canberra. In subsequent issues, much of Mr. Ellis's article of a statistical nature has been advanced, as has the general information on the more important developments in this field, but for details of general, descriptive and historical matter reference should be made to the original article. Appended to the special article (pp. 1140–41) was a bibliography of selected books, reports, papers, etc., dealing with the development of the water resources of Australia and their conservation.

For further details on geographical and climatic features determining the Australian water pattern, reference should be made to Chapter II.—Physiography ; on water supply and sewerage in metropolitan areas, cities and towns to Chapter XIX.—Local Government ; and on the generation of hydro-electric power to Chapter VIII.—Electric Power Generation and Distribution, of this issue.

A series of maps showing the location of major dams and reservoirs and the various irrigation schemes operating in each of the States was published on pp. 1073–9 of Official Year Book No. 40.

A map showing the extent of known artesian basins throughout Australia is shown on page 307 of this Year Book.

§ 2. Water Resources and their Utilization.

1. **Surface Supplies.**—Though river gaugings have been recorded over considerable periods in some parts of Australia, records elsewhere are intermittent, of short duration, or non-existent. At present, therefore, it is impossible to estimate, with any degree of reliability, the total average annual flow of Australian streams, but it would probably amount to only a small figure in comparison with the flow of rivers in other continents, some examples of which, expressed as mean annual discharges in millions of acre feet, are : Nile, 72 ; Danube, 228 ; Amazon, 1,780 ; Volga, 148 ; Mississippi, 474 ; and the ten main rivers of the United States of America, 900 (in the aggregate).

2. **Major Dams and Reservoirs.**—The table below lists existing major dams and reservoirs together with those under construction or projected as at June, 1957.

MAJOR DAMS AND RESERVOIRS IN AUSTRALIA.

Name.	Location.	Capacity (Acre feet).	Height of Wall (Feet).	Remarks.
EXISTING DAMS AND RESERVOIRS.				
Eildon	Upper Goulburn River, Victoria	2,750,000	250	Earthen embankment 3,300 feet long. Storage for irrigation and for the generation of electricity.
Hume	Murray River near Albury	1,452,000	140	Part of Murray River Scheme—storage for domestic, stock and irrigation purposes. Being increased to 2,500,000 acre feet. Hydro-electric power being developed.
Miena	Great Lake, Tasmania	(a)948,500	40	Regulates water to Waddamana hydro-electric power station.
Burrinjuck ..	Murrumbidgee River, New South Wales	837,000	264	Storage for irrigation and production of hydro-electric power.
Somerset	Stanley River, Queensland	735,000	173	Brisbane-Ipswich water supply, flood mitigation and small hydro-electric power station.
Lake Victoria ..	Murray River near South Australian border, in New South Wales	551,700	..	Natural storage for irrigation in South Australia.
Lake St. Clair ..	Central Highlands, Tasmania	(a)412,200	..	Improved natural storage for Tarraleah hydro-electric power station

MAJOR DAMS AND RESERVOIRS IN AUSTRALIA—*continued.*

Name.	Location.	Capacity (Acre feet).	Height of Wall (Feet).	Remarks.
EXISTING DAMS AND RESERVOIRS—*continued.*				
Lake Echo ..	Lake Echo, Tasmania	(*a*)412,200	60	Storage for Lake Echo and Tungatinah hydro-electric power stations.
Waranga	Goulburn River, Victoria	333,400	..	Earthen embankment, 23,800 feet long. Irrigation storage.
Wyangala ..	Lachlan River, New South Wales	303,900	190	Storage for domestic, stock and irrigation purposes and for generation of hydro-electric power.
Rocklands ..	Glenelg River, Victoria	272,000	..	Part of Wimmera-Mallee domestic and stock water supply system.
Clark	Derwent River, Tasmania	(*a*)253,400	200	Serves Tarraleah hydro-electric power station.
Avon	Avon River, New South Wales	173,800	232	Part of Sydney water supply.
Lake Brewster ..	Lachlan River, near Hillston, New South Wales	123,900	..	Storage of rural water supplies for the lower Lachlan.
Cairn Curran ..	Loddon River, Victoria	120,600	..	Storage for irrigation.
Glenmaggie ..	Gippsland, Victoria	106,000	100	Storage for irrigation. Being increased to 154,300 acre feet.
DAMS AND RESERVOIRS UNDER CONSTRUCTION OR PROJECTED.				
Burdekin Falls ..	Burdekin River, North Queensland	6,584,000	150	Projected for generation of hydro-electric power, irrigation and flood mitigation.
Adaminaby ..	Eucumbene River, New South Wales	3,500,000	390	Under construction as part of Snowy Mountains Hydro-electric Scheme. Storage of water commenced June, 1957.
Menindee Lakes Project	Darling River near Menindee, New South Wales	2,000,000	..	Part of Darling River water conservation scheme—under construction.
Warragamba ..	Warragamba River, New South Wales	1,694,900	373	Under construction for Sydney water supply. Also provides for generation of hydro-electricity and flood mitigation.
Jindabyne ..	Snowy River, New South Wales	1,100,000	274	Projected as part of Snowy Mountains Hydro-electric Scheme.
Burrendong ..	Macquarie River, near Wellington, New South Wales	914,000	193	Under construction for rural water supplies.
Blowering ..	Tumut River, New South Wales	800,000	300	Projected as part of Snowy diversion scheme.
Warkworth ..	Wollombi Brook (Hunter Valley), New South Wales	400,000	100	Projected as a flood mitigation dam for the Hunter Valley.
Keepit	Namoi River, near Gunnedah, New South Wales	345,000	176	Under construction for rural water supplies.
Arthurs Lakes ..	Source of Lake River near Great Lake, Tasmania	(*a*) 339,000	50	Projected as part of Great Lake hydro-electric power development
Tinaroo Falls ..	Barron River, North Queensland	320,000	133	Under construction for irrigation purposes in the Mareeba-Dimbulah area.
Glenbawn ..	Hunter River, near Scone, New South Wales	293,000	251	Under construction as part of Hunter Valley conservation work.
Tantangara ..	Murrumbidgee River, New South Wales	200,000	150	Projected as part of Snowy Mountains Hydro-electric Scheme.
Wellington ..	Collie River, Western Australia	150,000	110	Existing dam to be enlarged for supply of water to irrigation districts and to agricultural areas and towns.
Koombooloomba ..	Tully River, North Queensland	146,000	123	Under construction for hydro-electric and possibly irrigation purposes.
Upper Yarra ..	Yarra River, Victoria	110,000	270	Under construction for Melbourne water supply.

(*a*) Useful storage only.

3. Irrigation.—(i) *History.* For some brief remarks on the history of irrigation in Australia referring to the efforts of the Chaffey Brothers and to the Victorian Irrigation Act in 1886 *see* issues of the Official Year Book prior to No. 39. Trends in irrigation practice in more recent years were described in Official Year Book No. 37, p. 1009.

(ii) *Extent and Nature of Irrigated Culture.* About half of Australia's irrigated acreage is in Victoria, and about two-thirds is situated along the Murray and its tributaries (including the Murrumbidgee) in the three States of New South Wales, Victoria and South Australia. In those areas served by the Murray and its tributaries, irrigation water is used extensively for vines, orchards, pastures, fodders, and for domestic and stock purposes. Approximately half of Queensland's irrigated acreage is devoted to sugar cane. Western Australia's small irrigated acreage is confined to areas in the south-west where vegetables, orchards, fodders, and pastures are served. Large scale irrigation schemes have not been developed in Tasmania or the Northern Territory although reference is made on page 328 to investigations at present being carried out in the Northern Territory to determine the availability of irrigation water for rice production.

The following table shows the area of land irrigated in each State during the years 1952–53 to 1956–57 :—

AREA OF LAND UNDER IRRIGATED CULTURE.

(Acres.)

Season.	N.S.W. (*a*)	Vic. (*b*)	Q'land.	S. Aust.	W. Aust.	Tas.	N.T.	A.C.T.	Aust.
1952–53 ..	494,900	755,030	126,693	57,057	31,067	8,414	..	606	1,473,767
1953–54 ..	540,243	821,025	146,282	62,062	34,247	9,412	..	800	1,614,071
1954–55 ..	616,264	863,563	139,414	69,452	36,130	13,761	151	791	1,739,526
1955–56 ..	379,611	634,334	136,019	70,987	37,164	11,499	225	774	1,207,613
1956–57 ..	525,236	855,182	121,672	66,118	38,567	12,110	168	885	1,619,938

(*a*) Source : Water Conservation and Irrigation Commission. (*b*) Source : State Rivers and Water Supply Commission.

The next table shows the area of land irrigated in each State during 1956–57 according to the nature of irrigated culture.

AREA OF LAND UNDER IRRIGATED CULTURE, 1956-57.

(Acres.)

Crop.	N.S.W. (*a*)	Vic. (*b*)	Q'land.	S. Aust.	W. Aust.	Tas.	N.T.	A.C.T.	Aust.
Rice ..	50,417	..	..	..	..	..	..	..	50,417
Vegetables ..	18,481	17,410	25,096	11,725	7,990	1,117	75	196	82,090
Fruit	18,144	31,732	3,660	16,984	5,137	773	69	6	160,802
Vineyards ..	12,547	46,593		24,664	493	..	..	..	
Sugar-cane ..	(*c*)	..	57,158	..	..	..	..	..	57,158
Hops	..	(*c*)	..	..	..	1,330	..	..	1,330
Cotton	..	..	407	..	..	..	..	..	407
Other Crops (including Fodder and Fallow land)	100,901	83,689	(*d*)29,790	3,038	1,627	1,469	24	474	221,012
Total, Crops	*200,490*	*179,424*	*116,111*	*56,411*	*15,247*	*4,689*	*168*	*676*	*573,216*
Pastures ..	*324,746*	*e 675,758*	*5,561*	(*f*)*19,707*	*23,320*	*7,421*	..	*209*	*1,046,722*
Total .. .	**525,236**	**855,182**	**121,672**	**66,118**	**38,567**	**12,110**	**168**	**885**	**1,619,938**

(*a*) Source : Water Conservation and Irrigation Commission. (*b*) Source : State Rivers and Water Supply Commission. (*c*) Included in Other Crops. (*d*) Includes Tobacco, 6,350 acres. (*e*) Excludes lucerne fed off, included in "Other Crops". (*f*) Includes lucerne for pasture.

(iii) *Research.* Comprehensive programmes of research and investigation are being pursued by State water and agricultural authorities and the Commonwealth Scientific and Industrial Research Organization, often in collaboration. Special attention is being given to the following :—high water tables due to the application of water ; surface accumulation of salt and other soil changes associated with irrigation ; methods of applying water efficiently ; increasing density of stock on irrigated pastures which leads to the spread of such diseases as foot rot and fluke in sheep, and mastitis and contagious abortion in cattle ; growth problems affecting plants and trees ; the prevention of evaporation from water storages ; and the potability of saline waters for stock.

The Commonwealth Scientific and Industrial Research Organization maintains the following research stations :—Merbein (Victoria)—horticultural problems, particularly of the dried vine fruits industry ; Griffith (New South Wales)—the influence of irrigation on plant life (using horticultural trees as test plants), irrigation methods, land drainage and soil structure ; Deniliquin (New South Wales)—pastures ; and the Kimberley Research Station (Western Australia)—tropical crops and pastures. In the maintenance of Merbein and Griffith Stations, the Commonwealth is assisted, financially and otherwise, by the New South Wales Water Conservation and Irrigation Commission, by the Dried Fruits Export Control Board and by private organizations.

The Soils Division of the Organization has made detailed surveys of more than a million acres since 1927, with less detailed reconnaissance surveys over many millions of acres. The Division works closely with State authorities. The keynote of soil investigations is relationship between soil and land use, and there is an increasing tendency to seek such surveys before irrigation districts are established. Research is also conducted in the field of water percolation in relation to soil structure.

The Irrigation Research and Extension Committee plays an important part in the agricultural activity of the Murrumbidgee Irrigation Areas. It is representative of the State Department of Agriculture, the Commonwealth Scientific and Industrial Research Organization, the Rural Bank of New South Wales, the Soil Conservation Service of New South Wales and certain farmers' organizations (including Extension Groups). Finance is provided by these authorities on an agreed basis. The objectives are :—to enable the agricultural extension services to the farmers in the defined sub-region to be continued and developed ; to provide a system for advising on local agricultural policy and organization ; to provide means for farmer opinion to have due weight in the consideration of regional agricultural administration and policy ; to achieve a unified approach to sub-regional extension in all branches of agriculture ; to advise on the research needs of the sub-region and the co-ordination of the agricultural research of the various rural institutions working therein ; to achieve close liaison between research and extension ; and to conduct research in extension methods.

4. **Preservation of Catchments.**—Since water conservation commences on the catchments, it is becoming increasingly recognized that anything which interferes with catchment efficiency affects the quantity of water available for all purposes. Active steps are being taken to counteract soil erosion, to conserve soil generally, and to minimize the effects of floods, overstocking, bush fires, and the destruction of vegetative cover. All States and the Commonwealth have initiated forestry policies which provide for reafforestation and the preservation of catchments. In recent years, efforts to counteract soil erosion have been intensified and there is some evidence of a more unified approach to catchment, water, forestry, and land use factors regarded as parts of a single problem.

5. **Sub-surface Supplies.**—(i) *General.* While a more or less complete general picture of the available and potential surface water resources exists, much remains to be done with regard to the location and development of sub-surface supplies (artesian, sub-artesian and ground water), in view of their importance as the basis of settlement over large areas of Australia.

The extent of the artesian basins—particularly the Great Artesian Basin—has been fairly accurately determined, while the use of sub-artesian supplies is extensive and more development is possible. The shallower ground-water supplies, however, particularly along alluvium valleys and coastal sandbed areas, have not been investigated and developed to any degree, except in a few localities.

(ii) *Artesian and Sub-artesian Supplies.* Pressure water, variable in quantity and quality, either artesian or sub-artesian, is obtainable in many parts of Australia, the various artesian basins extending over approximately one-third of the continent. A map of Australia showing the extent of the known artesian basins appears on page 307 of this Year Book.

The Great Artesian Basin, the most extensive in the world, underlies an area of approximately 670,000 square miles, comprising about 430,000 in Queensland, 80,000 in New South Wales, 120,000 in South Australia and 40,000 in the Northern Territory. Of the numerous defined major and minor water-bearing basins in Australia, the following are the principal :—

PRINCIPAL WATER-BEARING BASINS : AUSTRALIA.

Name.	State.	Geological Age of Chief Aquifers.	Approximate Area.	Depth to Pressure Water.
			Square Miles.	Feet.
Great Artesian	Queensland, New South Wales, South Australia and Northern Territory	Pliocene-Permian ..	670,000	Up to 7,000
Desert and Fitzroy	Western Australia	Cainozoic-Palaeozoic	160,000	100 to 1,500
Murray ..	Victoria, New South Wales and South Australia	Miocene-Oligocene ..	107,000	100 to 900
Eucla	Western Australia, South Australia	Pliocene-Miocene ..	68,000	300 to 2,000
Barkly ..	Northern Territory, Queensland	Cretaceous, Cambrian and Upper Precambrian	57,000	150 to 1,000
North-west ..	Western Australia	Tertiary-Permian ..	40,000	230 to 4,000
South-west ..	Western Australia	Recent, Jurassic ..	10,000	200 to 2,500
Pirie-Torrens ..	South Australia..	Recent, Pleistocene ..	4,000	Up to 600
East Gippsland ..	Victoria ..	Pleistocene-Oligocene	2,500	200 to 1,800
Adelaide ..	South Australia..	Recent, Oligocene ..	1,100	10 to 850
Basins of Ord-Victoria Region	Northern Territory, Western Australia	Mainly Cambrian and Permian	Unknown	Unknown

More than 3,000 artesian bores have been constructed within the Great Artesian Basin and the daily free discharge from all bores continuing to flow in Australia has been stated to exceed 350 million gallons, of which the loss by evaporation and seepage has been estimated at more than 90 per cent. Sub-artesian bores and wells throughout Australia number more than 200,000.

Artesian water generally is good stock water, but it is unsuitable for plant life, while in certain areas sub-artesian waters are suitable for all uses including irrigation. In some districts a considerable amount of irrigation is carried out from shallow ground-water supplies.

In common with other countries possessing artesian supplies, Australia has been faced with the problem of flow diminution. It was recognized early that flows were diminishing as more bores were drilled, but it is now considered that while many of the bores will ultimately cease to flow, many will not cease, but will assume a perpetually steady rate of flow, corresponding with the average intake of water from rainfall absorbed by sandstone outcrops. Diminution in flows from artesian bores has emphasized the need to eliminate wastage as much as possible, and investigations have been made regarding wasteful methods of distribution of artesian water by open channels or "bore drains" and the careless use of water. (For greater detail on this subject *see* Official Year Book No. 37, pp. 1103–4.)

(iii) *Ground Water.* Ground water supplies are used in various parts of Australia for industry, irrigation, stock and domestic purposes. Two of the most important of these supplies are in New South Wales. The Hunter District Water Board pumps 15 million gallons a day for general use from the Tomago coastal sands near Newcastle and at Botany, Sydney, private industry pumps 5 million gallons a day for its own use from similar sands.

Recent exploration of the coastal sands north of the Tomago Sands has revealed a further potential production of 25 million gallons a day.

§ 3. National and Interstate Aspects.

1. General.—As the Commonwealth Constitution makes special reference to water problems, both the Commonwealth and the State Governments have an interest in the control and conservation of water. The main responsibility for control of water resources resides in the individual State governments, but as political boundaries sometimes intersect river valleys and catchments, co-operation between governments has been necessary to develop resources in certain cases. Specific examples of Commonwealth–State and interstate co-operation and approach are given in the following sections.

In the Report on Irrigation, Water Conservation and Land Drainage presented to the Commonwealth Government by the Rural Reconstruction Commission in 1945, national aspects of water conservation and use were emphasized. The report recommended that to obviate lack of co-ordination, an all-Australian plan, having the assent of the various governments be adopted, and that the Commonwealth should endeavour to promote interstate co-operation and co-ordinated development generally.

In 1946, a conference between the Commonwealth and States agreed to revive the Irrigation Production Advisory Committee first established under the authority of the Australian Agricultural Council in 1938. Its functions are :—(*a*) to prepare for the consideration of the Australian Agricultural Council or any Committee of Ministers appointed by the Council, conclusions formed from investigations to be carried out by Commonwealth and State Officers into the various agricultural industries which it is possible to develop on irrigated lands ; (*b*) to undertake long-term co-ordination of land utilization in irrigable areas served by the River Murray and its tributaries, this involving co-ordination of all available lands and the carrying out of such supplementary investigations as may prove necessary.

2. Murray River Scheme.—(i) *General.* The Murray River and its tributaries form the largest river system in Australia. The catchment is approximately 414,000 square miles, or one-seventh of the area of the Australian continent, comprising five-sixths of New South Wales, over one-half of Victoria, one-sixth of Queensland and one-fortieth of South Australia. The Murray proper is 1,600 miles long. Its main tributaries are the Murrumbidgee (980 miles), the Darling (1,700 miles), and the Goulburn (280 miles). The average annual flow of each of the chief contributory streams is as follows :—Upper Murray, including the Mitta Mitta and Kiewa Rivers, 3,506,000 acre feet ; Murrumbidgee River, 2,280,000 acre feet ; Goulburn River (including Broken River), 2,502,000 acre feet ; Darling River, 2,224,000 acre feet ; and Ovens River, 1,169,000 acre feet. Irrigated production in the River Murray basin is mainly in the form of wine, dried fruits, fresh fruits, rice, vegetables, dairy produce, wool, fat lambs, poultry, eggs and pigs.

For a brief summary of the historical events leading up to the River Murray Agreement (1915) by the Governments of the Commonwealth, New South Wales, Victoria, and South Australia, *see* issues of the Year Book prior to No. 39. The Agreement provided for the construction of works, the allocation of the water between the three States, and the appointment of a Commission to implement the Agreement. The Commission comprises four Commissioners, representing the Commonwealth and the three States respectively. The Commonwealth representative presides.

(ii) *River Murray Waters Agreement.* Under the Agreement, construction works are carried out by the States (who are also responsible for maintenance) subject to the approval and direction of the Commission. The Agreement provides that the minimum quantity of water to be allowed to pass for supply to South Australia in each year shall be sufficient to fill Lake Victoria storage once, and with the aid of water returned from Lake Victoria, to maintain certain specified flows in the lower river varying from 47,000 acre feet per month in the winter months to 134,000 acre feet per month in the four summer months of maximum demand—the total amounting to 1,254,000 acre feet over twelve months. These flows are to meet domestic and stock requirements in South Australia, losses of water in lockages and evaporation losses other than in the lakes at the Murray mouth, together with 603,000 acre feet per annum for diversion from the Murray for irrigation in South Australia. The flow at Albury is shared equally by New South Wales and Victoria, and each of these States has full control of its tributaries below Albury, subject in each case to the fulfilment of the South Australian allocation. For a brief outline of the operation of the Agreement prior to 1949 *see* Official Year Book No. 40 (p. 1065) and earlier issues.

At a Conference of Ministers held in July, 1949, to consider the diversion of the Snowy River, it was decided that, by diversion of streams in the Snowy Mountains area, an average of approximately 400,000 acre feet per annum would be added to the Murray River (*see* para. 4, Snowy Mountains Hydro-electric Scheme, page 303) and that a storage of not less than 1,500,000 acre feet should be provided in order to give additional regulation of the Murray River itself as well as to provide for regulation of the diverted waters. Hydro-electric potentialities would also affect the size of the storage.

The River Murray Commission investigated the position and found that an increase in capacity of 500,000 acre feet in storage on the Upper Murray River above Albury was the maximum that was economically justifiable for the regulation for irrigation purposes of the waters of the Upper Murray River and of waters added from the Snowy River. The Commission agreed that this increase could best be provided by increasing the size of the Hume Reservoir from its previously designed capacity of 2,000,000 acre feet to 2,500,000 acre feet, but if additional storages for hydro-electric purposes become justified in the future further increases would best be provided at some other site. It subsequently recommended to the contracting Governments that the River Murray Waters Agreement be amended to provide for this enlargement of the Hume Reservoir to 2,500,000 acre feet. A conference of Ministers considered the recommendation in July, 1954 and agreed to the enlargement. In addition, it was agreed that the Commission should be given power to construct regulators and to carry out such other work on the River Murray between Tocumwal and Echuca as it considered necessary to reduce the losses from the regulated flow in that stretch of the river. The amended Agreement was ratified in the Parliaments of the Commonwealth and the three States and was proclaimed on 7th April, 1955.

The total estimated quantity of water diverted from the Murray and its tributaries (under the River Murray Agreement, in 1955–56 for irrigation and other purposes, including impounding in dams, was as follows (in acre feet) :—New South Wales, 1,008,000 ; Victoria, 3,108,000; South Australia, 190,500; a total of 4,306,500 acre feet. Owing to the floods in the latter half of 1956 the quantity of water diverted in 1956–57 was considerably less than that for the preceding year.

(iii) *River Murray Works.* One of the major works of the Murray River Scheme is the Hume Reservoir, situated just below the junction of the Murray and Mitta Mitta Rivers, 10 miles above Albury, forming a lake of 33,000 acres. The design comprises a mass concrete spillway and outlet works extending 1,000 feet and an earthen embankment 110 feet high extending for 4,000 feet across the river flats. The length of the total structure is approximately one mile. Work is now in progress on the enlargement of the reservoir to its recently approved capacity of 2,500,000 acre feet.

The Yarrawonga Diversion Weir was completed in 1939 to raise the river level so that water could be diverted by gravitation into main channels constructed on either side of the river. Between the Yarrawonga Weir and the Murray mouth, thirteen weirs and locks have been built. Two flood diversion weirs have been constructed on the Murrumbidgee—one between Hay and the Lachlan Junction and the other below the Lachlan Junction.

The Mulwala Canal, served by the Yarrawonga Weir, has an off-take capacity of 2,500 cubic feet per second, and will serve 1,500,000 acres of land in New South Wales. The Yarrawonga Channel, on the Victorian side, has an off-take capacity of 1,250 cubic feet per second, and is designed to serve 270,000 acres. Only a portion of both these areas will be irrigated.

Adjoining the river in New South Wales and 35 miles from the Murray-Darling Junction, Lake Victoria storage, with a capacity of 551,700 acre feet and a surface area of 27,670 acres, was completed in 1928. The water released from Lake Victoria is used by the South Australian settlements. Work has recently been completed on the enlargement of the inlet channel to Lake Victoria to permit greater diversion of periodical flood flows of short duration.

Five barrages across channels near the Murray River mouth connecting Lake Alexandrina with the sea were completed in 1940 to prevent ingress of salt water to Lakes Alexandrina and Albert and to the lower river, thereby increasing the productivity of adjacent lands. The structures maintain a sufficiently high level for 50 miles up river to permit watering by gravitation of a considerable area of reclaimed river flats. The total distance across the barrages and intervening islands is 15 miles.

In addition to the works carried out under the auspices of the Commission, the separate States have constructed thousands of miles of distribution channels and have provided a number of storages on the tributaries, thereby contributing very materially to the large amount of irrigation development in the Murray Basin. The total capacities of such main storages are : New South Wales—Burrinjuck (Murrumbidgee), 837,000 acre feet ; Wyangala (Lachlan), 303,900 acre feet ; Victoria—Eildon (Goulburn), 2,750,000 acre feet ; Waranga (Goulburn), 333,400 acre feet. More details of these and other State works on Murray tributaries will be found in the sections dealing with State systems. No storages exist on the Murray in South Australia.

3. **New South Wales-Queensland Border Rivers Agreement.**—The New South Wales-Queensland Border Rivers Agreement came into effect on 1st July, 1947. The Agreement provides for the construction of certain works on parts of those portions of the Severn, Dumaresq, Macintyre and Barwon Rivers which constitute part of the boundary between New South Wales and Queensland, for the furtherance of water conservation, water supply and irrigation in those States.

The works to be constructed comprise a dam on the Dumaresq River at a site to be selected by the Commission to give a storage basin with a capacity as large as is reasonably practicable and not less than six nor more than twelve weirs as may be found necessary to meet the requirements of irrigation along the rivers. Provision is also made for the construction of not more than four regulators in the effluents from the barrier rivers and for the taking over of the existing weir in the Macintyre River at Goondiwindi and the existing weir in the Barwon River at Mungindi. The costs of these works and of administration are to be borne by the States in equal shares. The agreement further provides that the water discharged from the Dumaresq storage, whether by regulated or unregulated flow, shall be available to the two States in equal shares.

The Water Conservation and Irrigation Commission of New South Wales, which is the constructing authority for the dam, carried out investigations of several dam sites on the Dumaresq River near Mingoola Station Homestead which is approximately 39 miles from Tenterfield. Foundation drilling supplemented by a geophysical survey carried out by the Commonwealth Bureau of Mineral Resources disclosed unfavourable foundation conditions at all sites, the depth of alluvium overlying sound rock exceeding 150 feet in all cases. In an endeavour to obtain more economical storages, investigations were extended to tributary streams and superficially suitable sites have been located on Pike Creek and the Mole River. A geophysical survey was made at each of these sites and preliminary comparative estimates prepared to determine the relative economy of providing one large storage at Mingoola or two smaller storages on the tributaries. It is now intended to do exploratory drilling of the tributary sites.

The Irrigation and Water Supply Commission of Queensland is the constructing authority for the new weirs and regulators. The construction of Bonshaw and Cunningham Weirs on the Dumaresq River was completed in January, 1953 and June, 1954 respectively.

Investigations are proceeding and designs are being prepared for a weir and regulator on the Barwon River at the offtake of the Boomi River and construction of a low level weir to establish a pumping pool at Glenarbon on the Dumaresq River has been authorized. The existing Goondiwindi and Mungindi Weirs are being maintained, operated and controlled by the Queensland Irrigation and Water Supply Commission. Until a dam has been constructed, it is unlikely that any weirs, other than those referred to above, will be required.

The catchments for the border streams (2,000 square miles) extend to the granite areas in the vicinity of Tenterfield (New South Wales) and Stanthorpe (Queensland) and elevation rises to 3,000 feet. Average rainfall is 30 inches. The catchments and the areas suitable for irrigation are approximately equal in each State. Climatic conditions are such that it is necessary to supplement rainfall from April to October by irrigation to stabilize and increase production. The capacity of the area to grow lucerne and tobacco under irrigation has already been demonstrated. Other possible development of the area includes irrigation of cotton, root crops, cereals, and citrus fruit, and expansion of the fat stock industry.

4. **Snowy Mountains Hydro-electric Scheme.***—(i) *General.* Following a comprehensive investigation into both the water and power potential of the Snowy River waters by a Technical Committee representative of the Commonwealth and the States of New South Wales and Victoria in 1947 and 1948, and the submission by the committee of reports in 1948 and 1949, the Commonwealth Parliament in July, 1949 passed the Snowy Mountains Hydro-electric Power Act setting up an Authority to implement the proposals agreed upon.

The basis of the proposals is to impound the Snowy River waters at high elevations and, by diverting them into tunnels passing under the Alps, to use their potential power for the generation of electricity and then to discharge them into the Murray and Murrumbidgee River systems for use in the irrigation areas.

The scheme will be constructed in two parts, the first being known as the Snowy-Murray Development where the water is to be diverted by tunnel from a large dam across the Snowy River at Jindabyne to the Swampy Plains River in the Murray Valley, and the second as the Tumut Development, in which water will be diverted by tunnel from a dam at Adaminaby on the Eucumbene River, a tributary of the Snowy, to the Tumut River, a tributary of the Murrumbidgee. The whole scheme will involve the construction of seven major dams (with a total storage capacity of approximately 7 million acre feet), fifteen power stations, more than 80 miles of large diameter tunnels, and over 330 miles of racelines at high elevations.

Latest estimates indicate that the total cost will be approximately £419 million. The scheme is the greatest engineering and developmental work ever undertaken in Australia and one of the major engineering projects of the world.

(ii) *Snowy Mountains Hydro-electric Power Act* 1949. The Snowy Mountains Hydro-electric Authority is constituted by a Commissioner, who is assisted by two Associate Commissioners. The functions of the Authority are defined in the Act as follows :—(*a*) to generate electricity by means of hydro-electric works in the Snowy Mountains area and (*b*) to supply electricity so generated to the Commonwealth for defence purposes and for consumption in the Australian Capital Territory. The general powers of the Authority as defined in the Act are as follows :—For the purpose of performing its functions the Authority shall have power to construct, maintain, operate, protect, manage and control works—(*a*) for the collection, diversion and storage of water in the Snowy Mountains Area ; (*b*) for the generation of electricity in that area ; (*c*) for the transmission of electricity generated by the Authority ; and (*d*) incidental or related to the construction, maintenance, operation, protection, management or control of any of the works specified above. The Act provides that the Authority may sell to a State, or to an authority of a State, electricity generated by the Authority which is not immediately required by the Commonwealth for defence purposes or for consumption in the Australian Capital Territory.

* *See also* Chapter VIII.—Electric Power Generation and Distribution, p. 272. For more detailed information *see* special article by the Commissioner, Snowy Mountains Hydro-electric Authority (Sir William Hudson) which appeared in Chapter XXIX.—Miscellaneous, of Official Year Book No. 42.

(iii) *The Authority's Objectives and Programme.* The two basic objectives are the production of electricity and the diversion of water inland.

The first power station, at Guthega, came into service in April, 1955. Additional generating capacity is scheduled to become available progressively.

By the end of 1959, the Snowy Scheme will supply the Murrumbidgee River with approximately 300,000 acre feet per annum of additional water and by 1962 this amount will have increased to 500,000 acre feet per annum. Ultimately the scheme will provide approximately 1,818,000 acre feet per annum of additional regulated water of which 1,020,000 acre feet will go to the Murrumbidgee and 798,000 acre feet per annum to the Murray.

The New South Wales Department of Public Works, on behalf of the Authority, is supervising the construction of the Adaminaby Dam, for which a contract was let in May, 1956. Construction of the dam was sufficiently advanced to permit closure of the diversion tunnel gates on 22nd June, 1957 and the waters of the Eucumbene River are now being stored for later use through the Tumut Power Stations. The Department of Main Roads and the Snowy River Shire are reconstructing over 90 miles of existing roads. Construction is now in progress on the 14 mile Eucumbene–Tumut Tunnel, Tumut Pond Dam, the 8,000 feet pressure tunnel leading to Station T1, and on Station T1 itself. Designs for the Tooma–Tumut Diversion, the T2 Project and the Murrumbidgee–Eucumbene Diversion were sufficiently advanced to permit the calling of tenders for these works before the end of 1957.

B. STATES AND TERRITORIES.

§ 1. Australian Local Pattern of Water Conservation and Use.

The foregoing sections deal with water conservation and irrigation in Australia generally and with national and interstate projects. The following survey indicates the local pattern of water resources and the steps taken by the State Governments to bring about their development. It will be seen that water policies in the various States tend to assume a distinctive and characteristic pattern closely allied with climatic conditions and specific local needs.

In Victoria, almost every form of water scheme is in operation. In New South Wales, major emphasis at present is on irrigation and stock development in the dry areas along the Murray and Murrumbidgee Rivers, though a substantial scheme of intensive irrigation is being conducted in the Murrumbidgee Irrigation Areas. In Queensland, up to the present, the predominant emphasis has fallen on water (mainly underground sources) for stock, and the development of small irrigation schemes in sub-humid and humid areas, especially to stabilize sugar production.

Apart from regular irrigation practices along the Murray River, South Australian authorities are vitally concerned with reticulated supplies for rural areas and towns. Western Australia has developed unique rock catchments and piped supplies for agricultural areas and towns in dry districts. Tasmanian interest appertains to hydro-electric generation almost exclusively. The Northern Territory is primarily concerned with stock supplies and the safeguarding of long stock routes.

§ 2. New South Wales.

1. General.—(i) *Rainfall and History.* In issue No. 37 of this publication (p. 1110) information on the pattern of rainfall and the history of irrigation in New South Wales preceded the description of water conservation and use in that State, but it has now been omitted. (*See also* Chapter II.—Physiography, p. 45 of this Year Book.)

(ii) *Administration.* The Water Conservation and Irrigation Commission of New South Wales consists of three members appointed by the Governor. The operations of the Commission cover water conservation, control of irrigation areas, establishment, operation and maintenance of works for domestic and stock water supply, irrigation districts, flood control districts, sub-soil drainage districts, constitution of water trusts, the issue of licences for private irrigation, artesian and shallow boring, assistance under the provisions of the farm water supplies scheme and river improvement works.

Under the Water Act, the right to the use and flow, and the control of water in all rivers and lakes which flow through, or past, or are situated within, the land of two or more occupiers, is vested in the Commission for the benefit of the Crown. A system of licences operates for the protection of private works of water conservation, irrigation, water supply, drainage, and prevention of inundation.

For particulars of the New South Wales–Queensland Border Rivers Agreement ratified by Acts of both States in 1947, *see* page 302 of this Chapter.

2. Schemes Summarized.—(i) *Location and Type.* The bulk of irrigated land is along the Murray and its tributary the Murrumbidgee. Smaller areas are served by the Wyangala Dam and Lake Brewster on the Lachlan, a tributary of the Murrumbidgee. None of the other rivers is regulated by large head storages, though weirs and dams have been provided for town supplies, etc., in many places, and head storages have been commenced on the Macquarie, Namoi and Hunter Rivers. Substantial use is made of artesian and sub-artesian water in pastoral areas.

New South Wales legislation provides for the constitution and control of various schemes having different characteristics and including Irrigation Areas, Irrigation Districts, Water Trust Districts, Flood Control and Irrigation Districts and River Improvement Districts. There are five Irrigation Areas :—The Murrumbidgee Irrigation Areas consisting of 451,251 acres served with water through a channel system stemming from the river at Berembed Weir ; the Coomealla Irrigation Area of 34,693 acres, served by pumping from the Murray ; the Curlwaa Irrigation Area of 10,549 acres, supplied from the Murray by pumping ; the Hay Irrigation Area of 6,806 acres, supplied with water pumped from the Murrumbidgee ; and the Tullakool Irrigation Area of 18,006 acres supplied from the Edward River at Stevens Weir. All these areas are administered by the Commission, and details of the various schemes are given in sub-section (iii) below.

(ii) *Works.* The capacities of the main storages (in acre feet) are :—

Murray :—Half share of Hume Reservoir, weirs and locks to Wentworth (835,420) ; Stevens Weir, Edward River (7,165).

Murrumbidgee :—Burrinjuck Dam (837,000) ; Berembed Weir (10,000) ; Redbank Weir (7,360) ; Maude Weir (6,740).

Lachlan :—Wyangala Dam (303,900) ; Lake Brewster (123,900) ; Lake Cargelligo (29,435) ; Jemalong Weir (2,200).

Water from the Hume Reservoir is used for domestic and stock purposes, to provide bulk supplies for country towns, for the irrigation of vines, fruits and fodder in the Curlwaa and Coomealla areas, for rice and other cereals and for pastures in the Tullakool Irrigation Area, for domestic and stock supply and irrigation in the Berriquin, Wakool and Denimein Districts, and for water trusts for domestic and stock purposes and/or irrigation.

The Wyangala Dam is 30 miles upstream from Cowra in the Central West. It has a catchment of 3,200 square miles. Water from the dam, supplemented by the unregulated flow of the Belubula River, provides for domestic and stock purposes along the full length of the river (over 700 miles) and also for irrigation by land holders operating licensed pumps. The towns of Cowra, Forbes, Condobolin, Hillston and Booligal are supplied. Balance storages at Lake Cargelligo and at Lake Brewster conserve water during periods of high flow for release as required. Water from the Lachlan, diverted at Jemalong Weir, supplied the districts of Jemalong and Wylde's Plains, serving an area of 224,556 acres. Proposals for future development include provision of a head storage on the Belubula River.

The approximate total length of channels (including main canals) constructed by the Water Conservation and Irrigation Commission in New South Wales is 2,957 miles. The approximate length of drains and escape channels is 860 miles, and the total length of pipe lines is approximately 50 miles, making a grand total of 3,867 miles of channels and pipe lines, etc.

(iii) *Extent of Systems and Nature of Irrigated Culture.* The following table shows the areas of the various irrigation systems and particulars of the areas under irrigated culture in New South Wales during 1956–57.

AREAS OF SYSTEMS AND OF LAND UNDER IRRIGATED CULTURE: NEW SOUTH WALES, 1956-57.

(Acres.)

System, etc.	Total Area.	Area under Irrigated Culture.										
		Rice.	Other Cereals Grown for Grain.	Lucerne. (a)	Other Fodder Crops.	Pastures.		Vineyards.	Orchards. (c)	Vegetables.	Fallow Land and Miscellaneous.	Total.
						Sown. (b)	Natural.					
Irrigation Areas—												
Murrumbidgee (within the Areas) ..	451,251	30,182	2,511	2,911	1,190	61,704	1,934	4,660	12,144	4,108	20,589	141,933
Lands adjacent supplied under agreement	(d)	..	4	92	2	3,533	10	2	77	6	4	3,730
Coomealla	34,693	..	..	9	..	..	..	4,261	829	10	..	5,109
Curlwaa	10,549	..	..	24	36	..	..	579	1,031	10	..	1,680
Hay	6,806	..	..	42	59	1,083	50	..	..	..	..	1,234
Tullakool	18,006	840	160	80	..	4,215	..	..	..	..	630	5,925
Total	*e 521,305*	*31,022*	*2,675*	*3,158*	*1,287*	*70,535*	*1,994*	*9,502*	*14,081*	*4,134*	*21,223*	*159,611*
Irrigation Districts—												
Benerembah ..	112,818	4,974	1,335	410	150	17,187	60	..	..	219	3,656	27,991
Tabbita	10,745	350	..	20	..	1,120	..	..	..	40	90	1,620
Wah Wah	571,358	..	..	385	250	4,140	100	..	..	..	1,325	6,200
Berriquin	779,564	..	3,321	30,317	..	120,153	1,290	..	..	15	3,030	158,126
Wakool	493,730	6,700	350	1,510	470	47,020	1,060	..	..	50	850	58,010
Denimein	147,005	3,396	187	1,103	522	9,269	3,836	..	12	..	100	18,425
Jemalong and Wylde's Plains	224,556	..	1,325	3,352	322	7,113	2,985	..	..	..	925	16,022
Gumly	345	..	26	63	..	..	35	..	19	56	..	199
Deniboota	306,907	3,975	50	212	110	3,825	4,082	..	..	..	544	12,798
Total	*2,647,028*	*19,395*	*6,594*	*37,372*	*1,824*	*209,827*	*13,448*	..	*31*	*380*	*10,520*	*299,391*
Flood Control Districts—												
Lowbidgee	375,000	..	..	..	..	..	(f)94,118	..	..	..	..	(f)94,118
Medgun	272,800	..	..	..	..	..	(f)61,760	..	..	..	..	(f)61,760
Total	*647,800*	..	..	..	..	..	*f 155,878*	..	..	..	..	*f 155,878*
Irrigation Trusts—												
Pomona	1,580	..	..	..	..	..	..	770	130	..	..	900
Blairmore	315	..	..	..	..	..	..	..	..	..	..	(d)
Bringan	4,933	..	..	..	..	..	..	..	..	..	..	(d)
Bungunyah-Koraleigh	1,810	..	..	..	50	..	..	996	72	80	..	1,198
Glenview	661	..	..	60	..	..	320	..	70	..	..	450
Goodnight	1,167	..	..	..	..	..	..	550	41	5	8	604
Bama	3,446	..	..	..	..	..	..	..	..	..	..	(d)
Total	*13,912*	..	..	*60*	*50*	..	*320*	*2,316*	*313*	*85*	*8*	*(e) 3,152*
Water Trusts—Domestic and stock supplies ..	*2,914,831*	..	..	..	..	..	..	..	..	..	..	..
Licensed Diversions(g)—To irrigate	(d)	..	..	*11,196*	*4,398*	*25,970*	*2,652*	*729*	*3,719*	*13,882*	*(h) 536*	*63,082*
Grand Total(e) ..	(d)	50,417	9,269	51,786	7,559	306,332	174,292	12,547	18,144	18,481	32,287	*i* 681,114

(a) Includes grazing and cutting. (b) Perennial and annual self-seeding. Perennial amounted to 39,183 acres. (c) Citrus and deciduous. Deciduous amounted to 6,825 acres of which 6,144 acres were in the Murrumbidgee Irrigation Area. (d) Not available. (e) Incomplete. (f) Area irrigable; details of area actually irrigated are not available. (g) Excludes domestic and stock supplies for which particulars are not available. (h) Tobacco. (i) Includes Flood Control Districts; but excludes some Irrigation Trusts for which information is not available.

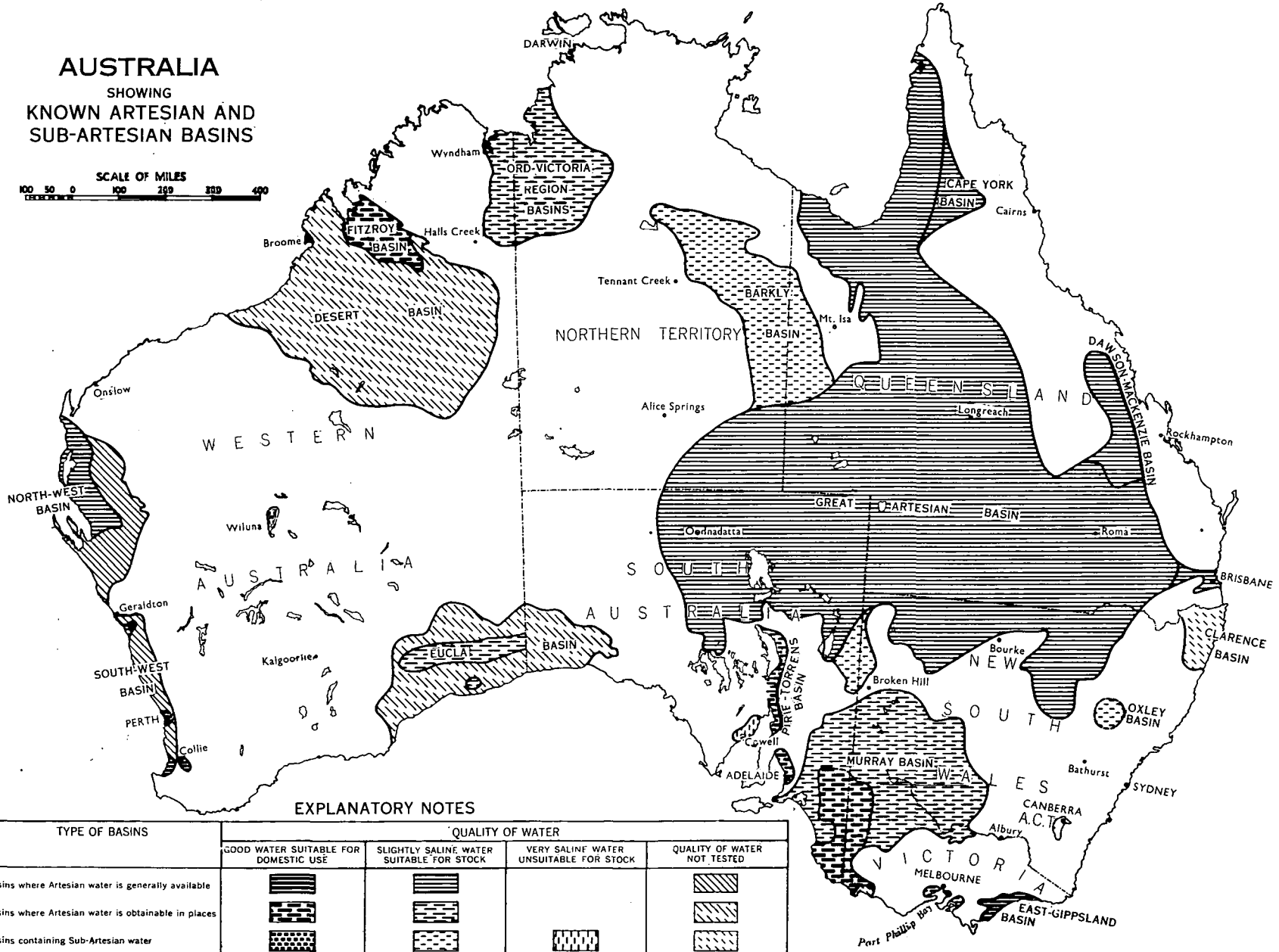
AUSTRALIA

SHOWING

KNOWN ARTESIAN AND SUB-ARTESIAN BASINS

SCALE OF MILES

100 50 0 100 200 300 400



EXPLANATORY NOTES

TYPE OF BASINS	QUALITY OF WATER			
	GOOD WATER SUITABLE FOR DOMESTIC USE	SLIGHTLY SALINE WATER SUITABLE FOR STOCK	VERY SALINE WATER UNSUITABLE FOR STOCK	QUALITY OF WATER NOT TESTED
Basins where Artesian water is generally available				
Basins where Artesian water is obtainable in places				
Basins containing Sub-Artesian water				

Adapted from the map" Underground Water " Atlas of Australian Resources : Published by the Department of National Development : 1953

3. **Murrumbidgee Irrigation Areas.**—(i) *Description.* These areas comprise about a third of the State's irrigated acreage and in 1956–57, together with lands adjacent supplied under agreement, received 318,388 acre feet of the total water allocated within the State for stock, domestic supply and irrigation (1,112,236 acre feet). They are served by the Burrinjuck Dam (capacity 837,000 acre feet), 40 miles north-west of Canberra, on the Murrumbidgee. The catchment above the dam is 5,000 square miles. The river rises on the high plateau north of Mount Kosciusko where the average annual rainfall exceeds 60 inches. Flow for the irrigation districts is supplemented by unregulated flow below the dam from the Tumut River. The dam also provides town supplies for Gundagai, Wagga, Narrandera, Hay, Balranald, and for towns served by the South-West Tablelands scheme.

Domestic and stock water and water for irrigation are supplied for the Irrigation Districts of Tabbita, Benerembah and Wah Wah and the Flood Control and Irrigation District of Lowbidgee. Flood flows are relied on to serve the Lowbidgee district and water is not released from the dam for that purpose. For the other undertakings, however, water is stored during the winter and spring freshets, fed by melting snows, and is released during the September-April irrigation season. It passes along the river channel to Berembed Weir, 240 miles westward, where it is diverted to the main canal with an off-take capacity of 1,600 cubic feet per second. The main canal has been completed to beyond Griffith, 96½ miles from the off-take. Reticulation channels aggregate approximately 857 miles and drainage channels 785 miles. In addition, approximately 374 miles of supply channels run through adjacent irrigation districts in which the water supply is operated and maintained by the Commission, but land transactions are not under its control.

The land on which the Murrumbidgee Irrigation Areas are situated originally comprised large sheep stations and was sparsely populated. Population was 12,000 in 1923, 15,000 in 1929, 20,000 at the 1947 Census and 24,000 at the 1954 Census. At the 1954 Census the population of the Yanco district (with Leeton as the centre) was 10,000 and the population of the Mirrool Area (with Griffith as the centre) was 14,000.

(ii) *Administration.* The Water Conservation and Irrigation Commission controls land transactions and water supplies for the Murrumbidgee Irrigation Areas. Other local government services, including electricity and town water supply, are provided by Councils. Land is disposed of by the Commission under freehold or perpetual lease tenure or leased for short terms for grazing or cultivation. The area under occupation at 30th June, 1957, was 377,248 acres, including 38,918 held for short lease grazing, agriculture, etc.

(iii) *Production.* Since the inauguration of the scheme in 1912 the volume of production from the area has greatly increased. Numbers of new crops are grown while the volume of the major products of the area prior to the scheme, such as wool and livestock for slaughtering, has expanded considerably. The principal products to-day are : wool, livestock for slaughtering, rice, citrus fruits, peaches and nectarines, grapes, tomatoes, peas, beans and root vegetables.

Rice growing was initiated on the Murrumbidgee Irrigation Areas in 1924 and has since become the most important crop grown in the area. In 1956–57, the total area sown in the Murrumbidgee Irrigation Areas was 30,182 acres and the total quantity of water delivered for the rice crops was 154,672 acre feet.

In a normal season, the water supplied for rice represents about one-half of the total delivered on the Murrumbidgee Irrigation Areas.

Co-operation is a prominent feature in the Murrumbidgee Areas. Co-operative organizations in the Mirrool section handle about 300,000 bushels of fruit per year (compared with 54,600 in 1927–28). The annual sales turnover of the Leeton cannery in recent years has exceeded £2,000,000. Settlers and government agencies co-operate extensively in all matters relating to irrigation practice.

4. **Other Irrigation Areas.**—The Curlwaa, Coomealla, Hay and Tullakool Irrigation Areas follow the same administrative pattern as the Murrumbidgee Areas—that is, land transactions are administered by the Water Conservation and Irrigation Commission which also is responsible for the operation and maintenance of works to supply water at rates determined by the Commission.

Curlwaa Area, on the Murray near Wentworth, consists of 10,549 acres of which 7,754 acres were occupied at 30th June, 1957. Production consists of dried vine fruits, deciduous fruits and fodder crops.

Coomealla Area, 9 miles upstream from Curlwaa, comprises 34,693 acres of which 30,948 acres were occupied at 30th June, 1957. Production consists of vine and citrus fruits. An extension of the Coomealla Irrigation Area has been completed in recent years to provide irrigation farms for ex-servicemen and 100 ex-servicemen have been placed on the new farms.

Tullakool Area, formerly part of the Wakool Irrigation District, comprises 18,006 acres of which 14,396 acres are occupied. Production consists of fat lambs, wheat and rice.

Hay Area, on the lower Murrumbidgee, consists of 6,806 acres, of which, 6,240 acres are occupied. Production comprises dairy products, fat lambs, sheep, wool and fodders.

5. **Irrigation Districts.**—These Districts are set up under the Water Act for (*a*) domestic and stock water supply and (*b*) irrigation. They differ from water trusts in that the cost of the works is not required to be repaid over a period, but annual charges are made by the State for water supplied to landholders. The following are the districts or provisional districts constituted and the areas of land benefited :—*Murray River*—Wakool District (completed) 493,730 acres, Berriquin Provisional District (completed) 779,564 acres, Deniboota Provisional District (first section completed) 306,907 acres, Denimein Provisional District (completed) 147,005 acres, Jernargo Provisional District (certain portions of which have been included in Berriquin District) 4,505 acres, Barramein Provisional District (domestic and stock supply only—works not yet commenced) 88,651 acres ; *Murrumbidgee River* (completed)—Benerembah District 112,818 acres, Tabbita District 10,745 acres, Wah Wah Provisional District 571,358 acres, Gumly Provisional District 345 acres ; *Lachlan River* (completed)—Jemalong and Wylde's Plains District 224,556 acres.

Since the completion of the Hume Reservoir, several such districts have been established along the Murray to utilize the New South Wales share of the storage. Water is not available for the whole of the 5,000,000 acres adjacent to the Murray in New South Wales, and therefore the schemes are based on " extensive " irrigation—that is, water rights are allotted to holdings on the basis that only a portion of each holding (one acre in three, five or ten, according to the district, etc.) will be irrigated, but additional water, when available, may be obtained by landholders. " Water right " means right to such a quantity annually of water, 12 inches deep, as will cover an area of one acre.

Water to serve Berriquin and Wakool Districts is diverted through a main canal which will be 100 miles long when completed. At 30th June, 1957, the total length of completed canal and channels in Berriquin District was 870 miles, including Mulwala Canal 75 miles, Berrigan channel 22 miles, subsidiary channels 729 miles, escape channels 33 miles and cross drainage channels 11 miles. Off-take capacity of the Mulwala Canal is 5,000 acre feet per day. Ultimately the water will serve Deniboota and other districts for which works have yet to be completed.

Wakool, with 384 miles of channel, contains 292 holdings and the area developed by irrigation comprises about one acre in 9 of the total area. The total area irrigated in 1956–57 was 58,010 acres and water supplied was 103,554 acre feet. Crops comprised fodders, pastures, rice, cereals and vegetables, but sheep raising is the main industry.

Considerable subdivision has occurred within the Berriquin District and the proportion of the total area developed for irrigation is higher than in the case of Wakool. Total irrigated acreage was 158,126 at 30th June, 1957. Sheep and wheat growing are the main industries. The fat lamb industry is well developed and expanding. Dairying is making headway, and a butter factory has been established at Finley.

In the Benerembah, Tabbita and Wah Wah Districts, supplied from the channels of the Murrumbidgee Irrigation Areas, the quantity of water supplied during the 1956–57 season for irrigation, etc. was 94,184 acre feet, and the area irrigated was 35,811 acres, including rice and other cereals, pastures, and fodder crops.

For the same season, 23,260 acre feet of water were supplied from the Lachlan River to irrigate a total area of 16,022 acres within the Jemalong and Wylde's Plains Districts.

6. **Water Trust Districts, Irrigation Trusts and Flood Control and Irrigation Districts.**—The Water Act provides for the constitution of Trust Districts for domestic and stock water and irrigation and empowers the Commission to construct, acquire or utilize necessary works. When the works are completed, they are handed over to trustees to administer.

The trustees are elected by the occupiers of the land and act with a representative of the Commission. They are empowered to levy and collect rates covering the cost of the works repayable to the Crown by instalments and also the cost of operation and maintenance of the works. The rates are struck according to the area of land which benefits. The following water trusts—other than irrigation—have been constituted (the area in acres of each district is shown in parentheses)—*Murray River*—Tuppal Creek (78,080), Bullatale Creek (68,320), Little Merran Creek (157,440), Poon Boon (32,980), Minnie Bend Flood Prevention (2,190) ; *Murrumbidgee River*—Yanco, Colombo and Billabong Creeks (1,001,210) ; *Lachlan River*—Torriganny, Muggabah and Merrimajeel Creeks (170,240) Condobolin West Weir (4,480), Marrowie Creek (292,640), Ulonga (71,655), Micabil Weir (11,500) ; *Miscellaneous*—Algudgerie Creek (9,760), Nidgery Weir (46,880), Great Ana Branch of Darling River (967,339), Collarenebri town water supply (117)—making in all a total area of 2,914,831 acres. Thirteen of these trusts have been formed for the provision of water for domestic and stock purposes, one for a town supply and one for flood prevention.

Irrigation Trusts are established under the same Act and are administered by trustees in a similar way. The following are the Trust Districts (area in acres is shown in parentheses) :—*Hunter River*—Blairmore (315) ; *Murray River*—Bama (3,446), Goodnight (1,167), Bungunyak–Koraleigh (1,810), Glenview (661), Bringan (4,933) ; *Darling River*—Pomona (1,580)—making in all a total area of 13,912 acres.

The Lowbidgee Provisional Flood Control and Irrigation District (375,000 acres), the first of its kind, was constituted in 1945. Its purpose is to provide flood irrigation for pasture lands on the lower Murrumbidgee by water diverted from the Maude and Redbank Weirs. There are 50 holdings. Another district, Medgun (272,800 acres) near Moree in the North-West is also in operation. There are 20 holdings in the district and the area benefited by controlled floodings is approximately 61,800 acres.

7. **River and Lake, and Farm Water Supplies.**—During recent years, the numbers of licences and permits issued to individuals to draw water from rivers and lakes for irrigation have increased substantially, especially along the coastal streams in sub-humid districts where the value of supplementary irrigation is becoming more recognized as a means of stabilizing production in lean months. There has also been a considerable increase along the Murrumbidgee and Lachlan.

The Farm Water Supplies Act was passed in 1946. Technical advice and assistance, and also financial assistance, are made available to aid individual farmers and groups of farmers to provide and improve water supplies for domestic, stock and irrigation purposes by means of wells, bores, excavated tanks, weirs or dams.

8. **Underground Water.**—Extensive use is made of artesian, sub-artesian, and shallow underground water. Fractured Palaeozoic rocks in the South-east corner of the State provide useful supplies of ground water usually at depths of 50–250 feet. Eighty thousand square miles in the northern and western portions are covered by the Great Artesian Basin. Eighty-one Bore Water Trusts and twelve Artesian Wells Districts have been constituted. The Bore Trusts are administered in the same way as Water Trusts, but in Artesian Wells Districts settlers maintain the drains. Bore Trusts and Artesian Districts cover about 5 million acres and water is distributed through approximately 7,400 miles of open earth drains. The number of artesian bores giving a flowing or pumping supply at 30th June, 1957, was 1,036 and the estimated total daily flow from 581 flowing bores was 59 million gallons. The estimated flow in 1914–15 was 99 million gallons a day for 372 bores. The deepest bore is Boronga No. 2 (4,570 feet), which also has the greatest flow, namely 1,115,000 gallons a day. Of the total number of bores sunk, 238 have been installed by the Government in connexion with public watering places, Bore Water Trusts or Artesian Wells Districts.

Since 1912, the Government has assisted settlers in shallow boring operations for which repayments are required over a period. To 30th June, 1957, the total constructed by the Commission's plants was 4,714 and their average depth was 304 feet.

9. **Future Programme.**—The programme of post-war development already in hand includes the provision of eighteen dams and storages, eight diversion weirs, and flood mitigation and river protection works in various parts of the State. Construction has been commenced on head storages at Keepit on the Namoi, Glenbawn on the Hunter and Burrendong on the Macquarie, while legislation has been passed authorizing the construction of a flood control dam at Warkworth in the Hunter Valley and a storage dam at Blowering on the Tumut River. In the case of Burrendong Dam, work has been temporarily suspended in order to enable the Water Conservation and Irrigation Com-

mission to concentrate its available resources on the speedy completion of works having higher priority. The Menindee Lakes storage project—part of the scheme for conserving the waters of the Darling River—has been recommenced, while Glenbawn Dam on the Hunter River is substantially complete. The Hunter River development concerns an exceptionally fertile coastal valley, forming the hinterland to Newcastle, where the annual rainfall is not heavy and variations from month to month are considerable. This is the first coastal scheme initiated in New South Wales. The total estimated capacity of all proposed new storages is 5,500,000 acre feet. At 30th June, 1957 work was in hand to begin construction of a diversion weir at Gogeldrie on the Murrumbidgee River from which water will be supplied to a new irrigation area (Coleambally) on the south side of the river containing not less than 800 new irrigation farms. Later, development will extend to a new area on the north side of the river.

10. **Hydro-electricity.**—A survey of the use of water for power generation in New South Wales may be found in the previous chapter (*see* page 279).

§ 3. Victoria.

1. **General.**—(i) *Rainfall.* Particulars of the rainfall pattern of Victoria were given on page 1117 of Official Year Book No. 37. (*See also* Chapter II.—Physiography, p. 45 of this Year Book.)

(ii) *Administration.* The passing of the Irrigation Act of 1886 put the control of surface waters under the Crown, provided for the establishment of Irrigation Trusts and marked the beginning of irrigation development. In 1905, the Water Act established the State Rivers and Water Supply Commission and gave it control of all irrigation, rural domestic and stock supplies, town water supplies and flood protection and drainage undertakings outside the Metropolitan area, with the exception of the irrigation area operated by the First Mildura Irrigation Trust and the town water supplies operated by locally constituted Waterworks Trusts or local governing bodies.

The operations of the First Mildura Irrigation Trust and the various Waterworks Trusts and local governing bodies, as well as the various Sewerage Authorities which control sewerage undertakings in country towns, are also subject to general supervision by the Commission.

2. **Systems Summarized.**—(i) *Works.* Since 1902, when a great drought emphasized the need for a concerted attack on water problems, the total capacity of water storages has increased from 172,000 to 4,962,550 acre feet (including Victoria's share of the Hume Reservoir). By means of channels, bores, etc., one-fourth of the State is artificially supplied for stock and domestic purposes. Large areas, which would be largely unproductive without water, are now contributing to the State's wealth. The area actually irrigated has increased from 105,000 acres in 1906 to 855,200 acres in 1956–57 and irrigation channels supply 2,150,000 acres.

The Commission controls 38 large reservoirs and 240 subsidiary storages. The capacities of the principal storages in acre feet within the various systems at 30th June, 1957 were as follows :—

Goulburn System :—Eildon Reservoir, 2,750,000 ; Goulburn Weir, 20,700 ; Waranga Basin, 333,400 ; Total, 3,104,100 ; *Murray–Loddon System :*—Half share of River Murray Commission storages including Hume, Yarrawonga, Torrumbarry, Euston, Mildura and Wentworth, 835,420 ; Cairn Curran, 120,600 ; Kow Swamp, Laanecoorie, Kerang–North-West Lakes, Lake Boga and Lake Cullulleraine, 148,210 ; Total, 1,071,230 ; *Wimmera-Mallee :*—Rocklands, 272,000 ; Total, 538,900 ; *Maffra-Sale :*—Glenmaggie, 106,040 ; *Coliban :*—62,730 ; *Werribee :*—34,900 ; *Mornington Peninsula :*—5,800 ; *Otway :*—1,080 ; *Miscellaneous :*—4,770 ; *Total :*—4,962,550.

Irrigation channels extend 5,000 miles, domestic and stock channels 9,500 miles and drainage and flood protection channels 2,000 miles, a total of 16,500 miles. In addition, the Commission controls 1,200 miles of piping, comprising 250 miles of mains and 950 miles of reticulation. Farm holdings served with water total 37,500 and another 7,000 holdings are in drainage or flood protection districts. Urban districts with a reticulated water supply number 282, of which 131 are served by the Commission's channels and pipelines and 151 are supplied by Trusts under the supervision of the Commission. The total number of persons served by a reticulated water supply is approximately 675,000 or 70 per cent. of the State's population outside Greater Melbourne.

To 30th June, 1957, the net capital expenditure on irrigation, rural water supply, country town water supply, and flood protection and drainage works amounted to £93,979,000, two-thirds of which was in respect of irrigation.

Of this net capital liability, at 30th June, 1957, £81,649,000 was borne by the State and £12,330,000 was borne by the water users. Waterworks Trusts and local governing bodies had a net capital liability of £9,130,000 at 30th June, 1957, of which £3,978,000 was borne by the State and £5,152,000 by the Authorities.

(ii) *Extent of Systems and Nature of Irrigated Culture.* Although the area irrigated is less than 2 per cent. of the State, it yields approximately 15 per cent. of Victoria's rural production. The following table shows the areas of the various irrigation systems and the areas under irrigated culture during 1956–57.

AREAS OF SYSTEMS AND OF LAND UNDER IRRIGATED CULTURE : VICTORIA, 1956-57.

(Acres.)

System.	Total Area.	Area under Irrigated Culture.									
		Cereals.	Lucerne. (a)	Other Fodder Crops.	Pastures.		Vineyards.	Orchards.	Market Gardens.	Fallow and Miscellaneous.	Total.
					Sown.	Natural.					
Goulburn	*1,257,268*	*1,256*	*13,217*	*6,075*	*293,524*	*26,018*	*199*	*14,740*	*2,702*	*4,957*	*362,688*
Murray—											
Torrumbarry Weir ..	377,591	2,571	3,161	2,008	139,879	32,517	6,373	1,148	1,852	2,152	191,661
Yarrawonga Weir ..	267,324	103	23,173	422	65,359	3,159	38	3,536	939	72	96,801
By Pumping ..	35,730	52	236	60	337	76	24,223	1,493	369	269	27,115
Total	*680,645*	*2,726*	*26,570*	*2,490*	*205,575*	*35,752*	*30,634*	*6,177*	*3,160*	*2,493*	*315,577*
Loddon and other Northern Systems ..	*(b) 19,735*	*349*	*1,546*	*687*	*13,406*	*4,372*	*8*	*3,726*	*1,263*	*637*	*25,994*
Southern Systems ..	*148,094*	*71*	*1,891*	*448*	*41,815*	*2,427*	..	*640*	*5,211*	*1,286*	*53,789*
Mildura and Private Diversions	*(c) 45,000*	*2,983*	*7,852*	*2,287*	*43,828*	*9,041*	*15,752*	*6,449*	*5,074*	*3,868*	*97,134*
Grand Total ..	2,150,742	7,385	51,076	11,987	598,148	77,610	46,593	31,732	17,410	13,241	855,182

(a) Includes lucerne for both hay and pasture. (b) Area of Campaspe District only. (c) Area of First Mildura Irrigation Trust only.

(iii) *Production.* The influence of irrigation on Victorian production has been considerable, the value of production from irrigation districts as estimated by the Commission having risen from £500,000 in 1905–6 to about £42 million in 1955–56. The major products of irrigated farms are : dairy products, livestock for slaughtering, wool, vine fruits, fresh and canning orchard fruits and vegetables.

3. **Goulburn System.**—This comprises the Eildon and Waranga Reservoirs, the Goulburn Weir and over 2,570 miles of distributary channels. The total capacity of these storages was 3,104,100 acre feet at 30th June, 1957. The Eildon Reservoir (capacity 2,750,000 acre feet) which was completed in June, 1955, is the largest dam in Australia and the largest earthen dam in the Southern Hemisphere. The enlargement of Eildon means that when the necessary distributary works are completed, the area at present irrigated from the Goulburn River can be practically doubled to 600,000 acres.

Water from Eildon Reservoir flows down the Goulburn for 150 miles to the Goulburn Weir, which raises the summer level of the river about 45 feet to 408 feet above sea level, and where water is diverted to two main channels. The eastern main channel conveys water to four irrigation districts surrounding Shepparton and the western main channel fills Waranga Basin in addition to supplying the eastern portion of the Rodney Irrigation District. Following completion of Eildon Reservoir, the latter channel was duplicated to Waranga Basin.

Two main outlet channels issue from the Waranga Reservoir ; one serves the Western part of the Rodney district, while the other serves districts as far west as Boort, and continuing to Beulah East, about 230 miles by channel from Waranga Basin or some 400 miles from Eildon, supplements the Wimmera-Mallee system.

Districts served comprise 196,000 acres east of the Goulburn ; 602,000 acres between the Goulburn and Campaspe ; 380,000 acres between the Campaspe and Loddon ; and 80,000 acres west of the Loddon—a total of 1,258,000 acres.

The main products of the Goulburn districts are dairy products, fruit, wool and fat lambs. The development of the fruit canning industries is an index of the results of irrigation policy. Annual production from the Shepparton, Kyabram and Mooroopna canneries, together with that of city canneries—from Goulburn Valley fruit—normally represents about two-thirds of Australia's total production of canned peaches, pears and apricots.

4. **Murray River System.**—The waters of the River Murray are used to supply an area of more than 700,000 acres between Yarrawonga and Merbein, and channels totalling 1,450 miles are in service. The districts between Yarrawonga and Swan Hill, except Tresco, are supplied by gravitation and those down the river (Red Cliffs, Merbein, Nyah and Mildura) are supplied by pumping.

The Murray Valley Irrigation District, which is served from Yarrawonga Weir, comprises 267,000 acres with 550 miles of distributary channels. This district lies west of Yarrawonga between the River Murray and Broken Creek, its main products being dairying, fat lambs and deciduous fruit. A major post-war development has been a Soldier Settlement Scheme involving 60,000 acres. With the exception of the necessary drainage works, which are under construction, this project is complete.

The gravitation system based on Torrumbarry Weir (52 miles downstream from Echuca) serves an area of 377,600 acres through 846 miles of supply channels. The weir raises the level of the river some 16 feet and enables water to be diverted throughout the year.

Robinvale Irrigation District, between Swan Hill and Mildura is a soldier settlement project established after the 1939–45 War. Set up on modern lines, the 3,000 acres irrigated annually are showing good yields of fruit. About ninety per cent. of the area is devoted to dried vine fruits, and the remainder to orchards.

Red Cliffs Irrigation District comprising 13,600 acres, of which, at present, 11,650 acres are irrigated, ranks first in importance among Victoria's pumping schemes. A system of main and distributary channels supplies every holding in the district. The district, originally set aside for soldier settlement, has been subdivided into 700 blocks. The area is planted mainly with vines and citrus. The average harvest is now 18,000 tons of raisins, currants and sultanas as well as large quantities of grapes for dessert and distillation.

Merbein Irrigation District comprises 9,200 acres and contains over 300 holdings averaging about 30 acres each. A reticulated pipe system supplies the town of Merbein, and the pumps also supply 51,200 acres forming part of the Millewa Waterworks District,

Nyah Irrigation District is supplied with water diverted from the Murray by a high-lift pumping plant, serving 3,840 acres in about 200 holdings devoted mainly to vineyards.

5. **First Mildura Trust District.**—The First Mildura Irrigation Trust—the only Irrigation Trust operating in Victoria—controls an area of 45,000 acres, of which 15,000 acres are irrigated. Of this area, some 80 per cent. is used for the production of vine fruit and the bulk of the remainder for citrus and other fruit. The Trust area produces approximately 15,000 tons of raisins, currants and sultanas each year. The irrigation water is pumped from the River Murray and distributed through 168 miles of channels.

6. **Wimmera-Mallee System.**—The Wimmera-Mallee scheme is regarded as the most extensive domestic and stock supply system in the world. The main supply is drawn from the Grampians storages with a capacity of 538,900 acre feet. Supplementary water is drawn from the Goulburn channels and the Loddon River. The system serves an area of 11,000 square miles or nearly one-eighth of the State, which is largely devoted to wheat and pastoral industries. Without the artificial supply of water, development would be meagre.

Once a year, in the winter or spring, a volume of 72,000 acre feet of water is distributed through 6,500 miles of open channels and some 3,000 miles of farm channels. It is the responsibility of farmers to provide storages sufficient in size to meet their stock and domestic requirements for the ensuing year. About 10,000 farmers' tanks are served. In addition

forty-seven towns with a total population of 40,000 obtain their water from the system. A total population of 80,000 depends upon the scheme. In the vicinity of Horsham and Murtoa, near the main storage, 3,500 acres are irrigated for soft fruits and pastures. With the completion of the Rocklands Reservoir, this irrigation area is being extended to 7,000 acres.

The northern part of the system is affected by sand drifting into the channels, particularly in years of dry weather conditions, and the Commission is involved in substantial annual expenditure to remove this sand drift before the annual water distribution can be made. This expenditure can be reduced by better farming methods, and efforts in this direction such as the sowing of rye-corn, and the use of compulsory powers to prohibit the fallowing of land or burning of stubble within three chains of channels in light sandy country have resulted in marked savings in maintenance costs.

7. **Private Water Supplies.**—The Rural Finance Corporation Act 1949 gave farmers assistance in establishing or improving domestic and stock water supplies on their farms. Water may be obtained from underground sources, from catchment and gully dams by diversion from existing streams and channels, by storage of sufficient water to meet a year's requirements and by installation of windmills or hydraulic rams.

The control of private diversions from the streams is an important function of the State Rivers and Water Supply Commission. About 10 per cent. of irrigation production in the State comes from private diverters, mainly around the River Murray. In recent years, there have been substantial increases in the areas licensed, the total increase over the past ten years being approximately 50 per cent. At present 4,500 private diverters are licensed annually.

A Farm Water Supplies Branch set up by the State Rivers and Water Supply Commission advises farmers on farm water supply matters even if finance is not required. Comprehensive booklets prepared by this Branch have been widely circulated to landholders.

8. **River Improvement, Flood Protection and Drainage.**—The largest drainage work undertaken by the State Rivers and Water Supply Commission is Koo-wee-rup-Cardinia Flood Protection District embracing 80,000 acres of a continuous depression along the seaboard of Westernport. Once useless, indeed a hindrance to communication, this area now yields primary products worth £3 million per year.

The Rivers and Streams Fund, established in 1931 from the rentals on river frontage reserves, gave an impetus to river improvement, but development accelerated rapidly after the 1948 River Improvement Act.

Under this Act, the formation of River Improvement Trusts is facilitated, assistance being granted by the State Government to supplement funds raised locally, and the importance of river improvement work is expected to continue to grow.

9. **Underground Resources.**—Due to inadequate information as to their extent, the underground waters of Victoria have not as yet been greatly utilized. The first stage of a comprehensive survey of these resources by the Victorian State Rivers and Water Supply Commission, which is responsible for the location, investigation and development of subterranean waters, has been completed and published recently. It provides records of bores in the Mallee, Wimmera and Glenelg regions, and a description of the Murray Artesian Basin. Investigations have also been made into the underground water resources of local areas such as Orbost Flats, Llowalong Estate on the Avon River and elsewhere.

The Murray Artesian Basin underlies an area of 107,250 square miles, of which 26,808 square miles are in Victoria, 28,269 square miles in South Australia and 52,173 square miles in New South Wales. The quality of the water varies from suitable for domestic purposes in much of the South-western part of the basin to saline and suitable for stock in the rest of the basin. Over 300 bores exist in Victoria, with an average daily flow of 3,000,000 gallons. Bores range in depth from 50 to 3,000 feet.

10. **Future Programme.**—With the completion of the Eildon and Cairn Curran Reservoirs, storage capacity in Victoria has risen from 172,000 acre feet in 1902 to nearly 5,000,000 acre feet in 1957. In the near future, as a result of the enlargement of the Glenmaggie and Hume Reservoirs, a further increase of 600,000 acre feet of storage capacity will become available.

The most important work at present facing the Commission is the enlargement of the Goulburn Channel System to enable full advantage to be taken of the additional water now available from Eildon Reservoir. A new channel of 1,500 cubic feet capacity from the Goulburn Weir to Waranga Reservoir, duplicating the channel already there was completed in 1956–57 at a cost of £2,000,000. Approximately half the work was done on other contracts worth £2,750,000 and the channel construction programme generally is being completed as funds become available.

It will be possible to develop the present districts progressively before the whole operation is completed and in the meantime, the water already stored in the Eildon Reservoir will provide a valuable safeguard against any possible drought.

11. **Hydro-electricity.**—Details of hydro-electricity potential and utilization in Victoria may be found in the previous chapter (*see* page 283).

§ 4. Queensland.

1. **General.**—(i) *Rainfall.* Particulars of the rainfall pattern of Queensland were given in Official Year Book No. 37, page 1122. (*See also* Chapter II.—Physiography, page 45 of this Year Book).

(ii) *Administration.* The administration of irrigation and water supply in Queensland is under the control of a Commissioner of Irrigation and Water Supply. For a description of the development of the present administration *see* Official Year Book No. 42 and earlier issues.

(iii) *Water Utilization in Queensland.* Queensland's predominant interest in the field of water conservation is the provision of stock and domestic water supplies in its great pastoral areas which contain nearly half of the Commonwealth's cattle and a seventh of the sheep. But in addition to the stabilization of water supplies in the pastoral areas and the provision of water along stock routes for travelling stock, the development of irrigated pastures on the eastern seaboard for fattening stock adjacent to meat works and markets has received much attention in later years.

The State's agricultural crops differ from those of other States in that a large proportion are tropical. Sugar-cane is the greatest individual crop, representing in value approximately 50 per cent. of total agricultural production. Approximately 16 per cent. of the sugar-cane acreage is irrigated and represents some 50 per cent. of the total irrigated area in Queensland. Queensland is Australia's major tobacco-producing State, and plans are in hand to increase annual production of this crop greatly by means of development under irrigation. The area of tobacco irrigated during 1955–56 represented 88 per cent. of the total plantings of this crop in the State.

2. **Great Artesian Basin.**—(i) *General.* Western Queensland beyond the 20 inch rainfall belt is predominantly pastoral and is mainly dependent for water supplies on artesian and sub-artesian bores and, where surface storage is not readily available, on excavated tanks. The Great Artesian Basin in Queensland corresponds approximately with the area lying west and south of the Great Dividing Range, excluding the Cloncurry Mineral Field and the Barkly Tableland. It comprises 430,000 square miles or about two-thirds of the total State area of 670,500 square miles. Statistics of bores and flow as at 30th June, 1957, are :—Artesian bores drilled, 2,525 ; artesian bores still flowing, 1,627 ; total depth drilled, 3,596,000 feet ; deepest bore, 7,009 feet ; total estimated flow, 211 million gallons a day. The average depth of artesian bores is 1,425 feet. Some 9,000 sub-artesian bores, within the Great Artesian Basin, have been registered in Queensland. Artesian pressure and flow are both steadily diminishing despite new bores drilled. The rate of diminution varies widely throughout the basin. Present general average rates of diminution are :—pressure, 1–2 feet/head, total flow, 1½–2 per cent. per annum.

The greater part of the artesian discharge is distributed by open earth channels totalling some 16,000 miles in length. Most of the water flowing along these channels is lost by soakage and evaporation and less than 10 per cent. is actually used by stock. The amount of soakage depends largely on the permeability of the earth and the rate of evaporation varies from season to season, but the shape and maintenance of the drains constitute further factors. The effective utilization of this water could be increased by the use of piping to overcome the loss by soakage and evaporation occurring in open earth channels.

Although artesian beds underlie such a large area of the State, only 80,000 square miles are primarily watered by bore drains. The remaining area is watered by artesian bores (with small or no flow and limited drains), sub-artesian bores, excavated tanks, dams and natural waterholes. In many districts, artesian bores are not economical watering facilities, because of depth, limited area to be watered, and difficult terrain for distribution of water by drains. High costs have restricted deep drilling. Very few new bores exceed 2,000 feet in depth, and a new bore greater than 3,000 feet in depth is exceptional.

Shallow sub-artesian supplies, of variable quality and volume, are available at depths less than 1,000 feet over a large area of the basin. These beds are not connected with the artesian beds. An essential practical consideration is that the main artesian beds are continuous and the sub-artesian beds are not continuous.

Though the number of bores has gradually increased over the years, the total flow of all bores has declined since the peak flow of 351 million gallons per day was recorded in 1914. By 1938, the flow was only 230 million gallons per day. The decline gave rise to the fear that supplies were giving out and that the basin was seriously threatened. In 1939, the Queensland Government appointed a committee to ascertain the nature and structure of the Great Artesian Basin with particular reference to the problem of diminishing supply. In its final report, presented in 1954, the majority of the Committee found that the output will continue to decline during the next sixty years when the flow from the remaining flowing bores will be of the order of 110 million gallons per day. At this stage the discharge from windmills, springs and other leakages and the underflow past the Queensland borders will be of the order of 20 million gallons per day. The total discharge of the order of 130 million gallons per day will be in equilibrium with the recharge of the basin. Numbers of bores on higher ground will cease to flow during the next sixty years and the area served by flowing bores will contract by perhaps 20 per cent.

A programme of strict conservation, involving the restriction of bore flows and improved bore drains, would result in smaller shrinkage of the area served by flowing bores and would actually cost less than the installation and maintenance of pumps or other watering facilities which would be required to provide alternative water supply as additional bores ceased to flow because of a policy of non-restriction. On the other hand, strict conservation would not increase the amount of water ultimately available as perennial flowing supply and would in fact decrease the amount of water passed from intake beds to aquifers within the basin by flattening the hydraulic gradient. The benefit from strict conservation was not considered sufficiently great, nor sufficiently concrete to warrant implementation.

The quality of artesian water from the greater part of the basin is such that it is not suited for prolonged use for irrigation on most soils. Moreover, artesian supplies are not sufficient for both large scale irrigation and stock-watering. Practically the whole of the final steady-rate discharge from flowing bores will be needed for the watering of stock.

(ii) *Bore Water Areas.* The constitution of Bore Water Areas was inaugurated in 1913 to aid pastoral settlement in districts where large flows were available at a cost beyond individual capacity and to conserve artesian supplies by fully utilizing the flows from the existing bores on the land resumed for closer settlement. Bores and drains are constructed from loan funds repayable over a period of years. The areas are administered by Local Boards or by the Commissioner of Irrigation and Water Supply, acting as a Board. Rates are levied to meet interest, redemption, maintenance and administration costs. Statistics for the year 1956–57 are :—Areas constituted, 63 ; administered by Commissioner, 56 ; administered by Local Boards, 7 ; area benefited, 4,232,671 acres ; average rate per acre, 0.95d. ; number of flowing bores, 55 ; total flow, 25,524,000 gallons per day ; drains served, 2,822 miles.

3. **Other Basins.**—Two major areas marginal to the Great Artesian Basin in Queensland carry artesian water. One occurs on the western slopes of Cape York Peninsula and the other in the Dawson-Mackenzie River Basin. A small area in which flowing wells occur (the Gatton Basin) extends from Gatton to the coast.

Sub-artesian water supply from the Barkly Basin which extends into western Queensland from the Northern Territory, is referred to in the section dealing with the Northern Territory.

4. **Stock Route Watering.**—During 1935, a scheme was inaugurated to water adequately stock routes in the western portion of the State including main trunk routes connecting Eromanga to Burketown, Charleville to Normanton, and Clermont to Einasleigh, with branches to railheads, a total distance of 3,117 miles. Watering facilities were also provided on subsidiary routes. Under the Stock Routes and Rural Lands Protection Act of 1944, a co-ordinating board was constituted, representative of Government departments and pastoral interests, under the direction of the Minister for Lands, and with an officer of that Department as superintendent, whose duty was, *inter alia*, to investigate and implement a long-range, co-ordinated plan for adequate watering of all stock routes through-

out the State. Natural waters are being supplemented by artificial facilities at intervals of about 9 miles. Construction is supervised by the Irrigation and Water Supply Commission and by local authorities. Completed facilities are vested in local authorities for control and maintenance. From 1935 to 30th June, 1957, 409 facilities had been completed and at 30th June, 1957, 77 facilities were under construction or investigation.

5. **Irrigation.**—(i) *General.* Irrigation as a means of stabilizing and increasing agricultural production is receiving growing attention in Queensland. In addition to the Theodore Irrigation Area on the Dawson River, orthodox projects served by a channel system are being developed at Clare, Millaroo and Dalbeg, all on the Burdekin River, Gibber Gunyah on the Dawson River and St. George on the Balonne River. Construction of the Clare, Millaroo and Dalbeg irrigation works was completed during the year ended 30th June, 1957, but a small amount of drainage work requires to be completed. Works were virtually completed in the Gibber Gunyah Area and construction of the St. George Area was advanced sufficiently to permit opening of 10 farms. A start has been made on construction of part of the main channel system within the Mareeba-Dimbulah Irrigation Area. Because of the large variations in both monthly and annual river flows, major developments cannot be undertaken until large storage works are provided. Most irrigation in Queensland is performed by private farmers operating under licence, and obtaining water by pumping from streams or from natural underground storages. Where available, electricity is the most popular source of power for pumping ; the principal areas supplied with electricity comprise the Burdekin Delta and the Lockyer Valley.

Furrow irrigation is used for cotton, sugar cane, most tobacco and some other crops. Spray irrigation is adopted to a considerable extent for fruit, vegetables, fodder crops and a small part of the tobacco. Spraying is well suited to the application of water on deep soils by small pumping plants, particularly when the quantity of water available is limited. Experimental use of the border check method in the irrigation of pasture and fodder crops has proved successful and may supersede other methods.

The following table shows for each division of the State the number of irrigators and the areas under irrigated culture for the year ended 31st March, 1957.

AREA OF LAND UNDER IRRIGATED CULTURE : QUEENSLAND, 1956-57.(*a*)

Division.	No. of Irrigators.	Area under Irrigated Culture (Acres).							
		Vegetables.	Fruit.	Sugar-cane.	Tobacco.	Cotton.	Other Crops.	Pastures.	Total.
Southern Queensland ..	4,259	20,566	2,950	11,949	1,988	5	20,082	4,326	61,866
Central Queensland ..	340	719	115	..	1	326	2,825	526	4,512
Northern Queensland ..	1,479	3,811	595	45,209	4,361	76	533	709	55,294
Total	6,078	25,096	3,660	57,158	6,350	407	23,440	5,561	121,672

(*a*) Year ended 31st March, 1957.

The growth of irrigation is illustrated by the following figures for the total area of irrigated land :—1906, 9,922 acres ; 1916, 10,886 acres ; 1926, 24,250 acres ; 1935–36, 44,283 acres ; 1945–46, 68,347 acres ; 1955–56, 136,019 acres.

The pattern of irrigation in Queensland is unlike that in southern States ; the more important developments in tropical and sub-tropical areas are therefore discussed briefly in the sub-sections following. It should be noted that the spring to autumn " irrigation season " of the temperate southern irrigated lands is not applicable, and that round-the-year irrigation is required throughout most of the State, the timing and duration of the summer " wet " season being too variable to enable a definite non-irrigation season to be fixed.

(ii) *Lockyer Valley.* West of Brisbane and within 30 miles of that metropolitan market is the Lockyer Valley, which is portion of the Brisbane River Basin. The Valley comprises an extensive flood plain where heavy black alluvial soil thickly overlies gravels and sands carrying water suitable for irrigation. Despite a mean annual rainfall of 30

inches the variation is great, and irrigation is necessary for continuous agricultural production. Surveys suggest that some 60,000 acres of land highly suitable for irrigation are available. Of this area, only about 30 per cent. is under irrigation, the number of pumps operating from wells and open water exceeding 550 and 600 respectively. Over 60 per cent. of the farmers operate electric pumps for irrigation purposes and a special policy designed to encourage such development is fostered by the Southern Electric Authority of Queensland. The Irrigation and Water Supply Commission has constructed a number of small weirs on Lockyer Creek with a total storage of 1,370 acre feet. These also tend to augment and conserve underground supplies. To study local problems, an Irrigation Research Station was established at Gatton in 1946 by the Bureau of Investigation.

The Lockyer Valley produces a substantial proportion of Queensland's onions, potatoes, pumpkins, lucerne, hay, green fodder, maize and dairy products.

(iii) *Burdekin River.* The Burdekin River, which enters the sea between Townsville and Bowen, is a major factor in the life of North Queensland. In most years, heavy floods from a catchment twice the size of Tasmania cause extensive damage and traffic disabilities. On the other hand, the fertile Delta Area with its underground water supplies at shallow depth has contributed greatly to the agricultural prosperity of North Queensland. Present development is confined to the Delta Area. The average annual rainfall of this area is some 41 inches, but the major part falls in the months December to March. Consequently sugar growers and other farmers have tapped the underground water resources of the Delta to obtain supplies in the dry periods. Sugar is the main irrigated crop, though citrus, pine-apples, vegetables and tobacco are also irrigated. The irrigated area is in excess of 30,000 acres, up to 1,000 acre feet of water being drawn daily from underground sources.

In the Home Hill–Inkerman areas on the south side of the Burdekin, water is obtained from shallow wells by electric pumps supplied from a local power station controlled by the Townsville Regional Electricity Board. Around Ayr, on the north side of the river, electric power from the mains of the Townsville Regional Electricity Board is now being adopted in place of the individual internal combustion engines previously used. At both Home Hill and Ayr, water for domestic supply is raised by a windmill on each property.

In 1940, the Burdekin River Trust was formed to safeguard the sugar areas of the Delta from erosion and floods. An Irrigation Research Station has recently been established to study the development of pastures and irrigated crops under local conditions.

A major multi-purpose scheme, involving irrigation, flood control and hydro-electric power generation, is being investigated by the various interested Government Departments under the general supervision of the Burdekin River Authority. The development envisaged includes a dam storing 6,584,000 acre feet, which would make water available for the irrigation of at least 250,000 acres. The principal industries anticipated are tobacco-growing, dairying and cattle-fattening, with sorghum, sunflowers, peanuts, cotton and sugar-cane as other possible forms of production. The projected scheme, together with the high-level railway bridge at present under construction, will change the Burdekin from a mixed blessing to one of the Commonwealth's greatest resources for agricultural and industrial production.

The Clare Irrigation Area, constituted in 1949, the Millaroo Irrigation Area, constituted in 1952, and the Dalbeg Irrigation Area, constituted in 1953, are at present being developed for tobacco production. Located from 25 to 65 miles upstream from the mouth of the Burdekin, these areas comprise 12,000 acres and obtain irrigation waters from central pumping stations drawing initially on the unregulated flow of the Burdekin. A temporary storage of 6,700 acre feet capacity has been constructed about 79 miles upstream from the mouth of the Burdekin. To 30th June, 1957, 73 farms had been opened for selection in the Clare Area, 60 in the Millaroo Area and 45 in the Dalbeg Area.

(iv) *Dawson Valley.* The Dawson River, a 392-mile long tributary of the Fitzroy River, rises in the Carnarvon Range and joins the Mackenzie River to form the Fitzroy 50 miles west of Rockhampton. Lands bordering the river in its northerly course of about 170 miles before its confluence with the Mackenzie River are commonly termed the Dawson Valley. A scheme for the development of the Dawson Valley under irrigation was inaugurated in 1923, providing for the irrigation of 70,000 acres. Storage for the scheme was to be provided by a dam of 2,000,000 acre feet capacity at Nathan Gorge. Much investigational and survey work on the scheme was carried out, but the general financial depression and limited loan funds brought about the cessation of this work. However, the initial step in construction had been completed, comprising a weir on the river at Theodore and irrigation works to serve an area of 3,500 acres supplied from a central

pumping station. Two additional weirs have since been built, giving a total storage of 9,000 acre feet. Pasture, vegetables, cotton, fruit and dairy products are the principal produce. Attention has recently been given to the former plans for the Valley and earlier work is now under close scrutiny as a prelude to future development. Construction of works to serve some 2,400 acres at Gibber Gunyah, adjacent to the existing Theodore Area, was virtually completed at 30th June, 1957, and allotment of farms had commenced.

(v) *Mareeba-Dimbulah Area.* The existence of large areas of sandy soils suitable for tobacco production in the valleys of the Walsh and Barron Rivers in the neighbourhood of Mareeba and Dimbulah has led to large-scale investigations into possible irrigation development in the area. Surveys indicate that 40,000 acres of land suitable for irrigated culture, including 32,000 acres suitable for tobacco, are available. In 1955–56, some 3,026 acres of high-grade tobacco were grown. Seven weirs of combined capacity of 2,600 acre feet have been completed on a number of streams to store water for irrigation.

During 1952, a report on the utilization of waters of the Barron and Walsh Rivers was prepared and the establishment of an irrigation undertaking approved by the Queensland Government. The projected undertaking provides for construction of a major storage at Tinaroo Falls on the Barron River to store 320,000 acre feet, and construction of irrigation works to serve 78,000 acres commanded by this storage. In each case, construction has commenced. Further development by construction of a second storage at Nullinga on the Walsh River has been deferred for the present. Tobacco will be the basic crop while peanuts, vegetables, maize, cotton and stock fattening also appear suitable.

(vi) *Border Rivers Project.* The development of the rivers constituting portion of the border between Queensland and New South Wales is under the authority of the Dumaresq-Barwon Border Rivers Commission on which each State is represented. For information on the project *see* page 302.

(vii) *Balonne River.* The St. George Irrigation Area has been constituted and construction of works to serve some 11,000 acres is in progress. Water supply for the area will be obtained by pumping from the combined weir and road bridge on the Balonne River at St. George.

6. **Bureau of Investigation.**—Under the Land and Water Resources Development Act of 1943, a Bureau of Investigation has been set up for the co-ordinated investigation of land and water resources development.

The Bureau consists of representatives from the authorities controlling water resources, lands and agriculture, under the chairmanship of the Co-ordinator-General of Public Works. Among notable works carried out by the Bureau of Investigation since its inception has been the trial planting of irrigated pastures with a view to developing mixtures suited to the special conditions of each part of the State. Other valuable work has included the mapping of the ultimate land uses of the State and the detailed investigation of the agricultural and pastoral potentialities of many regions.

7. **Channel Country.**—Extensive investigations of the Channel Country fed by inland rivers in the south-western corner of the State have been made by the Bureau of Investigation. This country is intersected by shallow and irregular flood channels through which huge volumes of flood waters pass in favourable seasons ; consequent on the flooding, a heavy growth of natural pastures is produced on the flooded lands, providing feed in quantities far in excess of that required for the normal stock population of the area. If the occurrence of flooding could be made more reliable by means of storages to create artificial floods, the pastoral resources of the area would be enormous. However, inquiries directed on these lines have revealed that little can be done to increase or stabilize the turn-off of fat cattle by artificial storage.

At 30th June, 1952, 41 watering facilities, at an estimated cost of £277,000, had been proposed under a Commonwealth-State agreement for stock routes through, and in the approaches to, the Channel Country. By 30th June, 1957, 28 had been completed, while two sub-artesian bores and one excavated tank were under construction.

8. **Hydro-electricity.**—An outline of Hydro-electricity Schemes operating in Queensland is given in the previous chapter (*see* page 286).

§ 5. South Australia.

1. **General.**—(i) *Rainfall.* Brief particulars of the climatic conditions in South Australia were given on page 1129 of Official Year Book No. 37. (*See also* Chapter II.—Physiography, p. 45 of this Year Book.)

(ii) *Administration.* Water supplies, other than irrigation works, are under the control of the Engineering and Water Supply Department, which administers the Waterworks Act governing the supply of water through mains in water districts for townships and farm lands. The Water Conservation Act provides for the construction of storages in non-reticulated areas and authorizes the Minister to " divert and impound the water from any streams or springs or alter their courses, and take water therefrom, or any other waters as may be found in, under, or on, any land entered upon for the purpose of supplying water to the inhabitants of any water district ".

(iii) *Methods of Catchment and Conservation.* Early steps were taken to vest all running streams, springs and " soaks " in the Crown. Since the Water Conservation Act was passed in 1886 more than 550 dams, tanks and " rainsheds " have been built or acquired by the State, in addition to 460 wells and 340 bores, at a total cost of £1,751,269. The rainsheds comprise timber frameworks roofed with galvanized iron to catch precipitation which is delivered to storage tanks. Rainshed catchments vary from a few hundred square feet to four acres, discharging water into tanks ranging in capacity from 2,000 to 500,000 gallons. Over most of the State extraordinary precautions are taken to counteract evaporation. Pipelines in preference to open channels are used to reduce seepage and evaporation. Meters are attached to practically all services to check usage by individual consumers.

2. **Irrigation.**—In South Australia, irrigation is almost exclusively confined to the Murray Valley. Except for that held in various lock pools, no water from the Murray is stored in South Australia. Water is either pumped on to the land or gravitated from the river. The upper Murray of South Australia and the Mildura area of Victoria formed the cradle of Australian irrigation. South Australian irrigation commenced with an agreement between the Government and the Chaffey brothers in 1887 whereby an area of land at Renmark was made available for the establishment of certain irrigation works. Including land allotted for War Service Land Settlement purposes, the Department of Lands administers in the Murray Valley an area of 32,729 acres of irrigable high land together with 9,434 acres of reclaimed swamp and 167,223 acres of non-irrigable land in the irrigation areas and 29,731 acres of land temporarily leased and reserved for commonage or other purposes, amounting in all to 239,117 acres. In addition, the Renmark Irrigation Trust controls 20,557 acres, of which more than 9,500 are irrigated. Water used for irrigation purposes in 1956–57 in the high land irrigation areas controlled by the Department of Lands, excluding War Service Land Settlement areas in course of development, was approximately 100,000 acre feet. No water was applied to the reclaimed areas during the 1956–57 season because of inundation by the floodwaters of the River Murray The swamps were de-watered however, by 30th June, 1957. In the Renmark area, 28,200 acre feet of water were used for irrigation in 1956–57. The production of the upper Murray areas is almost exclusively fruit and vines. Principal crops are sultanas, currants, lexias, apricots, peaches, nectarines, pears and figs (mainly for dried fruit), wine grapes, and citrus fruits. Before irrigation, these semi-arid lands were of little productive value.

Renmark Irrigation Trust is administered by a local board of management consisting of seven members. This area differs from other South Australian irrigation areas in that the land is freehold instead of leasehold, self-contained and self-controlled. Every settler is entitled to vote for the election of Trust members. The Trust maintains 100 miles of channel for reticulation to 9,550 acres.

The following tables show the acreage devoted to various crops in the government-controlled and Renmark Irrigation Trust areas on the upper Murray, and in the government-controlled reclaimed swamp districts near the mouth of the Murray, which are devoted to dairying.

AREA OF LAND UNDER IRRIGATED CULTURE, 1956–57.

IRRIGATION AREAS ADMINISTERED BY THE DEPARTMENT OF LANDS AND THE RENMARK IRRIGATION TRUST.

(Acres.)

Area.	Vine Fruits.	Tree Fruits.	Citrus Fruits.	Lucerne.	Sown Pastures.	Total.
Areas Administered by the Department of Lands.						
Orchard Land—						
Berri	5,304	958	1,260	..	..	7,522
Cadell	600	141	113	..	..	854
Waikerie	1,930	509	1,186	..	..	3,625
Cobdogla	3,929	160	184	..	..	4,273
Moorook	341	131	208	..	..	680
Kingston	239	77	233	..	..	549
Mypolonga	..	341	536	..	..	877
Chaffey—Ral Ral Division	795	55	12	..	..	862
Total	*13,138*	*2,372*	*3,732*	..	..	*19,242*
War Service Land Settlement—						
Cooltong Division ..	380	245	483	..	..	1,108
Loxton area ..	3,063	1,060	2,176	..	..	6,299
Loveday Division ..	235	47	22	..	..	304
Total	*3,678*	*1,352*	*2,681*	..	..	*7,711*
Reclaimed Swamp Land—a						
Monteith	..	..	..	..	..	..
Mypolonga	..	..	..	..	..	..
Wall	..	..	..	..	..	..
Burdett	..	..	..	..	..	..
Mobilong	..	..	..	..	..	..
Long Flat	..	..	..	..	..	..
Neeta	..	..	..	..	..	..
Pompoota	..	..	..	..	..	..
Cowirra	..	..	..	..	..	..
Jervois	..	..	..	..	..	..
Total	..	..	..	..	..	..
Renmark Irrigation Trust.						
Renmark Irrigation Trust	*7,330*	*950*	*1,270*	..	..	*9,550*

(*a*) No water was applied to these lands during 1956–57. *See* text.

3. **Water Supply Schemes.**—(i) *Summary.* Water conservation and distribution works in South Australia have cost £51,264,226 (exclusive of river control and irrigation works on the River Murray which are dealt with above). A summary of statistical information concerning country supplies in 1956-57 is as follows :—Length of water mains, 5,934 miles ; capacity of storages, 35,092 acre feet ; approximate population served, 300,000; area served, approximately 5,000,000 acres ; total capital cost, £27,237,093.

Areas extending for a distance of 90 miles north of Adelaide are supplied from the Warren and Barossa Reservoirs in the Barossa Ranges. Further developments currently being undertaken include the construction of a main pipeline and pumping stations for

pumping water from the River Murray to Adelaide and, by means of a branch pipeline, to Warren Reservoir. Another reservoir (South Para Reservoir), to supplement the Warren and Barossa Reservoirs, is also being constructed on the South Para River. Agricultural towns and areas further north are supplied from Beetaloo, Bundaleer and Baroota Reservoirs, with a connexion to the Warren system. Eyre Peninsula has, up to the present, been supplied from the Tod River Reservoir (9,167 acre feet) and three small reservoirs near the Franklin Harbour District, but demands have increased to such an extent in recent years that further sources of supply are necessary, and with this end in view a water-bearing area known as the Uley-Wanilla Basin has been developed, and water from it is now being used in the Tod River system.

(ii) *Morgan-Whyalla Water Supply Scheme.* For particulars of the construction and works of the main 223-mile pipe line bringing water from the Murray at Morgan to Whyalla on Spencer Gulf *see* Official Year Book No. 37, page 1132. A 19-mile branch-line has also been constructed to Jamestown. The Morgan-Whyalla Water Supply Scheme forms part of the South Australian Country Water Supply system referred to above.

4. **Underground Water.**—The occupied portion of South Australia is, on the whole, well endowed with underground water and the extent of the several artesian basins is reasonably well known. There are also considerable areas, notably in the south-east of the State, in which ground water occurs. Quality varies widely, but a great deal is at least useful for watering stock, the major use to which it is put.

The deepest portion of the Great Artesian Basin (in the north-east) is not extensively developed because development costs are large in proportion to the carrying capacity of the arid land. However, deep boreholes have been drilled by the government to provide watering places along stock routes, and pastoralists rely largely on supplies from non-pressure aquifers at shallower depths. Marree township is supplied from this source, its deepest bore being 575 feet.

The use of the waters of the Murray Basin is essential to settlement in the Murray Mallee country and in the south-east of the State, especially for farms, but also for township supplies to Mount Gambier, Naracoorte, Bordertown, Pinnaroo, Penola, Lamaroo, Coonalpyn, Nangwarry, Mount Burr, Kingston (S.E.), Parilla and Karoonda. The deepest bore in this Basin is 415 feet. Towns elsewhere which are supplied from bores include Mount Barker, Port Lincoln, St. Kilda, Peterborough, Warooka and Willunga.

Pastoralists, farmers, market gardeners and others have been assisted with expert advice on drilling, for which the Government maintains about 30 drills. The whole of the Murray River Basin has been examined critically to ascertain the extent of land which could be used for lucerne and considerable tracts of previously undeveloped country in the Upper South-east, Kangaroo Island and Yorke Peninsula have been found to have usable water and are now being opened up.

Ground water resources surveys are undertaken continuously by Departmental geologists, the results being published in various bulletins, reports and investigations issued from time to time.

5. **Farm Water Schemes.**—While the Department of Mines and Engineering and Water Supply Department give assistance to individual farmers in the provision of supplies from underground sources, a great part of the farming areas derive water supply under pressure from the extensive distribution systems connected to various reservoirs on the Murray River.

6. **South-Eastern Drainage.**—For some information on the drainage schemes necessary for the disposal of surplus water in areas in the south-east of South Australia *see* Official Year Book No. 37, page 1133.

§ 6. Western Australia.

1. **General.**—(i) *Rainfall.* Brief particulars of the climatic conditions in Western Australia were given on page 1133 of Official Year Book No. 37. (*See also* Chapter II.—Physiography, page 45 of this Year Book.)

(ii) *Administration.* Irrigation districts are administered by the Minister for Water Supply, Sewerage and Drainage under the Rights in Water and Irrigation Act 1914–1951, and he is advised by an Irrigation Commission representing the local irrigationists and governmental technical and financial branches. Water supplies in country areas in Western Australia coming under the provisions of the Water Boards Act 1904–1954 and the Country Areas Water Supply Act 1947–1954 (which are administered by the Minister for Water Supply, Sewerage and Drainage) are controlled either by the local authority or by the Water Supply, Sewerage and Drainage Department. Those controlled by the Water Supply, Sewerage and Drainage Department (except for some water supplies to country towns still under the provisions of the Water Boards Act) form the Country Areas Water Supply, consisting of the Goldfields and Agricultural Water Supply (formerly the Goldfields Water

Supply) the Great Southern Towns Water Supply and water supplies to country towns. Also controlled by the Water Supply, Sewerage and Drainage Department are individual water supplies serving isolated mines, stock routes, and agricultural areas: these works are done under the provisions of the Public Works Act 1902–1956. The Water Supply, Sewerage and Drainage Department is divided into metropolitan and country parts. The country part is combined with the Public Works Department. The Minister for Works is also the Minister for Water Supply, Sewerage and Drainage. Water rights over water flowing in streams and watercourses are vested in the Crown unless specifically appropriated for irrigation purposes under the irrigation legislation.

2. **Irrigation.**—(i) *South-West.* The main irrigation areas are situated along the South-Western Railway between the towns of Waroona (70 miles from Perth) and Dardanup (116 miles from Perth).

The Water Supply, Sewerage and Drainage Department controls three irrigation districts—Waroona, Harvey and Collie—the total area irrigated in these districts during 1956–57 being 24,724 acres and the total water used approximately 75,000 acre feet. The total of acre waterings (that is, the number of acres watered multiplied by the average number of waterings) was 141,714. Investigations are being carried out with a view to irrigating a further 30,000 acres south of the Collie Irrigation District.

The Waroona Irrigation District (10,302 acres) is supplied from Drakes Brook Dam (1,854 acre feet capacity) and Samson Brook Dam (6,624 acre feet), the Harvey Irrigation District (36,823 acres) from the Harvey Weir (8,370 acre feet) and Stirling Dam (44,160 acre feet), and the Collie Irrigation District (36,020 acres) from the Wellington Dam (29,440 acre feet).

The following table, which shows acre waterings supplied to crops in the irrigation districts of Harvey, Waroona and Collie during the seasons 1952–53 to 1956–57 illustrates the growth of these irrigation schemes.

IRRIGATION, WESTERN AUSTRALIA : ACRE WATERINGS(*a*).

Year.	Pasture.	Fodder.	Potatoes.	Vege-tables.	Orchard.	Flax, Broom Millet, and Preparation of Ground.	All Crops.
1952–53	95,491	2,235	4,185	2,588	1,070	536	106,105
1953–54	98,645	3,435	4,405	3,003	1,072	115	110,675
1954–55	112,659	3,268	2,363	3,294	845	121	122,550
1955–56	108,468	3,599	1,834	3,452	946	127	118,426
1956–57	129,502	3,757	3,995	3,317	1,024	119	141,714

(*a*) Number of acres watered multiplied by average number of waterings.

(ii) *General.* In 1956–57 the total area irrigated in Western Australia was 38,567 acres made up of vegetables (7,990 acres) fruit (5,137 acres) vineyards (493 acres) pastures (23,320 acres) and other crops (1,627 acres).

An area of approximately 500 acres of Gascoyne River flats adjacent to Carnarvon has been under irrigated cultivation for a considerable period. The principal crop has been bananas but others such as beans and tomatoes, are also grown. For this agriculture a total of over 220 acre feet of water per week is drawn from river underflow.

Following successful experimental work, commercial production of rice is currently being developed, requiring irrigation water to be diverted from the Fitzroy River. The first stage of this work involving the deepening and grading of an anabranch of the Fitzroy River 25 miles to the rice growing area where a natural storage of 2,000 acre feet existed, was carried out by the Public Works Department in 1956.

The Ord River in the Kimberley Division of Western Australia traverses a tropical area served with monsoonal rains of irregular incidence and quantity, varying from 20 inches in the south to 30 inches in the north. The hottest months (December to March) are also the months of highest rainfall. Communications and population are sparse. The Western Australian Government is considering a proposal to build a dam to conserve 3,000,000 acre feet of water, equipped with a hydro-electric plant, which might supply irrigation water for an area of 100,000 acres, if investigations show that the climate and soil conditions are suitable for vegetables, tropical fruits and rice. The economic production of these and other crops, as well as the possible use of such irrigation areas for interim fattening of cattle, is being examined at the Kimberley Research Station on the Ord River.

3. **Water Supply Schemes.**—(i) *Goldfields and Agricultural Water Supply.* Western Australia has one of Australia's most spectacular water supply schemes, and a brief account of its development will be found on page 1134 of Official Year Book No. 37, and an account in greater detail on page 576 of Official Year Book No. 6. Mundaring reservoir on the Helena River, 26 miles from Perth, is the source of water supplied to the Eastern Goldfields and has a capacity of 55,767 acre feet and a catchment of 569 square miles. The water passes through 346 miles of main, mostly steel and 30 inches in diameter, aided by seven pumping stations and one booster pumping station.

Maximum pumping capacity from No. 1 Pumping Station at Mundaring Weir is nominally 15.9 million gallons per day. The total capacity of all receiving, regulating, standby and service tanks along the main pipe line is 154 million gallons which includes three standby reservoirs at Kalgoorlie having a combined capacity of 60 million gallons.

Hundreds of miles of branch pipe lines have been laid to mining areas, agricultural areas and country towns, a notable one being the Norseman extension of 101 miles. The system serves some 72 towns and water is reticulated to about 2,000,000 acres of mixed farming lands. The total length ot pipe lines is 2,578 miles and the number of services is 20,647. The total quantity of water pumped from Mundaring in 1956–57 was 3,076 million gallons. The total cost of the scheme to the end of 1956–57 was £11,410,906.

District water supply schemes established for the purpose of supplying certain country towns and mixed farming lands have been absorbed into the Goldfields and Agricultural Water Supply Scheme. For further particulars *see* Official Year Book No. 37, page 1135.

(ii) *Comprehensive Water Supply Scheme.* A comprehensive water supply scheme to supplement water supplies to the goldfields, agricultural areas, and country towns, authorized in 1947 as a joint work between the Commonwealth and State and estimated to cost £10,000,000 is at present (1957) under construction in two main parts. The northern section is an enlargement and extension of the Goldfields and Agricultural Water Supply Scheme. The southern section is the Great Southern Towns Water Supply Scheme. Linked with Wellington Dam (initially an irrigation work on the Collie River) by 80 miles of 30-inch diameter pipe through two pumping stations to Narrogin, it will eventually supplement the existing water supplies to country towns along the Great Southern Railway, north to Brookton and south to Katanning. The raising of the impounding wall of Wellington Dam to increase its storage to about 150,000 acre feet is also in progress.

(iii) *Country Towns Water Supplies.* Country towns supplied by schemes otherwise than above comprise those in the remaining agricultural and mining areas, including the North-West and Kimberley Divisions. Sixty separate reticulated water supplies serve country towns. Of these, 50 are controlled by the Public Works Department and the remainder by the Local Authority.

(iv) *Catchments.* The water supplies to these country schemes come from stream flow, dams, tanks, wells and bores. Three types of catchment peculiar to this State deserves special mention, namely, rock catchments, which consist of mostly clear granite out-cropping rock, from which the overall run-off from rain amounts to approximately 40 per cent.; bituminous catchments, which are areas which have been sealed with emulsified bitumen—some hundreds of acres have been so treated and yield a run-off of approximately 80 per cent. of the rainfall; and roaded catchments, where selected areas of a catchment are cleared, graded and formed into roads to assist in obtaining additional rainfall run-off.

4. **Underground Water.**—Individual farmers, orchardists, market gardeners and others pump ground water from wells and bores, using windmills, engines or electric power. Water is also obtained from artesian and sub-artesian bores. The Public Works Department hires out to local authorities boring plants which are then hired out to farmers to assist their boring operations. In addition the Public Works Department operates its own boring plants and contracts with private firms in connexion with water supply works.

§ 7. Tasmania.

1. **General.**—(i) *Rainfall.* Brief particulars of the rainfall pattern in Tasmania were given on page 1136 of Official Year Book No. 37. (*See also* Chapter II.—Physiography, page 45 of this Year Book.

(ii) *Main Purposes of Conservation and Utilization.* Owing to Tasmania's fortunate rainfall position, scarcity of water is not a serious problem in normal seasons. Conservation of water for hydro-electric generation is the predominant interest, and conservation for

domestic and industrial purposes is more important than irrigation. Conservation of water on farms is not practised to the same extent as on the mainland, probably because running streams and good rainfall are on a more generous scale. Provision of artificial storages (apart from house tanks) is rare, but progressive landowners are beginning to take advantage of modern plant, such as bulldozers, to provide small excavated storages on their properties. Underground water is of poor quality, but a small quantity which has been exploited to a limited extent only by bores and windmills exists over an area in the Midlands. Geological conditions do not appear to favour the utilization of underground water except on a minor scale.

(iii) *Administration.* The State does not own all natural waters, and consequently the subject of water rights is a difficult one. The Mines Department has power to grant certain rights for mining operations, and the Hydro-Electric Commission must approve the abstraction of water from any stream or lake of potential value for power generation. Under the provisions of an Act passed in 1944, the Water, Sewerage and Drainage Board was constituted to consider the financial and technical practicability of all water supply schemes constructed by local authorities, other than the cities of Hobart and Launceston. Legislation was also enacted during 1952 empowering Local Authorities to take water from specific sources of supply and to construct waterworks. The Act does not cover irrigation, which is practised to a limited extent only by private interests. Provision has been made in the Act for the protection of riparian rights, but there is no general legislation for the control of water courses.

2. **Hydro-electricity.***—Tasmania depends entirely on water for power development. The Hydro Electric Commission, the authority controlling the generation of electricity in Tasmania, conducts a continuous survey of the water power resources of the State assisted by modern methods such as aerial photography and geophysical exploration.

Most of the water potential is located on the Central Plateau with an area of about 1,500 square miles at an altitude of from 2,000 to 4,000 feet and subject to rainfall of from 30 inches a year in the east to 80 inches on the western perimeter. On the plateau are a large number of lakes which provide the means for storage at low cost. These include Great Lake with an area of 58 square miles, Lake St. Clair and Lake Echo, each more than 12 square miles, and others of smaller area. Parliamentary approval has recently been given for the Commission to proceed with the development of the waters of the Great Lake through a 300,000 kW underground power station at the foot of the Western Tiers some 10 miles from Cressy. The power station will operate under a head of 2,750 feet and will utilize the existing Great Lake storage which is to be supplemented by water pumped from an additional storage which will be created at Arthurs Lakes some four miles to the east of the southern end of the Great Lake.

The Derwent River and its tributaries which flow south-easterly carry off by far the greater part of the water which falls on the plateau and these rivers are therefore the most abundant source of power. They have been the cheapest to develop to date and most of the existing generating stations are located on them.

The three main rivers running westerly from the plateau—the Arthur, Pieman and Gordon—have only a small portion of their catchment areas at high level, but they run through regions of high rainfall and their power potentials are considerable. However, because of inaccessibility and climate, development of these rivers may be rather expensive and has been deferred in favour of more convenient schemes.

Rivers draining from the plateau towards the north and north-west coast, including the Emu, Forth and Mersey, have small catchments at high levels and no natural storages.

Two other important water power sources, independent of the Central Plateau, are the South Esk River in the north and the Huon River in the south. A power station at Trevallyn, near Launceston, utilizes water from the South Esk. The Huon has a large low-level catchment in the high-rainfall area near the west coast. Storage could be provided on this river at a reasonable cost and, because of its proximity to Hobart, a future power station would have considerable value for peak load development.

3. **Industrial.**—Three principal industrial schemes have been installed privately. Australian Newsprint Mills Ltd. pump approximately 6 million gallons a day from the Derwent River at Lawitta for the Boyer Mills. Associated Pulp and Paper Mills Ltd. pump several million gallons a day from the Emu River at Burnie, and Titan Products Pty. Ltd. reticulate water from Chasm Creek to their factory at Heybridge. In addition the State has constructed a regional water scheme to serve the Australian Aluminium Production Commission's plant at Bell Bay on the River Tamar and to supply several Municipalities with bulk water for domestic and industrial purposes.

* *See also* Chapter VIII.—Electric Power Generation and Distribution, p 291.

A second regional water scheme draws water from the River Derwent at Lawitta to provide domestic and industrial supplies in five southern Municipalities. Potential sources capable of greater development without storage exist on the Derwent, South Esk, Huon, Lake, Mersey and Forth Rivers. There is also a great reserve of untapped permanent streams in the western half of the State which is largely unsettled. Diversion to the eastern side of the watersheds is not regarded as practicable.

4. **Irrigation.**—There are no State irrigation projects, but preliminary inquiries as to the possibility of establishing one in the Coal River Valley have been made. Legislation is before Parliament to give a new Commission extensive powers for river control and for the design of irrigation projects. All systems operating are privately owned, and with one exception (at Bushy Park) are single-farm units. At Bushy Park, a small system serves a group of properties. The larger proportion of the area under irrigation is watered by gravitational systems and the remainder comprises areas devoted to vegetables and served by municipal water supplies. Irrigation as practised in Tasmania, was applied in 1956–57 to 12,110 acres devoted to : hops (1,330 acres) ; fruit (773 acres) ; pastures (7,421 acres) ; green fodder, etc. (877 acres) ; and other crops (1,709 acres).

§ 8. Northern Territory.

1. **Climate and Topography.**—Some particulars of the climate and main topographical features of the Northern Territory were given on page 1138 of Official Year Book No. 37, and in this issue information on climatic conditions will be found in Chapter II.—Physiography, and a brief outline of contour and physical characteristics in Chapter V.—The Territories of Australia.

2. **Administration.**—Under the Control of Waters Ordinance 1938–1955 of the Northern Territory natural waters are vested in the Crown. Where a watercourse or lake forms a boundary of any land alienated by the Crown, the beds and banks are deemed to remain the property of the Crown (except in special cases) and diversion of water is prohibited except under conditions prescribed. There is a Water Use Branch in the Northern Territory Administration under the control of a Director. The functions of the Branch include systematic stream gauging, collection of data on surface and underground water supplies, planning of water use for irrigation and town water supplies, flood prevention and control.

3. **Underground Water.**—The marked seasonal rainfall over the whole of the Northern Territory is one of the basic factors affecting the pastoral industry which provides the bulk of the Territory's income. The inadequacy of surface water during the dry season underlines the importance of underground water supplies in the Territory where most of the cattle population is dependent on underground supplies for three to five months each year.

Rainfall is one of the factors controlling cattle population but geological features, controlling both soils and the storage of underground water, are even more important. In the northern-most portion of the Territory, which receives from 25 to 60 inches of seasonal rainfall per year, surface water supplies are, in general, adequate for the pastoral industry. Despite this, however, this area has a comparatively low carrying capacity for cattle and the pastoral industry is concentrated more in inland areas where feed retains more nutritive value in the winter despite dry conditions.

South from this well-watered northern-most portion, the Territory becomes progressively drier, with an annual average rainfall of only five inches at the margins of the Simpson Desert in the south-east corner. In the lighter rainfall areas, the search for potable underground water becomes exacting but, in general, the regions providing the best pastures—the Ord-Victoria Region, the Barkly Tablelands and smaller areas in the Alice Springs district—provide also sub-surface conditions suitable for the storage of water. This comes about largely because, in these areas, both pasture and water are related to flat lying or gently folded limestones or volcanics of Upper Proterozoic or Cambrian age, overlying the basement of older, more tightly folded, metamorphic rocks and granites which crop out over wide areas within the Territory.

In the Ord-Victoria Region, probably the best grass lands overlie volcanic rocks and extend over some 10,000 square miles. Ground water is obtained in shallow bores averaging 70 to 80 feet in depth and producing small supplies which range up to 1,500 gallons per hour. For the most part, water is stored in joints, faults or cracks in the rocks although

in places sub-artesian conditions pertain and, on the whole, selection of bore sites is difficult. There are also small sedimentary basins in the region, some of which yield sub-artesian, and in places, artesian water and provide areas of good pastures.

The Barkly Tablelands, which extend into Western Queensland, overlie flat-lying limestone, sandstone and shale of the Barkly Basin. In most places, underground water is under pressure (sub-artesian) but no flowing bores are known. Sandstones and beds of limestone with fractures and solution cavities provide a number of aquifers within the Basin. The hydraulic surface (to which pressure water will rise in bores) ranges between 500 and 600 feet above sea level and adequate supplies for the watering of stock are available at depths ranging from 150 to 400 feet from the surface. The water from over 90 per cent. of the bores is suitable for stock and over 50 per cent. of it is suitable for human consumption. Investigations by the Commonwealth Bureau of Mineral Resources indicate that underground water supplies will be more than sufficient for the future development of the pastoral industry on the Tablelands.

A review is being made of the information available concerning the number of bores and wells sunk in the Territory. Preliminary information shows that in 1956–57, some 1,190 bores and 190 wells were registered. Of the 1,190 bores, 621 were on pastoral properties (33 being provided by the Government by way of assistance to pastoralists), 25 on Native Reserves, 8 for town water supplies and 6 for mining fields. It is not known how many of 341 registered bores drilled originally for defence and road construction purposes are still in use but it is probable that most of them have been abandoned.

The number of stock route bores established by the Government for watering some 2,500 miles of stock routes, is 160 which represents on the average one every 16 miles.

Regional surveys by the Bureau of Mineral Resources and the Commonwealth Scientific and Industrial Research Organization from 1947 to 1955 have established the existence of the valuable Barkly Basin of 57,000 square miles in the eastern part of the Territory and extensions of the Gulf Basin in the north-western part.

4. **Irrigation.**—There are no large-scale water conservation projects in the Territory with the exception of the Manton Dam (12,700 acre feet), which serves Darwin with a reticulated supply. Hydrological investigations are being carried out by the Administration and a public company to determine the supply of water and the best methods of control and use in the potential rice growing areas of the Territory. Agricultural activity in the Territory is not extensive.

The Katherine River appears to offer irrigation potentialities on the levee soil below the township. The river passes through a gorge upstream under conditions which appear suitable for dam construction. The Administration and the Commonwealth Scientific and Industrial Research Organization are investigating the potentialities of the area for agricultural production. For particulars of these *see* p. 1138 of Official Year Book No. 37.

§ 9. Papua and New Guinea.

1. **Rainfall.**—Rainfall in Papua and New Guinea varies considerably from approximately 250 inches near Lindenhafen (New Britain) and 231 inches at Kikori (Papua) to about 70 inches near Marienburg (New Guinea) and 40 inches at Port Moresby (Papua).

2. **General.**—For a general description of these territories *see* Chapter V.—The Territories of Australia, p. 125, of this Year Book. Irrigation has not been developed on any organized basis owing to the availability of high rainfall and the nature of agricultural development.

The Territory of Papua and New Guinea is well served with large rivers deriving their water from heavy tropical rains and high mountains which rise to over 14,000 feet. However, complete data regarding water resources are not available.

The largest rivers in the Territory include the Fly (a description of which is given in Chapter XXVI. of Year Book No. 40), the Sepik (700 miles), the Ramu (450 miles), the Purari (300 miles) and the Markham (110 miles).

The main water conservation interest in New Guinea at present is the hydro-electric potential which is extensive. An outline of schemes at present in operation is given in the previous chapter.