WATER RESOURCES AND POWER DEVELOPMENT ON THE CENTRAL PLATEAU

by J.R. Ashton

Hydro-Electric Commission of Tasmania.

The Central Plateau region of the State - the lake country of Tasmania - has undoubtedly been responsible for sparking the enthusiasm that had led to the extensive development of the hydro-electric resources of this State. This enthusiasm resulted from the obviously favourable characteristics of the area for power development - good rainfall, cheap storage sites and favourable topography for developing suitable "drops" for power development. Furthermore, these resources were all located in relatively accessible areas.

In reviewing the power development on the Plateau it is proposed to deal first with those aspects of the climate of particular interest to the water resources of the area and then deal with the manner in which these water resources have been used to date and may be used in the future.

Climate and Water Resources

The Central Plateau slopes generally in a south-easterly direction from an average level of about 4,000 ft. (1200 m) in the north-west to 2,000 ft. (600 m) in the south. In the north and the east the plateau is bounded by the escarpments of the Western Tiers that fall steeply to plains at an elevation of 600 to 1,000 ft. (180 to 300 m).

Most of the plateau lies in the catchment area of the Derwent River and its tributaries - the Nive, Dee, Ouse and Shannon Rivers. Other significant areas include the Fisher River catchment upstream from Lake Mackenzie and the Lake River catchment upstream from Arthurs Lake.

Because of its elevation the climate is harsh in Australian terms. In the Gt. Lake area the temperature varies from a daily mean of 12°C during summer months to 2°C in mid-winter. Widespread severe frosts are common during the winter. Snow and hail can be experienced at any time of the year and the area above 3,500 ft. (1050 m) is frequently covered by snow for extended periods.

Heaviest snow falls occur, as a rule, in late winter and spring and less frequently in June and July.

There is a strong rainfall gradient from north-west to south-east over the region which reflects the topography of the area. For example the mean annual rainfall in the Cressy area at the foot of the escarpment is about 25" (63 cms), rising to 80 inches (200 cms) or more on the escarpment then falling to 36" (90 cms) at Liawenee, which is less than 12 miles (19 km) from the escarpment.

The mean annual rainfall for selected stations in the area are as follows:-

TABLE 16

Location	Mean Annual Rainfall ins cm
Cressy	25 - 63
Breona	72 - 183
Lake Mackenzie	71 - 180
Liawenee	36 - 90
Miena	33 - 84
Lake Echo	41 - 104
Steppes	29 - 73

The mean annual evaporation from a free water surface is difficult to determine, but is estimated to be in range of 25 to 30 inches (63 to 76 cms) over the region. The majority of the evaporation takes place during summer months. In a dry month the loss from Gt. Lake due to evaporation has been as high as 7 inches (18 cms).

The most significant feature of the runoff occurring in streams in this region is the high yield occurring over the narrow high rainfall band along the escarpment. However, this yield tapers off rapidly away from the escarpment. As a result the catchment yields for Great Lake, Arthurs

Lake and Lake Echo, when expressed in inches of runoff per square mile, are amongst the lowest yields of all catchments developed by the Commission.

The yields for major catchment areas in the Central Plateau region are summarised below:

TABLE 17

Catchment	Catchment Area (sq. miles) - (sq. km)	Mean Annual Yield	
		Cubic feet per second - kilolitres per second	Inches - cm
Lake Mackenzie	30-78	153-4.34	67-170
Ouse at Liawenee	110-285	351-9.98	36-91
Gt. Lake	153-387	304-8.65	22-56
Arthurs Lake	101-263	142-4.04	16-41
Lake Echo	50-131	40-1.14	11-28

The streamflow varies from a minimum in January to a maximum in August, which coincides well with the variation in power demand over the year. In terms of variability of yield, the streamflow in the region is twice as variable as the runoff in west coast catchments. However, a number of suitable water storage sites are available and have been exploited to overcome this yield variability.

Existing Power Developments

The first hydro-electric power plant in Tasmania was installed at Waratah by the Mt. Bischoff Mining Company in 1883. The installation of a number of small hydro-electric plants followed, most being installed by mining companies early this century. However, of all these installations only the Moorina (1909) and Lake Margaret (1914) plants are still in operation.

The first public venture was the construction of the Duck Reach hydro-electric scheme on the South Esk River by the Launceston Municipal Council in 1895.

The first major undertaking was the construction of Waddamana Power Development in the Central Plateau region. Work on this development commenced towards the end of 1911 when a concession was granted by the Parliament of Tasmania to the Hydro-Electric Power and Metallurgical Company. At a later stage the scheme was taken over by the Government and placed under the direction of the Hydro-Electric Department. The first generators were placed in service in May 1916.

The major attractions of the Waddamana Power Development were the large storage potential of the Great Lake, the runoff available from the catchment (which at the time must have appeared to be adequate to meet the power demand for many years ahead) and the suitable topography for power development. The fall available from the Penstock Lagoon to the Ouse River of 1,127 ft. was a high head involving large stresses on pipelines and machines, but the technology of the day was capable of handling the problems with the materials available.

The rapid increase in the demands for power brought about the construction of a multiple arch dam on Great Lake to provide more storage, the diversion of the Upper Ouse River to Great Lake via Liawenee Canal, and a continuing increase in the generator capacity in the original power station, which reached its ultimate installed capacity of 49,000 kW in April 1923.

In 1930 the State hydro-electric works and the business of the Hydro-Electric Department were vested in the Hydro-Electric Commission of Tasmania. This Commission continued to concentrate its attention upon the power resources of the Central Plateau region. Its first project was the Shannon Power Development which utilised the head available between Miena Dam and Waddamana Penstock Lagoon. This station commenced operation in 1934.

The average load met by the power system in 1916 was about 500 kilowatts. By 1934 this load had risen to 41,100 kilowatts. As the average capacity of the combined Waddamana and Shannon Power Developments was only about 42,000 kilowatts, it was obvious that a new source of energy would have to be developed. The scheme selected for this purpose was the Tarraleah Power Development.

The attractions of the Tarraleah proposal were the high yield obtainable - particularly from the Lake St. Clair catchment - the favourable water storage prospects of Lake St. Clair and at the Butlers Gorge site, and the relatively simple works required in the way of flume and canal to create a drop of about 1,000 feet (300 m) at Tarraleah Power Station. The first machine commenced generating energy at Tarraleah Power Station in March 1938. At that time the canal intake on the Derwent River near Butlers Gorge, the 14 miles (22.5 km) of flume and canal, and the pipelines leading to the power station were complete. The installation of three of the machines was completed by July 1938; the other three machines were brought into service in 1943, 1945 and 1951.

Lake St. Clair pumping station commenced operation in June 1940, thus enabling water to be drawn from Lake St. Clair - partly by gravity discharge and partly by pumping - to maintain a minimum flow of 450 cubic feet per second (12.8 kl/sec) at Tarraleah Station. The construction of Clark Dam and Butlers Gorge Power Station was commenced during the war years, with the first concrete being placed in October 1945. Clark Dam was completed in 1949 and immediately began assisting the regulation of waters flowing to Tarraleah Power Station. Butlers Gorge Power Station commenced operation in October 1951.

During this period the demand for energy had continued to increase at a rate that required the doubling of the energy generating capacity of the system every ten years. The peak load of the system was increasing even more rapidly over this period and to meet this peak load it was necessary to install a second power station at Waddamana - called Waddamana 'B' Power Station. The installation of the four 12,000 kilowatt machines in this station (equivalent in capacity to the nine machines in Waddamana 'A' Station) was completed over the period January 1944 to July 1949.

This was essentially the state of development of the hydro-electric resources of the State at the end of the 1939-45 war years. At that time, apart from Duck Reach Power Station on the South Esk River at Launceston, which was acquired by the H.E.C. in 1944, all power stations were located in the Central Plateau region.

Meeting the rapid growth in the demand for power in the post war years presented a tremendous challenge to the Hydro-Electric Commission - a task made even more difficult by the shortage of labour and materials for these works.

The completion of a new development was a matter of great urgency in the late 1940's. Again the Central Plateau provided the answer with the Tungatinah and Lake Echo Power Developments. Tungatinah Power Development involved the construction of Pine Tier Dam on the Nive River and the diversion of the Nive River through flume and canal to a series of marshes which were converted to storage lakes by the construction of several low dams. A tunnel and pipelines lead from the final storage lake to Tungatinah Power Station, located on the Nive River nearly opposite Tarraleah Power Station. Again the fall from the marshes to the power station was approximately 1,000 ft. (300 m). The installation at this station consists of five 25,000 kW machines, the first commencing service in July 1953 and the fifth in May 1956.

The Lake Echo works as initially proposed involved a small dam on Lake Echo and a dam on the Dee to divert the water at this point through a tunnel to the Tungatinah marshes and thence to Tungatinah Power Station. Later modifications incorporated in the adopted scheme involved the diversion of the Little Pine and part of the Ouse River yield through Monpeelyata Canal to Lake Echo, a substantial increase in height of Lake Echo Dam and construction of Lake Echo Power Station to develop the fall available between Lake Echo Dam and Dee Dam. Lake Echo Power Station, containing one 32,400 kilowatt machine, came into operation in July 1956.

Further works carried out on the Plateau during the 1950's included the construction of Lake Augusta Dam to improve the regulation of flow to Liawenee Canal (1953); the diversion of the Clarence River by pipeline to Bronte Lagoon (1953); the diversion of Dunnys, Wentworth and Hornes Creeks to Tarraleah forebay (1958); the construction of a second canal between Clark Dam and Tarraleah forebay (1954) and the installation of pumps on the Derwent River below Tarraleah Canal offtake to pump the pickup at that point to Tarraleah No. 2 Canal (1958).

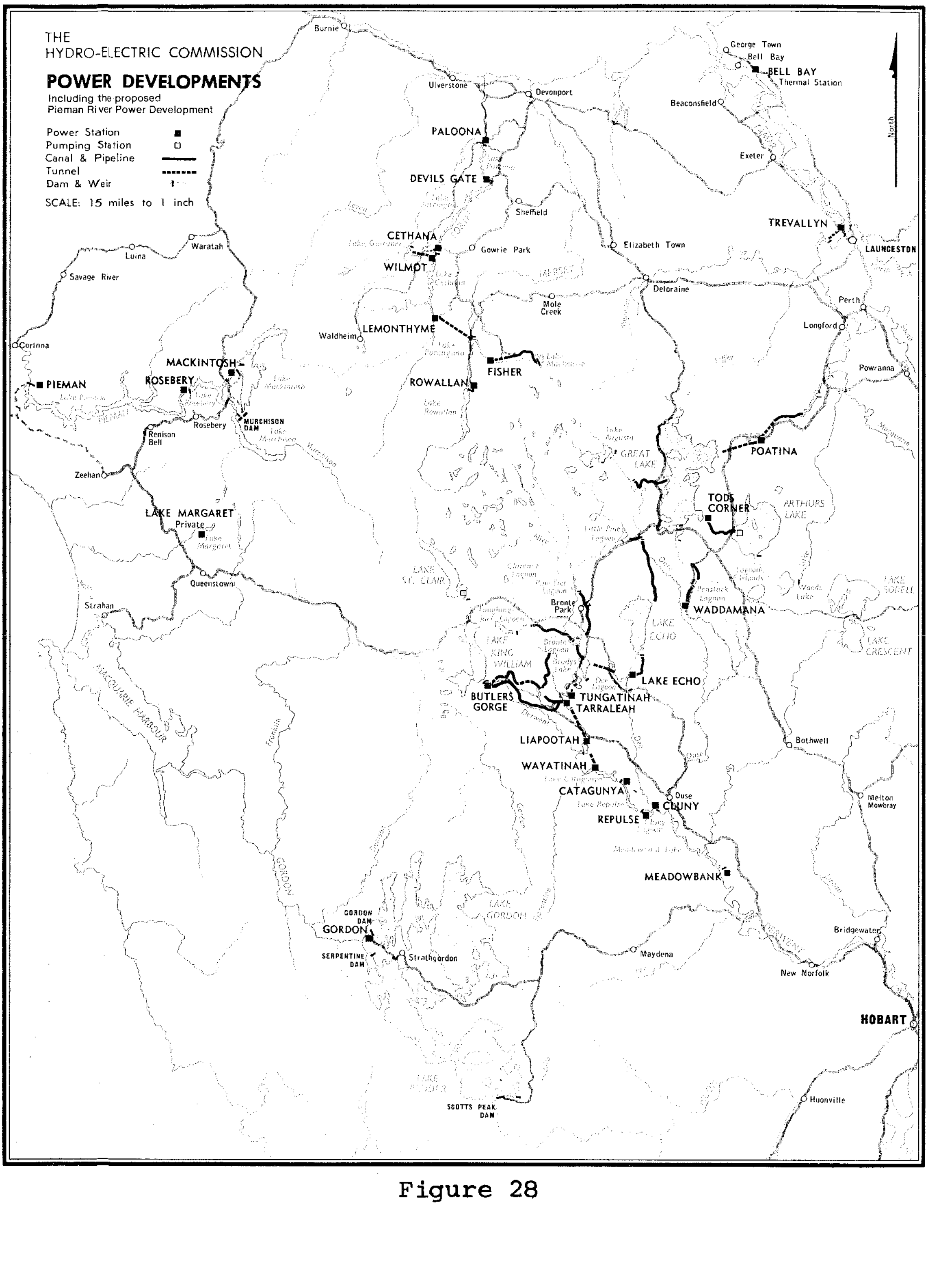
THE
HYDRO-ELECTRIC COMMISSION
POWER DEVELOPMENTS
Including the proposed
Pieman River Power Development
Power Station
Pumping Station
Canal & Pipeline
Tunnel
Dam & Weir
SCALE: 15 miles to 1 inch
North
Burnie
Ulverstone
Devonport
George Town
Bell Bay
BELL BAY
Thermal Station
Beaconsfield
Exeter
PALOONA
DEVILS GATE
Sheffield
CETHANA
WILMOT
Gowrie Park
Elizabeth Town
TREVALLYN
LAUNCESTON
Deloraine
Mole Creek
Perth
Longford
LEMONTHYME
Waldheim
FISHER
ROWALLAN
Powranna
Waratah
Luina
Savage River
Corinna
PIEMAN
MACKINTOSH
ROSEBERY
Rosebery
MURCHISON DAM
Renison Bell
Zeehan
LAKE MARGARET
Private
Queenstown
Strahan
MACQUARIE HARBOUR
POATINA
GREAT LAKE
TODS CORNER
ARTHURS LAKE
LAKE ST. CLAIR
Bronte Park
WADDAMANA
LAKE ECHO
LAKE KING WILLIAM
BUTLERS GORGE
TUNGATINAH
TARRALEAH
LIAPOOTAH
WAYATINAH
CATAGUNYA
Ouse
CLUNY
REPULSE
Bothwell
Melton Mowbray
MEADOWBANK
GORDON
LAKE GORDON
GORDON DAM
SERPENTINE DAM
Strathgordon
Maydena
Bridgewater
New Norfolk
HOBART
LAKE PEDDER
SCOTTS PEAK DAM
Huonville

Figure 28

At this stage a very large part of the Central Plateau region had been harnessed for hydro-electric power development. Developments were also taking place outside the region, the most notable at that time being the Trevallyn Power Development on the South Esk at Launceston. Trevallyn, which superseded the Duck Reach scheme, commenced operation in mid-1955 with four 20,000 kilowatt machines installed. Further schemes followed to make use of the discharge from Tungatinah and Tarraleah, together with natural pickup at a number of sites on the Nive and Derwent Rivers. However, as these schemes are located outside the Central Plateau region they will not be dealt with in any detail.

The next scheme affecting the Central Plateau was the Gt. Lake Power Development. Earlier in this paper the relatively simple method of developing the waters of the Gt. Lake and Upper Ouse River via Shannon and Waddamana Power Stations was described. In this way a total fall of about 1,400 ft. (430 m) was used for power development. However, just to the north-east of the Great Lake lies the very steep drop known as the Western Tiers. By the construction of a power development at this end of the lake the development of a fall of 2,720 feet (830 m) was possible, with utilisation of the outflow from this station over a further 415 ft. (125 m) at Trevallyn. Development to the north would therefore result in the generation of more than twice as much energy from Gt. Lake than it would be possible to develop through Waddamana and Shannon. Furthermore, Waddamana 'A' Power Station had by that time been in operation for nearly 50 years and complete replacement of the pipelines, power station building and turbo generators would have been necessary for the station to continue in service.

Studies showed that the Poatina Power Scheme was by far the most economic proposal for utilisation of Gt. Lake waters. This scheme involved the diversion of the Great Lake waters from the northern end of the lake by tunnel and pipeline to an underground power station at the foot of the Tiers.

Associated with the construction of Poatina Power Station was the diversion of Arthurs Lake to Great Lake. This involved the construction of a dam on the outlet from Arthurs Lake with a pumping station and pipeline to raise the water some 460 feet (140 m) and a flume and canal to carry it to Great Lake. Tods Corner Power Station was constructed to utilise the fall of 140 ft. (43 m) from the end of this canal to the Gt. Lake.

The first of six 50,000 kilowatt machines at Poatina Power Station came into service in March 1964, Arthurs Lake pumps commenced operation in May 1966 and Tods Corner in December 1966.

No doubt the possibility of developing Gt. Lake in a northerly direction was considered when power schemes were being investigated in this area in 1911. However, several factors mitigated against a decision to develop to the north. First, the very small demand for power at that time necessitated that the selected scheme be capable of being developed economically in small stages. The surface development at Waddamana was ideal from that point of view. Secondly, the very high head of 2,700 ft. (830 m) that would apply to the northern development for the most economic scheme arrangement involved very high stresses on pipelines and turbines. At that time the materials and technology necessary to undertake such works were not available.

Because of the very high head available at Poatina considerable attention has been given to diversion of extra catchments to Great Lake - particularly those catchments adjacent to the escarpment where rainfall is highest. Consequently the Upper Liffey near the Lake Highway and the upper reaches of Westons and Brumbys Creeks west of the Poatina Highway have been diverted to Gt. Lake and the inflow to Shannon Lagoon from the surrounding natural catchment is pumped back through Miena Dam.

Great Lake, Lake Echo, Lake St. Clair and Lake King William constitute the major water storages of the present hydro-electric system. These storages are drawn upon during dry summer periods, and even more importantly, when a series of dry years is encountered. As the system grows the need for storage increases. To meet these increased demands it has been necessary to enlarge some of these lakes. In 1966 the raising of Clark Dam by 20 feet (6 m) was completed. At Miena it was found that the most economic method for raising the lake level was to construct a new rockfill dam downstream from the old multiple arch dam. This new dam was constructed in 1967 to a height sufficient to enable the maximum level of Gt. Lake to be increased from S.L. 3380 (1030 m) to S.L. 3391 (1034 m). Provision has been made in the design of the dam for a further raising of the lake level to S.L. 3410 (1040 m) when necessary.

The Lake Mackenzie area is the most recent segment of the plateau to be developed. Work on the Lake Mackenzie Scheme, (which forms part of the Mersey-Forth Power Development) is well advanced, and the scheme is expected to commence operation early in 1973. The scheme comprises a dam on Lake Mackenzie with flume and canal leading to a vertical shaft, tunnel and pipeline connecting to a power station located some 2,000 ft. (610 m) below.

In Table II it is shown that the plateau area in this region is an area of very high yield. The high head available for power development, together with the high yield, makes minor diversions to the main scheme attractive. Because of this a number of pumped diversion schemes and diversion canals have been incorporated in the scheme.

Future Power Developments

No doubt in future years further diversions to Lake Mackenzie and Great Lake will be investigated and carried out if proved economical. One such scheme that has already been investigated to a limited extent is the diversion of part of the Upper Meander catchment in the vicinity of Wild Dog Tier to Great Lake.

Investigations have also been carried out on schemes located on the Nive River catchment upstream from Pine Tier Dam. Much more work is required on these proposals however before the desirability or otherwise of such schemes can be assessed.

It must be emphasised that the investigation studies carried out by the Hydro-Electric Commission do take environmental matters into account. Conservation of water catchments is, of course, a vital matter for hydro-electric engineers. In the high region of the Plateau where regrowth is so slow, adequate conservation measures are of particular importance.