C MACQUARIE CATCHMENT

1.0 Hydrology

The upper Macquarie River catchment is one of the driest areas in the state as it lies in the rain shadow of both westerly and easterly weather systems. Townships such as Campbell Town and Ross have historically experienced hardships in terms of the available supply of water and it is for this reason that man-made storages have been constructed. Lake Leake and Tooms Lake were created largely to meet township requirements for water as well as stock and domestic requirements downstream, but they also provide irrigation relief from the ephemeral (i.e. intermittent) nature of the streams in these areas. It is not unusual for there to be effectively zero flow in this region during summer months.

The main river system is also ephemeral. Long "broadwaters" or ponds form in the river reaches and these have been assessed to be vital for the maintenance of the local aquatic ecosystems.

1.1 Historical Background

Records on flows in the Macquarie River are surprisingly sparse given the attempts to develop the area. The longest periods of record appear to be related to Lake Leake and Tooms Lake. These records do provide some overall picture of monthly catchment yields, however, they also include the effect of evaporation on the storages and hence tend to under-estimate true runoff.

Tributary	Station Name	Station Number	Period of Record	Catchment Area (Km^2)
Macquarie River				
	Macquarie downstream Longmarsh Dam	18210	1975 - 1990	89.7
	Tooms Lake outflow	18206	1973 - 1992	60.2
	Macquarie at Trefusis	18217	1979 - 1992	365
	Elizabeth at Lake Leake	9	1922 - 1988	69.7
	Macquarie downstream Elizabeth River	18312	1989 - 1995	2041
	Lake R. downstream Woods Lake	165	1955 - 1991	347
	Poatina Discharge	502	1964 - 1991	-

+ Sites with altered catchments due to water diversions for irrigation schemes or HEC operations.

1.2 Catchment Yields and Distribution of Flows

Excluding diversions from Great Lake, the Macquarie River catchment provides about 28% of the natural annual flow at Launceston.

Annual Yields

Figures 1.1a to 1.1d show the average annual, average winter, and average summer flows at key monitoring sites throughout the catchment. All sites have high variability in average flows from year to year.

Flows in the upper catchment above Ross have been measured at the site of the proposed Long Marsh Dam, at Trefusis and on the Tooms River downstream Tooms Lake. The difference in flows at Trefusis and in the Tooms River is effectively the flow coming from the upper catchment.

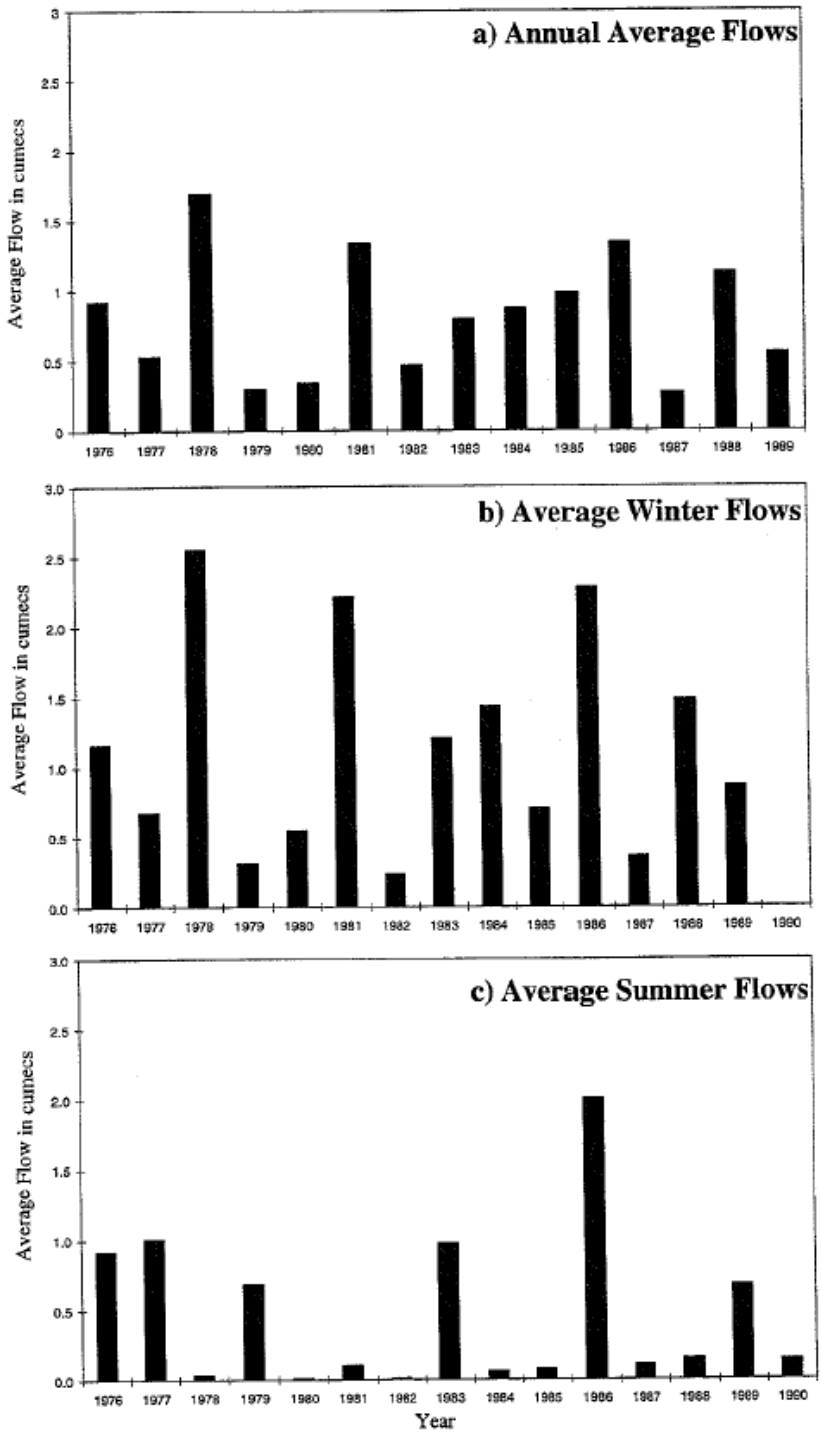

Figure 1.1a Average annual, winter and summer flows in the Macquarie d/s Longmarsh Dam.

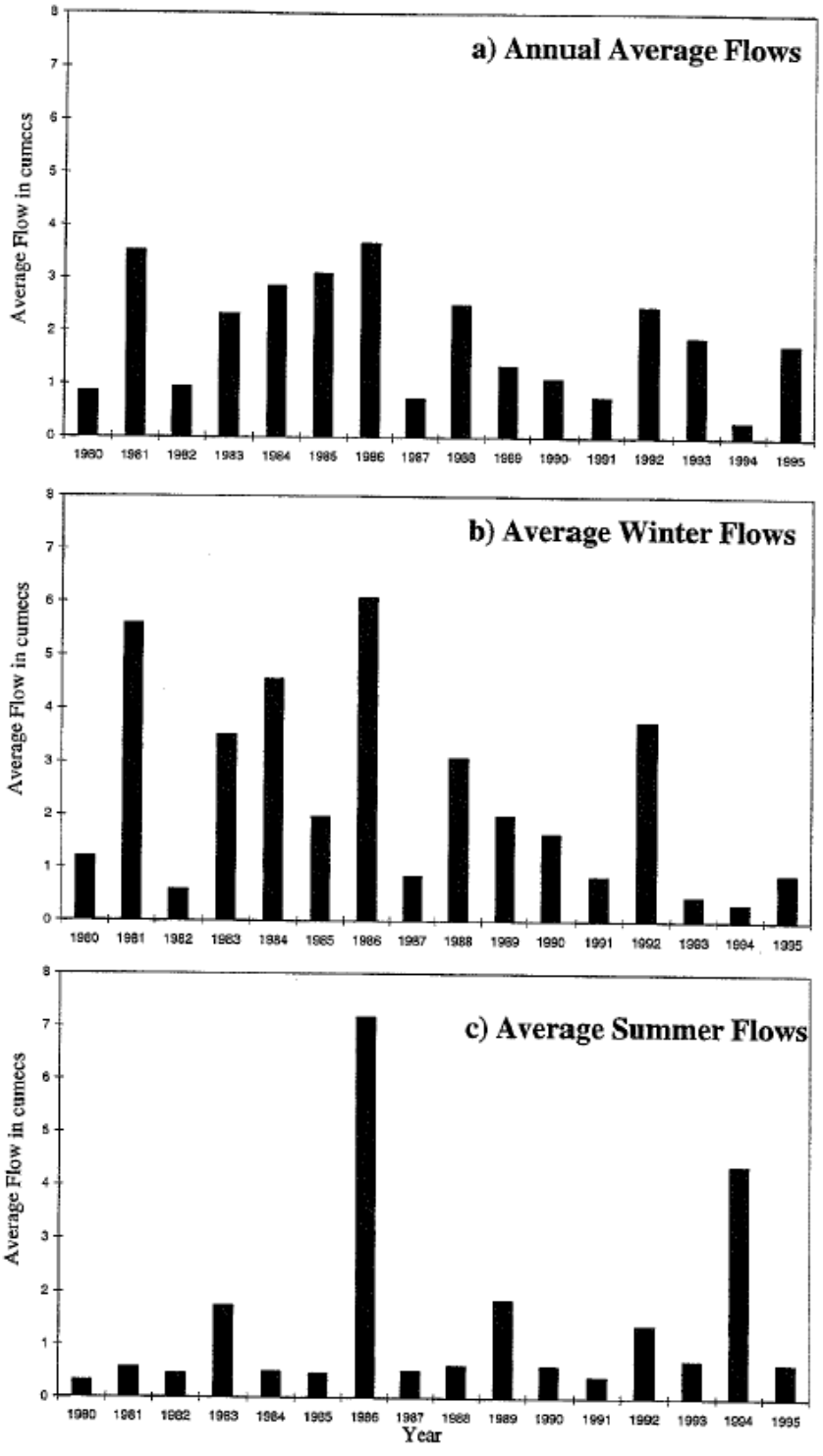

Figure 1.1b Average annual, winter and summer flows in the Macquarie at Trefusis.

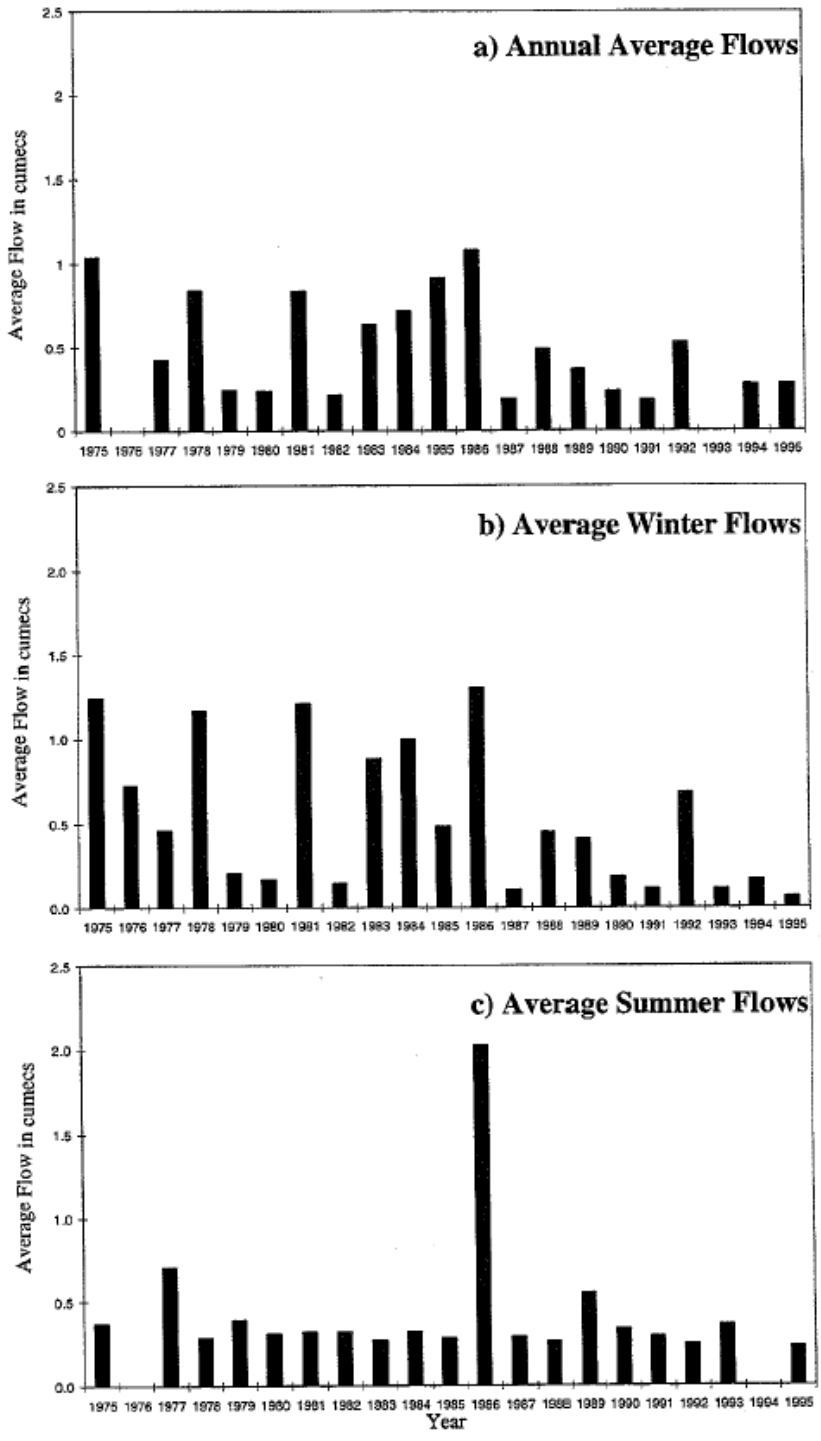

Figure 1.1c Average annual, winter and summer flows in Tooms River d/s Tooms Lake.

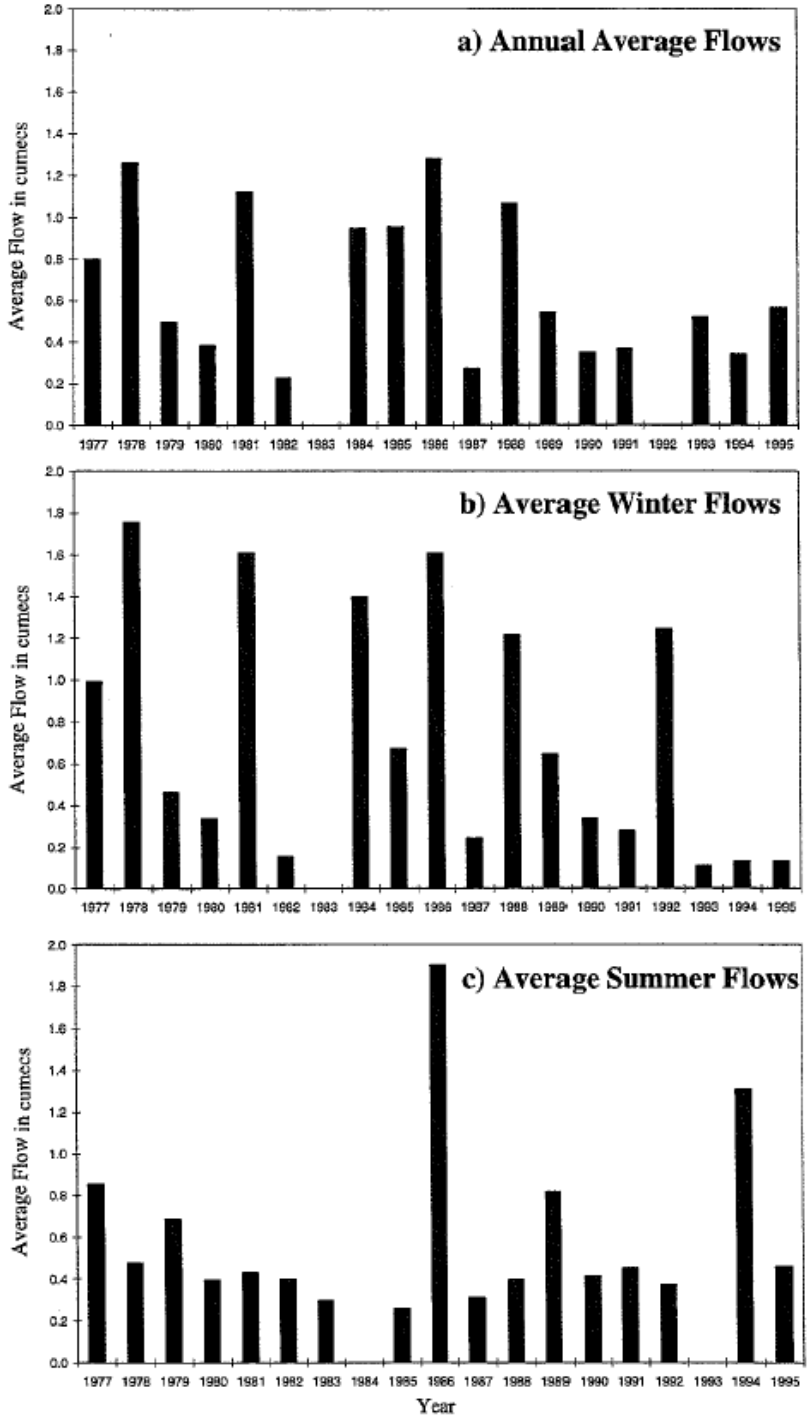

Figure 1.1d Average annual, winter and summer flows in the Elizabeth d/s Lake Leake.

Inspection of Figures 1.1a to 1.1c shows that there is a high correlation between flows at the three sites especially on an annual average basis and during high flow months. However the effect of Tooms Lake regulation on flows at Trefusis is clearly evident in summer. Flows in this area are highly variable in both winter and summer. Further information on the regulation of Tooms Lake is provided in Section 1.6.

Figure 1.1d provides a graphical summary of releases (and spill) from Lake Leake. Again high variability in both winter and summer flows is seen with a relatively consistent base level of flows from the lake during summer. Further information on the regulation of Lake Leake is provided in Section 1.6.

Flows down the Lake River are now regulated by releases from Woods Lake. The Hydro-Electric Commission is currently reviewing these measurements and hence the data was unavailable for analysis.

Monthly Yields

The variability of monthly flows in the Macquarie River catchment is shown in Figures 1.2a to 1.2e which provide box and whisker plots for each of the study sites.

Box and whisker plots for Longmarsh and Trefusis show high variability in the occurrence large flows throughout the year, longer records may realise more information on the occurrence of these events. These plots are highly seasonal with peak median flow occurring in July. The ephemeral nature of the river is seen during the December through May period.

Outflows from Tooms Lake are clearly noticeable in the November through April period when the median flows in the Tooms River "jump" above the normal trend. Once again the occurrence of high flow outliers is wide spread throughout the year. Interestingly the peak median flow occurs in July and/or August suggesting some lag in releasing water from the lake through replenishment of the storage capacity.

Regulation of Lake Leake is also evident in the box and whisker plot of monthly flows. In this case the period December through March seems to be the dominant period for releases. In general releases and spills from Lake Leake seem to be more variable than those from Tooms Lake. Peak median flows from the lake occur in August and September which is surprising since Tooms Lake has a larger storage capacity than Lake Leake.

1.3 Floods

A substantial length of record is required to perform flood frequency analysis. In the Macquarie River catchment the only site at which flood frequency analysis was possible was Macquarie at Trefusis; and only after substantial theoretical corrections were made to account for years with no flooding (ie peak flows <= 100 cumecs). For this reason the calculation of flood probabilities outside the general cluster of observations should be treated with care (Figure 1.3).

1.4 Droughts and Low Flows

Low flow frequency curves have been derived for a range of durations from 1 day through 90 days (Figures 1.4a to 1.4f). The curves give the probability that any given minimum flow will occur over various time periods. For example, over five days the probability that a minimum average daily flow of about 0.25 cumecs will occur is approximately 90%, while over a longer period such as ninety days this probability decreases down to around 25%.

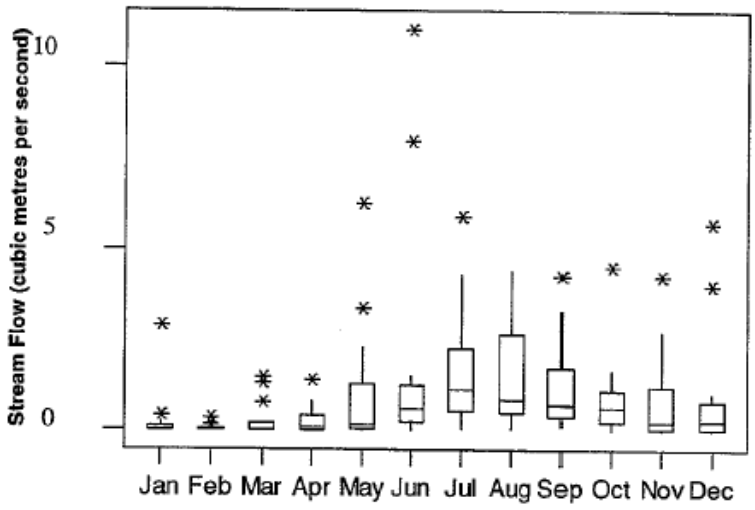

Figure 1.2a Monthly Flows in the Macquarie d/s Longmarsh Dam.

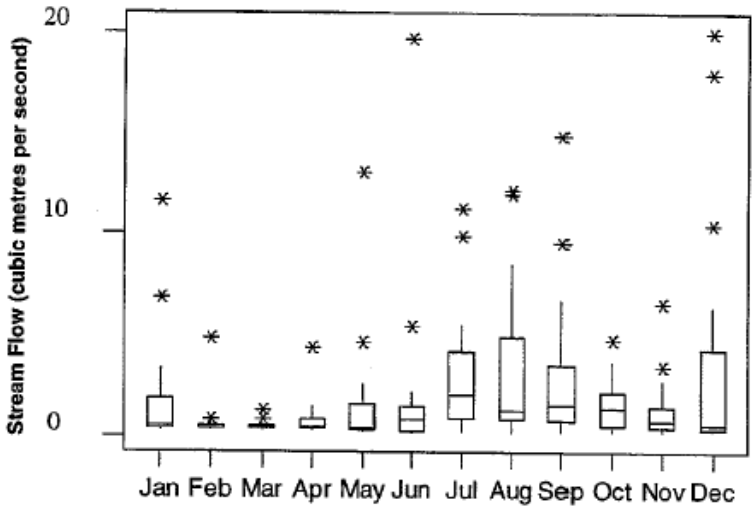

Figure 1.2b Monthly Flows in the Macquarie at Trefusis.

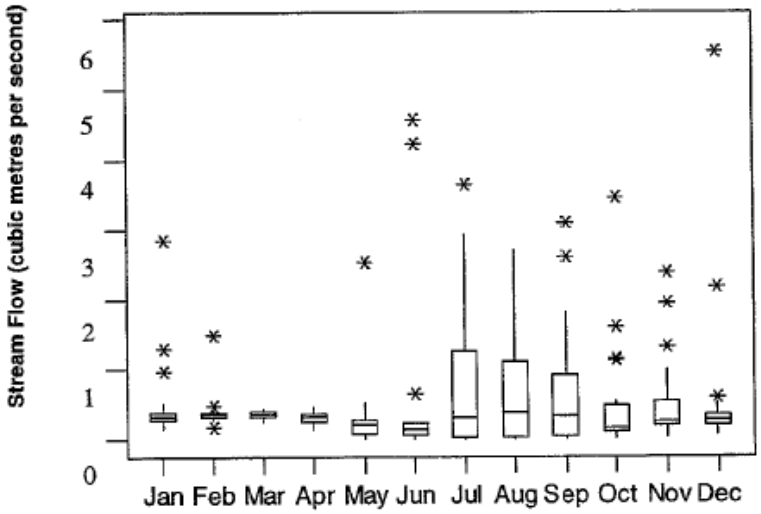

Figure 1.2c Monthly Flows in Tooms River d/s Tooms Lake.

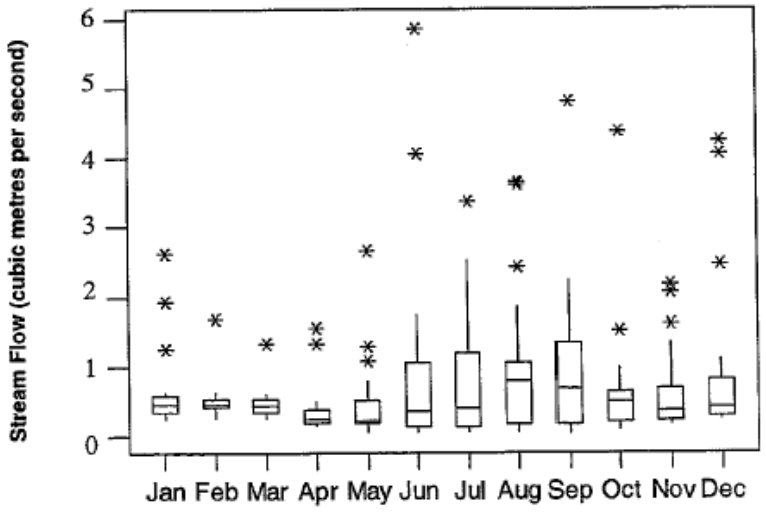

Figure 1.2d Monthly Flows in the Elizabeth River d/s Lake Leake.

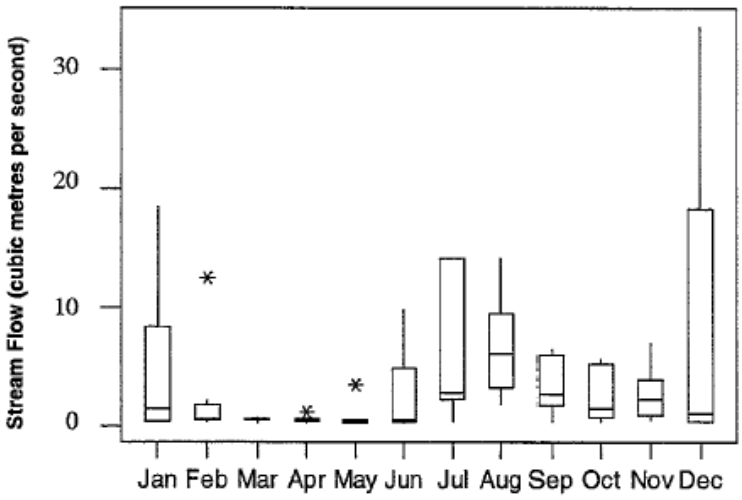

Figure 1.2e Monthly Flows in the Macquarie d/s Elizabeth (Morningside).
Statistics based on only 7 yrs of data.

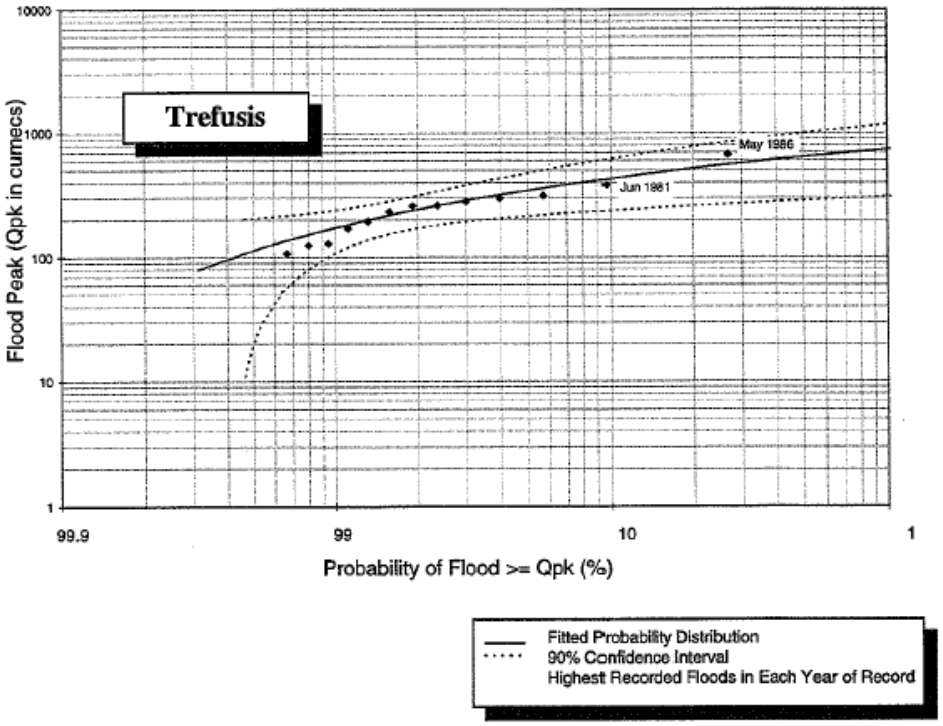

Figure 1.3 Flood frequency curves for the Macquarie River at Trefusis.

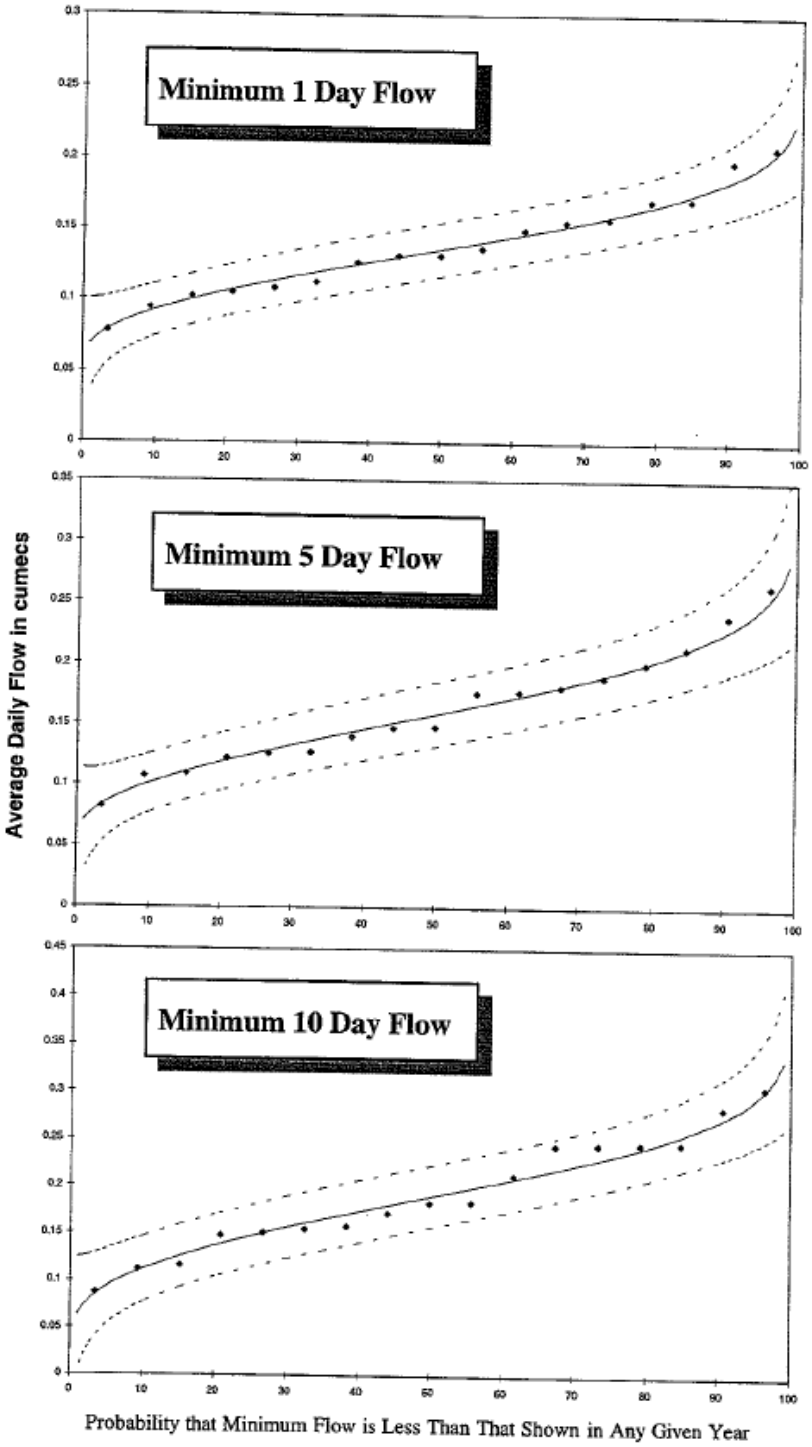

Figure 1.4a - c Low flow frequency curves for the Macquarie River at Trefusis

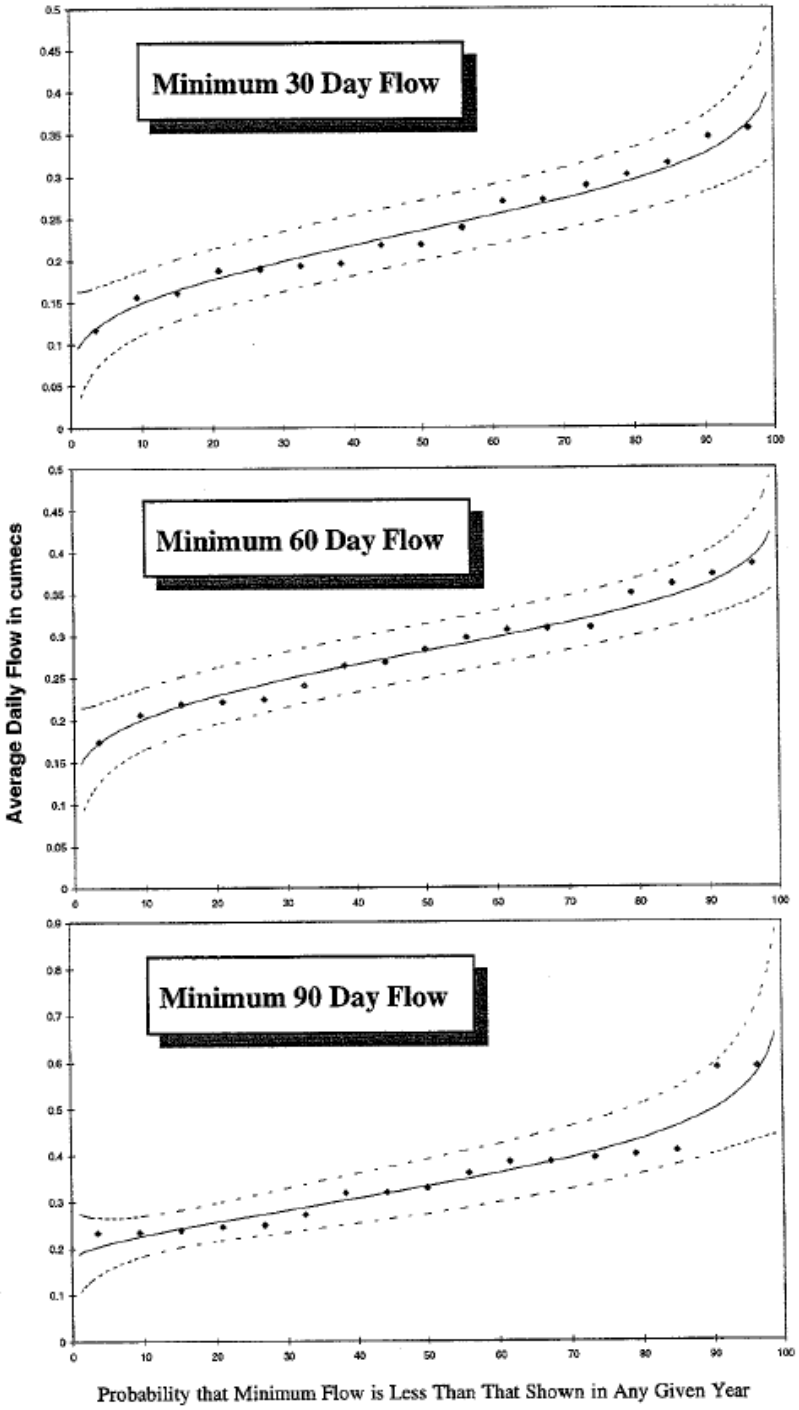

Figure 1.4d - f Low flow frequency curves for the Macquarie River at Trefusis

1.5 The Impacts of HEC Regulation

Over the last 30 to 40 years the HEC has had a substantial effect on flows in the middle to lower reaches of the Macquarie River catchment:

1962 Arthur Lakes dammed to form Arthurs Lake
1964 First release from Poatina P.S.
1965 Lake River dammed to form Woods Lake
1966 Arthurs Lake water diverted into Great Lake.

Currently Arthurs Lake does not release water down the Lake River unless absolutely necessary. The majority of the water is pumped over the hill into the Great Lake catchment where it passes through Tods Corner power station and eventually back into the Basin via the Poatina power station.

Woods Lake provides a regulated flow in the Lake and lower Macquarie Rivers to provide riparian, stock and domestic requirements to prescriptive right holders.

Substantial volumes of water are diverted from the Lake River into Great Lake, but generally much more water is released into the South Esk Basin via Poatina than is diverted through Tods Corner Canal. This is due to the diversion of water from the top of the Ouse River catchment into Great Lake via Lake Augusta and the Liawenee canal. As a broad guide to the amount of water diverted into the Basin the two power station discharges have been differenced and are presented in Figure 1.5, negative figures indicate a net loss to the Basin, positive figures a net gain.

Poatina usually provides around 60 to 70% of the flows experienced at Launceston during the summer months. This percentage decreases markedly during winter and starts to increase once more circa September each year. These releases from Poatina cause increased flows in the lower Maquarie River during summer.

1.6 Irrigation Storage

Lake Leake

Lake Leake was constructed after much debate and enterprise during the later half of the 19th century finally being closed in 1883/1884. The 5 metre dam has a storage volume of some 18.90 Mm^3 and a surface area of 6 Km^2.

Although it is believed that storage levels have been collected since the closure of the dam the only records available at this point in time are for a short period from 1922 - 1928 and from 1946 to date. The behaviour of the lake for the latter period is displayed in Figure 1.6, the solid horizontal lines represent the onset of spill at the lake and this level was altered circa 1971/1972 when the spillway crest was raised by seven (7) inches.

The figure shows that Lake Leake has not failed in this 50 year period, but is maintained at or above about half full volume. This is surprising given the relatively small size of the storage and the severity of the drought periods experienced in that time. However, the operating criteria for the lake are not based solely on the allocation of water downstream, water is effectively allocated within storage to maintain the lake as a popular fishing and recreational attraction.

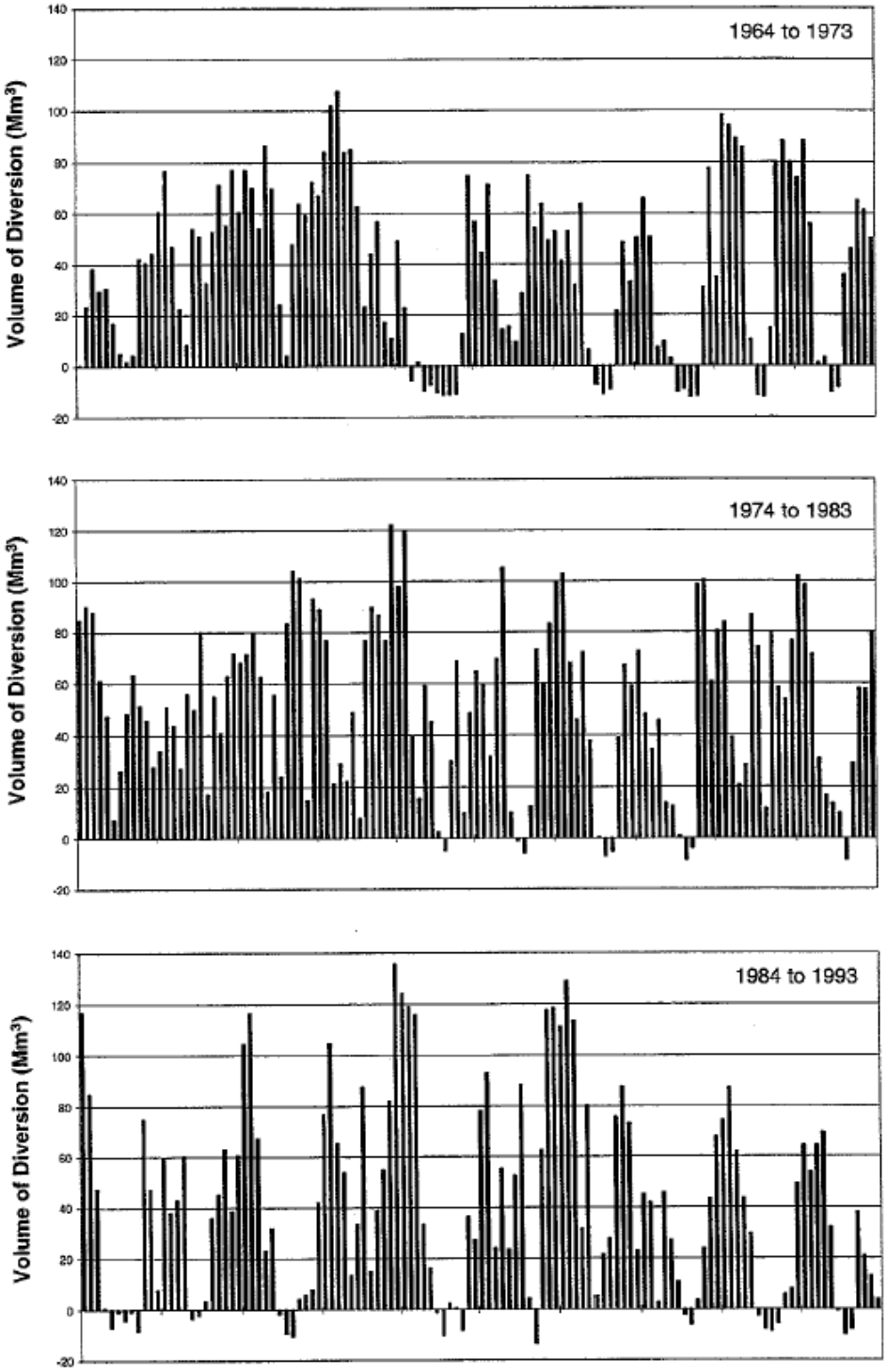

Figure 1.5 Monthly diversion of water into the Macquarie catchment via the Poatina Power station. Negative columns indicate net loss to the catchment.

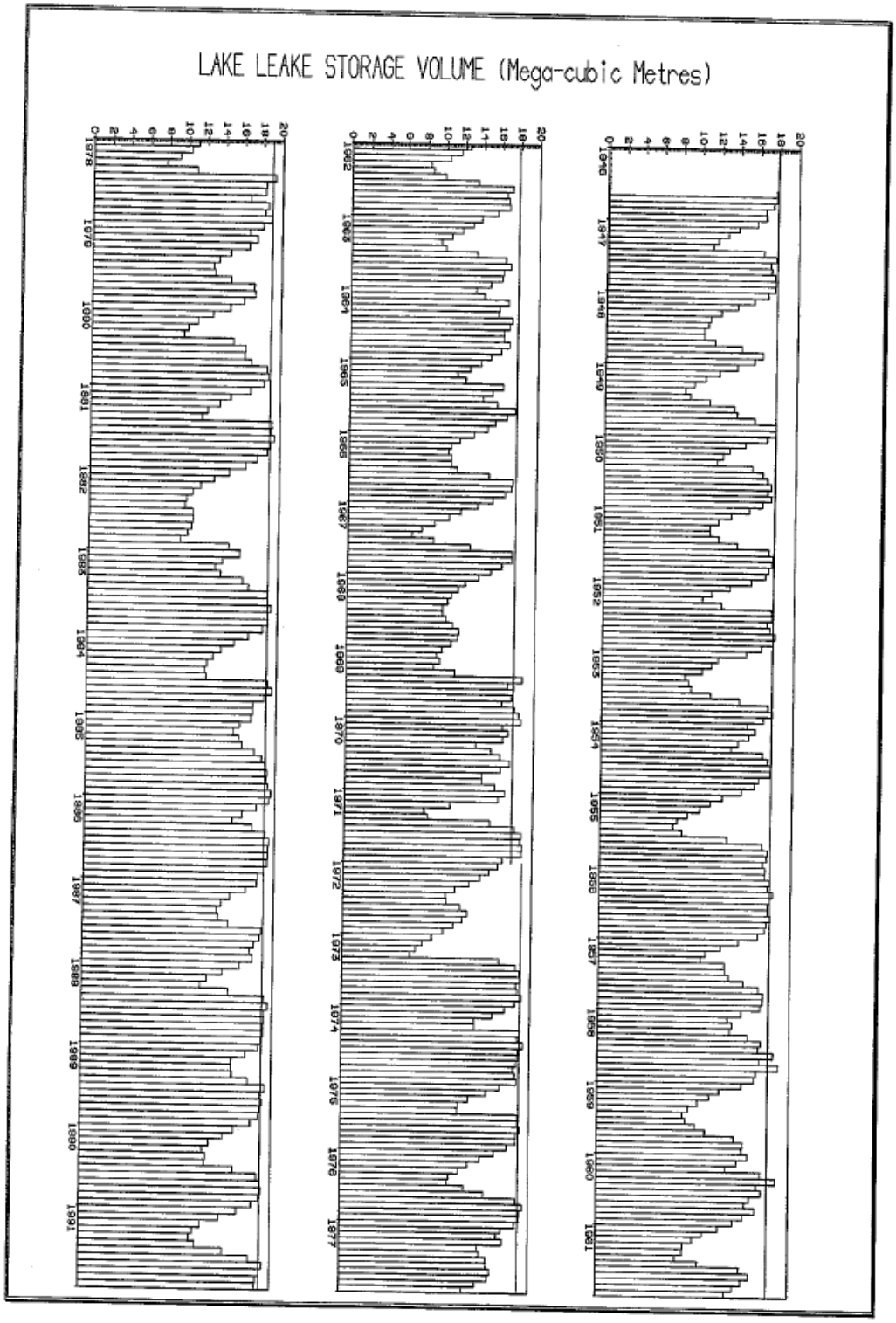

Figure 1.6 Lake Leake storage volumes between 1946 and 1991. # Solid line indicates spillway level.

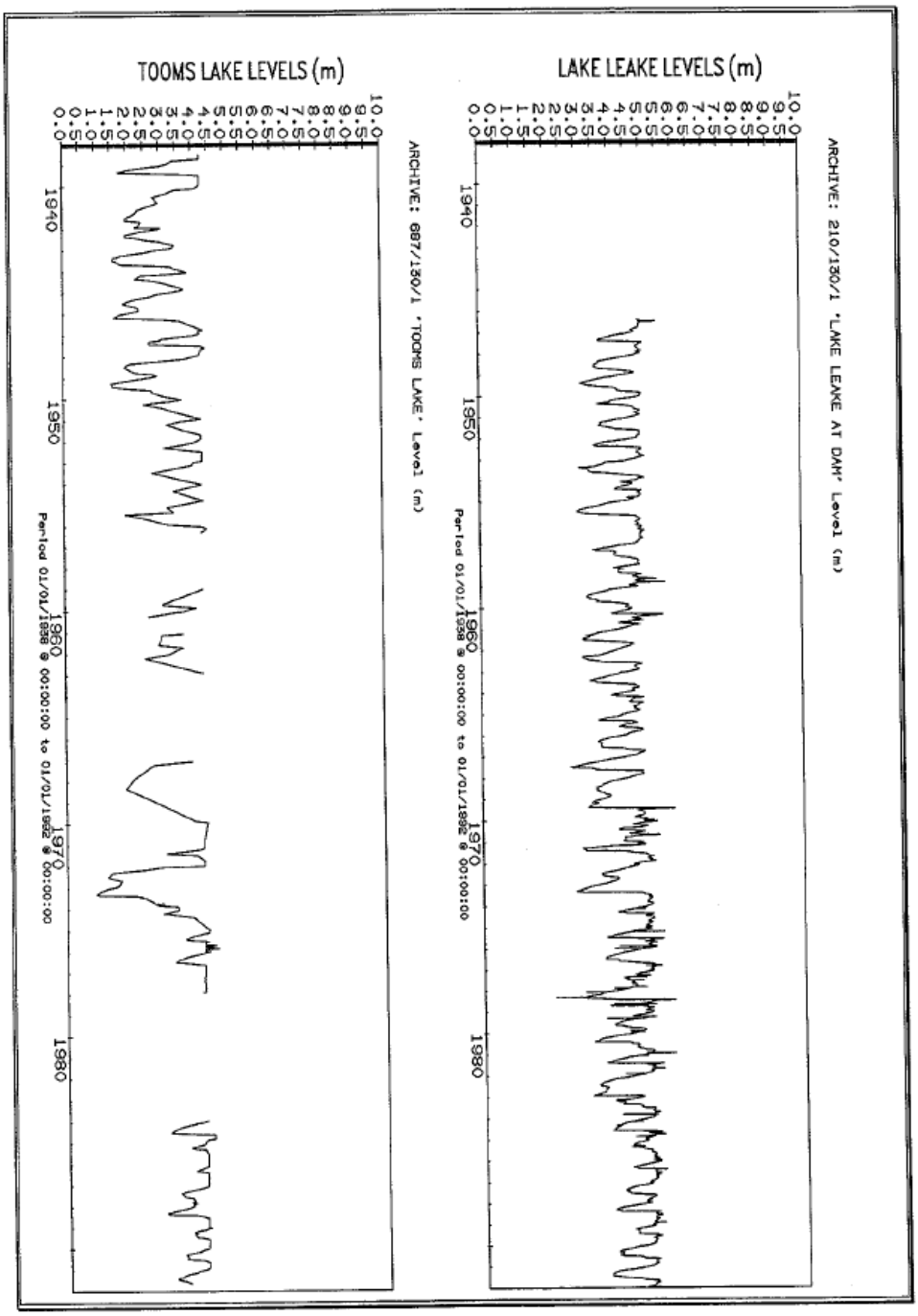

Figure 1.7 Comparison of changes in lake levels at Lake Leake and Tooms Lake between 1947 and 1990. Records at Toom Lake are intermittent and of lower quality than that from Lake Leake.

Tooms Lake

Tooms Lake is a larger storage than Lake Leake having a capacity at Full Supply Level of some 24800 ML. Data on the behaviour of the lake is relatively sparse. Collection and processing of some intermittent records held by the Ross Council does however, indicate that, in broad terms, the behaviour of Tooms Lake is not unlike that at Lake Leake (Figure 1.7).

2.0 Water Quality

2.1 Historical Background

The Macquarie River drains approximately 3860 km^2 and incorporates the Lake River, the Elizabeth River, Tooms River and the Blackman River. Flows in the Upper Macquarie, the Elizabeth and the Lake River are regulated through releases of water from impoundments in the headwaters. Flows in the lower reaches of the Macquarie River are further greatly increased during the summer through discharge from the Poatina Power Station which generates hydro-electricity from water from Great Lake on the Central Plateau.

The majority of land use in the area is forestry, beef cattle and sheep grazing and limited irrigation of crops along suitable sections of river. The main tributaries of the catchment also provides the local water supply for the towns of Ross, Campbelltown and Cressy.

Historical data on water quality is sparse for this area, with very little record available. Most data collected during this study was from the Dept. of Environment and Land Management archives and Municipal Councils and relates to those parameters connected to water processing and treatment. These records are generally discontinuous and patchy in their distribution. Other data, available from the State water quality database was from broad scale sampling throughout the State during the late 1970's - early 1980's as part of a Federally funded monitoring program. No significant reports from this data were produced.

Those parameters of greatest interest were total and suspended solids, pH, turbidity, various bacterial parameters and colour. Areas of significant record are the Elizabeth River, the Cressy Water Supply Pumping station on the Macquarie River and Brumbys Creek.

Brief mention is made in a Dept. of Environment Annual Report (No. 65, 1974) of an investigation into the source of river discolouration which had been the cause of complaints from councils in the Midlands area. The results of sampling in the Elizabeth River indicated that at the time, suspended solids concentrations tended to increase downstream of Quorn Hall, just outside the Campbelltown township boundary. The conclusion was that road reconstruction on the Lake Leake road was responsible.

Similar investigations in the Macquarie River to determine if discoloured water originated from areas of forestry activity concluded that no one tributary was responsible. It was stated that while forestry activities could not be discounted, a 10% increase in pasture land in the region around Ross and Campbelltown in 1974 - 76 may have had some influence on increased sediment loads in the river in that area.

Another significant quantity of data has been collected on water quality and chlorophyll levels at Woods Lake on the western side of the Central Plateau, at the headwaters of the Lake River. The Inland Fisheries Commission has been monitoring nutrients, turbidity, chlorophyll and algal species since the 1990 as part of a biological consultancy for the Hydro-Electric Commission. This study was commenced as a result of angling concerns

about water quality and the trout fishery in the lake and is continuing. Although most of this data is confidential, some will be commented on in a later section of this report.

Data summaries of all data collected from the various agencies and stored on the State WQ database will be collated and presented in a separate document.

The Present Study

During this study, water quality data on nutrients and general ions were collected routinely at 11 sites throughout the catchment (Figure 2.1). Sites are located at either existing stream flow monitoring stations or at locations where river level is monitored for the purposes of flood warning. In the Macquarie catchment river flow is presently recorded continuously by the Land and Water Resources Division at 4 sites. Several other sites have gauge boards to allow river level recording but are un-rated for flow conversion. The Bureau of Meteorology currently utilizes sites at Ross and Morningside on the Macquarie River for the purposes of flood warning.

One previously established site, Elizabeth u/s Macquarie, where some rating record was available, was temporarily reopened during this study to allow export calculations for the Elizabeth River to be estimated.

The Lake River site, which was previously a Rivers and Waters Supply Commission stream gauging station was closed in the 1980's and although the gauge boards are still intact, was not able to be used for flow monitoring as the control at this site was considerably altered.

Sites were visited on a monthly basis, with field collection commencing at most sites in mid-1992 and finishing in October 1995. The amount of record collected at each site varied as not all sites were monitored for the entire study period. Sites at the outflows of Tooms Lake and Lake Leake were only monitored for one year as relatively little changes in water quality were found.

Flood sampling in the Macquarie catchment was limited to infrequent spot sampling as flooding was less frequent and priority was given to automated sampling in the Meander and South Esk catchments. However sufficient sampling was carried out to allow estimates of export loads to be calculated for three riverine sites. Export estimates for both lake outflow sites was performed.

Longitudinal sampling along the length of the Macquarie River was carried out during stable summer (March) and winter (August) flows in 1995 to give a snapshot view of water quality in the catchment. The aim of these surveys was to highlight any changes in water quality due to tributaries or point source inputs to the river and reveal any trends in water quality down the length of the river. On one survey samples were tested for heavy metals and bacteria, as well as nutrients.

The data discussed in the following sections is based on routine monthly visits and represents baseline conditions. The data from flood samples which were collected at various sites have been excluded, as the number of samples collected during high flow events at each site varied and their inclusion would significantly alter the data and make comparison between sites difficult. Data from flood sampling will be discussed in the section on flood water quality and nutrient export.

The summary statistics for physico-chemical parameters, general ions and nutrients collected during routine monthly visits to all sites is given in Appendix A. The following sections will present and discuss some of the conclusions which can be drawn from this data.

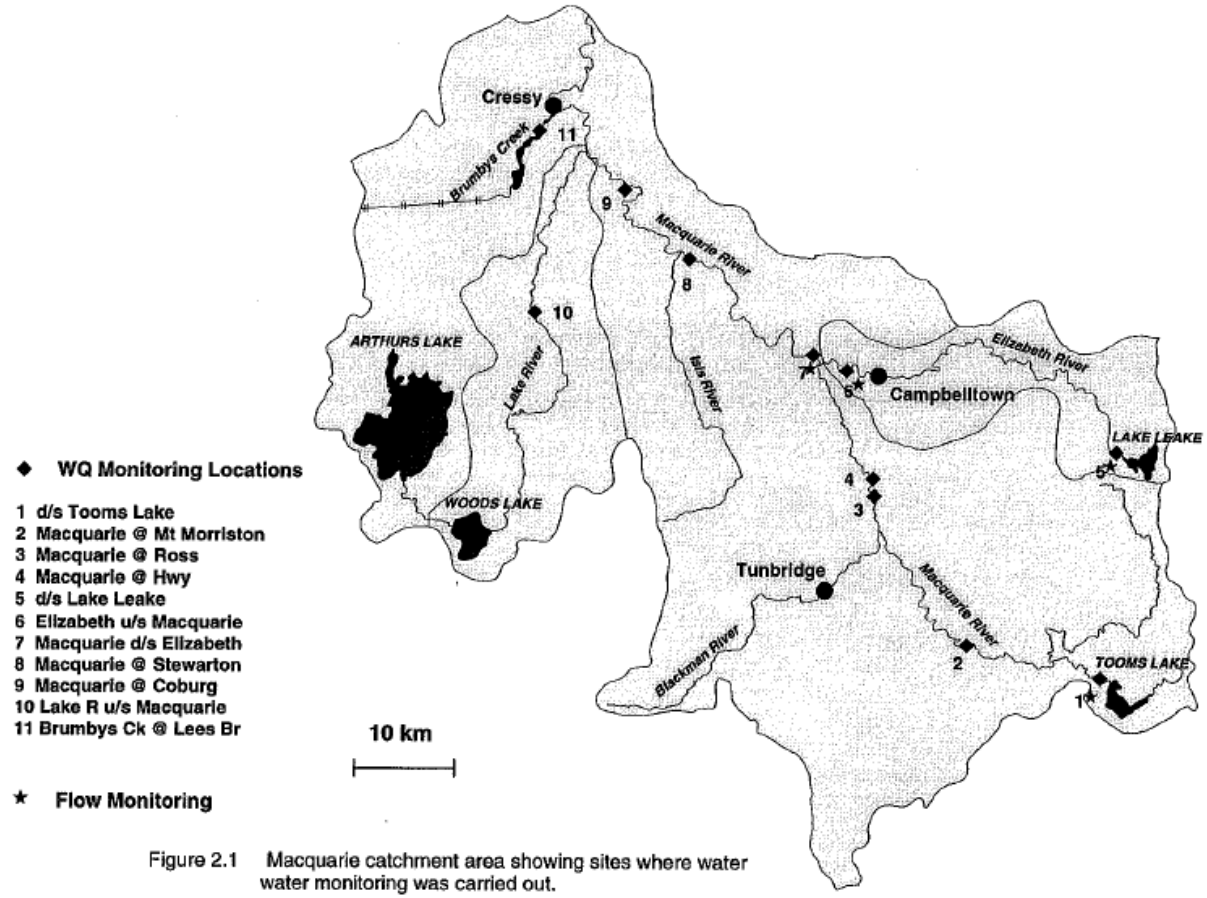

Figure 2.1 Macquarie catchment area showing sites where water water monitoring was carried out.

2.2 Physical Parameters

Temperature

Water temperature at all sites showed a distinct seasonal pattern with minimum water temperatures occurring around July - August and maximum temperatures in January - February. Temperatures at sites within the lower Macquarie River typically ranged from 5 ^{o}C to 23 ^{o}C while at sites higher in the river and in the main tributaries the temperature range was typically 4.5 ^{o}C to 18 ^{o}C (Figure 2.2). The Lake River and Brumbys Creek, whose water flows from storages in the Central Highlands, was generally always lower than at other sites in the catchment.

Electrical Conductivity

Electrical conductivity (EC) throughout the Macquarie catchment is generally higher than either the South Esk or Meander catchments. There is a distinct increase in EC from sites high in the headwaters, such as the outflows of Lake Leake (median EC of 56 μS/cm) and Tooms Lake (median EC of 74 μS/cm) to sites low in the main river such as Coburg (median EC of 216 μS/cm) (Figure 2.3). Maximum EC only exceeded 300 μS/cm in the Macquarie River at Ross during periods of extreme low flows which occurred during a drought in 1994-95.

The median of both the Lake River and Brumbys Creek is between 75-80 μS/cm however unlike the Lake River, EC levels in Brumbys Creek clearly fluctuate as a result of Poatina Power Station operation which maintains very low EC from spring through autumn (Figure 2.4). Seasonal changes in EC at all sites other than Brumbys Creek were fairly indistinct although higher EC tends to occur at most sites during the winter. An insufficient length of record is available for any analysis of long term trends.

The diluting effect of Lake River and Brumbys Creek inflows on the Macquarie River was obvious during longitudinal transects of the river during March and August of 1995 (Figure 2.5).

In the summer plot three marked decreases in EC occur due to tributary inflows. These occur at Morningside downstream of the Elizabeth River, at Westmoor Bridge below the Lake River and downstream of Westmoor Bridge where the Macquarie is dominated by the very dilute water being discharged from Poatina Power Station. During the winter survey, the power station was not operating and dilution was only apparent from Lake River inflow.

At Longford, where the Macquarie joins the South Esk, EC is monitored continuously using an in situ conductivity instrument. Figure 2.6 shows a time series at this site which demonstrates the effects of both Brumbys Creek and the South Esk River on EC at this site.

EC during the summer periods tends to fluctuate wildly during as a result of Poatina Power Station output. During the remainder of the year, EC at this site is governed by the relative influence of flows from either the Macquarie and the South Esk rivers.

Reaction (pH)

The pH of rivers in the Macquarie catchment is fairly typical of poorly buffered water with pH ranging widely between 5.6 and 8.3 (Figure 2.7). The median field pH at most sites was generally between 6.3 and 6.8. pH values reported here are for field measurements made with temperature compensation. Laboratory determinations made on stored samples were found to be significantly higher than those taken ‘in situ’ which highlights the need to measure and report field measurements of pH.

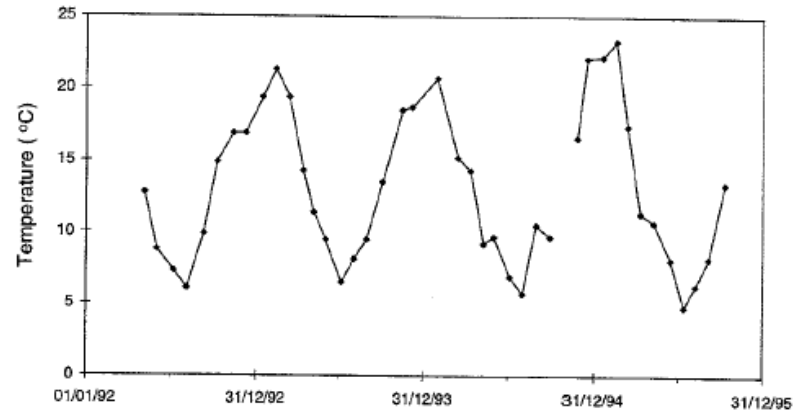

Figure 2.2a Seasonal changes in water temperature in the Macquarie River at Morningside.

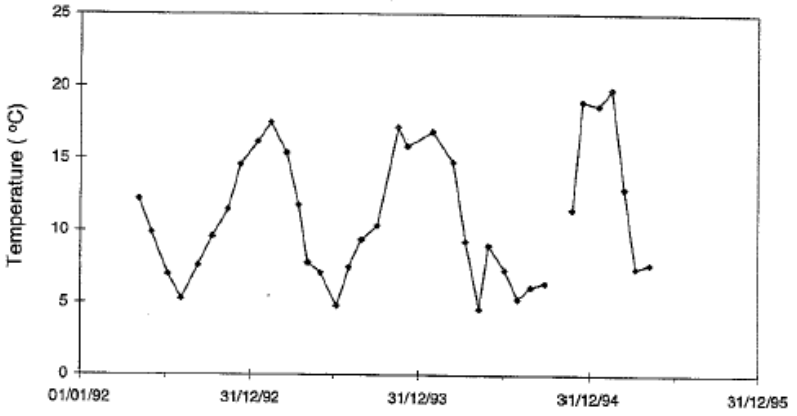

Figure 2.2b Seasonal changes in water temperature in the Lake River.