CHAPTER XXVI.

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 was a bibliography of selected books, reports, papers, etc. dealing with the development of the water resources of Australia and their conservation (*see* pp. 1140–41).

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 XV.—Local Government; and on the generation of hydro-electric power to Chapter XXV.—Electric Power Generation and Distribution.

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.

§ 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. Therefore, it is impossible at present to estimate, with any degree of reliability, the total average annual flow of Australian streams but it has been doubted whether the total average annual flow of all Australian rivers would exceed 60,000,000 acre feet, a figure small in comparison with the flow of rivers in other continents, some examples of which are given below expressed as mean annual discharges in millions of acre feet: 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, 1954.

MAJOR DAMS AND RESERVOIRS IN AUSTRALIA.

Name.	Location.	Capacity (Acre feet).	Height of Wall (Feet).	Remarks.
EXISTING DAMS AND RESERVOIRS.				
Hume	Murray River near Albury	1,382,000	110	Part of Murray River Scheme—storage for domestic, stock and irrigation purposes. To be increased to 2,500,000 acre feet. Hydro-electric power to be developed.
Miena	Great Lake, Tasmania	1,125,000	40	Regulates water to Waddamana hydro-electric power station.
Burrinjuck ..	Murrumbidgee River, New South Wales	652,200	247	Storage for irrigation and production of hydro-electric power.
Lake Victoria ..	Murray River near South Australian border, in New South Wales	551,700	..	Natural storage for irrigation in South Australia.
Waranga	Goulburn River, Victoria	333,400	..	Earthen embankment, 23,800 feet long. Irrigation storage.
Eildon	Upper Goulburn River, Victoria	361,000	..	Rock filled embankment, 2,300 feet long and concrete spillway, 700 feet. To be increased to 2,750,000 acre feet. Irrigation storage.

MAJOR DAMS AND RESERVOIRS IN AUSTRALIA—*continued.*

Name.	Location.	Capacity (Acre feet).	Height of Wall (Feet).	Remarks.
EXISTING DAMS AND RESERVOIRS—*continued.*				
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	243,000	200	Serves Tarraleah hydro-electric power station.
Avon	Nepean River, New South Wales	173,800	230	Part of Sydney water supply.
Lake Brewster ..	Lachlan River, near Hillston, New South Wales	108,000	..	Storage of rural water supplies for the Lower Lachlan.
Glenmaggie ..	Gippsland, Victoria	106,000	100	Storage for irrigation.
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	Projected as part of Snowy Mountains Hydro-electric Scheme.
Eildon	Upper Goulburn River, Victoria	2,750,000	..	Existing dam being enlarged for irrigation storage and production of hydro-electric power.
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	1,678,500	415	Under construction for Sydney water supply.
Jindabyne ..	Snowy River, New South Wales	1,200,000	260	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	846,000	300	Projected as part of Snowy diversion scheme.
Somerset	Stanley River, Queensland	724,000	130	Under construction for Brisbane–Ipswich water supply
Tantangara ..	Murrumbidgee River, New South Wales	600,000	183	Projected as part of Snowy Mountains Hydro-electric Scheme.
Warkworth ..	Wollombi Brook (Hunter Valley), New South Wales	400,000	100	Projected as a flood mitigation dam for the Hunter Valley.
Lake Echo ..	Lake Echo, Tasmania	384,000	55	Under construction for hydro-electric purposes.
Keepit	Namoi River, near Gunnedah, New South Wales	345,000	135	Under construction for rural water supplies.
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	296,000	240	Under construction as part of Hunter Valley conservation work.
Koombooloomba ..	Tully River, North Queensland	146,000	123	Under construction for hydro-electric and possibly irrigation purposes
Cairn Curran ..	Loddon River, Victoria	120,000	..	Under construction as part of Murray-Loddon supply system.
Upper Yarra ..	Yarra River, Victoria	110,000	270	Under construction for Melbourne water supply.

The maps on pp. 1073-9 of Official Year Book No. 40 show the positions of the above-mentioned dams and reservoirs.

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.

(ii) *Extent and Nature of Irrigated Culture.* About half of Australia's irrigated acreage is now 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 these 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. Irrigation schemes have not been developed in Tasmania or the Northern Territory.

The following table shows the area of land irrigated in each State during the years 1938-39 and 1949-50 to 1953-54 :—

AREA OF LAND UNDER IRRIGATED CULTURE.

(Acres.)

Season.	N.S.W. (a)	Vic. (b)	Q'land.	S. Aust.	W. Aust.	Tas.	A.C.T.	Aust.
1938-39 ..	c183,518	515,357	48,953	43,602	14,278	8,599	50	814,357
1949-50 ..	628,610	662,290	90,543	49,089	31,573	7,525	637	1,470,267
1950-51 ..	597,773	716,051	83,150	79,062	28,197	7,242	468	1,511,943
1951-52 ..	596,601	723,797	113,040	58,427	29,106	6,830	656	1,528,457
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

(a) Source : Water Conservation and Irrigation Commission. (b) Source : State Rivers and Water Supply Commission. (c) Excludes pasture and fallow lands.

The next table shows the area of land irrigated in each State during 1953-54 according to the nature of irrigated culture.

AREA OF LAND UNDER IRRIGATED CULTURE, 1953-54.

(Acres.)

Crop.	N.S.W. (a)	Vic. (b)	Q'land.	S. Aust.	W. Aust.	Tas.	A.C.T.	Aust.
Rice	38,858	..	(c)	..	..	..	..	38,858
Vegetables ..	16,138	13,607	19,784	7,218	6,755	(c)	116	63,618
Fruit	18,680	36,398	} 4,011	{ 13,004	4,347	802	14	} 162,714
Vineyards ..	13,433	44,458		{ 26,704	863	..	..	
Sugar-cane ..	(c)	..	64,109	..	..	..	..	64,109
Hops	..	(c)	..	..	..	1,193	..	1,193
Cotton ..	..	..	746	..	..	..	..	746
Other Crops (including Fodder and Fallow land)	129,595	93,764	(d)35,693	1,964	1,108	2,106	566	264,796
Total, Crops	216,704	188,227	124,343	48,890	13,073	4,101	696	596,034
Pastures ..	323,539	e632,798	21,939	(e) 13,172	21,174	5,311	104	1,018,037
Total ..	540,243	821,025	146,282	62,062	34,247	9,412	800	1,614,071

(a) Source : Water Conservation and Irrigation Commission. (b) Source : State Rivers and Water Supply Commission. (c) Included in Other Crops. (d) Includes tobacco, 3,626 acres. (e) Includes lucerne for pasture.

(iii) *Irrigation Trends.* In Official Year Book No. 37, p. 1099, the following trends in irrigation practice were described :—the improvement of irrigation techniques in established areas, a growing appreciation of the benefits and necessity of irrigation in humid and sub-humid areas with a flush annual rainfall, the use of irrigation to stabilize the stock industries, especially on an " extensive " basis, consideration regarding the provision of weirs to prevent the entry of salt water, the increasing quest for cheap electric power to aid pumping operations for stock, domestic and irrigation purposes, and an increase in the extent of spray irrigation.

(iv) *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; and growth problems affecting plants and trees.

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)—influence of irrigation on plant life (using horticultural trees as test plants), irrigation methods, land drainage and soil structure; Deniliquin (New South Wales)—pastures; Werribee (Victoria)—diseases of dairy cattle; Ayr (Queensland) 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.**—As 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 effects of floods, overstocking, bush fires, and 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 and potentials of the artesian basins—particularly the Great Artesian Basin—have been fairly accurately determined, and 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 in 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 1211 of Official Year Book No. 39.

The Great Artesian Basin, the most extensive in the world, underlies an area of approximately 550,000 square miles, comprising about 350,000 in Queensland, 76,000 in New South Wales, 100,000 in South Australia and 24,000 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.	Area.	Depth of Water.
			Square Miles.	Feet.
Great Artesian..	Queensland, New South Wales, South Australia and Northern Territory	Cretaceous-Jurassic..	550,000	Up to 7,000
Murray ..	Victoria, New South Wales, and South Australia	Miocene	107,000	100 to 900
Torrens ..	South Australia	Recent Pleistocene ..	4,000	Up to 600
Coastal Plain ..	Western Australia	Recent Jurassic ..	10,000	200 to 2,500
Adelaide ..	South Australia..	Recent Oligocene ..	1,100	100 to 500
Gippsland ..	Victoria ..	Pleistocene-Oligocene	1,800	200 to 1,800
Port Phillip ..	Victoria ..	Pleistocene-Oligocene	300	Up to 600
Eucla.. ..	Western Australia, South Australia	Pliocene-Miocene ..	68,000	300 to 2,000
North-west ..	Western Australia	Tertiary Permian ..	40,000	400 to 4,000
Collie ..	Western Australia	Permian	500	..
Desert ..	Western Australia	Permian	130,000	200 to 3,000

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, the most notable scheme being that conducted by the Hunter District Water Board where ground water from the Tomago sandbeds near the mouth of the Hunter River, New South Wales, is used to supplement water storages fed from surface sources. For further information on ground water *see* Official Year Book No. 37, p. 1104.

§ 3. National and Interstate Aspects.

1. **General.**—As the Commonwealth Constitution makes special reference to water problems, both the Federal 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 the adoption of an all-Australian plan, having the assent of the various governments, to obviate lack of co-ordination, 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 irrigible 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 (1,050 miles), the Darling (1,760 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, 2,600,000 acre feet; Goulburn River (including Broken River), 2,502,000 acre feet ; Darling River, 2,150,000 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, dairy produce, wool, fat lambs, rice, vegetables, 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 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 for hydro-electric purposes additional storages 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 enlargment 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 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 total estimated quantity of water diverted in 1953-54 for irrigation and other purposes from the Murray and its tributaries (under the River Murray Agreement) was as follows (in acre feet):—New South Wales, 975,000; Victoria, 2,006,000; South Australia, 164,000; a total of 3,145,000 acre feet.

(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 106 feet high extending for 4,000 feet across the river flats. The length of the total structure is approximately one mile. Work on the installation of a hydro-electric generating station below the dam is now in progress. Two 25,000 kW turbo generators will be installed initially but the powerhouse may be extended later to house a third machine. Work is also proceeding on the completion 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 is proceeding 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 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), 652,200 acre feet; Wyangala (Lachlan), 303,900 acre feet; Victoria—Eildon (Goulburn), 361,000 acre feet (now being increased to 2,750,000 acre feet); Waranga (Goulburn), 333,400 acre feet. No storages exist on the Murray in South Australia. More details of these and other State works on Murray tributaries will be found in the sections dealing with State systems.

3. New South Wales-Queensland Border Rivers Agreement.—The New South Wales-Queensland Border Rivers Agreement which was ratified by the Parliament of both States, was executed on 27th November, 1946 and came into effect on 1st July, 1947. However, the Dumaresq-Barwon Border Rivers Commission, which is charged with the duty of giving effect to the Agreement and the ratifying Acts, was not constituted until 1st May, 1948. 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, has for some time past been carrying out investigations of alternate dam sites on the Dumaresq River near Mingoola Station Homestead which is approximately 39 miles from Tenterfield. These investigations have advanced to a stage where it has become necessary to carry out a geophysical survey of the site. The survey is being carried out by the Commonwealth Bureau of Mineral Resources

and until such time as the survey has been completed, it will not be possible for the Commission to determine the exact site of the dam and to authorize the preparation of the design thereof.

The Irrigation and Water Supply Commission of Queensland, which is the constructing authority for the new weirs and regulators, has carried out detailed investigations as to sites for such works. 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 for a low level weir to establish a pumping pool at a location 32.9 miles on the Dumaresq River. The existing Goondiwindi and Mungindi Weirs are being maintained, operated and controlled by the Queensland Irrigation and Water Supply Commission.

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. Irrigation of cotton, root crops, cereals, and citrus fruit, and expansion of the fat stock industry, is being examined.

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 system, 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 Snowy-Tumut system, the water in which will be diverted by tunnel from a dam on the Eucumbene River—a tributary of the Snowy—at Adaminaby 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 7,000,000 acre feet); sixteen power stations; 86 miles of tunnels varying in diameter from 18 feet to 42 feet—one projected tunnel 30 miles long under the Alps will be one of the largest in the world; nearly 500 miles of racelines at high elevations.

The total expenditure was originally estimated to be £225,000,000 but latest expectations are that the cost will be approximately £422,000,000. The scheme will form 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; he 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

* *See also* Chapter XXV.—Electric Power Generation and Distribution, pp. 916–9.

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.

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

It is anticipated that the first instalment of power, estimated at approximately 60,000 kW will be available by early 1955 and additional generating capacity is scheduled to become available gradually up to 660,000 kW by 1962.

The Snowy Scheme will by 1958 or 1959 supply the Murrumbidgee River with 500,000 acre feet per annum of additional water. Ultimately the scheme will provide approximately 1,818,000 acre feet per annum to the two rivers of which 1,020,000 acre feet per annum will go to the Murrumbidgee and 798,000 acre feet to the Murray.

The Department of Public Works, New South Wales, has undertaken the design and construction of Adaminaby Dam on which work has already commenced, and the Department of Main Roads, New South Wales, and the Snowy Shire have undertaken the reconstruction of over 70 miles of existing roads. A contract has been placed with an oversea firm for the design and construction of the complete Guthega Project on the Upper Snowy River. This work is already well advanced and is expected to be completed early in 1955. Contracts for the construction of the Adaminaby Tunnel of the dam at Tumut Pond and of the power station on the Tumut River were placed during 1953-54.

B. STATES AND TERRITORIES.

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

The foregoing sections deal generally with water conservation and irrigation in Australia 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 for the stock industries (mainly underground sources), 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. 18 of this issue.)

(ii) *Administration.* Under the amendment of the Irrigation Act, made by the Conservation Authority of New South Wales Act, 1949, which came into force on 1st July, 1949, the Water Conservation and Irrigation Commission of New South Wales now consists of three members appointed by the Governor, one of whom is appointed as Chairman. 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 950 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, another tributary. 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 403,256 acres served with water through a channel system off-taking from the river at Berembed Weir; the Coomealla Irrigation Area of 35,450 acres, served by pumping from the Murray; the Curlwaa Irrigation Area of 10,209 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 16,305 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 (736,420); Stevens Weir, Edward River (7,165).

Murrumbidgee :—Burrinjuck Dam (652,200); Berembed Weir (10,000); Maude Weir (6,740); Redbank Weir (7,360).

Lachlan :—Wyangala Dam (303,900); Lake Cargelligo (29,435); Jemalong Weir (2,200); Lake Brewster (108,000).

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, supplies the districts of Jemalong and Wylde's Plains, serving an area of 224,556 acres. Wyangala is now producing hydro-electric power. Proposals for future development include provision of a head storage on the Belubula River.

The approximate total length of channels (including main canals) in New South Wales is 2,757 miles. The approximate length of drains and escape channels is 942 miles, and the approximate total length of pipe lines is 13 miles, making a grand total of 3,712 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 the areas under irrigated culture in New South Wales during 1953–54, the latter according to the nature of irrigated culture.

AREAS OF SYSTEMS AND OF LAND UNDER IRRIGATED CULTURE : NEW SOUTH WALES, 1953-54.

(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) ..	403,256	24,628	9,160	2,893	813	60,127	3,070	5,826	13,521	3,116	31,354	154,508
Lands adjacent supplied under agreement	(d)	62	..	51	1	3,232	8,415	4	82	16	2,138	14,001
Coomealla	35,450	..	..	15	..	..	..	3,757	587	16	..	4,375
Curlwaa	10,209	..	..	21	39	..	..	722	945	12	..	1,739
Hay	6,866	..	..	44	190	1,103	..	..	..	..	2	1,339
Tullakool	16,305	2,084	1,000	60	428	4,918	..	..	..	..	2,083	10,573
Total	e 472,026	26,774	10,160	3,084	1,471	69,380	11,485	10,309	15,135	3,160	35,577	186,535
Irrigation Districts—												
Benerembah ..	134,921	3,658	4,583	1,155	365	21,480	900	..	..	10	5,800	37,951
Tabbita	5,980	106	200	60	30	870	20	..	..	..	150	1,436
Wah Wah	577,039	..	650	290	..	7,570	200	..	..	..	970	9,680
Berriquin	770,564	..	3,198	10,104	2,224	118,011	4,244	..	..	40	4,282	142,103
Wakool	495,430	8,320	4,357	1,515	989	44,791	2,750	..	..	12	3,015	65,749
Jemalong and Wylde's Plains	1147,005	..	3,538	993	420	6,229	5,433	..	12	..	1,069	17,694
Denimein (f) ..	224,556	..	3,034	5,988	1,730	5,136	3,888	..	..	..	283	20,059
Gumly	345	..	24	50	..	35	..	..	19	46	..	174
Total	2,364,840	12,084	19,584	20,155	5,758	204,122	17,435	..	31	108	15,569	294,846
Flood Control Districts—												
Lowbidgee	375,000	..	..	..	..	..	g 94,118	..	..	..	..	(g)94,118
Medgun	272,800	..	..	..	..	..	g 61,760	..	..	..	..	(g)61,760
Total	647,800	..	..	..	..	..	g 155,878	..	..	..	..	g 155,878
Irrigation Trusts—												
Pomona	1,580	..	..	..	..	..	..	770	130	..	..	900
Blairmore	315	..	8	44	42	46	..	..	..	..	..	140
Bringan	4,033	..	100	200	..	195	725	..	50	2	..	1,272
Bungunyah–Koraleigh	1,804	..	..	..	10	..	..	1,060	72	40	..	1,182
Glenview	661	..	..	22	..	41	336	..	71	..	..	470
Goodnight	1,167	..	..	..	4	..	..	519	41	..	..	594
Bama	3,446	..	..	..	..	..	..	..	..	..	..	(d)
Total	13,906	..	108	266	56	282	1,061	2,379	364	42	..	4,558
Water Trusts—Domestic and stock supplies ..	2,945,097	..	..	..	..	..	..	..	..	..	..	..
Licensed Diversions(h)— To irrigate	(d)	..	..	11,400	6,076	15,887	3,887	745	3,150	12,828	(i) 331	54,304
Grand Total(e) ..	(d)	38,858	29,852	34,905	13,361	289,671	j 189,746	13,433	18,680	16,138	51,477	j 696,121

(a) Includes grazing and cutting. (b) Perennial and annual self-seeding. Perennial amounted to 32,449 acres of which 13,658 acres were in the Berriquin Irrigation District. (c) Citrus and deciduous. Deciduous amounted to 8,236 acres, of which 7,559 acres were in the Murrumbidgee Irrigation Area. (d) Not available. (e) Incomplete (f) Works incomplete. (g) Area irrigable ; details of area actually irrigated are not available. (h) Excludes domestic and stock supplies for which particulars are not available. (i) Tobacco. (j) Includes Flood Control Districts—*see* (g).

3. **Murrumbidgee Irrigation Areas.**—(i) *Description.* These areas comprise about a third of the State's irrigated acreage and in 1953–54 received 306,000 acre feet of the total water allocated for stock, domestic supply and irrigation (978,620 acre feet). They are served by the Burrinjuck Dam (capacity 652,200 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 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 840 miles and drainage channels 810 miles.

In addition, 380 miles of supply channel 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 with a sparse population.

Population was 12,000 in 1923, 15,000 in 1929, 20,000 at the 1947 Census and was estimated at 24,900 at 30th June, 1954. At the 1947 Census the population of the Yanco district (with Leeton as the centre) was 9,000; and the population of the Mirrool Area (with Griffith as the centre) was 11,000.

(ii) *Administration.* The Water Conservation and Irrigation Commission controls land transactions and water supplies for the Murrumbidgee Irrigation Areas, also the distribution of electricity throughout those areas. Other local government services, including town water supply, are provided by Shire 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, 1954 was 352,618 acres, including 41,292 held for short lease grazing, agriculture, etc.

(iii) *Production.* Since the scheme was inaugurated in 1911 the value of rural production from the Murrumbidgee Irrigation Areas and the adjoining Irrigation Districts supplied with water from the channels of the Murrumbidgee Irrigation Areas has aggregated approximately £84,000,000. During the year ended 30th June, 1954, production was valued at £8,280,000.

Livestock slaughtered contributed £1,094,000 (comprising sheep, £807,000; cattle, £220,000; pigs, £67,000); wool, £1,421,000; and other pastoral and dairying products, £263,000.

Rice (£2,280,000) and wheat and oats (£522,000) contributed a total of £2,801,000. Horticulture accounted for £2,255,000, comprising almonds, apricots, citrus, drying grapes, table grapes, wine grapes, figs and olives, peaches and nectarines, pears, plums and prunes, quinces and apples. The greatest individual contributions were made by peaches and nectarines, £714,000, grapes, £496,000 and citrus, £394,000.

The total value of all vegetables was £445,000, including root crops, £188,000, peas and beans, £101,000, tomatoes, £63,000, cabbages, cauliflowers, onions and other products.

Rice growing was initiated on the Murrumbidgee Irrigation Areas in 1924. Since then, aggregate production from those areas and from the other localities mentioned hereunder has been approximately 1,220,000 tons, valued at about £20,083,000 to the grower. In 1953–54 total area sown was 38,858 acres, including 28,454 acres on the

Murrumbidgee Irrigation Areas and adjoining districts, 8,320 acres at Wakool and 2,084 acres at Tullakool. The total quantity of water delivered for the rice crops during the 1953–54 season was 219,693 acre feet. Water supplied for rice represents about one-half of the total delivered on the Murrumbidgee Irrigation Area and slightly less than a quarter of the water artificially supplied for irrigation in New South Wales. During and after the 1939–45 War the area planted was increased to the limit of water available.

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). Sales turnover of the Leeton cannery in each of the past five years was over £1,000,000. 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 operation and maintenance of works to supply water at rates determined by the Commission.

Curlwaa Area, on the Murray near Wentworth, consists of 10,209 acres of which 2,307 acres at 30th June, 1954, comprised irrigated holdings. Production consists of dried vine fruits, deciduous fruits and fodder crops of a total estimated value in 1953–54, of £194,000.

Coomealla Area, 9 miles upstream from Curlwaa, comprises 35,450 acres of which 5,893 acres at 30th June, 1954 comprised irrigated holdings. Other land in the undeveloped part is leased for grazing. Production consists of vine and citrus fruits of an estimated value, in 1953–54 of £309,000. An extension of the Coomealla Irrigation Area has been undertaken in recent years to provide irrigation farms for ex-servicemen As a result, 100 ex-servicemen have now been placed on these new farms.

Hay Area, on the lower Murrumbidgee, consists of 6,806 acres, of which 1,164 acres are occupied as irrigated holdings. Annual production, valued in 1953–54 at £32,000, 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) 495,430 acres, Berriquin Provisional District (almost complete) 779,564 acres, Deniboota Provisional District (in progress) 304,321 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 134,921 acres, Tabbita District 5,980 acres, Wah Wah Provisional District 577,039 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, 1954, the total length of completed canal and channels was 812 miles, including Mulwala Canal 75 miles, Berrigan channel 22 miles, subsidiary channels 673 miles, escape channels 33 miles and cross drainage channels 9 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 361 miles of channel, contains 274 holdings and it is expected that the area developed by irrigation will comprise about one acre in 13 of the total area. The total area irrigated in 1953–54 was 65,749 acres and water supplied was 119,142 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 it is expected that the proportion of total area to be developed for irrigation will be considerably higher than in the case of Wakool. Total irrigated acreage was 142,103 at 30th June, 1954. 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 1953–54 season for irrigation, etc. was 81,397 acre feet, and the area irrigated was 49,067 acres, including rice and other cereals, pastures and fodder crops.

For the same season 21,360 acre feet of water were supplied from the Lachlan River to irrigate a total area of 20,059 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 (32,985), 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 (295,040), Ulonga (71,655), Micabil Weir (11,500); *Miscellaneous*—Algudgerie Creek (9,760), Nidgery Weir (46,880), Great Ana Branch of Darling River (995,200), Collarenebri town water supply (117)—making in all a total area of 2,945,097 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 (1,804), Glenview (661), Bringan (4,933); *Darling River*—Pomona (1,580)—making in all a total area of 13,906 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 48 holdings. Another district, Medgun (272,800 acres) near Moree in the North-West is also now 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. 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 5,000,000 acres and water is distributed through 3,285 miles of open earth drains. The number of artesian bores giving a flowing or pumping supply at 30th June, 1954, was 977 and the estimated total daily flow from 560 flowing bores was 59,189,000 gallons. The estimated flow in 1914–15 was 99,350,000 gallons per 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 per day. Of the total number of bores sunk, 224 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, 1954, the total constructed by the Commission's plants was 4,417 and their average depth was 303 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 Commission 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 commenced, but as in the case of Burrendong Dam, work has been temporarily suspended. 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. Total estimated capacity of all proposed new storages is 5,500,000 acre feet.

10. **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. 916–9). However, there are possibilities of relatively large scale developments on the Clarence, Shoalhaven and Macleay Rivers as well as numerous minor schemes. These various schemes are being investigated by the New South Wales Government.

The largest existing hydro installations are the 20,000 kW station at Burrinjuck Dam on the Murrumbidgee River (1927) and the 7,000 kW station at Wyangala Dam on the Lachlan River (1947). The output of both these plants is dependent on the release of waters for irrigation purposes.

* *See also* Chapter XXV.—Electric Power Generation and Distribution, pp. 916–23.

Similar schemes, for which the water release will be dependent upon other than electrical requirements, are being constructed at the Hume Irrigation Dam on the Murray River and at Warragamba Dam which is being constructed to provide water supply for the Sydney Metropolitan Area. At Hume, two 25,000 kW units are to be installed and the output of the station will be shared equally between New South Wales and Victoria. At Warragamba, a 50,000 kW unit is to be installed.

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, which now has a capacity of 4,600 kW, commenced operation in 1924. The County Council also has two 100 kW hydro units in operation at Dorrigo on Bielsdown Creek, a tributary of the Nymboida River. The investigation of a number of much larger schemes for the further development of the Nymboida River is at present in progress.

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. The proposal has been examined in sufficient detail to indicate that the scheme may provide for the installation of about 100,000 kW of hydro generating plant.

The New England County Council has under construction a 2,500 kW hydro scheme near Armidale on the Oakey River, a tributary of the Macleay River.

The Mullumbimby Municipal Council has in operation two 150 kW hydro units, which were installed in 1925, 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, which now has a capacity of 1,900 kW, was opened in 1944. Work is in progress on extensions to provide for two further 1,000 kW units.

§ 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. 18 of this issue.)

(ii) *Administration.* Although practical steps were taken to organize Victoria's water resources before the turn of the century, the passage of the Water Act in 1905 marked the commencement of sustained progress. The State Rivers and Water Supply Commission established by this Act is vested with the 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 2,430,800 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 110,000 acres in 1906 to 821,025 in 1953–54, and irrigation channels command 2,146,622 acres.

The Commission controls 37 large reservoirs and 241 subsidiary storages. The capacities of the storages in acre feet within the various systems at 30th June, 1954 were as follows :—

Goulburn System :—Eildon Reservoir, 361,000 (being enlarged); Goulburn Weir, 20,700; Waranga Basin, 333,400; *Murray-Loddon System* :—Half share of River Murray Commission storages including Hume, Yarrawonga, Torrumbarry, Euston, Mildura and Wentworth, 802,420; Kow Swamp, Laanecoorie, Kerang-North-West Lakes, Lake Boga and Lake Cullulleraine, 148,210; total, 950,630; *Wimmera-Mallee* :—538,900; *Maffra-Sale* :—106,040; *Coliban* :—62,730; *Werribee* :—34,900; *Bellarine Peninsula* :—10,850; *Mornington Peninsula* :—5,800; *Otway* :—1,080; *Miscellaneous* :—4,770; *Total* :—2,430,800.

Irrigation channels extend 4,884 miles, domestic and stock channels 8,049 miles and drainage and flood protection channels 2,094 miles, a total of 15,027 miles. In addition, the Commission controls 1,224 miles of piping, comprising 273 miles of mains and 951 miles of reticulation. Farm holdings served with water total 43,923. Urban districts supplied by the Commission's channels and pipelines have a population of 175,310 persons in 130 towns, and a further 143 towns with a total population of 439,780 persons are supplied by Trusts under the supervision of the Commission.

To 30th June, 1954, the total capital expenditure on irrigation, rural water supply, country town water supply, and flood protection and drainage works amounted to £74,724,236, one-half of which was in respect of irrigation.

The total capital liability in respect of works under the control of the Commission at 30th June, 1954 was £71,795,000, of which £63,621,000 was borne by the State and £8,174,000 by water-users. Waterworks Trusts and local governing bodies had a total capital liability of £7,255,000 at 30th June, 1954, of which £3,341,000 was borne by the State and £3,914,000 by the Authorities.

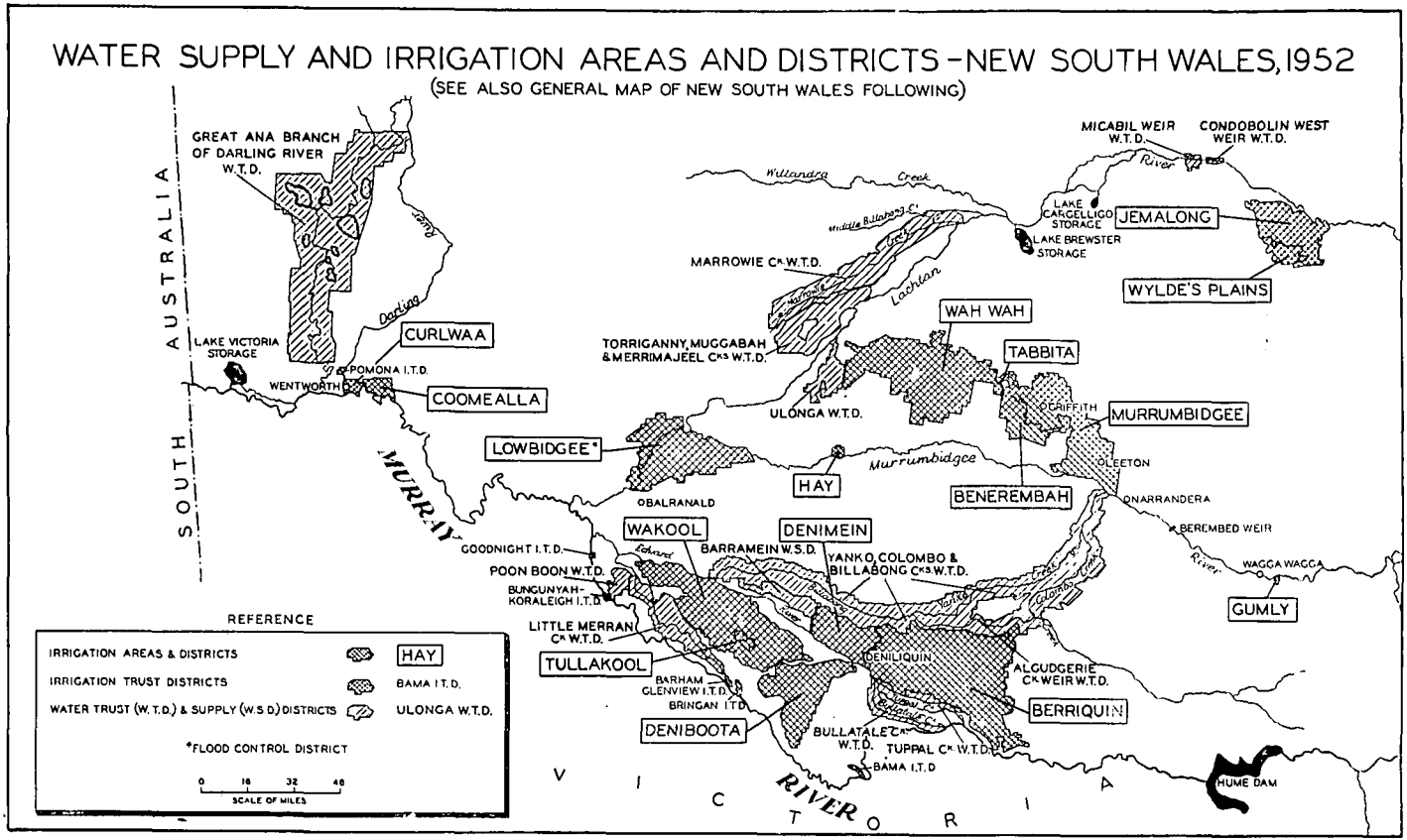
(ii) *Extent of Systems and Nature of Irrigated Culture.* Although the area irrigated is less than 2 per cent. of the State, it yields approximately 11 per cent. of Victoria's rural production. The following table shows the areas of the various irrigation systems and the areas under irrigated culture during 1953-54.

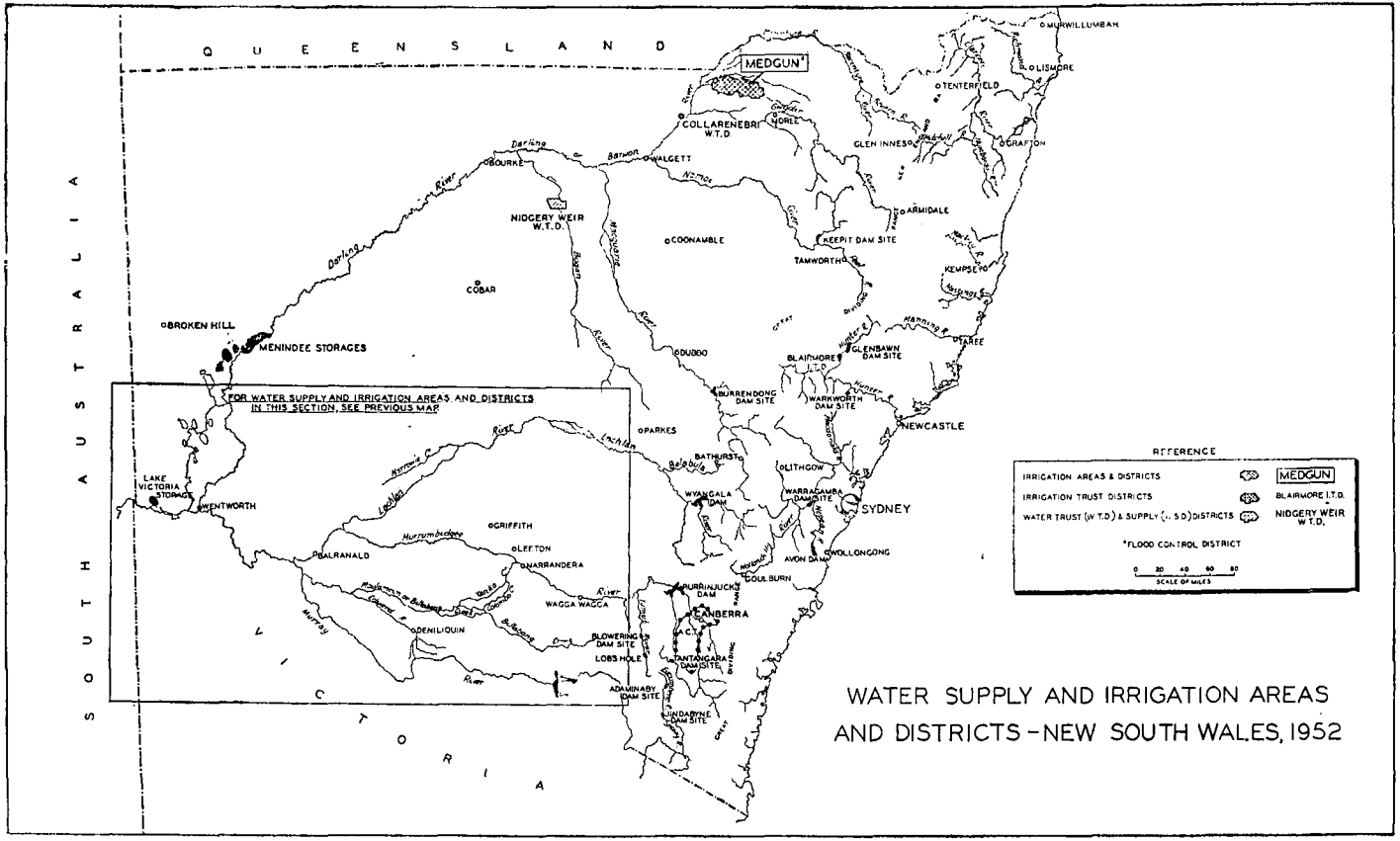
AREAS OF SYSTEMS AND OF LAND UNDER IRRIGATED CULTURE : VICTORIA. 1953-54.

(Acres.)

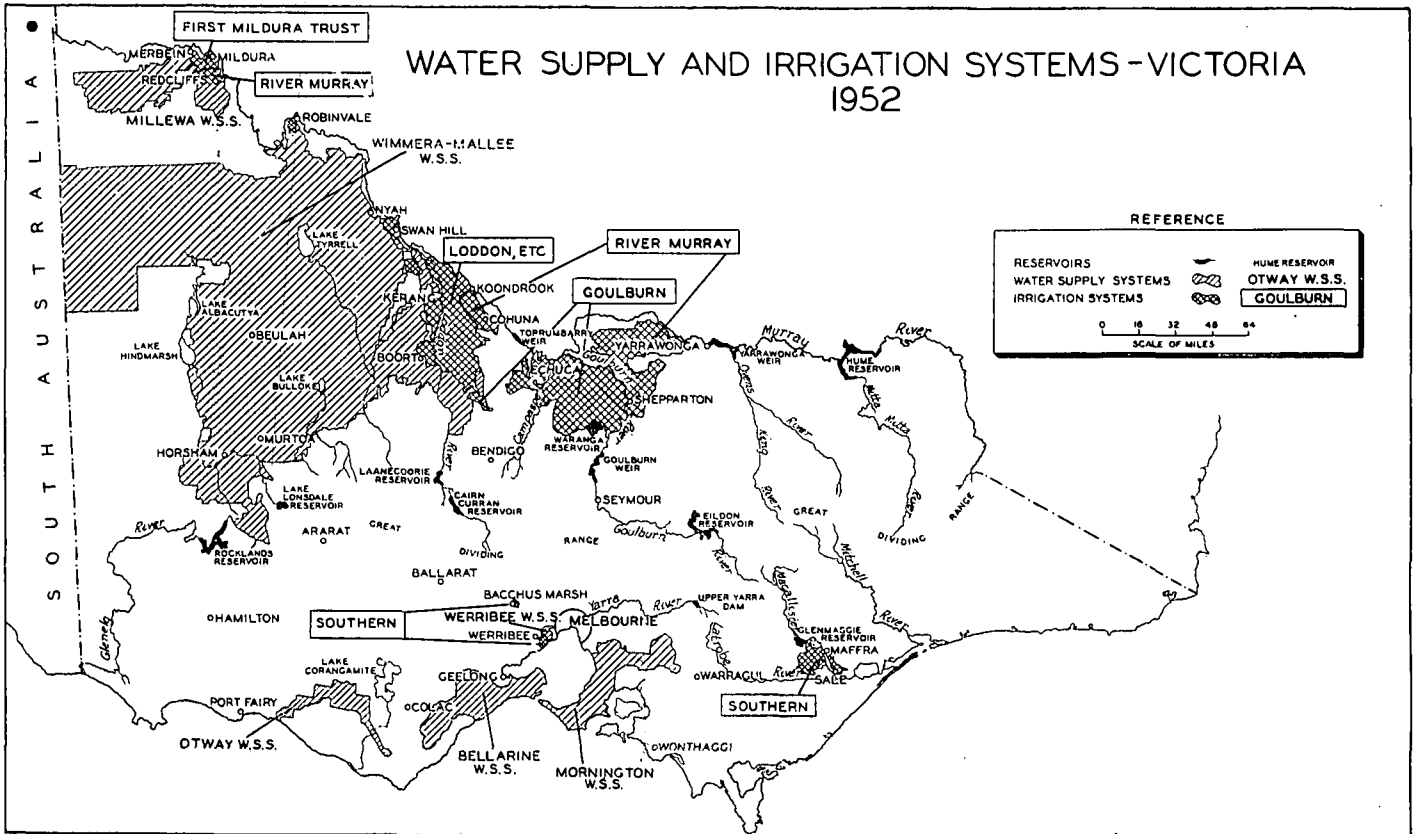
System.	Total Area.	Area under Irrigated Culture.									
		Cereals.	Lucerne.	Other Fodder Crops.	Pastures.		Vineyards.	Orchards.	Market Gardens.	Fallow and Miscellaneous.	Total
					Sown.	Natural.					
Goulburn	1,257,683	13,313	19,383	4,127	271,640	27,736	299	18,805	2,936	5,317	363,556
Murray—											
Torrumbarry Weir ..	377,678	12,787	5,376	2,765	135,626	47,872	5,588	2,191	835	6,774	219,814
Yarrawonga Weir ..	267,012	35	15,432	295	46,127	2,457	52	3,227	686	9	68,320
By Pumping ..	31,658	90	175	273	293	60	23,236	1,556	241	..	25,924
Total	676,348	12,912	20,983	3,333	182,046	50,389	28,876	6,974	1,762	6,783	314,058
Loddon and other Northern Systems ..	(a) 19,736	1,817	1,399	438	9,031	3,552	19	4,238	914	4,424	25,832
Southern Systems ..	147,855	55	1,853	230	32,253	1,070	.	551	4,316	651	40,979
Mildura and Private Diversions	(b) 45,000	3,977	4,898	1,539	28,037	6,667	15,264	5,830	3,679	6,709	76,600
Grand Total ..	2,146,622	32,074	c48,516	9,667	523,007	89,414	44,458	36,398	13,607	23,884	821,025

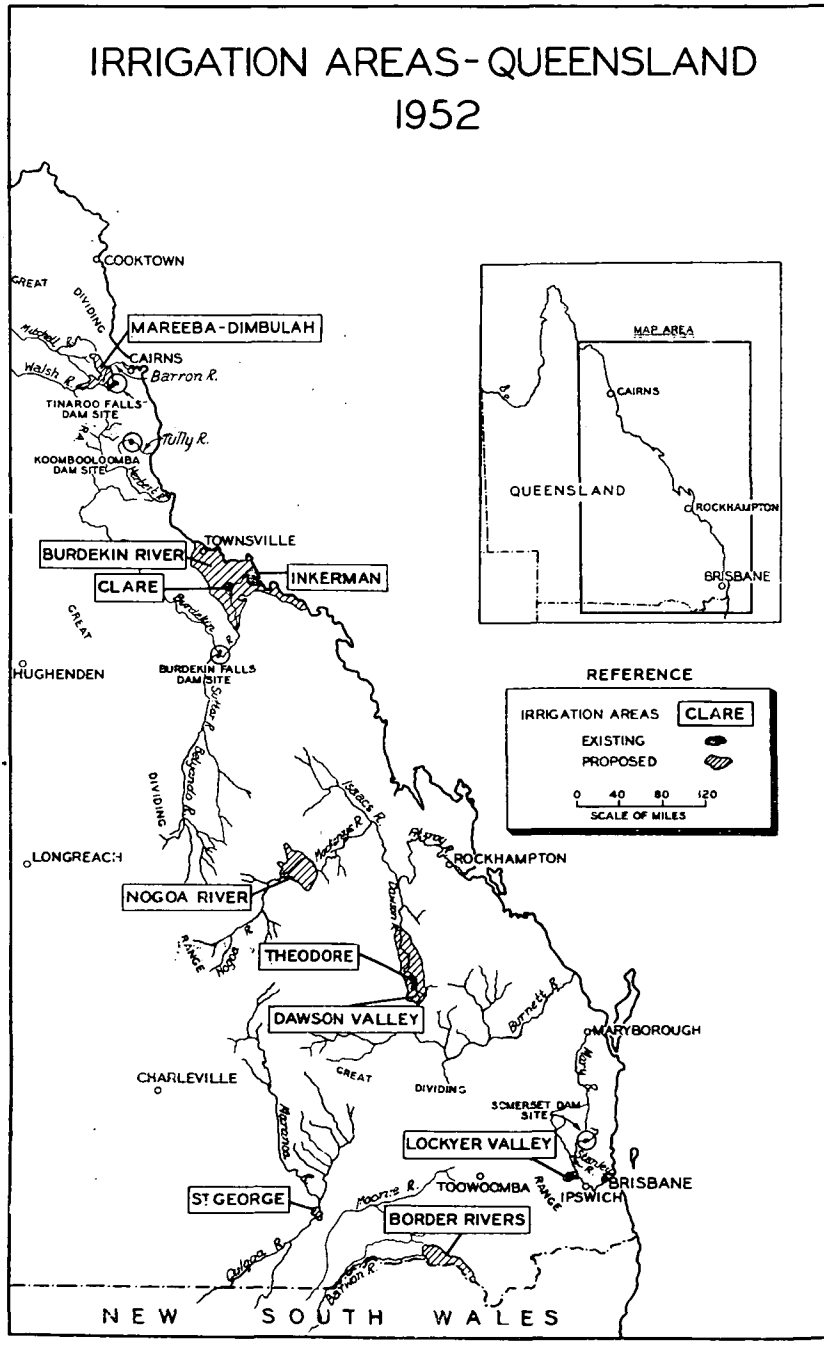
(a) Area of Campaspe District only. (b) Area of First Mildura Trust District only. (c) Includes lucerne for both hay and pasture.

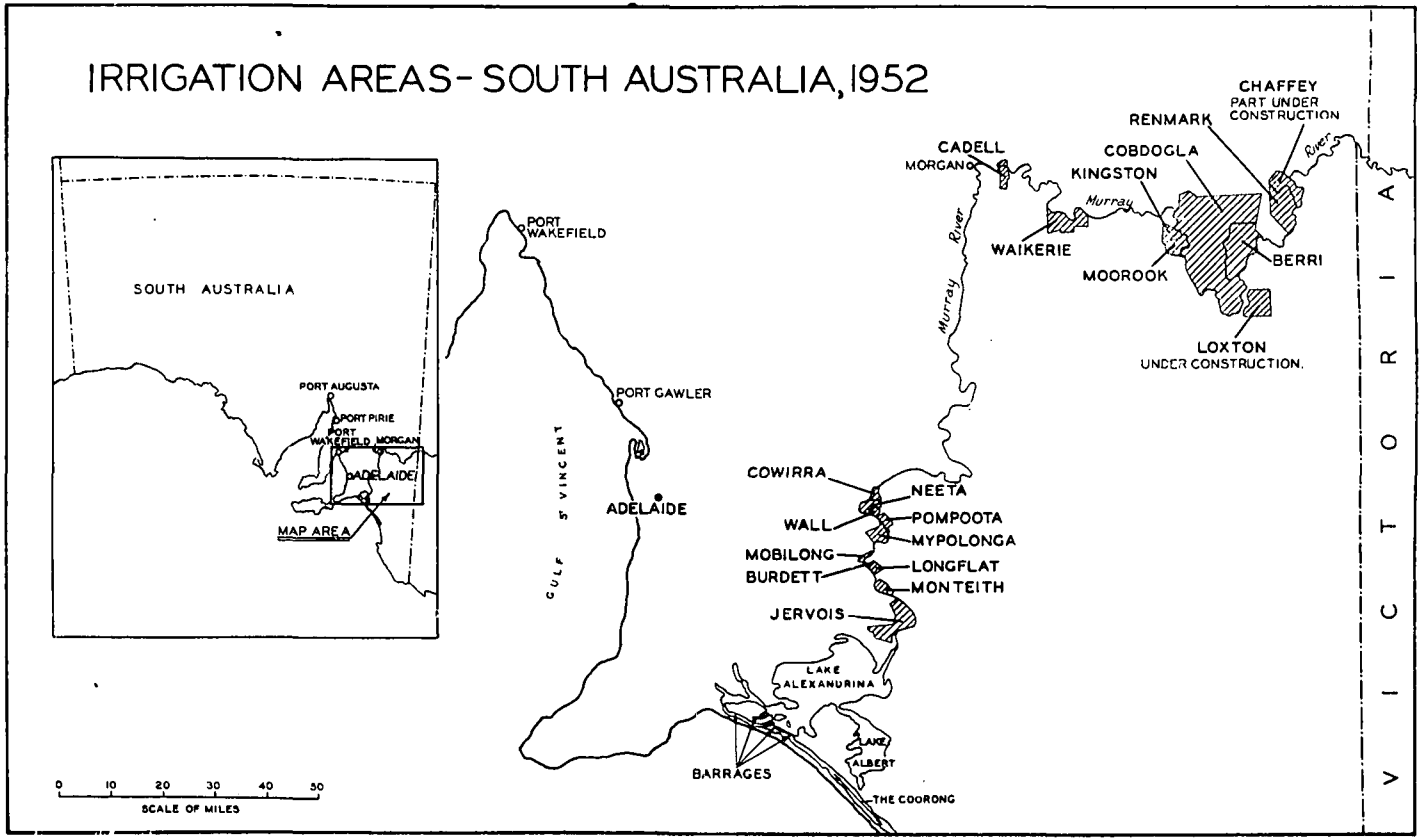

WATER SUPPLY AND IRRIGATION AREAS AND DISTRICTS - NEW SOUTH WALES, 1952
(SEE ALSO GENERAL MAP OF NEW SOUTH WALES FOLLOWING)
SOUTH AUSTRALIA
GREAT ANA BRANCH OF DARLING RIVER W.T.D.
Darling
CURLWAA
LAKE VICTORIA STORAGE
POMONA I.T.D.
WENTWORTH
COOMEALLA
MURRAY
LOWBIDGEE*
OBALRANALD
GOODNIGHT I.T.D.
POON BOON W.T.D.
BUNGUNYAH-KORALEIGH I.T.D.
LITTLE MERRAN Cr W.T.D.
TULLAKOOL
BARHAM GLENVIEW I.T.D.
BRINGAN I.T.D.
DENIBOOTA
WAKOOL
DENIMEIN
BARRAMEIN W.S.D.
YANKO, COLOMBO & BILLABONG Crs W.T.D.
HAY
Murrumbidgee
ULONGA W.T.D.
TORRIGANNY, MUGGABAH & MERRIMAJEEL Crs W.T.D.
MARROWIE Cr W.T.D.
Willandra Creek
Middle Billabong Cr
Lachlan
WAH WAH
TABBITA
GRIFFITH
MURRUMBIDGEE
BENEREMBAH
LEETON
NARRANDERA
BEREMBED WEIR
WAGGA WAGGA
GUMLY
MICABIL WEIR W.T.D.
CONDOBOLIN WEST WEIR W.T.D.
LAKE CARGELLIGO STORAGE
LAKE BREWSTER STORAGE
JEMALONG
WYLDE'S PLAINS
DENILIQUIN
ALGUDGERIE Cr WEIR W.T.D.
BERRIQUIN
BULLATALE Cr W.T.D.
TUPPAL Cr W.T.D.
BAMA I.T.D.
HUME DAM
VICTORIA
RIVER
REFERENCE
IRRIGATION AREAS & DISTRICTS
HAY
IRRIGATION TRUST DISTRICTS
BAMA I.T.D.
WATER TRUST (W.T.D.) & SUPPLY (W.S.D.) DISTRICTS
ULONGA W.T.D.
*FLOOD CONTROL DISTRICT
0 16 32 48
SCALE OF MILES

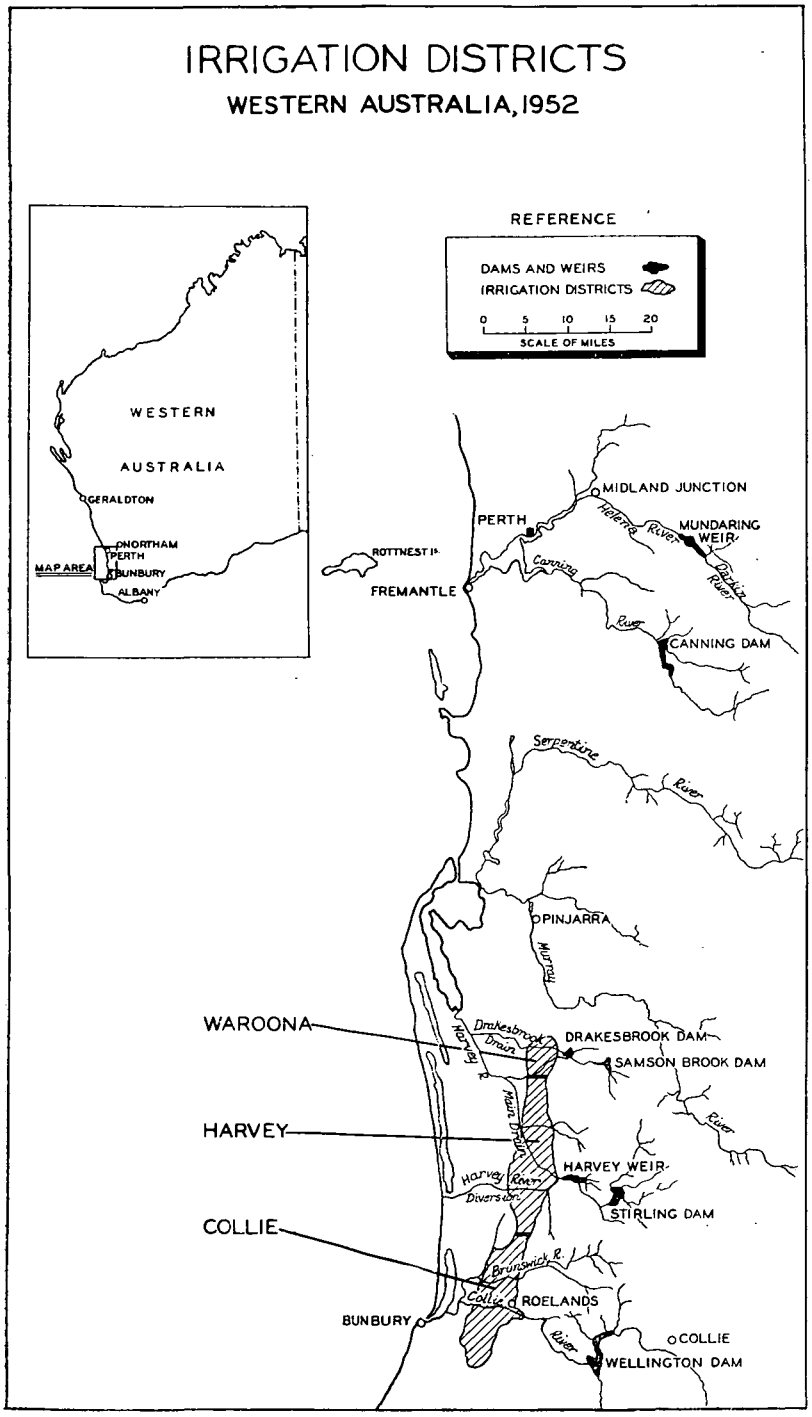


WATER SUPPLY AND IRRIGATION AREAS AND DISTRICTS - NEW SOUTH WALES, 1952


WATER SUPPLY AND IRRIGATION SYSTEMS - VICTORIA
1952
SOUTH AUSTRALIA
FIRST MILDURA TRUST
MERBEIN
MILDURA
REDCLIFFS
RIVER MURRAY
MILLEWA W.S.S.
ROBINVALE
WIMMERA-MALLEE W.S.S.
LAKE TYRRELL
SWAN HILL
LODDON, ETC
RIVER MURRAY
KOONDROOK
GOULBURN
KERANG
COHUNA
TORRUMBARRY WEIR
YARRAWONGA
LAKE ALBACUTYA
BEULAH
LAKE HINDMARSH
BOORT
LAKE BULLOKE
MECHUCA
SHEPPARTON
YARRAWONGA WEIR
HUME RESERVOIR
Murray River
Ovens River
Kiewa River
Mitta Mitta River
HORSHAM
MURTOA
BENDIGO
WARANGA RESERVOIR
GOULBURN WEIR
LAANECOORIE RESERVOIR
Loddon River
Campaspe River
LAKE LONSDALE RESERVOIR
CAIRN CURRAN RESERVOIR
SEYMOUR
EILDON RESERVOIR
GREAT DIVIDING RANGE
Goulburn River
Mitchell River
ROCKLANDS RESERVOIR
ARARAT
BALLARAT
BACCHUS MARSH
Yarra River
UPPER YARRA DAM
HAMILTON
SOUTHERN
WERRIBEE W.S.S.
MELBOURNE
WERRIBEE
Glenelg River
Latrobe River
GLENMAGGIE RESERVOIR
MAFFRA
WARRAGUL
SALE
LAKE CORANGAMITE
GEELONG
PORT FAIRY
COLAC
SOUTHERN
OTWAY W.S.S.
BELLARINE W.S.S.
MORNINGTON W.S.S.
WONTHAGGI
REFERENCE
RESERVOIRS
HUME RESERVOIR
WATER SUPPLY SYSTEMS
OTWAY W.S.S.
IRRIGATION SYSTEMS
GOULBURN
0 16 32 48 64
SCALE OF MILES

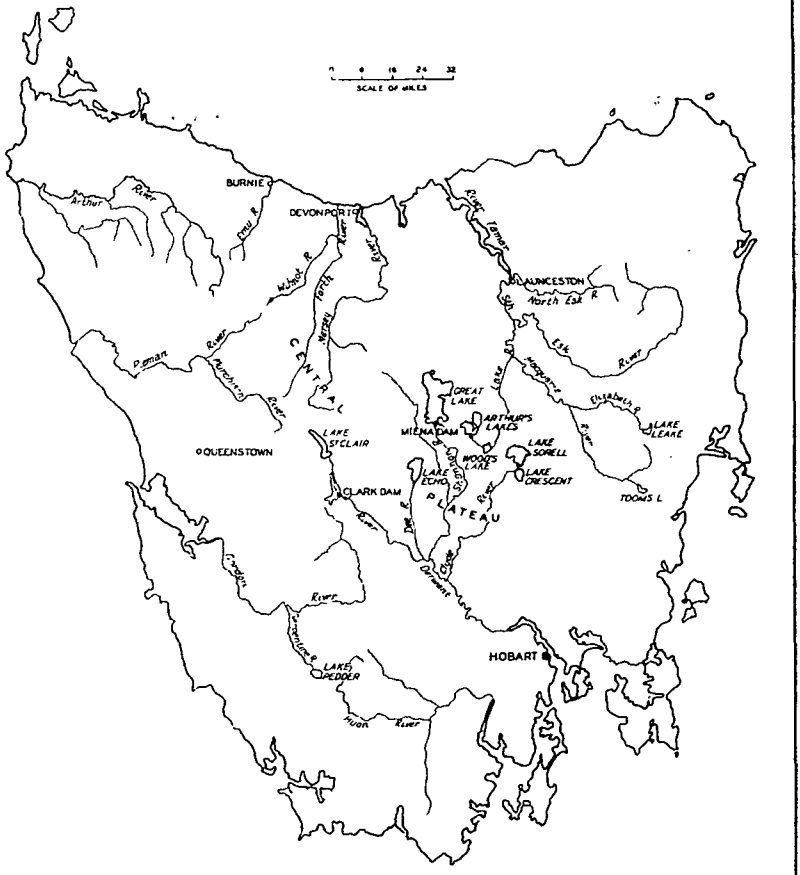

IRRIGATION AREAS - QUEENSLAND
1952
COOKTOWN
GREAT DIVIDING
MAREEBA-DIMBULAH
CAIRNS
Barron R.
Walsh R.
TINAROO FALLS DAM SITE
Tully R.
KOOMBOOLOOMBA DAM SITE
Herbert R.
TOWNSVILLE
BURDEKIN RIVER
INKERMAN
CLARE
Burdekin R.
GREAT
HUGHENDEN
BURDEKIN FALLS DAM SITE
Suttor R.
Belyando R.
DIVIDING
LONGREACH
Isaacs R.
Mackenzie R.
NOGOA RIVER
ROCKHAMPTON
Fitzroy R.
Dawson R.
Nogoa R.
RANGE
THEODORE
DAWSON VALLEY
Burnett R.
MARYBOROUGH
Mary R.
CHARLEVILLE
GREAT DIVIDING
SOMERSET DAM SITE
Nogoa R.
LOCKYER VALLEY
Lockyer R.
BRISBANE
TOOWOOMBA
RANGE
IPSWICH
ST GEORGE
Moonie R.
BORDER RIVERS
Culgoa R.
Barwon R.
NEW SOUTH WALES
MAP AREA
CAIRNS
QUEENSLAND
ROCKHAMPTON
BRISBANE
REFERENCE
IRRIGATION AREAS
CLARE
EXISTING
PROPOSED
0 40 80 120
SCALE OF MILES


IRRIGATION AREAS - SOUTH AUSTRALIA, 1952
SOUTH AUSTRALIA
PORT AUGUSTA
PORT PIRIE
PORT WAKEFIELD
MORGAN
ADELAIDE
MAP AREA
PORT WAKEFIELD
PORT GAWLER
ADELAIDE
GULF ST VINCENT
CADELL
MORGAN
KINGSTON
WAIKERIE
Murray River
Murray River
CHAFFEY
PART UNDER CONSTRUCTION
RENMARK
COBDOGLA
MOOROOK
BERRI
LOXTON
UNDER CONSTRUCTION.
COWIRRA
NEETA
WALL
POMPOOTA
MYPOLONGA
MOBILONG
LONGFLAT
BURDETT
MONTEITH
JERVOIS
LAKE ALEXANDRINA
LAKE ALBERT
BARRAGES
THE COORONG
0 10 20 30 40 50
SCALE OF MILES
V I C T O R I A


IRRIGATION DISTRICTS
WESTERN AUSTRALIA, 1952
REFERENCE
DAMS AND WEIRS
IRRIGATION DISTRICTS
0 5 10 15 20
SCALE OF MILES
WESTERN AUSTRALIA
GERALDTON
NORTHAM
PERTH
BUNBURY
ALBANY
MAP AREA
ROTTNEST I.
FREMANTLE
PERTH
MIDLAND JUNCTION
Helena River
MUNDARING WEIR
Darling Range
Canning River
CANNING DAM
Serpentine River
PINJARRA
Murray River
WAROONA
HARVEY
COLLIE
Drakesbrook Drain
DRAKESBROOK DAM
SAMSON BROOK DAM
Harvey R.
Main Drain
Harvey River Diversion
HARVEY WEIR
STIRLING DAM
Brunswick R.
Collie R.
ROELANDS
BUNBURY
COLLIE
WELLINGTON DAM

WATER RESOURCES OF TASMANIA

1952



(iii) *Production.* The influence of irrigation on Victorian production is illustrated by the following estimates, prepared by the Commission, of the value of production from irrigated areas :—1905–6, £500,000 ; 1925–26, £5,000,000 ; 1945–46, £12,000,000 ; 1952–53, £34,720,000. Detailed classification of the 1952–53 irrigation production estimates is as follows :—*Livestock* :—Dairying, beef and veal meats, etc., £10,650,000 ; Wool, lamb and mutton, £5,800,000 ; Pigmeats, poultry and eggs, £3,170,000 ; total Livestock, £19,620,000. *Horticulture* :—Vine fruits, £5,900,000 ; Fresh and canning fruits, £3,300,000 ; total Horticulture, £9,200,000. *Vegetables and other primary products*, £5,900,000.

3. **Goulburn System.**—This comprises the Eildon and Waranga Reservoirs, the Goulburn Weir and over 2,500 miles of distributory channels. The total capacity of these storages was 715,100 acre feet at 30th June, 1954 and these with the river flow gave a regulated supply in the vicinity of 800,000 acre feet per annum.

The Eildon Reservoir is at present being enlarged to a capacity of 2,750,000 acre feet and this will enable the supply to be doubled. It is anticipated that this enlargement will be completed in 1955.

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.

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 196,300 acres east of the Goulburn ; 601,900 acres between the Goulburn and Campaspe : 379,300 acres between the Campaspe and Loddon ; and 80,200 acres west of the Loddon—a total of 1,257,700 acres.

The main products of the Goulburn districts are dairy products, fruit and 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—amounts to an aggregate which represents 70 per cent. 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, supplied from Yarrawonga, will serve 280,000 acres when completed. At 30th June, 1954 550 miles of main and distributary channels were completed and supplied 267,000 acres west of Yarrawonga.

The gravitation system based on Torrumbarry Weir (52 miles downstream from Echuca) serves an area of 377,700 acres with 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.

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 commands every holding in the district. The district, originally for soldier settlement, has been subdivided into 700 blocks. The area planted is composed mainly of vines and citrus. The first harvest (1924) returned 570 tons of dried fruit in addition to table grapes. 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—which is the only Irrigation Trust operating in Victoria—controls an area of 45,000 acres, of which 15,000 acres are irrigated. This area irrigated includes 12,000 acres of vines, 960 acres of citrus trees and small areas of apricots, peaches, prunes, figs, almonds, olives, lucerne and other fodders. It 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 channel and some 4,000 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. It is considered that this expenditure could be reduced by better farming methods, and efforts in this direction such as the sowing of rye-corn, and including 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. **Farm Water Supplies.**—The Rural Finance Corporation Act 1949 is designed, *inter alia*, to give farmers an opportunity of 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.

A Farm Water Supplies Branch has been set up by the State Rivers and Water Supply Commission to advise farmers on farm water supply matters even if finance is not required. Comprehensive booklets entitled "Farm Water Supplies for Domestic and Stock Purposes" and "Farm Irrigation and Drainage" prepared by this Branch have been widely circulated to landholders.

8. **Underground Resources.**—The first stage of a comprehensive survey of the underground water resources of Victoria has been completed. 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 in different parts 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.

9. **Future Programme.**—*Victoria has reached the stage when the demand for water* for irrigation, domestic and stock purposes is far greater than the supply, and a comprehensive programme of water conservation and distribution works to meet this demand is being carried out by the State Rivers and Water Supply Commission. A new storage on the Glenelg River known as the Rocklands Reservoir with a capacity of 272,000 acre feet has been completed. Work on the new Eildon Dam has made considerable progress and it is expected that this will be completed in 1955. This work will increase the capacity of the Reservoir from 306,000 acre feet to 2,750,000 acre feet by the building of a large earthen embankment 260 feet high and 3,300 feet long, the cost of which will be in the vicinity of £22,000,000. Work was also commenced (but is temporarily suspended) on the construction of a reservoir on the Loddon River to be known as the Cairn Curran Reservoir to have a capacity of 120,000 acre feet.

10. **Hydro-electricity.***—The Kiewa project in the Australian Alps, on the Kiewa River, a tributary of the Murray, will comprise a series of power stations with a total installed capacity of approximately 300,000 kW, and an average annual production of more than 800 million kWh. It will be one of the largest hydro-electric developments in Australia. The authority responsible for its construction and operation is the State Electricity Commission of Victoria. Work is in progress on the undertaking. The first of the Kiewa power stations has been operating since 1944. Its installed capacity is 26,000 kW and it is contributing annually an average of 58 million kWh of electricity to the State system. A second power station of 62,000 kW capacity is scheduled for completion in 1955. When this new power station is in full operation, average annual production of electricity at Kiewa will be approximately three times that of the original power station. Tunnelling is in progress in connexion with a third power station of still larger capacity; and work, suspended for three years on account of financial conditions, has been resumed on one of the main storage reservoirs at Rocky Valley on the Bogong High Plains.

More extensive utilization is to be made by the State Electricity Commission of irrigation waters from the Goulburn River in a new power station of 135,000 kW capacity which has superseded the former Sugarloaf power station at Eildon Dam. The new power station, already in partial operation, will operate on the increased flow of water from the new Big Eildon Reservoir now being constructed by the State Rivers and Water Supply Commission of Victoria (*see* above). The power station is scheduled for completion in 1956.

Located within a few miles of Eildon Dam is a group of four hydro-electric power stations operating on the natural flow of the Rubicon and Royston Rivers. With a total installed capacity of 12,900 kW, the group has an average annual production of 80 million kWh. The Rubicon and Royston stations form the oldest existing hydro development in Victoria. The stations came into service in 1928 and for 25 years operated in conjunction with the former Sugarloaf power station (at the old Eildon Dam). Maximum production of the group is in winter and spring when water flow is at its greatest. The Rubicon and Royston stations will continue to offset the winter-time reduction in output at the new Eildon power station, which is designed primarily to operate on the summer-time release of water for irrigation purposes.

Irrigation water will also be utilized at the Hume Reservoir where a new power station being erected by the New South Wales Public Works Department will serve both Victoria and New South Wales. Initially, the installed capacity of the power station will be 50,000 kW. Production of electricity, averaging about 200 million kWh a year, will be shared equally by the two States, each contributing its quota of the annual cost. Victoria's share of the electricity generated will be fed into the State system.

* *See also* Chapter XXV.—Electric Power Generation and Distribution, pp. 924–30.

§ 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, p. 18 of this issue.)

(ii) *Administration.* The first comprehensive Water Act in Queensland was the Water Act of 1926 which vested in the Crown the right to the use and flow of all streams, lakes, watercourses, etc. which flowed through or were within the boundaries of two or more occupiers, and also vested in the Commissioner of Irrigation and Water Supply the bed and banks of all boundary streams. The Irrigation Act of 1922 provided for the establishment of Irrigation Areas in approved localities. From 1922 to 1931 the Commissioner of Irrigation and Water Supply administered the Acts, but in 1931 the Land Administration Board was appointed to act as the Commissioner and continued to act until the Irrigation and Water Supply Commission Act of 1946 was proclaimed in 1947. Under this Act the Corporation of the Commissioner of Irrigation and Water Supply was reconstituted. The Commissioner is responsible for carrying out the provisions of the Irrigation Acts 1922 to 1949 and the Water Acts 1926 to 1942. He is also responsible for investigations into, and the planned development of, water resources of Queensland under the Land and Water Resources Development Acts 1943 to 1946. For particulars of the New South Wales-Queensland Border Rivers Agreement ratified by Acts of both States in 1947 *see* page 950.

(iii) *Water Utilization in Queensland.* Queensland's predominant interest in the field of water conservation has in the past been the provision of stock and domestic water supplies in its great pastoral areas which contain nearly half of the Commonwealth's cattle, a seventh of the sheep and a third of the horses. More than half the State's rural production is derived from cattle and sheep. The cattle are distributed throughout the State, but most thickly between the east coast and the 20-inch average annual isohyet. Sheep are mainly pastured on the inland areas west of this isohyet, whilst dairying is concentrated in the south-eastern quarter of the State. 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 lately received much attention.

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 some 40 per cent. of total agricultural production. Approximately 14 per cent. of the sugar-cane acreage is irrigated and represents some 44 per cent. of the total irrigated area in Queensland. Queensland is Australia's major tobacco-producing State, and plans are in hand to increase greatly annual production of this crop by means of development under irrigation.

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, but excluding the Cloncurry Mineral Field and the Barkly Tableland. It comprises 350,000 square miles of the total State area of 670,500 square miles. Statistics of bores and flow as at 30th June, 1954 are:—Artesian bores drilled, 2,367; artesian bores still flowing, 1,432; total depth drilled, 3,415,000 feet; deepest bore, 7,009 feet; total estimated flow, 211,000,000 gallons per day. 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.

There are some 16,000 miles of bore drains and the greatest length served by one bore is 114 miles. This method of watering is somewhat wasteful, owing to evaporation and soakage, but it is the most economical in first cost. Not more than 5 per cent. of the water is actually used by stock, and present policy is to restrict working flows to serve limited drain systems of smaller dimensions and reduce evaporation and soakage losses. The average loss per mile of drain is 10,000 gallons per day; with smaller drains this is reduced to 7,000 gallons per day. Pipe lines are very rarely used for distribution owing to high initial cost.

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.

In 1939, a special Committee was appointed to inquire into the geology and hydrology of the Basin and economic use of artesian supplies. A first progress report has been issued by this Committee and its final report is now being prepared. It has been established that the rate of diminution of flow is declining.

In the past, many excavated tanks failed in dry seasons, because of insufficient original depth and capacity, and subsequent silting. Mechanical plant is now almost exclusively in use and much larger tanks are being excavated, even in areas where artesian water may be obtained at a reasonable depth. New tanks with capacities of 20,000 cubic yards and depths of 25 feet are not uncommon. Two tanks with capacities of 65,000 cubic yards each, and depths of 42 feet and 46 feet respectively have been completed for watering stock in an area where a good artesian flow may be obtained at a depth less than 2,000 feet.

(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 existing bores resumed with the land 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 1953-54 are :—Areas constituted, 65 ; administered by Commissioner, 54 ; administered by Local Boards, 11 ; area benefited, 4,934,552 acres ; average rate per acre, 1.8d. ; number of flowing bores, 58 ; total flow, 26,908,000 gallons per day ; drains served, 2,747 miles.

3. **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 throughout 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, 1954, 321 facilities had been completed and at 30th June, 1954, 175 facilities were under construction or investigation.

4. **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 Irrigation Area is nearing completion whilst at Millaroo, Gibber Gunyah and St. George construction is well advanced. A start has been made in 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, 1954.

AREA OF LAND UNDER IRRIGATED CULTURE: QUEENSLAND, 1953-54.(a)

Division.	No. of Irrigators.	Area under Irrigated Culture (Acres).							
		Vegetables.	Fruit.	Sugar-cane.	Tobacco.	Cotton.	Other Crops.	Pastures.	Total
Southern Queensland ..	4,024	15,500	3,095	11,269	1,331	101	28,168	20,567	80,031
Central Queensland ..	324	592	146	20	..	481	2,833	540	4,612
Northern Queensland ..	1,425	3,692	770	52,820	2,295	164	1,066	832	61,639
Total	5,773	19,784	4,011	64,109	3,626	746	32,067	21,939	146,282

(a) Year ended 31st March, 1954.

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; 1936–37 44,509 acres; 1946–47, 79,030 acres; 1953–54, 146,282 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 50 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 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 500 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 which serves the Valley. 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 joins 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. The projected irrigation, hydro-electric and flood mitigation 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. 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, pineapples, 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 now 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 would include 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 Clare Irrigation Area, constituted in 1949, and the Millaroo Irrigation Area, constituted in 1952, 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 will 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, 1954, 70 farms had been opened for selection in the Clare Area and 21 farms in the Millaroo 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 at Nathan Gorge of 2,000,000 acre feet capacity. 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 dairying 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, is in progress.

(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 1953–54 some 2,250 acres of high-grade tobacco were grown. Six weirs of combined capacity of 1,800 acre feet have been completed on a number of streams to store water for

irrigation and a seventh, to store an additional 800 acre feet, is now under construction. During 1952 a report on the utilization of waters of the Barron and Walsh Rivers was prepared and 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. 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 950.

(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.

5. **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 work 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.

6. **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, but that improved transport facilities are essential.

At 30th June, 1952, 41 watering facilities, at an estimated cost of approximately £277,000, had been proposed under a Federal-State agreement for stock routes through, and in the approaches to, the Channel Country. By 30th June, 1954, six had been completed. In addition, eight large excavated tanks and three bores were finished, but still required equipping with windmills, tanks and troughs.

7. **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

See also Chapter XXV.—Electric Power Generation and Distribution, pp. 933-5.

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.

A hydro-electric power scheme at Tully Falls is being constructed. Water controlled by Koombooloomba Dam to be built on the upper Tully River will be diverted, a short distance above Tully Falls, through a tunnel and steel penstocks to Pelton-driven generators under a head of 1,485 feet. Ultimate installation will be four 18,000 kW sets, two of which will be installed initially. 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.

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.

A power plant immediately below the Burdekin Falls Dam of the proposed Burdekin River Irrigation Scheme will operate under an average head of 225 feet. The output of firm power will depend upon the varying demand for water for irrigation, but it is expected to average about 50,000 kW.

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.

§ 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. 18 of this issue.)

(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 £1,319,937. 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 250,000 acres at Renmark were made available for irrigation settlement. Including land allotted for War Service Land Settlement purposes, the Department of Lands administers in the Murray Valley an area of 32,503 acres of irrigable high land, together with 9,427 acres of reclaimed swamp and 164,885 acres of non-irrigable land in the irrigation areas and

32,264 acres of land temporarily leased and reserved for commonage or other purposes, amounting in all to 239,179 acres. In addition, the Renmark Irrigation Trust controls 20,557 acres, of which more than 8,800 are irrigated. Water used for irrigation purposes in 1953–54 in the high land irrigation areas controlled by the Department of Lands was approximately 100,000 acre feet, in addition to which approximately 60,000 acre feet were used on reclaimed areas by gravitational watering. In the Renmark area water used for irrigation in 1953–54 was 26,670 acre feet. 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. 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.

IRRIGATION AREAS ADMINISTERED BY DEPARTMENT OF LANDS AND RENMARK IRRIGATION TRUST, SOUTH AUSTRALIA : AREA OF LAND UNDER IRRIGATED CULTURE, 1953–54.

(Acres.)

Area.	Vine Fruits.	Tree Fruits.	Citrus Fruits.	Lucerne.	Other Fodders.	Total
Orchard Land—						
Berri	5,513	781	1,155	53	..	7,502
Cadell	622	120	90	20	..	852
Waikerie ..	2,095	458	1,090	20	..	3,663
Cobdogla	4,058	393	167	62	..	4,680
Moorook ..	384	117	203	26	..	730
Kingston	268	83	219	2	..	572
Mypolonga ..	..	414	432	..	..	846
Chaffey	815	73	9	69	..	966
Total ..	13,755	2,439	3,365	252	..	19,811
War Service Land Settlement—						
Cooltong	364	235	481	4	..	1,084
Loxton	2,577	655	1,556	34	..	4,822
Loveday ..	235	47	22	..	..	304
Grand Total ..	16,931	3,376	5,424	290	..	26,021
Renmark Irrigation Trust	7,310	650	930	..	..	8,890
Reclaimed Swamp Land—						
Monteith ..	..	..	..	..	979	979
Mypolonga ..	..	..	..	40	1,162	1,202
Wall	..	..	..	38	472	510
Burdett	..	..	..	..	97	97
Mobilong	..	..	..	..	448	448
Long Flat ..	..	..	..	..	358	358
Neeta	..	..	..	..	549	549
Pompoota ..	..	..	..	..	421	421
Cowirra	..	..	..	19	543	562
Jervois	..	..	..	227	3,519	3,746
Total ..	..	..	..	324	8,548	8,872

The expenditure incurred by the State Government to 30th June, 1954, in purchase of land, reclamation of swamps, preparation of irrigable lands for fruit growing, and purchase of pumping plants for drainage and water supply was approximately £5,347,000. Further irrigation development is being undertaken as a part of the Commonwealth-wide War Service Land Settlement Scheme. South Australia's share of horticultural plantings under the scheme is 13,000 acres, comprising citrus 3,500 acres, vines 8,300

acres, and deciduous tree fruits 1,200 acres. Schemes already approved and under construction will absorb between 7,500 and 8,000 acres, and further areas are being selected to take up the balance. The area of 13,000 acres would provide holdings for about 500 settlers, from which, if developed, the estimated production would be :—Citrus, 750,000 bushels; deciduous tree fruits—fresh, 6,000 tons; dried vine fruits, 2,500 tons; wine grapes, 11,000 tons. On present-day prices, the value of this production would approximate £1,500,000.

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 8,890 acres.

3. **Water Supply Schemes.**—(i) *Summary.* Water conservation and distribution works in South Australia have cost £35,444,000 (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 1953–54 is as follows :—Length of water mains, 5,717 miles; capacity of storages, 35,086 acre feet; approximate population served, 264,000; area served, approximately 4,500,000 acres; and total capital cost, £20,370,000.

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. The extent of the several artesian basins is tolerably 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. Apart from numerous boreholes and wells tapping underground water for farms, stations and towns, two notable basins are being developed on Eyre Peninsula—one at Flinders (Streaky Bay) and the other at Uley-Wanilla, near Port Lincoln. Leigh Creek coalfield, some 360 miles north of Adelaide, derives its supply from a borehole at Sliding Rock mine, the water being pumped through a pipeline 25 miles long.

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. Deep boreholes have been drilled by the Government, however, to provide watering places along stock routes, and pastoralists rely largely on supplies in suspended basins at shallower depths.

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 and Pinnaroo. The maximum depth of township boreholes is 235 feet and the minimum 71 feet. Average tested yield is 14,808 gallons per day.

Pastoralists, farmers, market gardeners and others have been assisted with expert advice on drilling, for which the Government maintains about 40 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 an examination of a large part of Kangaroo Island and Southern Eyre Peninsula has been completed in connexion with Soldier Settlement schemes. Examination of large areas in the Upper South-East has been undertaken in connexion with land development schemes.

The results of comprehensive surveys of underground supplies undertaken by geologists of the South Australian Government have been published in the State's geological survey bulletins in recent years.

5. Farm Water Schemes.—While the Department of Mines and the 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, p. 18 of this issue.)

(ii) *Administration.* Irrigation districts are administered under the Rights in Water and Irrigation Act 1914–1949 and the Government is advised by an Irrigation Commission representing the local irrigationists and government technical and financial branches. The Goldfields Water Supply is administered by a branch of the Public Works Water Supply Department and its responsibilities include control of water from this scheme for agricultural purposes. The metropolitan water supply is controlled by a separate department under the control of the Minister for Water Supply, Sewerage and Drainage. Under the Water Boards Act 1904–1953 eight towns are administered by local water boards and 39 are under direct Ministerial control. The Minister also controls three District Farming Schemes. Water rights over water flowing in streams and water courses are vested in the Crown unless specifically appropriated for irrigation purposes under the irrigation legislation.

2. Irrigation.—The main irrigation districts—Harvey, Waroona and Collie—are along the south-west railway line between Waroona (70 miles from Perth) and Dardanup (116 miles from Perth). The total area irrigated in these districts during 1953–54 was 22,552 acres and the total water used was 75,162 acre feet. The total acre waterings (i.e., the number of acres watered multiplied by the average number of waterings) was 110,675. Investigations are being carried out with a view to irrigating a further 30,000 acres south of the existing Collie Irrigation District.

Harvey Districts (Nos. 1 and 2—32,663 acres) are supplied from the Harvey Weir (8,300 acre feet) and Stirling Dam (44,344 acre feet), Waroona District (10,325 acres) from Drakesbrook Dam (1,855 acre feet), and Samson Brook Dam (6,540 acre feet), and Collie District (28,762 acres) from Wellington Dam (27,800 acre feet).

The following table, which shows acre waterings supplied to crops in the irrigation districts of Harvey, Waroona and Collie during the seasons 1938–39 and 1949–50 to 1953–54 illustrates the growth of these irrigation schemes.

IRRIGATION, WESTERN AUSTRALIA: ACRE WATERINGS.

Year.	Pasture.	Fodder.	Potatoes.	Vegetables.	Orchard.	Flax, Broom Millet, and Preparation of Ground.	All Crops.
1938–39	31,949	934	3,142	692	922	..	36,739
1949–50	79,373	685	4,591	4,297	1,369	4	90,319
1950–51	76,431	793	2,946	4,090	1,180	..	85,440
1951–52	88,091	1,417	2,793	2,442	1,088	..	95,831
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

3. Water Supply Schemes.—(i) *Goldfields Scheme.* 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 goldfields, and has a capacity of 15,100 million gallons and a catchment of 569 square miles. The water now passes through 350 miles of steel main, mostly of 30-inch diameter, aided by seven pumping stations and one booster station, involving a total net lift of 1,280 feet.

Maximum pumping capacity from No. 1 Pumping Station at Mundaring is now 16 million gallons per day. The total capacity of all receiving and regulating tanks, etc., along the pipe line is 129 million gallons, which includes two standby reservoirs at Kalgoorlie having a combined capacity of 36 million gallons.

Hundreds of miles of branch mains and pipes have been laid to mining districts, towns and farming districts, the most important being the Norseman extension of 101 miles. The system serves 54 towns and water is reticulated to 1,804,600 acres of farming lands. Total length of mains is 1,812 miles and the population served is 68,000. Total quantity of water pumped from Mundaring in 1953–54 was 2,918 million gallons. Total cost of the system to the end of 1953–54 was £8,770,000.

(ii) *South-West Scheme (Comprehensive).* The Commonwealth Government has agreed to assist a scheme to extend water for agricultural areas and towns in the south-west of Western Australia, which will be administered by the State Government. Twenty-three towns and over 4,000,000 acres of agricultural country will benefit. The original estimated cost of this scheme was £4,300,000 of which the Commonwealth Government agreed to contribute 50 per cent., £2,150,000. The revised estimate at 1953 is £9,000,000. These estimates exclude the cost of the raising of Mundaring and Wellington Dams, the works of which form the headworks of the scheme and are financed solely by the State Government.

The work of raising Mundaring Weir 32 feet in height giving a total capacity of 15,100 million gallons was completed in 1951 and preparations are well in hand for commencing work in the raising of Wellington Dam 50 feet in height, increasing storage to 40,800 million gallons capacity. Forty-six miles of 30-inch pipe line from Wellington Dam to Narrogin have been laid, i.e., just over half the total distance. The new electric pumping station at Mundaring, having a maximum capacity of 16 million gallons per day, was opened in December, 1953 and construction of two electric stations on the Wellington Dam–Narrogin pipe line with a maximum capacity of nearly 7 million gallons per day is nearing completion.

(iii) *Rock Catchments.* An interesting feature of the State's conservation system is found in the Barbalin, Narembeen and Kondinin District Farming Land Schemes in the wheat belt, where extensive granite outcrops have been used as catchments. The rain is caught at the foot of the rocks, and pumped to tanks from which the water is reticulated to farms and to a number of small towns. For further particulars *see* Official Year Book No. 37, page 1135.

4. Underground Water.—Individual farmers, orchardists, market gardeners and others derive water from wells using windmills or, where power is available, pumps and motors are used to tap such supplies. The Department of Public Works has twelve hand-boring plants which are lent out to farmers to facilitate boring operations to an average depth of 150 feet, also eight power-boring plants which are hired to local authorities. The Department also contracts with private firms to bore for communal farm supplies. During the past 61 years 322 artesian and sub-artesian bores have been sunk, mostly for private purposes. The total daily flow of all recorded bores in Western Australia is 90,872,000 gallons, and the average depth at which water is struck is 791 feet. Maximum depth of any bore is 4,006 feet and minimum 21 feet.

5. Ord River Scheme.—The Ord River in the north-west 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 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 2,000,000 acre feet of water, equipped with 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.

§ 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, p. 18 of this issue.)

(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 and a small quantity exists over an area in the Midlands which has been exploited to a limited extent only by bores and windmills. Geological conditions do not appear to favour the utilization of ground water except on a minor scale. There is only one known flowing bore—at Spreyton—which yields 1,690 gallons per hour.

(iii) *Administration.* The State does not own all natural waters as in Victoria, 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. Although the survey is not yet conclusive it is considered that at least 1,865,000 kW of continuous power can be economically developed. At present only 311,700 kW of generating plant is in commission, but plant under construction will raise this total to 447,100 kW by 1956. Further construction, approved by Parliament, is about to be commenced and will increase the total to 569,000 kW.

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.

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

* *See also* Chapter XXV.—Electric Power Generation and Distribution, pp. 939–40.

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 favor 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 Esk River in the north and the Huon River in the south. A power station now under construction at Trevallyn, near Launceston, will utilize water from the Esk. The Huon has a large low-level catchment in the high-rainfall area near the west coast. Storage could be provided on it at a reasonable cost and because of the proximity to Hobart of a future power station, it has considerable value for peak load development.

3. **Industrial.**—Three principal industrial schemes have been installed privately. Australian Newsprint Mills Ltd. pump approximately 6,000,000 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 Emu River at Burnie, and Titan Products Pty. Ltd. reticulate water from Chasm Creek to their factory at Weybridge. In addition the State is actively engaged in the construction of a regional water scheme which will serve the Australian Aluminium Production Commission's plant at Bell Bay on the River Tamar. 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, at present 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 and legislation is under consideration. 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 1953-54 to 9,412 acres devoted to: hops (1,193 acres); fruit (802 acres); pastures (5,311 acres); green fodder, etc. (1,016 acres) and other crops (1,090 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) 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.

3. **Underground Water.**—Artesian water is found mainly in the south-east where the Great Artesian Basin enters the Territory. Pastoral (beef) production accounts for the bulk of the Territory's income, and the marked seasonal conditions affect the industry's economy. During the wet summer season there is adequate water, but during the winter most natural watering points disappear, and pastures dry. Bores supplement the permanent watering points, which are mainly along river frontages. The cattle industry is concentrated in the area in which the feed retains an appreciable nutritive value during the winter despite the dry conditions. This area is not in the wetter coastal regions, but in the inland belt of 15 to 25 inch rainfall and to the north of Alice Springs. Lack of bores is a limiting factor in the industry's economy, as cattle are able to thrive only within certain distances of reliable water.

In 1954 some 980 equipped bores were recorded, comprising 786 on pastoral properties (54 provided by the Government by way of assistance to pastoralists), 158 established by the Government on stock routes, 18 on Native Affairs Settlements, 11 on mining fields, 6 for Town Water Supplies and one maintained by the Postmaster-General's Department.

Latest details of bores on pastoral properties relate to 1952 and probably understate the present position. Compared with 1951 the figures for the various districts are :—

District.	1951.	1952.
Alice Springs	287	357
Barkly Tablelands	232	288
Victoria River Downs	80	87
Total	599	732

The number of stock route bores, watering some 2,500 miles of stock routes, has increased by approximately 50 per cent. in the seven years 1947–1954, and the present figure of 158 bores represents on the average approximately one per 16 miles.

4. **Irrigation.**—There are no large-scale water conservation projects in the Territory with the exception of the Manton Dam (80,350 acre feet) which serves Darwin with a reticulated supply. Irrigation has therefore assumed no current importance. For particulars of potentialities *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, page 114 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 main water conservation interest in New Guinea at present is the hydro-electric potential.

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).

It is known that the opportunities for production of hydro-electric power are extensive. However, present investigations have been limited to those areas where an early demand for power is likely to arise.

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 (kW) of 100,000; 150,000; 2,000,000; 250,000; and 3,000,000 respectively. These have estimated run-offs of 1,400; 600; 12,000; 1,000 and 75,000 cusecs respectively.

In an area of 150,000 sq. 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.