WATER RESOURCES

OF THE

MORUYA VALLEY

SURVEY OF THIRTY TWO N.S.W. RIVER VALLEYS

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WATER RESOURCES OF THE MORUYA VALLEY

PREFACE

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MINISTER FOR CONSERVATION

NEW SOUTH WALES

In accordance with the policy of the New South Wales Liberal-Country Party Government announced prior to its election to office at the May, 1965 State Elections, I directed the Water Conservation and Irrigation Commission to undertake a survey of the State's water resources on an individual valley basis to enable the formulation of a balanced and soundly based programme of water conservation.

The survey, which is the largest and most comprehensive study of its type ever undertaken, has recently been expanded to cover the Murray and Darling Basins in their entirety. It involves the preparation of twenty eight reports covering thirty two major river valleys of the State.

In the survey, studies are being made of the physiography, climate, groundwater potential and surface water resources of each valley. In addition to reviewing current water requirements, assessments are being undertaken of possible future water development.

Reports are being prepared progressively and those issued to date have covered twenty three major valleys and a number of minor valleys. This report on the water resources of the Moruya Valley is the eighteenth to be issued.

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WATER RESOURCES OF THE MORUYA RIVER VALLEY

1. INTRODUCTION

The most vital natural resource necessary for the welfare of mankind, apart from air, is water. Obviously there is a preponderance of this resource on the surface of the earth, over 74 percent of the total area being covered by the oceans and polar icecaps whilst the remaining 26 percent, comprising the land masses, is frequently covered by surface water in lakes or streams or by water vapour in clouds.

The overall amount of water on Earth has been estimated to be of the order of 320 million cubic miles and as each cubic mile is equivalent to about a million million gallons it is difficult to visualise the astronomical magnitude of this resource.

However the usefulness of this resource is most limited as about 97.2 percent is in the oceans and a further 2 percent is stored in the polar icecaps. In addition as underground water comprises over 99.5 percent of the remaining 0.8 percent, the amount of fresh water contained in lakes and streams approximates to only 0.004 percent of the total volume of water on Earth.

The gross water resources of any country are normally considered to be the total amounts of precipitation, in the forms of rain, hail or snow, which fall on the land. The surface water resources are usually regarded as the amounts of water in rivers and lakes.

Of all the continents, Australia has the least annual rainfall, the average being only about 1½ feet whereas Africa, Asia, Europe and North America each receive about 2 feet whilst South America receives an average of almost 4½ feet.

When losses due to the natural processes of evaporation, transpiration and seepage are deducted from the annual precipitations of the continents, comparison of the remainders (or surface water resources) shows that Australia has a comparative runoff much less than indicated by the average annual rainfalls. The surface water resources of the Australian mainland have been assessed at about 240 million acre feet per annum which is equivalent to a depth of less than 2 inches over the continental area. In comparison runoffs for the other continents are about 7 inches in Africa, 9 inches in Asia and Europe, 11 inches in North America and about 19 inches in South America.

Modern communities, particularly in large cities, make huge demands on water supplies for domestic, industrial and agricultural purposes. In the production of a ton of steel about 300 tons of water are used; about 2½ tons of water are required to grow the grain and produce a loaf of bread and a ton of paper requires about 60 tons of water. Furthermore it has been estimated that over thirty tons of water are required to produce a normal daily diet for an adult.

Water demands for irrigation purposes are much greater than for domestic or industrial uses. Annual requirements of crops are usually of the order of two to three feet depth and during droughts it is necessary to supply the majority of this requirement by irrigation. The relative magnitude of this demand can be assessed when it is realised that a depth of three feet over only one acre is equivalent to over 800,000 gallons (more than 3,500 tons).

In addition to the relatively low average annual runoff over the continent, Australian streams tend to exhibit great variability in flows. Therefore, it is necessary to construct relatively large water conservation storages if assured water supplies are to be maintained over the full period of each drought.

In view of the increasing demand for water for irrigation, industrial and domestic purposes, the continued development of Australia as a nation will require the construction of many more large water conservation storages in the future. Furthermore, it will be necessary to ensure that the flows provided by these and existing storages are used effectively.

The water resources of a nation are of major importance to national economy, the welfare of the community depending to a large extent on their proper development and use. Water conservation in Australia is therefore a service of prime national importance, increasing living standards and overall national wealth.

The surface water resources of the Moruya River Valley have been assessed as being of the order of 340,000 acre feet per annum. As the average annual rainfall over the valley is about 34 inches the surface water resources represent a runoff of about 32 percent. On a square mile basis, the surface water resources of the Moruya River Valley are about 1½ times the average for coastal basins in New South Wales and nearly six times the average for the total area of the State.

2. PHYSIOGRAPHIC FEATURES

The boundaries of the Moruya River Valley, adopted for the purposes of this report, encompass a total catchment area of about 600 square miles and are shown, together with the principal features and towns in the valley, at Figure 1. The generalised land slopes of the valley are shown at Figure 2.

The valley is located on the mid-southern coast of New South Wales and lies between the Clyde River Valley in the north, the Shoalhaven River Valley in the west and the Tuross River Valley in the south. A small coastal plain extends over an area 10 miles inland from the coast, whence the terrain rises sharply to heights of about 1,000 feet above sea level. The remainder of the catchment to the west consists of steep mountainous topography with isolated peaks reaching heights of over 3,000 feet.

The Moruya or Deua River rises in rugged country in the extreme south-west of the valley and flows westerly in its upper reaches before turning and flowing north through a heavily forested, steep-sided valley. The Minuma Range forms the western border of this valley and has an average height of the order of 3,000 feet with a maximum of more than 4,000 feet at Euranbene Mountain. The eastern border of the Upper Moruya Valley also consists of a range with an average height of about 3,000 feet.

After traversing the valley for about 15 miles, the Moruya River veers to the north-east and is joined by a number of small tributaries; Woolla Creek on the right bank and in turn, Moodong, Telowar and Bettowynd Creeks on the left bank. About 5 miles further downstream, a major tributary, Araluen Creek joins the Moruya River on the left bank.

The river turns to the south east below the Araluen Creek junction and flows through steep to rugged country, before being joined by Burra and Wamban Creeks on the right bank. The Moruya River then veers to the north-east and flows into the South Pacific Ocean at Moruya Heads.

Araluen Creek, a major tributary of the Moruya River, rises in the north-west of the catchment in steep country near Majors Creek and flows in a south-easterly direction through the fertile Araluen Valley before joining the Moruya River about five miles below Araluen. The catchment topography comprises a relatively flat valley floor, bordered by high ranges with steep terrain to the north-west of Araluen forming the headwater catchment of the creek.

The alluvial flats of the Moruya River Valley are mainly located on the coastal plain surrounding the township of Moruya and support an appreciable dairying industry. Cheese production is a major industry in the area and utilises the separated cream from the dairies, while wholemilk production is mainly used to meet local demands. Cultivation along the coastal plain with maize, lucerne and oats is also undertaken but to a minor degree in relation to the dairying industry.

Away from the coast, the ridge and valley terrain is sparsely populated, the only significant rural activity being timber getting. Little grazing occurs in these regions and only in the Araluen Valley, in the north of the catchment, does the terrain moderate sufficiently to permit efficient sheep and cattle grazing.

In the Moruya River Valley the predominant land terrain is of the rugged or mountainous category, land slopes of this type comprising about three quarters of the area of the valley.

Flat areas with slopes less than 3 degrees occupy only 3 percent of the valley. The remainder of the valley consists of approximately equal areas of undulating to hilly terrain (slopes greater than 3 degrees and less than 8 degrees) and hilly to steep terrain (slopes greater than 8 degrees and less than 15 degrees).

The timber resources of the valley are extensive with the natural vegetation existing at most locations other than on the coastal plain areas. Timber getting is a major industry in the valley and good quality hardwood is milled in the valley.

The rugged western areas of the valley contain large quantities of the wet hardwood species however to the east towards the coast, the drier foothills and lower ranges support large forests of dry hardwood species. Some areas of rain forest can be found under favourable conditions of warmth and moisture such as exist along the deep valleys dissecting the higher ranges. Spotted Gum is the most predominant hardwood species located in the valley, with Silvertop Ash occupying some of the more southerly sections of the valley.

Along the coastal strip, woodland areas contain a wide variety of species and vegetation in the tidal areas consists of a diverse group of plant communities with mangrove colonies predominating along the estuaries.

3. CLIMATIC FEATURES

Rainfall

Annual median rainfall over the Moruya River Basin is in general between 30 and 35 inches. The greatest annual rainfall occurs over the higher parts of the western boundary of the catchment. A slight rainshadow exists over the upper reaches of the Moruya River where annual median rainfall is generally less than 30 inches. (The median is that rainfall equalled or exceeded on fifty percent of occasions). The distribution of annual median rainfall over the basin is shown at Figure 3 whilst the distribution of monthly median rainfalls are shown at Figures 4 to 15.

The region is sheltered by the Australian Alps from moist south to west air streams which are the predominant rain producing systems over southern New South Wales in the winter and spring months. Consequently the period from August to November is relatively dry receiving only about 25 percent of the annual rainfall. August is usually the driest month receiving on the average about 5 percent of the annual rainfall. In this month the median rainfall is about 1 inch over most of the catchment. The wettest month varies from station to station in the catchment but it usually occurs in one of the months December, January or February. Median rainfalls in the wettest month are between 2½ and 3 inches.

Monthly and annual rainfalls recorded at Araluen, Bettowynd, Krawarree, Majors Creek, Moruya Heads and Nerringundah are given in Appendices 1 to 6 respectively.

Very heavy storm rainfalls may occur over the area when an active depression is centred off the New South Wales coast, north of the basin. Storms of this type have occurred on an average of about twice per year. The highest fall on record for a station in the catchment for a 24-hour period ending 9 a.m. is 15.83 inches at Araluen on 27th May, 1925.

Highest monthly totals on record are generally about 30 inches, however Araluen recorded a monthly total of 47.40 inches in May, 1925. Highest yearly totals are between about 60 and 70 inches. The tables at Appendix 7 show on a monthly and annual basis for Araluen, Bettowynd, Krawarree, Majors Creek, Moruya Heads and Nerringundah the following data:-

(1) the highest and lowest rainfalls on record;

(2) the 10th, 30th, 50th, 70th and 90th percentiles.

(A rainfall observation less than the 10th percentile can be expected once in ten years on the average. Similarly a rainfall observation less than the 70th percentile can be expected seven times in ten years on the average or alternatively, a rainfall observation greater than the 70th percentile can be expected on an average of three years in ten).

Tables for Araluen, Bettowynd and Moruya Heads indicating:

(i) the minimum cumulative rainfall on record commencing in any month of the year and continuing for up to 12 months;

(ii) the median cumulative rainfalls on record commencing in any month of the year and continuing for up to 12 months;

are shown at Appendices 8 and 9 respectively.

Although low rainfall totals may be recorded over a few consecutive months on occasions, it is rare for the valley to experience prolonged dry spells. On 90 percent of occasions at least 6 inches are received in any consecutive six month period. The corresponding median value is about 12 inches. Stations in the catchment rarely record an annual total of less than 20 inches.

Temperature.

Temperature averages for Moruya and Bodalla, representative of the coastal fringe and the lower parts of the catchment inland from the coast respectively, are shown in Tables 1 and 2. Temperature recordings are unavailable for the higher parts of the catchment however, an estimate of the averages for these higher areas may be made by decreasing the averages for Bodalla by 4°F per 1,000 feet difference in elevation between the area and Bodalla.

TABLE 1

MORUYA (Elevation 55 feet).

Average Temperature (°F) Based on 30 Years of Record.

Month	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Average Maximum Temperature	73.5	74.5	72.9	69.5	65.2	61.3	60.0	61.7	64.7	67.3	69.2	71.8	67.6
Average Minimum Temperature	61.1	62.1	59.8	55.1	49.7	45.5	43.7	44.4	47.9	52.2	55.6	59.1	53.0
Average Daily Temperature	67.3	68.3	66.4	62.3	57.4	53.4	51.9	53.1	56.3	59.8	62.4	65.4	60.3
Highest on Record 111.0°F							Lowest on Record 31.5°F						

TABLE 2

BODALLA (Elevation 40 feet)

Average Temperature (^{o}F) Based on 25 Years of Record

Month	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Average Maximum Temperature	76.2	77.6	75.4	71.1	66.5	62.9	62.1	64.0	67.5	70.2	72.2	74.9	70.0
Average Minimum Temperature	58.2	59.2	55.9	50.4	44.2	39.0	37.4	39.1	43.2	48.4	52.6	56.4	48.7
Average Daily Temperature	67.2	68.4	65.7	60.7	55.3	50.9	49.7	51.5	55.3	59.3	62.4	65.7	59.3
Highest on Record 113.0^{o}F.							Lowest on Record 25.5^{o}F.						

Very hot days are experienced occasionally in the summer. On the coastal fringe temperatures exceeding 100 degrees are recorded on an average of slightly less than one day per year while days on which the temperature exceeds 90 degrees occur about 4 times per year. Over the parts of the catchment inland from the coast, days on which the temperature exceeds the above limits would occur more frequently.

On occasions of clear skies and light winds during winter, very low over-night temperatures can occur particularly over the higher parts of the catchment. Bodalla has recorded an extreme minimum screen temperature of 25.5^{o}F. It is expected that screen temperatures as low as 15^{o}F could occur over parts of the catchment above 1500 feet.

Frost.

Frost incidence increases from almost nil on the coast to more than 50 per year on the average over the higher parts of the hinterland where frosts can occur in any month of the year. Severe frosts, however, are usually confined to over the highest parts of the catchment in the months from May to September. The season shortens rapidly in length with decreasing elevation and decreasing distance from the coast.

Sunshine

Estimates of the average number of hours of bright sunshine per day in each month for the basin are shown in Table 3. These estimates are based on cloud amount observations.

TABLE 3

Estimated Average Daily Hours of Bright Sunshine

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
8.1	7.9	7.4	7.3	6.5	6.0	6.5	6.8	7.5	8.1	8.3	8.2	7.4

Evaporation

Estimates of the average monthly and annual evaporation from an Australian Sunken Tank are shown in Table 4 together with estimates of the standard deviations. These estimates are based on radiation, air temperature and humidity considerations.

TABLE 4

Estimated Average Monthly and Annual Evaporation
(Inches)

Month	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Evaporation	5.4	4.5	3.8	2.4	1.8	1.2	1.4	1.8	2.4	3.5	5.0	5.2	38.4
Standard Deviation	0.8	0.8	0.7	0.4	0.4	0.3	0.3	0.3	0.4	0.4	0.6	0.8	2.8

Wind

The region experiences strong winds on occasions under the following meteorological conditions:-

(1) easterly to southerly winds with mean speeds of up to 50 m.p.h. and gusts up to 70 m.p.h. or more may occur on the coast when a deep depression is located off the southern New South Wales coast;

(2) strong north to north-west winds with mean speeds of 50 m.p.h. may occur as the pressure gradient tightens ahead of an approaching southerly change;

(3) the highest wind gusts are associated with severe local storms such as thunderstorms.

Table 5 gives the extreme wind gust likely to be experienced at any point in the region for various return periods.

TABLE 5

Estimated Extreme Wind Gusts to be Expected with Given Return Periods

Return Period (Years)	10	20	50	100
Extreme Wind Gust Equalled or Exceeded (m.p.h.)	85	90	100	105

4. GROUNDWATER POTENTIAL

The geology, which exerts a major influence on the groundwater potential of this area, is quite varied and the areal distribution of the main units is shown in Figure 16. Since there is very little data available concerning groundwater conditions in the area (less than 20 bores are recorded) a discussion of the geology will be followed by a generalised statement on the groundwater potential amplified where possible with more specific information.

Rocks of Ordovician age are the oldest exposed in the catchment, and they underlie the largest part of it. They are highly folded and jointed, the general trend being in a north-south direction. Phyllite, slate, shale, siltstone, sandstone, chert and quartzite form the bulk of the sequence.

Silurian limestone crops out in two very small areas near the western margin of the drainage basin but in terms of area of outcrop its importance is negligible.

The area was part of a land mass during most of Silurian time and for the early part of Devonian time. No sedimentary rocks were deposited but igneous intrusions took place and quite large areas are now underlain by granite, porphyry and related rocks. These are mainly in the extreme east and the north-west of the catchment.

Sedimentation recommenced in Upper Devonian time, following a period of folding and igneous intrusion. The Devonian sequence commenced with rhyolite which was extruded during an initial phase of volcanic activity. The rhyolite is overlain by a sequence of red beds including shale and sandstone, which are mainly of continental origin. The red beds are in turn overlain by a marine sequence of conglomerate, shale and sandstone. The Devonian strata have been folded into a gentle syncline whose axis trends in a northerly direction across the centre of the catchment. Apart from a very small area in the extreme west of the catchment, outcrops of Devonian rock are restricted to a narrow belt along this synclinal axis.

The only rocks in the area which are younger than Devonian are sandstone and basalt of Tertiary age, occupying a small area in the extreme south-east.

Quaternary unconsolidated deposits occur in only a few small areas. They are of two types, the most widespread being the alluvium associated with the Moruya River. The second type occurs along the coast north and south of the Moruya River, in the form of dune deposits. Little is known of the alluvium along the Moruya River. The main area, in the immediate vicinity of the town of Moruya, is subject to tidal influence from the river. Its depth and character are unknown. There are some small pockets of alluvium further upstream which are beyond the tidal influence, and test bores have indicated a maximum depth of about 70 feet. Coastal dune deposits occur both north and south of the Moruya River, but the total area within the catchment area is very small.

Groundwater is probably available from most of the geological units discussed above, but has actually been recorded only from some of them.

In general groundwater potential may be considered in three main categories, based on the nature of the strata and openings in the rocks in which the groundwater is stored. The three usual categories are; Jointed Rocks, Porous Rocks and Unconsolidated Deposits.

Jointed Rocks contain water in cracks, joints and fractures in otherwise impervious strata. Porous Rocks, such as sandstones contain water in the pore spaces between the cemented sand grains. Unconsolidated Deposits store water in sands or gravels associated with river deposited alluvium or in accumulations of beach and dune sands near the coastline.

In the Moruya River Valley the extent of porous rocks is insignificant and they have virtually no groundwater potential. This category of rocks is therefore not considered in this report.

Jointed Rocks

The Ordovician strata, being strongly deformed with intense folding and severe jointing, can be expected to store and transmit useful quantities of water. Bores at suitably located sites should yield a few hundred gallons per hour, but the water quality is known to be variable. In the very few bores recorded in this unit, the water salinity varies from 266 parts per hundred thousand (p.p.h.t.) to 3,000 p.p.h.t. i.e. from suitable for stock only to unsuitable for any purpose.

Results of drilling in the granite are likely to vary according to local conditions of topography, jointing and weathering. There are indications that shallow low salinity supplies are obtainable, but the overall success rate in this unit may not be very high.

No bores have been recorded in the Devonian rocks, but their nature is such that small to moderate supplies of groundwater suitable for stock and possibly also for domestic use should be generally available from bores at suitable sites.

Unconsolidated Deposits

The Tertiary rocks have a fairly low potential in this area, both because of generally low permeability and the elevated topographic situations in which they occur.

Tertiary-Recent deposits commonly have the best potential for the development of groundwater resources, but in this area this is only partly true. The largest and thickest areas of fluviatile alluvium here are subject to intrusion of the saline water in the river estuary to quite a marked degree. Hence there has been no development of large yielding bores or wells in the areas of thickest alluvium, nor is there likely to be.

About 14 bores and wells are recorded in probable fluviatile deposits, and all except three are less than 40 feet deep. Yields of 1,000 g.p.h. are rare among them. The three exceptions were bores sunk by Eurobodalla Shire Council to depths of 50 - 70 feet in a pocket of alluvium upstream from Moruya. Water bearing sand and gravel was encountered in all of these, but no record of the groundwater salinity is available.

A small number of shallow wells in the alluvium near Moruya are known to yield small supplies of low salinity water. They almost certainly obtain this water from a thin layer of fresh water overlying the deeper salt water, and which is recharged locally during rainy periods by direct infiltration. This is a useful source of stock and domestic water but is unlikely to support large scale withdrawal, e.g. for irrigation, except in exceptional circumstances.

There may be prospects of locating moderate supplies from the alluvium along Araluen Creek, but no data are available to confirm this.

To summarise, stock supplies should be obtainable from suitably located bores in most of the catchment, but water salinity will in many cases render the water unsuitable for domestic use. Yields large enough to be used for irrigation or municipal purposes have not been located so far, and prospects of finding such supplies are very poor with one or two minor exceptions.

5. STREAM GAUGING STATIONS

Streamflow originates in the precipitation of atmospheric moisture which is mainly evaporated from the oceans and is carried over the land masses by weather systems. Runoff is generally recognised to be that component of precipitation which appears as flow in streams after evaporation, transpiration and deep seepage losses have been satisfied.

In most areas of New South Wales rainfall records have been obtained for relatively long periods of time. Therefore, it could be expected that if satisfactory estimates were able to be made of losses due to evaporation, transpiration and deep seepage, the remainder of the precipitation, or runoff, could be reliably assessed. However, despite intensive research, no suitable method has yet been formulated for relating runoff and rainfall for any catchment to a satisfactory degree of accuracy in the absence of any streamflow information.

In water resources and other hydrologic investigations it is therefore essential to have basic streamflow data available in order to enable satisfactory results and conclusions to be obtained. In addition, it is most desirable that these streamflow records cover as long a period as possible.

The measurement of streamflow usually involves two steps, the first being the recording or observation of river stage or gauge height in relation to a fixed datum and the second being the correlation of the measured height with discharge.

Gauge heights are normally measured by visual observation of the water surface on a graduated scale or staff gauge or by means of a continuous record produced by a float or pressure actuated recorder.

The discharge at a stream gauging station is defined as the quantity of water flowing past a cross-section of the stream in unit time and is usually expressed in units of cusecs (cubic feet per second). Individual measurements of stream discharge are obtained by the use of a current meter to measure flow velocities inconjunction with survey methods to determine the area of effective flow. The combination of flow velocities, in feet per second, and effective discharge areas, in square feet, yields the discharge of the stream in cubic feet per second or cusecs.

The correlation between gauge height and discharge is obtained by plotting all available streamflow measurements against the corresponding gauge heights. The resulting curve is known as the stage discharge relationship or rating curve and enables discharges to be estimated for periods when only gauge heights are available.

Instantaneous flows in cusecs, can be converted to volumes in acre feet, for a particular period by the relationship that one cusec flowing for 24 hours is approximately equal to two acre feet; an acre foot of water being equal to the volume of water that would cover an area of one acre to a depth of one foot.

Stream height records were first obtained in the Moruya River Valley in 1954 following the installation of a staff gauge on the Moruya River at McGregors Creek. In 1959, a gauging station was installed on the Moruya River at Wamban, where a pressure recorder is operative and provides a continuous record of stream heights. Two further stations were recently installed and bring the total number of stations in the Valley to four.

The gauging station on the Moruya River at Wamban measures runoff from about 75 percent of the Moruya River Valley and thereby indicates, to a reasonable degree, the overall water yield which could be expected from the entire valley.

The density of gauging stations in the Moruya Valley of about 6.6 stations per thousand square miles of catchment is about three times the average density for New South Wales of 2.2 stations per thousand square miles and more than fourteen times the average for mainland Australia.

It is intended to expand the existing cover of stream gauging stations in the Moruya River Valley to five stations so as to provide adequate basic data for the majority of water resources investigations which are likely to be required for the valley.

The locations of the existing gauging stations in the Moruya River Valley are shown at Figure 17 and relevant details concerning each station are given in Table 6.

TABLE 6

Stream	Station	Catchment Area (Square Miles)	Type of Gauge	Period of Operation
Moruya River	Moodong	193	Float Recorder	1969 to Date
Araluen Creek	Araluen	50	Pressure Recorder	1969 to Date
Moruya River	McGregors Creek	344	Staff Gauge	1954 to Date
Moruya River	Wamban	445	Pressure Recorder	1959 to Date

6. CATCHMENT YIELDS

Yield, discharge and runoff are all terms that describe volumes or flows of water for a catchment, and, as such, are all influenced by the amount of precipitation, type of vegetation, topography and other catchment characteristics. Yield is normally considered in terms of total volume over a yearly period whereas discharge and runoff are usually expressed in terms of instantaneous rates.

The continuous measurement of streamflow provides the basic information for the determination of the water yield of a catchment.

Over the period of 11 years of complete records, commencing in 1955, at the Moruya River at McGregors Creek, the average flow has been 252,000 acre feet per year, equivalent to an average rate of 345 cusecs (129,000 gallons per minute).

Records of streamflow for the Moruya River at Wamban indicate that the average annual runoff has been at a rate of 478 cusecs (178,800 gallons per minute) or 349,000 acre feet per annum, during the period of eight years of complete record.

For the purpose of comparison, the yields at the current gauging stations, based on available computed records, are shown in Table 7. Details of monthly maximum, minimum and mean flows for the two gauging stations located on the Moruya River at McGregors Creek and at Wamban are tabulated in Appendices 10 and 11 respectively.

TABLE 7

Stream	Station	Years of Completed Records	Average Annual Yield over Period of Complete Years of Record		
			Acre Feet Per Annum	Cusecs	Gallons per Minute
Moruya River	McGregors Creek	11	252,000	345	129,000
Moruya River	Wamban	8	349,000	478	178,800

7. AVERAGE ANNUAL RUNOFF

As continuous streamflow records in the Moruya Valley are only of short duration, the present estimate of the long term average annual surface water resources of the valley is based on approximate streamflow correlations with well-established gauging stations in the Shoalhaven River Valley, where streamflow records commenced in 1909.

This assessment has indicated the average annual surface water resources of the Moruya River Valley to be of the order of 340,000 acre feet which is equivalent to a continuous rate of 175,000 gallons per minute. On a square mile of the catchment basis, the average value is 570 acre feet per square mile which is significantly greater than the average figure for New South Wales coastal basins of 387 acre feet per square mile of catchment.

In the following Table 8, the estimated long term average annual runoff for the Moruya Valley is compared with the corresponding long term runoffs of the adjacent Shoalhaven, Clyde, Tuross and Bega River Systems.

TABLE 8

Basin	Catchment Area (Square Miles)	Estimated Long Term Average Annual Runoff		
		Acre Feet Per Annum	Acre Feet per Annum per Square Mile	Percentage Runoff
Moruya Valley	600	340,000	570	32%
Shoalhaven Valley	2,820	1,460,000	520	28%
Clyde Valley	1,260	750,000	600	25%
Tuross Valley	840	420,000	500	28%
Bega Valley	740	400,000	540	27%

8. VARIABILITY OF STREAMFLOWS

Whilst average annual flows are suitable for comparison of long term yields from catchments, they do not indicate the surface water resources which could be available in a particular year or the probable extent to which the valley's surface water resources could be utilised without the construction of conservation works.

An indication of the variability of streamflows at the gauging stations in the Moruya Valley is given in Table 9. The Table shows the maximum, minimum and mean discharges recorded at the gauging stations over the periods of computed records.

TABLE 9

Stream	Station	Period of Computed Records	Recorded Discharges		
			Maximum	Minimum	Mean
Moruya River	McGregors Creek	January 1955 to November 1968	60,000 cusecs (22,500,000 g.p.m.)	0.2 cusecs (75 g.p.m.)	345 cusecs (129,000 g.p.m.)
Moruya River	Wamban	October 1959 to November 1968	94,000 cusecs (35,100,000 g.p.m.)	Zero	478 cusecs (178,800 g.p.m.)

Streamflow records for both gauging stations in the Moruya Valley show that there is an extremely high degree of variability in the annual water resources in the valley. In particular, streamflows during the high runoff year of 1961 were many times greater than the drought year of 1965.

During the flood month of November 1961 the total monthly flow of about 254,000 acre feet at the Moruya River at McGregors Creek was approximately equal to average annual flow over the period of records of 252,000 acre feet. The maximum discharge during the same month was about 60,000 cusecs (22,500,000 gallons per minute) and is equivalent to over 170 times the average daily flow at the station.

In comparison, during November 1968 the Moruya River at Wamban ceased to flow.

Monthly discharge hydrographs of streamflows for the Moruya River at McGregors Creek and at Wamban are shown at Figures 18 and 19 respectively. These graphs illustrate the extreme degree of variability of streamflow in the Moruya Valley.

The variations in the average monthly rainfalls at Nerringundah, Majors Creek, Araluen, Bettowynd, Krawarree and Moruya Heads are shown at Figures 20 to 24. The rainfall stations at Bettowynd and Moruya Heads can be considered representative of the inland and coastal regions of the valley and reference to Figures 22 and 24 indicates that, on the average, the highest rainfalls occur in the summer months with the lowest rainfalls occurring in August.

9. PERSISTENCE OF STREAMFLOWS

Flows in the majority of streams in the Moruya River Valley persist for extended periods after the cessation of runoff producing rainfall and consequently it would appear that the valley has a high groundwater storage capacity which is able to sustain flow, at a diminishing rate, in streams during dry periods.

Streamflow persistence is best shown graphically by the preparation of curves known as flow duration curves. These curves indicate the percentage of time for the period of records, during which the flow indicated was equalled or exceeded. Alternatively these curves can be constructed to indicate the percentage times when flow is equal to or less than a certain value. The flow duration curves given in this report correspond to percentages of time that flows equalled or exceeded any selected value.

The flow duration curve of the Moruya River at McGregors Creek is given at Figure 25 and the frequencies of flow at this station are given in the following Table 10.

TABLE 10

Percentage of Time Flow Equalled or Exceeded	Corresponding Flows	
	Cusecs	Gallons per Minute
10%	690	258,000
30%	180	67,300
50%	94	35,200
70%	38	14,200
90%	13	4,900
95%	7	2,600
100%	0.2	75

The duration curve for the Moruya River at Wamban is appended at Figure 26 and flow frequency data corresponding to the curve are given in the following Table 11.

TABLE 11

Percentage of Time Flow Equalled or Exceeded	Corresponding Flows	
	Cusecs	Gallons per Minute
10%	950	355,300
30%	255	95,400
50%	128	47,900
70%	63	23,600
90%	21	7,900
95%	10	3,800
100%	0	0

Whilst the flow duration curves at Figures 25 and 26 give an indication of stream persistence of the streams at a particular location, they do not enable a comparison to be made of the persistence of flows of the various sections or sub-catchments in the valley.

To enable this comparison to be made, composite flow duration curves, based on the discharge per square mile of catchment area for each location, have been derived and are shown at Figure 27. This figure indicates that Wamban, located near the coast and draining about 75 percent of the total Moruya Valley catchment, exhibits similar flow per square mile characteristics to the gauging station on the Moruya River at McGregors Creek, which drains the upper or more inland areas of the catchment comprising about 55 percent of the total catchment area.

It would normally be expected for the yield per square mile to decrease with increases in catchment area and, as such, the runoff per square mile of catchment for the McGregors Creek gauging station to be greater than the corresponding runoff for Wamban. However, a marked rainfall shadow occurs over the upper reaches of the Moruya River catchment and this apparently tends to reduce the runoff per square mile from the catchment area of the McGregors Creek gauging station to a value approximately equivalent to that from the larger catchment of the Wamban gauging station.

10. OCCURRENCE OF FLOODING

Flooding in the Moruya Valley is mainly confined to the coastal plain areas in the vicinity of the township of Moruya. The upper reaches of the Moruya River and its tributaries are contained within steep, densely forested valleys and flood damage mainly occurs in small areas adjacent to the stream channel where the terrain moderates.

The township of Moruya is the only major commercial and residential centre within the valley that is subject to flooding to any significant degree. Flooding in Moruya has been intensified in the past when high tides have coincided with flood periods.

The gauging station on the Moruya River at McGregors Creek, located about 20 river miles upstream of Moruya, is utilised for local flood warning purposes and records have indicated that floods of river stages of 21 feet or greater at the McGregors Creek gauge will cause some degree of flooding of the Moruya township and surrounding agricultural areas.

Six floods have exceeded this danger level of 21 feet at McGregors Creek over the period of available records since 1954 and are listed in Table 12, together with the two highest recorded floods at the other gauging station in the valley on the Moruya River at Wamban which was established in 1959.

TABLE 12

Stream	Station	Month	Maximum Flood Height	Estimated Maximum Flow (Cusecs)
Moruya River	McGregors Creek	November 1961	32'-0"	60,000
		October 1959	24'-6"	36,000
		November 1966	23'-9"	34,000
		October 1959	23'-3"	32,000
		May 1963	22'-9"	31,000
		April 1963	21'-0"	27,000
Moruya River	Wamban	November 1961	33'-3"	94,000
		October 1959	29'-8"	69,000

The November 1961 flood is the highest recorded flood at both stations, the maximum flow at Wamban being of the order of 94,000 cusecs, or about 35 million gallons per minute.

11. DROUGHT PERIODS

While there is no generally adopted definition of the term "drought", it is usually accepted as being an extended period of low rainfall over a particular catchment. However, the criteria used in assessing if an area is under drought conditions vary widely with geographical location, average rainfall and normal crop requirements. For example, a continuous period of twelve months with very low rainfalls may well be considered as a drought on a well-watered coastal catchment but as a normal condition on an inland catchment.

In general, an area is accepted as being under drought conditions when the soil moisture is insufficient for the requirements of the majority of crops during the growing season and when water shortages for domestic, industrial or municipal purposes are experienced. A diminished or exhausted rate of streamflow is a prime indicator of drought conditions.

Histograms of the annual recorded rainfalls at Moruya Heads and Bettowynd are appended at Figures 28 and 29 respectively. The former location may be considered to be representative of the rainfall regime of the coastal section whilst the latter could be considered representative of the inland section of the valley. These graphs indicate that the lowest calendar year rainfalls at Moruya Heads and Bettowynd were about 19.7 inches and 15.81 inches in 1885 and 1965 respectively.

Reference to Figures 28 and 29 indicates that the longest period of below average rainfall occurred from 1901 to 1910 inclusive and this appears to have been the most critical period for the Moruya Valley. At the Moruya Heads rainfall station, records are available prior to 1900 and indicate that during the 16 year period from 1894 to 1910, only two years registered above average rainfalls. Other periods of below average rainfall have occurred in the valley, however these periods are of shorter duration and have been offset by good rainfalls in the following years.

The lowest streamflows which have been recorded in the Moruya River Valley over a twelve month period occurred from December 1967 to November 1968, the total flow of the Moruya River at McGregors Creek being only 8,500 acre feet or 3½ percent of the average flow at this station.

Similarly the minimum twelve monthly flow of the Moruya River at Wamban from December 1967 to November 1968 was the lowest on record being only 14,600 acre feet or four percent of the recorded average annual flow.

In comparison the previously lowest twelve monthly flows at McGregors Creek and Wamban occurred during the 1964-1966 drought and were about 20,400 acre feet and 23,000 acre feet respectively.

The minimum twelve monthly figures are summarised in the following Table 13.

TABLE 13

Stream	Station	Minimum Twelve Monthly Flow		
		Period	Acre Feet	Percentage of Average Annual Flow
Moruya River	McGregors Creek	December 1967 to November 1968	8,500	3½%
Moruya River	Wamban	December 1967 to November 1968	14,600	4%

12. THE 1964-1966 AND 1968 DROUGHTS

In common with many areas of the State, the Moruya River Valley experienced periods of very low rainfall during the years 1964 to 1968. In the Moruya Valley, the critical periods of rainfall occurred during the period November 1964 to May 1966 and from about October 1967 to November 1968.

From November 1964, the valley generally experienced a period of eleven consecutive months of below average rainfalls before minor relief from dry conditions occurred with good rainfalls in October 1965. A further six months of below average rainfall occurred during the seven month period from November 1965 to May 1966.

From June 1966 to September 1967, rainfalls of about average values were recorded although some months of below average values occurred.

Rainfalls during 1967 generally relieved the critical drought condition that existed during 1964-1966.

From October 1967, the rainfalls in the valley again diminished and in the fourteen month period from October 1967 to November 1968, thirteen months recorded below average rainfalls. The recorded monthly rainfalls at Moruya Heads and Bettowynd for the period June 1964 to November 1968 are given in Table 14 on Page 23.

At Moruya Heads, the lowest twelve monthly rainfall total during the period 1964 to November 1968 occurred from September 1964 to August 1965 and totalled 17.41 inches. This was about 15 percent greater than the minimum recorded twelve monthly value of 15.10 inches (November 1884 - October 1885).

The lowest twelve monthly rainfall total at Bettowynd during the drought periods from 1964 to November 1968 was 12.25 inches and occurred from September 1964 to August 1965.

This was the lowest twelve monthly total registered over the period of records at Bettowynd since 1897.

As a result of these periods of low rainfall, streamflows diminished in the valley during the last two months in 1964, and with the exception of a few minor fluctuations, this trend continued throughout 1965.

Above average rainfalls late in 1965 improved the flow in most streams in the valley. However flows again diminished throughout 1966 until relieved by flood conditions in November 1966; a maximum flow of 42,000 cusecs being recorded during this month at the Wamban gauging station on the lower reaches of the Moruya River.

Streamflows throughout 1967 were maintained at reasonable levels. However following low rainfalls in the latter months of 1967 and throughout 1968, flows generally diminished, with some minor rises being experienced. By November 1968, streams in the valley were flowing at their lowest rates since the commencement of reliable records.

TABLE 14

Month	Moruya Heads	Bettowynd
June 1964	432	238
July 1964	47	148
August 1964	433	394
September 1964	74	111
October 1964	313	367
November 1964	202	117
December 1964	268	184
January 1965	82	49
February 1965	18	73
March 1965	24	2
April 1965	177	67
May 1965	239	8
June 1965	174	130
July 1965	129	79
August 1965	41	38
September 1965	211	298
October 1965	692	526
November 1965	121	55
December 1965	242	256
Total 1965	2,150	1,581
January 1966	218	136
February 1966	372	340
March 1966	289	194
April 1966	51	6
May 1966	35	55
June 1966	625	281
July 1966	112	123
August 1966	159	125
September 1966	265	334
October 1966	312	332
November 1966	661	1,102
December 1966	430	392
Total 1966	3,529	3,420
January 1967	416	309
February 1967	80	43
March 1967	252	153
April 1967	137	91
May 1967	56	112
June 1967	396	245
July 1967	145	68
August 1967	344	564
September 1967	339	429
October 1967	173	202
November 1967	134	84
December 1967	87	29
Total 1967	2,559	2,329
January 1968	357	236
February 1968	64	10
March 1968	345	202
April 1968	51	28
May 1968	561	517
June 1968	29	57
July 1968	81	68
August 1968	49	52
September 1968	11	2
October 1968	72	84
November 1968	228	110
Minimum Twelve Monthly Rainfall During 1964-1968	17.41 September 1964 to August 1965	12.25 September 1964 to August 1965
Minimum Twelve Monthly Rainfall on Record	15.10 November 1884 to October 1885	12.25 September 1964 to August 1965

At the gauging station on the Moruya River at McGregors Creek, the minimum twelve monthly discharge on record was registered during the 1964 to 1968 drought periods and was of the order of 8,500 acre feet. This occurred in the period December 1967 to November 1968 and was only about 3½ percent of the recorded annual average of 252,000 acre feet.

The lowest recorded twelve monthly discharge at the Moruya River at Wamban also occurred from December 1967 to November 1968 and was about 14,600 acre feet, which is equivalent to about 4 percent of the annual average discharge over the period of records.

The minimum twelve monthly flows for both stations are summarised in the following Table 15.

TABLE 15

Station	Stream	Minimum Twelve Monthly Flow During the 1964-1966 and 1968 Drought		
		Period	Acre Feet	Percentage of Mean Annual Flow
Moruya River	McGregors Creek	December 1967 to November 1968	8,510	3½%
Moruya River	Wamban	December 1967 to November 1968	14,600	4%

As well as low periods of twelve monthly flows occurring during the 1964-66 and 1968 droughts, very low discharges were recorded for shorter durations. At the McGregors Creek gauging station, the lowest flows on record were registered; the minimum being 0.2 cusecs which occurred continuously for 23 days during November and December 1968.

At the gauging station on the Moruya River at Wamban, the river ceased to flow for the first time during the period of records; zero flow being registered for a continuous period of 35 days during November and December 1968.

The minimum thirty days and sixty days discharges during the 1964-66 and 1968 droughts were also the minimum on record and are shown in the following Table 16.

TABLE 16

Stream	Station	Minimum Recorded Flow During the 1964-66 and 1968 Droughts	
		Thirty Days	Sixty Days
Moruya River	McGregors Creek	17 acre feet (18th November to 17th December 1968)	88 acre feet (19th October to 17th December 1968)
Moruya River	Wamban	0 (20th November to 19th December 1968)	43 acre feet (19th October to 17th December 1968)

Minor relief from drought conditions was obtained during late December 1968 when runoff producing rainfalls resulted in flows in the Moruya River at Wamban of the order of 100 cusecs.

13. WATER REQUIREMENTS FOR CURRENT DEVELOPMENT

Dairying is the principal rural activity on the coastal river flats and slopes of the Moruya Valley. Small areas of maize, lucerne and oats are also cultivated in association with dairying activities to ensure plentiful supplies of fodder throughout the valley.

While milk is produced in large quantities in the valley, only a minor percentage of the total output is used by local consumers; the remainder is separated and the cream utilised in the cheese production industry throughout the valley. The large quantities of skim milk available have stimulated development of pig raising in the valley, but this is of secondary importance to the dairying industry.

The area authorised for irrigation by license under the Water Act in the Moruya Valley has increased from 12 acres at June 1944 to 279 acres at June 1969, the corresponding number of licenses being only 1 in 1944 and 23 in 1969. The variation in the total number of irrigation licenses and corresponding areas over the period from June 1944 to June 1969 is shown at Figure 30.

Reference to Figure 30 indicates a somewhat erratic relationship between the number of licenses issued from year to year. Since 1952, the number of licenses current in the valley has shown a general increase with minor exceptions in 1963 and 1968.

The average area per license has been rather variable since 1944, the average falling from 12 acres at June 1944 to 6 acres in June 1947 and then rising to 12 acres in June 1969.

In addition to irrigation purposes, licenses are also issued for town, industrial and stock water supply purposes. At the end of June 1969 there were three such licenses in force with a maximum capacity of about 1,200 gallons per minute.

There are no major water conservation or water supply storages in the Moruya Valley. Domestic and stock water for all towns and habitation in the valley is obtained by direct pumping from the Moruya River and its tributaries.

The town of Moruya receives water for both domestic and industrial purposes from a site on the Moruya River about three miles upstream from the township at a maximum rate of about 340 gallons per minute. Further schemes which are presently under development by the Eurobodalla Shire are planned to augment the existing Moruya water supply reticulation system as well as catering for the demands of the adjacent coastal areas. The design of the augmentations has not yet been finalised but is likely to involve the construction of an additional pumping station upstream of the existing station, and a reservoir near the Moruya township of about 1,000,000 gallons capacity.

The estimated maximum requirements in the Moruya River Valley under present conditions for irrigation under license, water supply, and riparian usage (not including transmission losses) are given in Table 17.

TABLE 17

Requirement	Cusecs	Gallons Per Minute
Irrigation under license (279 acres at 2 feet per 8 month season)	1.2	450
Town, Commerical and Stock Water Supply	3.2	1,200
Riparian Usage	2.6	970
Total	7.0	2,620

The total demand for the Moruya Valley is about 4,800 acre feet per annum, of which only 558 acre feet is required for irrigation under license.

The foregoing requirements given in Table 17 do not include any allowance for transmission losses due to evaporation from the stream surface and seepage into the bed and banks of the channels. Such losses may be of substantial magnitudes during drought periods and are directly related to flow levels within the streams and groundwater conditions. Therefore these losses vary widely depending on antecedent meteorological conditions.

14. POSSIBLE IRRIGATION DEVELOPMENT

The main area of potential irrigation in the Moruya Valley lies along the Moruya River below the tidal limit where suitable and commandable land exists to a considerable distance from the river.

Before these lands could be developed under irrigation however, it would be necessary to either construct works to exclude salt water or to provide a storage above the tidal limit from which water could be reticulated by channel or pipeline. An improved and expanded drainage system would also appear to be necessary.

In addition to a compact area of about 1,000 acres of apparently suitable and irrigable land within the Araluen Valley there occur along the Moruya River and tributaries above the tidal limit isolated areas of potential irrigable land separated by rugged forest country.

Due to the rugged and steep terrain of the inland regions of the valley, suitable sites for the construction of farm dams are limited to isolated inland areas and the undulating areas near the coast. There has been negligible development of farm dam storages in the valley, however where suitable sites exist, the temporal rainfall pattern is such as to make the construction of farm dams economically feasible. It is expected that some water supplies will be provided from these works in the future for supplemental irrigation.

The areas of potentially irrigable land in the Moruya Valley, as assessed from inspections and aerial surveys, are summarised in Table 18.

TABLE 18

Stream	Assessed Areas Suitable for Irrigation (Acres)	
	Above Tidal Limit	Below Tidal Limit
Moruya River and tributaries above Wamban Creek	1,600	50
Araluen Creek	1,000	-
Moruya River and tributaries below Wamban Creek	570	2,130
Totals	3,170	2,180

It is evident from Table 18 that approximately 40 percent of irrigable land in the valley is situated below tidal limits. As already stated such areas cannot be readily irrigated unless works are constructed to prevent salt water intrusion or fresh water supplies are conveyed by channel or pipeline from upstream storages.

15. INVESTIGATION OF STORAGE PROPOSALS

Aerial photographs and preliminary field inspections have revealed the existence of a number of possible dam sites on the Moruya River and tributaries. The sites which merit further investigation are shown in Figure 31.

The most attractive sites are located upstream near the headwaters where grades are steep and storage capacities would be relatively small as a consequence.

Downstream storage sites, although of greater storage potential, would, if selected for construction of a dam, result in the submergence of large areas of fertile land.

Due to the current rapid increase in holiday population and residential building along the south coast there is a growing demand for a reticulated water supply in the area. Development of timber processing to exploit the surrounding forests would create a further major demand for water in the valley, which could necessitate the construction of a storage dam.

In addition to head storages, requests have been received from interested landholders for the construction of works across the Moruya River to prevent the ingress of salt water and provide a fresh water pool for the irrigation of extensive flats bordering the river along its tidal reaches.

Whilst a weir on the lower river would achieve these objectives it would nevertheless constitute an obstruction to navigation, increase the risk of upstream flooding and could cause a worsening of siltation at the entrance and at locations between the site and the river mouth. By increasing the tidal range it would also intensify flooding on downstream lands. Because of the width of the river in its downstream reaches, construction costs of any such works would be high in relation to any benefits.

However provision has been made in the Government's long term programme of works for the construction of a water conservation dam as well as a weir on the Moruya River. The feasibility and benefit-cost aspects of these proposals will need to be closely examined in relation to similar proposals throughout the State so that appropriate priorities can be established.

16. ACKNOWLEDGMENTS

The Water Conservation and Irrigation Commission gratefully acknowledges the assistance provided by the Director, Bureau of Meteorolcgy, in supplying the section on Climatic Features, the Rainfall Statistical Data and the Median Rainfall Maps for inclusion in this report as well as by the Department of Public Works and the Forestry Commission for providing the information on town water supply schemes and timber resources respectively.

ARALUEN RAINFALL STATISTICS
(Points)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
1891	-			NO	RECORDS				405	110	306	90	
1892	557	72	763	119	124	45	63	278	1514	580	130	206	4451
1893	381	114	471	758	60	745	347	64	58	533	395	124	4050
1894	766	483	1313	325	62	353	0	94	321	312	6	248	4283
1895	1070	301	56	71	90	0	15	128	287	39	22	145	2224
1896	212	350	200	30	777	739	9	210	3	70	520	112	3232
1897	439	55	17	153	112	478	175	391	193	277	46	359	2695
1898	70	2905	22	37	191	735	79	702	71	248	0	37	5097
1899	183	22	63	621	281	569	713	966	150	162	232	66	4028
1900	200	219	326	427	1094	433	1022	85	160	8	571	172	4717
1901	300	34	240	115	0	64	116	931	118	301	103	6	2328
1902	274	7	190	42	14	45	324	175	145	433	78	618	2345
1903	53	79	109	110	80	153	335	283	486	229	123	494	2534
1904	273	286	85	578	116	10	482	8	44	88	23	97	2090
1905	272	184	157	252	212	240	23	16	19	294	34	245	1948
1906	64	14	804	42	175	36	26	674	161	192	234	97	2519
1907	265	134	246	167	39	471	18	53	37	15	198	105	1748
1908	122	574	76	462	146	8	30	742	174	68	266	49	2717

Appendix 1
Sheet 1

ARALUEN RAINFALL STATISTICS
(Points)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
1909	126	504	46	14	64	859	258	106	42	145	21	296	2481
1910	1146	63	336	85	29	128	343	3	131	193	159	489	3105
1911	1575	125	485	53	467	95	193	213	369	124	111	199	4009
1912	92	425	633	117	137	239	903	81	66	51	210	85	3039
1913	13	28	326	373	1356	1319	83	51	78	247	17	65	3956
1914	47	55	1540	190	122	34	672	10	364	222	169	714	4139
1915	366	58	142	215	80	160	100	54	607	21	20	342	2165
1916	84	345	227	337	51	70	236	98	787	2056	368	272	4931
1917	260	346	60	223	143	120	26	77	229	181	592	165	2422
1918	713	385	77	108	20	9	652	86	87	58	119	29	2343
1919	32	976	208	161	433	11	62	77	144	151	443	798	3496
1920	835	200	462	93	57	70	103	196	162	184	285	1416	4063
1921	326	391	191	780	614	190	236	81	139	214	114	943	4219
1922	645	299	150	90	47	238	2734	137	448	85	28	154	5055
1923	217	20	259	71	32	389	222	167	443	355	153	364	2692
1924	186	395	354	207	65	115	282	80	97	127	490	440	2838
1925	405	254	182	37	4740	808	111	139	35	115	252	48	7126
1926	169	32	496	118	330	337	51	121	80	82	6	237	2059
1927	348	56	149	832	197	26	47	17	207	237	503	69	2688
1928	257	1023	903	117	49	460	212	32	30	44	35	107	3269

ARALUEN RAINFALL STATISTICS
(Points)

Appendix 1
Sheet 3

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
1929	21	1592	328	314	127	20	97	643	173	363	546	286	4510
1930	50	97	169	138	632	742	110	52	12	339	24	319	2684
1931	105	21	206	871	633	209	153	14	246	190	137	259	3044
1932	5	188	459	142	218	29	164	536	469	67	199	111	2587
1933	399	5	140	302	238	152	341	16	229	256	395	261	2734
1934	925	1113	116	554	281	824	909	427	106	285	448	224	6212
1935	334	467	120	441	31	169	66	22	250	534	116	313	2863
1936	335	598	473	213	130	823	184	136	71	36	60	418	3477
1937	504	235	485	73	53	429	51	328	167	331	276	233	3165
1938	723	278	231	157	228	38	99	1173	135	615	251	29	3957
1939	376	114	646	765	158	74	36	329	143	199	185	97	3122
1940	217	32	4	646	89	25	43	30	422	28	221	439	2196
1941	812	417	263	117	92	42	31	114	288	122	58	118	2474
1942	47	480	760	67	206	193	58	48	53	1090	622	260	3884
1943	426	130	65	223	1813	57	4	299	271	421	414	310	4433
1944	76	82	164	184	1419	20	115	63	11	126	61	226	2547
1945	440	288	161	2104	59	1159	96	85	56	271	226	253	5198
1946	401	242	215	407	106	403	16	39	61	127	366	32	2415
1947	37	1020	137	315	66	201	57	240	91	51	198	761	3174

ARALUEN RAINFALL STATISTICS
(Points)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
1948	720	416	112	94	939	611	20	3	102	253	113	332	3715
1949	303	268	807	48	648	1125	149	22	304	209	297	72	4315
1950	493	636	1040	756	517	977	388	115	103	684	237	88	6034
1951	956	753	12	15	107	1231	62	290	660	278	121	50	4535
1952	176	316	548	781	311	1140	420	879	78	491	483	372	5995
1953	235	299	58	51	1420	0	30	146	91	310	60	201	2901
1954	224	763	11	33	9	106	76	35	120	284	259	84	2004
1955	238	648	332	171	886	87	81	130	113	191	178	427	3482
1956	311	1074	954	174	660	990	347	90	34	392	37	80	5143
1957	36	410	128	22	0	354	898	417	55	33	114	309	2776
1958	392	799	347	188	28	853	139	142	227	129	18	262	3524
1959	349	469	563	316	51	1099	1137	52	128	1705	690	137	6696
1960	141	53	376	82	225	80	1068	57	447	254	201	1135	4119
1961	221	363	1331	136	40	430	693	516	318	411	1670	819	6948
1962	541	804	133	83	282	0	224	213	1143	213	133	623	4392
1963	268	299	727	798	842	382	281	183	448	86	218	746	5278
1964	46	146	276	732	189	352	129	421	114	312	110	183	3010
1965	44	56	5	74	13	154	106	49	327	681	62	241	1812
1966	134	331	190	11	82	379	151	140	304	309	1247	387	3665
1967	327	119	209	65	108	344	88	732	658	208	72	58	2988

Appendix 2
Sheet 1

BETTOWYND RAINFALL STATISTICS
(Points)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
1897	436	147	30	65	55	381	130	322	246	192	53	283	2340
1898	30	1420	24	43	135	409	63	510	53	213	19	46	2965
1899	158	12	59	619	227	432	427	622	134	117	224	70	3101
1900	222	175	302	378	951	291	750	79	165	6	412	178	3909
1901	309	48	286	126	2	101	96	772	137	274	61	12	2224
1902	294	8	203	42	15	46	238	154	149	245	76	537	2007
1903	49	81	103	143	80	92	395	219	393	223	229	435	2442
1904	300	242	99	495	100	26	254	24	77	94	52	142	1905
1905	365	155	130	218	129	193	35	17	26	199	24	273	1764
1906	77	11	678	58	140	33	49	490	192	200	129	124	2181
1907	270	126	224	221	14	351	28	44	44	23	189	105	1639
1908	114	535	124	418	69	6	33	607	167	77	222	79	2451
1909	169	459	52	15	45	578	262	53	54	142	48	288	2165
1910	703	42	341	70	18	99	315	23	130	203	169	326	2439
1911	1202	115	455	6	409	125	183	168	328	157	110	158	3416
1912	114	362	677	56	79	192	717	61	76	46	229	90	2699
1913	10	48	411	341	1019	1051	80	60	83	222	68	81	3474
1914	81	67	1403	207	103	38	430	26	272	219	194	538	3578

Appendix 2
Sheet 2

BETTOWYND RAINFALL STATISTICS
(Points)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
1915	240	153	120	193	41	151	67	41	554	23	13	297	1893
1916	130	201	364	281	37	69	168	108	650	1348	391	419	4166
1917	189	248	104	196	135	118	39	74	165	223	510	214	2215
1918	625	349	174	113	22	17	540	94	74	63	226	40	2337
1919	25	638	159	156	348	14	74	91	149	132	549	541	2876
1920	800	164	424	110	26	73	132	145	118	224	292	897	3405
1921	467	330	298	720	503	184	128	25	92	233	104	819	3903
1922	574	451	0	94	57	188	1727	78	313	94	28	59	3663
1923	164	18	214	35	34	324	171	149	438	257	120	381	2305
1924	186	247	240	188	49	89	169	107	74	99	526	459	2433
1925	360	301	154	38	2784	608	83	87	35	156	279	41	4926
1926	177	22	368	106	196	205	90	103	101	67	6	185	1626
1927	322	53	136	521	189	27	20	40	145	238	357	92	2140
1928	219	761	390	123	44	241	120	22	25	45	28	65	2083
1929	26	1210	223	266	62	0	72	503	157	304	611	233	3667
1930	46	93	166	122	417	541	89	38	0	319	21	231	2083
1931	95	16	235	448	336	192	111	10	163	179	241	203	2229
1932	2	100	489	117	132	23	151	442	268	129	275	128	2256

BETTOWYND RAINFALL STATISTICS
(Points)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
1933	384	38	116	279	154	154	278	20	174	240	354	335	2526
1934	1374	890	138	452	213	675	788	349	114	298	420	302	6013
1935	321	431	90	431	18	122	79	16	254	423	145	338	2668
1936	420	582	586	130	82	488	139	133	61	20	25	421	3087
1937	319	186	602	89	51	286	35	267	154	367	194	233	2783
1938	445	342	275	110	198	42	94	705	142	538	201	38	3130
1939	373	109	488	516	46	81	30	178	69	180	188	94	2352
1940	211	31	0	589	51	26	12	32	420	23	125	337	1856
1941	567	369	263	112	68	39	15	102	262	89	92	71	2049
1942	62	341	445	38	218	81	53	23	110	419	517	114	2421
1943	316	113	82	244	1096	58	0	228	257	417	407	310	3528
1944	81	64	119	160	923	21	86	42	2	112	70	281	1961
1945	432	223	111	1445	48	776	64	110	51	229	160	247	3895
1946	419	259	196	365	87	312	13	30	38	108	386	23	2236
1947	20	936	158	209	79	161	41	189	73	46	273	680	2865
1948	681	524	140	81	743	459	27	7	108	217	120	331	3438
1949	268	265	559	111	478	823	112	22	229	259	293	49	3468
1950	430	521	1005	668	399	468	315	83	111	645	204	138	4987

Appendix 2
Sheet 3

BETTOWYND MONTHLY RAINFALL STATISTICS
(Points)

Appendix 2
Sheet 4

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
1951	668	619	48	16	139	852	56	247	514	262	136	70	3627
1952	209	209	602	743	171	990	183	536	110	464	457	358	5032
1953	308	188	67	52	1169	0	26	142	115	221	35	205	2528
1954	134	637	2	26	6	107	58	70	97	290	271	67	1764
1955	191	628	400	106	920	73	55	136	126	206	148	491	3480
1956	250	843	732	325	657	881	294	66	62	404	20	88	4622
1957	13	202	131	37	4	330	708	291	59	45	88	242	2150
1958	413	410	212	148	22	631	142	130	171	101	39	278	2697
1959	314	344	515	359	46	707	642	37	161	1678	596	172	5571
1960	214	60	492	62	188	59	881	51	441	287	229	865	3829
1961	81	395	1194	115	44	230	640	380	270	382	1376	643	5750
1962	534	570	207	53	145	1	171	178	921	233	115	572	3700
1963	329	383	586	651	672	230	272	240	396	146	266	623	4794
1964	28	183	307	599	161	238	148	394	111	367	117	184	2837
1965	49	73	2	67	8	130	79	38	298	526	55	256	1581
1966	136	340	194	6	55	281	123	125	334	332	1192	392	3420
1967	309	43	153	91	112	245	68	564	429	202	84	29	2329

Appendix 3
Sheet 1

KRAWARREE RAINFALL STATISTICS
(Points)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
1898	NO RECORDS		17	16	102	27	38	64	88	226	20	15	
1899	90	32	25	498	198	241	648	806	45	130	119	72	2904
1900	279	147	310	427	801	235	1197	22	225	40	460	105	4248
1901	87	31	25	498	202	45	117	661	210	391	121	21	2409
1902	308	0	263	30	0	0	335	139	20	160	141	735	2131
1903	35	39	54	111	23	150	90	165	515	85	110	440	1817
1904	238	14	120	10	5	20	290	7	10	90	29	14	847
1905	325	335	430	282	135	265	127	50	106	391	130	64	2640
1906	4	35	468	15	255	63	34	265	303	203	340	275	2260
1907	468	227	266	240	70	647	40	123	90	66	240	405	2882
1908	363	401	205	510	198	231	303	760	248	178	341	90	3828
1909	346	276	50	45	33	501	232	65	36	218	22	172	1996
1910	577	20	314	35	25	120	336	59	164	243	140	223	2256
1911	1299	212	399	19	275	64	137	115	290	234	155	195	3394
1912	96	897	220	71	73	272	989	29	218	69	107	180	3221
1913	114	22	351	228	672	1381	40	3	163	224	25	105	3328
1914	5	63	1339	340	17	36	218	12	217	200	155	559	3161
1915	122	61	0	140	23	218	88	47	619	5	0	416	1739

Appendix 3
Sheet 2

KRAWARREE RAINFALL STATISTICS
(Points)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
1916	278	NO RECORDS			72	80	191	136	706	1322	695	390	
1917	374	350	745	294	42	180	100	465	219	250	428	355	3802
1918	580	160	165	379	29	20	536	100	92	66	62	20	2309
1919	20	582	126	145	327	40	108	101	130	149	315	440	2483
1920	836	222	290	132	50	106	107	72	132	189	292	879	3307
1921	545	398	326	688	357	256	63	0	65	140	98	581	3517
1922	556	554	0	57	72	212	1901	93	545	110	10	85	4195
1923	119	17	192	105	48	277	140	110	600	265	151	397	2421
1924	224	280	90	170	0	127	152	91	125	135	705	445	2544
1925	251	367	150	10	1700	666	83	50	40	115	298	80	4810
1926	NO RECORDS									59	20	308	
1927	458	53	154	465	232	13	53	17	223	280	467	167	2582
1928	175	767	470	80	9	183	73	6	28	47	9	127	1975
1929	59	1330	216	372	104	15	26	550	276	256	446	227	3877
1930	1	76	191	106	366	260	128	59	42	357	4	320	1910
1931	37	10	177	231	377	225	85	25	204	241	287	127	2026
1932	0	97	515	243	152	21	144	240	262	117	213	160	2164
1933	431	0	84	289	82	146	310	33	245	214	624	369	2827

KRAWARREE RAINFALL STATISTICS
(Points)

Appendix 3
Sheet 3

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
1934	1228	938	150	316	178	627	1047	379	133	170	461	237	6064
1935	387	330	95	599	19	104	57	29	253	602	161	318	2854
1936	335	446	477	149	111	439	179	146	39	51	40	373	2885
1937	359	81	670	95	55	165	64	250	178	374	216	351	2858
1938	298	43	100	108	196	93	87	883	140	319	258	17	2542
1939	331	111	552	484	31	87	3	404	28	189	206	103	2529
1940	176	68	0	575	102	58	14	40	497	18	126	429	2103
1941	671	395	185	53	145	39	10	71	209	137	140	100	2155
1942	107	122	563	33	267	158	117	51	62	456	581	167	2684
1943	288	120	157	188	898	30	28	205	208	377	474	438	3411
1944	125	60	178	148	1102	8	200	54	18	133	50	224	2300
1945	360	318	40	745	47	553	52	111	60	258	223	244	3011
1946	258	323	213	202	93	478	42	30	80	140	506	26	2391
1947	23	991	159	140	83	103	28	150	73	81	552	641	2924
1948	652	557	95	138	836	616	7	21	64	303	130	287	3706
1949	227	346	942	77	383	684	69	23	282	283	279	46	3641
1950	372	543	1300	413	360	462	334	83	120	606	264	179	5036
1951	667	909	100	46	139	874	55	355	375	338	83	143	4084

Appendix 3
Sheet 4

KRAWARREE MONTHLY RAINFALL STATISTICS
(Points)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
1952	269	116	441	597	194	1255	205	408	33	556	523	511	5108
1953	350	336	89	58	858	4	15	130	171	165	56	142	2374
1954	239	674	3	57	0	111	64	67	80	203	316	106	1920
1955	177	576	397	638	534	51	38	95	54	308	142	562	3572
1956	767	714	925	383	895	1088	400	48	67	350	28	43	5708
1957	11	171	192	18	0	275	718	321	61	48	140	352	2307
1958	460	296	147	120	37	482	159	194	168	111	159	397	2730
1959	352	369	574	271	13	613	592	77	186	1684	608	167	5506
1960	223	78	459	78	197	72	961	72	440	245	219	917	3961
1961	181	346	849	138	31	212	657	332	423	444	1529	628	5770
1962	537	689	131	42	115	0	148	230	853	147	115	797	3804
1963	372	285	456	556	613	301	270	201	250	141	247	483	4175
1964	34	48	424	707	159	152	121	495	182	339	238	206	3105
1965	49	60	15	101	25	134	53	74	252	553	87	542	1945
1966	128	362	268	16	61	305	NO RECORDS						
1967	NO RECORDS												

Appendix 4
Sheet 1

MAJORS CREEK MONTHLY RAINFALL STATISTICS
(Points)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
1898	N.R.	2208	50	53	202	645	52	698	141	329	12	58	
1899	161	65	96	593	177	491	664	1222	229	237	379	119	4433
1900	261	329	423	408	1137	540	997	95	168	19	630	261	5268
1901	476	107	281	155	3	94	107	890	131	363	180	50	2837
1902	214	12	133	94	42	56	330	151	97	419	130	710	2388
1903	91	141	211	132	69	212	385	250	453	388	136	678	3146
1904	282	600	133	463	157	15	705	14	114	158	58	100	2799
1905	308	274	139	311	171	238	59	12	50	259	55	297	2173
1906	141	67	881	102	199	47	8	471	206	228	263	174	2787
1907	395	146	275	230	28	446	28	47	70	23	359	138	2185
1908	141	729	94	349	143	10	63	603	143	106	346	113	2840
1909	179	634	85	66	50	704	231	122	65	201	26	299	2662
1910	1209	63	378	79	24	150	430	40	169	236	183	406	3367
1911	1267	337	453	32	518	122	273	226	307	141	123	164	3963
1912	120	486	615	84	109	258	868	83	102	74	225	87	3111
1913	30	40	524	443	1234	1096	104	57	129	243	29	88	4017
1914	97	88	1446	284	95	71	476	0	263	256	214	686	3976
1915	260	98	193	167	95	225	76	60	571	47	10	421	2223

Appendix 4
Sheet 2

MAJORS CREEK MONTHLY RAINFALL STATISTICS
(Points)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
1916	65	442	316	313	49	101	212	95	496	1274	114	183	3660
1917	318	162	160	120	91	125	0	96	220	186	441	48	1967
1918	855	609	88	68	0	0	441	49	60	13	10	13	2206
1919	45	595	NO RECORDS										
1920 to 1946	NO RECORDS												
1947	50	956	152	327	35	167	69	281	NO RECORDS				
1948	NO RECORDS						25	0	44	223	95	472	
1949	435	351	719	63	516	925	122	40	295	175	285	30	3956
1950	508	773	1086	615	535	908	376	37	52	622	342	203	6057
1951	1009	0	738	45	87	1255	103	365	718	232	108	55	4715
1952	65	180	768	733	265	997	473	1064	130	310	730	415	6130
1953	337	217	67	36	1300	55	50	42	95	25	30	219	2473
1954	205	550	35	68	12	105	91	64	195	314	301	106	2046
1955	259	881	472	227	842	122	66	197	142	207	192	398	4005
1956	358	1460	1116	374	523	917	481	125	98	474	26	31	5983
1957	58	527	214	32	6	432	768	445	35	38	81	353	2989
1958	396	698	310	180	55	661	254	194	230	190	91	247	3506
1959	447	530	679	391	3	1101	777	23	184	1708	780	238	6861

Appendix 4
Sheet 3

MAJORS CREEK MONTHLY RAINFALL STATISTICS
(Points)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
1960	355	169	572	96	321	90	1250	57	578	276	246	1101	5111
1961	245	400	984	121	19	505	629	560	312	455	1285	840	6355
1962	727	863	245	108	337	0	284	192	1209	198	173	839	5175
1963	325	476	850	804	684	363	316	188	596	71	267	874	5814
1964	335	93	354	672	155	527	164	310	173	378	236	218	3315
1965	52	57	10	133	10	189	142	69	378	779	97	375	2291
1966	286	442					NO RECORDS						
1967							NO RECORDS						

Appendix 5
Sheet 1

MORUYA HEADS MONTHLY RAINFALL STATISTICS
(Points)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
1875		NO	RECORDS			108	58	63	28	286	169	199	
1876	95	164	117	93	490	374	391	75	464	776	804	62	3910
1877	222	106	862	229	543	54	459	10	410	293	89	116	3393
1878	211	1944	213	72	0	20	138	231	361	25	367	395	3977
1879	503	795	1134	82	1101	120	92	569	1049	303	362	269	6379
1880	140	350	749	888	145	30	741	42	367	178	703	143	4476
1881	418	268	519	69	282	253	50	87	217	986	296	251	3796
1882	73	24	312	869	190	328	52	220	38	774	129	407	3416
1883	278	583	47	413	333	5	35	51	252	230	118	113	2458
1884	244	64	155	808	284	144	191	51	42	447	136	14	2580
1885	367	79	150	69	73	143	257	46	63	113	282	325	1967
1886	432	185	119	268	19	35	150	246	49	435	184	569	2691
1887	651	309	332	644	103	457	145	354	137	168	375	580	4255
1888	96	239	259	0	123	149	49	60	233	135	55	766	2164
1889	441	172	81	190	649	127	147	194	248	297	509	194	3249
1890	151	785	1629	56	329	513	387	86	458	192	181	141	4908
1891	493	177	18	496	68	2005	266	430	488	252	344	126	5163
1892	342	97	755	326	82	90	129	212	1562	1107	166	272	5140
1893	759	365	442	1472	108	292	599	46	29	246	432	370	5160

MORUYA HEADS MONTHLY RAINFALL STATISTICS

(Points)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
1894	468	393	1886	352	38	382	5	53	452	198	21	229	4477
1895	1017	570	71	52	277	11	4	265	177	18	13	46	2521
1896	216	398	230	10	616	1134	88	231	118	84	260	105	3490
1897	460	183	71	345	192	638	152	503	346	129	53	368	3440
1898	160	1463	52	41	301	575	67	427	56	224	9	74	3449
1899	178	23	71	456	396	660	276	819	265	360	253	92	3849
1900	472	71	245	502	1461	655	508	36	158	23	458	124	4713
1901	184	60	380	130	46	87	144	937	242	256	118	51	2635
1902	331	47	323	78	63	113	602	151	103	305	156	435	2707
1903	50	84	147	75	214	251	435	470	587	248	141	542	3244
1904	178	160	363	483	134	10	976	38	34	178	36	111	2701
1905	190	385	154	368	220	157	39	151	23	320	60	258	2325
1906	120	97	1380	47	231	8	17	324	215	156	183	109	2887
1907	369	157	294	411	112	694	11	57	12	44	118	87	2366
1908	112	510	119	553	90	87	86	603	136	95	178	3	2572
1909	349	575	39	30	0	531	394	49	48	161	51	284	2511
1910	1356	26	305	60	8	154	251	10	93	165	236	406	3070
1911	1771	104	560	24	685	108	138	301	256	129	184	107	4367

Appendix 5
Sheet 2

Appendix 5
Sheet 3

MORUYA HEADS MONTHLY RAINFALL STATISTICS
(Points)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
1912	115	281	904	114	246	348	861	34	44	58	340	88	3433
1913	29	36	475	500	650	1361	154	15	367	230	64	63	3944
1914	84	48	1284	647	145	61	433	19	507	125	341	542	4236
1915	455	57	83	255	94	155	136	87	473	26	19	301	2141
1916	196	375	671	435	61	78	176	60	706	891	405	547	4601
1917	303	162	244	302	298	188	25	45	221	165	303	92	2348
1918	598	176	72	215	77	17	565	142	174	67	242	43	2388
1919	62	1120	169	122	772	32	74	142	143	173	446	490	3745
1920	877	120	286	109	61	91	229	98	151	126	301	1000	3449
1921	342	757	209	597	460	271	124	91	38	277	223	589	3978
1922	795	403	12	139	131	247	979	178	520	417	45	181	4047
1923	176	96	79	136	26	253	122	72	403	315	104	556	2438
1924	206	265	366	323	113	85	410	78	80	82	351	890	3249
1925	625	36	709	168	214	210	151	64	261	117	5	279	2583
1926	369	191	219	39	3415	442	144	129	21	145	237	63	5670
1927	250	26	225	877	288	20	88	40	297	231	441	82	2865
1928	307	617	807	124	227	606	135	58	20	62	32	106	3101
1929	226	1710	273	483	73	16	134	646	101	102	478	272	4514

Appendix 5
Sheet 4

MORUYA HEADS MONTHLY RAINFALL STATISTICS
(Points)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
1930	119	32	171	140	743	790	103	54	38	433	82	345	3050
1931	144	94	175	762	403	178	226	26	221	256	259	179	2923
1932	3	177	385	94	281	28	229	296	369	204	458	232	2756
1933	713	90	345	462	329	252	403	81	96	278	459	327	3835
1934	1796	851	260	959	325	700	1021	357	180	281	331	116	7176
1935	351	451	381	491	64	192	165	20	172	360	451	421	3519
1936	480	419	730	291	211	305	272	123	113	100	83	629	3756
1937	540	254	863	150	55	729	43	478	153	295	114	173	3847
1938	695	274	306	93	301	66	234	651	115	552	316	24	3627
1939	493	81	712	534	120	89	122	328	141	169	478	116	3383
1940	291	95	18	606	167	38	34	11	276	43	130	441	2150
1941	417	410	432	540	90	54	35	275	294	180	109	210	3046
1942	114	204	810	216	267	135	52	19	65	455	832	106	3275
1943	329	103	84	111	1170	148	5	554	397	575	461	466	4403
1944	95	46	68	330	1164	23	90	100	24	98	77	176	2291
1945	568	216	117	1390	130	533	85	54	56	203	129	218	3699
1946	274	276	137	285	133	464	2	56	167	149	741	134	2818
1947	54	379	52	408	88	354	11	431	53	85	442	814	3171

Appendix 5
Sheet 5

MORUYA HEADS MONTHLY RAINFALL STATISTICS
(Points)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
1948	1013	378	84	107	603	500	12	11	61	265	211	227	3472
1949	475	355	627	141	419	1041	206	166	207	296	506	248	4687
1950	654	489	1343	820	548	661	569	110	108	677	256	208	6543
1951	521	549	39	65	93	1128	130	325	936	364	135	136	4421
1952	221	175	781	1216	310	1163	203	849	69	891	475	348	6701
1953	302	185	99	143	1743	31	12	175	134	332	112	241	3509
1954	273	1124	42	50	92	135	91	26	129	262	347	240	2811
1955	333	996	498	107	1068	181	101	118	110	330	219	317	4378
1956	500	935	1161	210	807	948	449	66	256	507	220	160	6219
1957	12	496	117	16	0	366	971	724	84	25	86	228	3128
1958	862	572	523	96	73	721	93	155	157	148	60	276	3736
1959	323	416	1370	248	50	491	472	82	140	1434	716	386	6128
1960	335	72	776	137	270	145	346	89	535	218	199	855	3977
1961	403	241	892	76	49	425	572	693	463	361	1023	751	5949
1962	666	397	167	190	148	2	150	293	549	181	290	534	3567
1963	264	230	517	737	1005	845	354	221	304	75	295	859	5706
1964	40	129	268	918	271	432	47	433	74	313	202	268	3395
1965	82	18	24	177	239	174	129	41	211	692	121	242	2150
1966	218	372	289	51	35	625	112	159	265	312	661	430	3529
1967	416	80	252	137	56	396	145	344	339	173	134	87	2559
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	N.A.							

Appendix 6
Sheet 1

NERRINGUNDAH MONTHLY RAINFALL STATISTICS
(Points)

Year.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
1900	NO RECORDS				1955	307	606	48	225	46	511	138	
1901	70	75	290	190	50	130	142	1109	271	312	168	25	2832
1902	292	43	280	58	8	82	712	131	208	371	192	1147	3524
1903	66	129	143	96	207	350	383	284	380	228	168	679	3113
1904	395	458	230	468	189	27	411	102	26	187	70	101	2664
1905	272	199	212	360	128	127	21	49	55	337	44	316	2120
1906	169	124	1425	76	216	18	31	570	275	160	176	154	3394
1907	532	77	312	162	129	514	16	106	10	79	193	163	2293
1908	90	883	168	566	123	43	30	926	223	161	259	49	3521
1909	313	439	57	15	15	711	307	78	87	200	41	222	2465
1910	977	16	357	28	18	106	328	19	148	212	202	304	2715
1911	2027	178	531	10	312	129	125	246	184	105	117	276	4240
1912	89	321	653	80	222	324	1062	28	29	59	281	167	3315
1913	87	23	628	445	1020	1310	103	21	252	409	85	80	4463
1914	159	116	1842	878	110	31	602	32	688	218	502	514	5692
1915	234	96	66	286	31	339	59	128	566	63	35	320	2223
1916	172	405	423	253	31	53	132	101	862	1700	390	613	5135
1917	534	283	184	331	436	160	32	54	280	176	907	263	3640

NERRINGUNDAH MONTHLY RAINFALL STATISTICS
(Points)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
1918	951	247	137	129	29	27	896	63	237	65	212	36	3029
1919	18	1346	115	106	580	20	61	86	205	238	888	750	4413
1920	1209	171	192	171	103	46	231	123	144	124	160	839	3513
1921	333	896	158	515	352	NO RECORDS							
1922 to 1961	NO RECORDS												
1962	NO RECORDS						128	239	1210	225	408	768	
1963	322	259	500	950	995	N.R.	463	NO RECORDS					
1964	NO RECORDS												
1965	NO RECORDS												
1966	N.R.	N.R.	374	37	67	556	184	146	214	322	1430	N.R.	
1967	NO RECORDS												

STATISTICAL RAINFALL DATA

(Points)

Computed to 1965

Station	Rainfall Statistic	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Araluen (Period 74 years)	Minimum	5	5	4	14	0	0	0	3	3	8	0	6	1748
	10%	45	30	51	40	29	16	22	17	36	42	22	50	2181
	30%	173	114	139	94	65	72	63	60	89	127	107	112	2690
	50%	270	287	221	164	134	197	116	115	144	214	174	235	3203
	70%	396	417	418	316	281	447	270	213	248	298	256	316	4129
	90%	789	890	837	762	913	984	806	659	459	557	512	730	5238
	Maximum	1575	2905	1540	2104	4740	1319	2734	1173	1514	2056	1670	1416	7126
Bettowynd (Period 69 years)	Minimum	2	8	0	6	2	0	0	7	0	6	6	12	1581
	10%	28	31	48	38	18	21	27	22	44	45	25	49	1893
	30%	134	113	130	94	49	73	64	44	92	129	92	114	2236
	50%	250	223	214	143	103	161	112	102	137	217	188	233	2697
	70%	365	383	390	281	198	324	183	178	192	259	271	331	3474
	90%	625	638	602	599	920	707	642	503	420	423	510	572	4794
	Maximum	1374	1420	1403	1445	2784	1051	1727	772	921	1678	1376	897	6013
Krawarree (Period 65 years)	Minimum	0	0	0	10	0	0	3	0	10	5	0	14	847
	10%	22	21	25	32	11	18	27	19	35	60	27	45	1963
	30%	124	74	130	92	46	84	64	51	79	137	121	139	2388
	50%	279	260	192	148	115	165	117	93	168	203	161	227	2858
	70%	365	367	404	321	237	273	221	195	229	287	293	399	3528
	90%	658	735	700	584	815	655	681	477	463	449	513	600	4900
	Maximum	1299	1330	1339	745	2700	1381	1901	885	853	1684	1529	917	6064

STATISTICAL RAINFALL DATA
(Points)

Station	Rainfall Statistic	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Majors Creek (Period 37 years to 1965)	Minimum	30	0	10	32	0	0	0	0	35	13	10	13	1967
	10%	57	54	81	43	5	14	46	21	58	25	26	45	2183
	30%	149	121	173	95	49	103	105	57	120	165	101	115	2792
	50%	261	329	316	155	109	225	273	96	173	232	183	219	3367
	70%	380	529	598	335	299	518	460	214	282	312	278	389	4267
	90%	886	791	1004	626	901	1017	795	660	582	653	650	839	6072
	Maximum	1267	1460	1446	804	1300	1255	1250	1222	1209	1708	1285	1101	6861
Moruya Heads (Period 90 years to 1965)	Minimum	3	18	12	0	0	2	2	10	12	18	5	3	1967
	10%	82	46	52	50	49	20	18	21	38	63	51	64	2368
	30%	192	105	140	110	97	96	90	56	102	148	129	128	2960
	50%	326	223	271	216	214	190	145	105	173	227	222	241	3461
	70%	466	396	511	450	320	439	263	259	273	304	346	362	3978
	90%	754	794	903	819	803	784	572	567	505	667	478	588	5619
	Maximum	1795	1944	1886	1472	3415	2005	1021	937	1562	1434	1023	1000	7176
Nerringundah (Period 20 years to 1920)	Minimum	18	16	57	10	8	18	16	19	10	59	35	25	2120
	10%	66	25	71	16	15	21	22	22	26	63	41	37	2230
	30%	111	102	173	85	37	44	60	57	145	135	130	157	2750
	50%	253	175	255	167	126	117	137	102	216	194	184	270	3[illegible]55
	70%	491	310	403	317	213	275	366	130	274	235	245	45[illegible]	3605
	90%	1186	840	1348	556	566	691	878	890	676	405	849	830	5068
	Maximum	2027	1346	1842	878	1020	1310	1062	1109	862	1700	907	1147	5692

MINIMUM RAINFALL RECORDED IN PERIODS OF UP TO TWELVE MONTHS
COMMENCING IN THE MONTH INDICATED
(Points)

Computed to 1965.

Station	Number of Months	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Araluen	1	5	5	4	14	0	0	0	3	3	8	0	6
	2	41	36	27	22	29	15	23	35	52	41	37	61
	3	105	135	53	101	105	90	58	105	109	186	129	126
	4	179	148	159	176	187	209	123	141	216	207	184	288
	5	192	298	232	259	346	335	321	248	237	387	305	362
	6	346	408	270	379	359	396	426	269	453	553	472	375
	7	452	457	390	630	581	622	481	534	624	784	485	529
	8	501	784	674	652	726	820	643	860	898	797	639	635
	9	828	987	708	797	912	949	1130	1125	911	951	745	684
	10	1445	1009	853	1009	1161	1316	1428	1229	1065	1057	794	1011
	11	1571	1154	1065	1359	1474	1428	1461	1486	1171	1106	1121	1542
	12	1748	1366	1415	1559	1518	1813	1615	1592	1220	1433	1758	1733
Bettowynd	1	2	8	0	6	2	0	0	7	0	6	6	12
	2	58	31	27	31	39	26	34	38	67	36	65	43
	3	124	142	33	103	88	70	78	92	98	138	119	148
	4	191	150	140	196	120	151	139	120	163	164	235	275
	5	199	280	198	266	338	263	240	185	189	363	294	375
	6	329	359	268	363	497	333	305	211	499	507	491	383
	7	408	397	365	620	525	546	331	560	560	612	495	513
	8	446	695	655	648	590	572	662	951	925	646	630	592
	9	744	1075	926	713	616	855	981	1003	959	955	709	630
	10	1270	1126	993	739	984	1062	1317	1027	1092	1076	747	928
	11	1325	1369	1129	1202	1108	1537	1321	1357	1187	1114	1045	1406
	12	1581	1476	1332	1570	1624	1548	1571	1532	1225	1412	1467	1482

MINIMUM RAINFALL RECORDED IN CONSECUTIVE PERIODS OF UP TO TWELVE MONTHS
COMMENCING IN THE MONTH INDICATED
(Points)

Computed to 1965

Station	Number of Months	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Moruya Heads	1	3	18	12	0	0	2	2	10	12	18	5	3
	2	65	42	69	16	20	15	23	69	56	31	59	105
	3	124	219	69	92	158	83	80	113	114	77	211	153
	4	301	337	309	230	250	237	124	172	220	293	259	346
	5	513	514	410	381	473	335	242	278	373	489	355	569
	6	714	712	436	523	569	412	329	430	564	579	713	694
	7	843	784	565	741	699	534	441	629	635	931	739	895
	8	884	880	827	804	811	750	951	1059	1091	1156	992	1069
	9	1095	993	888	863	1027	1112	1070	1355	1377	1380	1114	1141
	10	1343	1275	934	1079	1425	1267	1377	1428	1520	1531	1186	1261
	11	1398	1504	1150	1477	1600	1388	1619	1571	1700	1603	1397	1374
	12	1967	1720	1548	1707	1665	1763	1762	1828	1741	1844	1510	1656

MEDIAN RAINFALL RECORDED IN CONSECUTIVE PERIODS OF UP TO TWELVE MONTHS COMMENCING IN THE MONTH INDICATED

(Points)

Computed to 1965

Station	Number of Months	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Araluen	1	270	287	221	164	134	197	116	115	144	214	174	235
	2	576	561	547	386	448	476	349	329	410	388	397	550
	3	928	834	809	698	720	723	508	545	599	685	749	906
	4	1275	1182	1079	1026	958	944	868	821	885	1058	1126	1199
	5	1603	1519	1289	1264	1267	1253	1044	1140	1220	1393	1447	1518
	6	1775	1804	1692	1524	1486	1435	1357	1502	1633	1738	1744	1850
	7	1995	2020	1865	1692	1651	1675	1795	1873	1984	2034	2036	2114
	8	2186	2239	2075	1891	2052	2102	2154	2159	2237	2283	2257	2370
	9	2370	2435	2204	2214	2466	2488	2413	2465	2508	2524	2541	2531
	10	2687	2665	2505	2665	2801	2847	2614	2682	2739	2902	2807	2675
	11	2943	2980	2907	3038	3082	3089	2960	2960	3131	3185	2894	2961
	12	3203	3459	3318	3348	3374	3386	3196	3225	3358	3279	3173	3139
Bettowynd	1	250	223	214	143	103	161	112	102	137	217	188	233
	2	520	552	483	318	334	325	278	262	387	377	403	497
	3	815	744	682	540	567	572	464	485	568	623	731	855
	4	1119	936	810	757	786	766	771	763	800	907	1009	1065
	5	1288	1214	974	953	1032	969	946	1107	1063	1239	1328	1357
	6	1418	1373	1332	1207	1171	1179	1226	1305	1400	1557	1572	1583
	7	1643	1480	1484	1376	1400	1453	1505	1613	1704	1823	1804	1688
	8	1859	1759	1648	1537	1656	1799	1814	1879	1946	2060	1976	1938
	9	1989	1892	1855	1804	2054	2070	2167	2119	2277	2259	2176	2080
	10	2185	2126	2104	2232	2369	2388	2333	2353	2386	2466	2363	2264
	11	2335	2359	2441	2580	2668	2532	2500	2594	2878	2619	2476	2513
	12	2697	2813	2758	2829	2851	2890	2718	2909	2813	2664	2768	2647

MEDIAN RAINFALL RECORDED IN CONSECUTIVE PERIODS OF UP TO TWELVE MONTHS COMMENCING IN THE MONTH INDICATED

(Points)

Computed to 1965

Station	Number of Months	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Moruya Heads	1	326	223	271	216	214	190	145	105	173	227	222	241
	2	614	614	622	556	501	436	396	343	455	470	470	561
	3	1121	996	1036	822	798	686	585	628	673	785	861	918
	4	1352	1310	1353	1086	966	898	841	914	974	1151	1256	1320
	5	1661	1614	1507	1328	1164	1155	1145	1225	1379	1520	1591	1706
	6	1937	1778	1738	1539	1423	1403	1441	1593	1719	1911	1960	1976
	7	2088	2014	2000	1847	1735	1771	1858	2015	2221	2266	2261	2192
	8	2482	2291	2234	2043	2049	2226	2345	2428	2496	2513	2514	2419
	9	2720	2576	2507	2348	2416	2551	2562	2700	2779	2833	2743	2694
	10	2984	2791	2788	2845	2900	2918	2856	2910	2993	3059	2909	2995
	11	3207	3146	3197	3228	3245	3142	3115	3242	3250	3323	3169	3250
	12	3461	3467	3519	3474	3643	3463	3519	3461	3486	3500	3480	3452

MORUYA RIVER AT McGREGORS CREEK

LOCATION:	Latitude 35°47' Longitude 149°57'
PERIOD OF ESTABLISHMENT:	December 1954 to date.
COMPLETE YEARS OF COMPUTED RECORDS:	11 Years.
ZERO OF GAUGE:	R.L. 56.07 Assumed Datum.
CATCHMENT AREA:	344 Square Miles.
CONTROL:	Rock Bar
EQUIPMENT:	Staff gauge, range 0 to 40 feet.
CURRENT METER OBSERVATIONS:	(a) Number obtained : 86
	(b) Maximum observation in cusecs : 1,436
	(c) Minimum observation in cusecs : 4.3
MAXIMUM ESTIMATED DISCHARGE DURING PERIOD OF RECORDS:	60,000 cusecs
MEAN DAILY DISCHARGE FOR 11 YEARS:	345 cusecs.
MEAN ANNUAL DISCHARGE FOR 11 YEARS:	252,000 acre feet.

MORUYA RIVER AT McGREGORS CREEK

Year 1955

Month	Discharge in Cusecs Max.	Min.	Mean	Discharge for Month Acre Feet
Jan.	17	1.2	4.3	264
Feb.	450	10	100	5,574
Mar.	940	120	317	19,650
Apr.	100	36	145	8,692
May	24400	140	1463	90,734
June	520	100	228	13,682
July	100	49	75	4,672
Aug.	49	36	44	2,700
Sept.	49	31	37	2,248
Oct.	49	31	35	2,160
Nov.	36	10	18	1,076
Dec.	91	17	26	1,616
Total	..	..	..	153,068

Year 1956

Month	Discharge in Cusecs Max.	Min.	Mean	Discharge for Month Acre Feet
Jan.	73	17	41	2,538
Feb.	5395	20	997	57,848
Mar.	6870	560	1376	85,330
Apr.	840	152	353	21,162
May	18350	272	1418	87,934
June	13850	177	2247	134,846
July	7200	435	999	61,960
Aug.	450	82	310	19,238
Sept.	191	100	127	7,640
Oct.	238	164	201	12,454
Nov.	164	65	98	5,876
Dec.	177	36	96	5,954
Total	..	..	.	502,780

Year 1957

Month	Max.	Min.	Mean	Acre Feet
Jan.	110	27	59	3,646
Feb.	100	12	27	1,536
Mar.	65	17	33	2,034
Apr.	27	12	18	1,104
May	12	7	10	616
June	640	8	103	6,160
July	No Records			
Aug.	No. Records			
Sept.	No Records			
Oct.	136	26	67	4,172
Nov.	65	11	30	1,792
Dec.	19	4	7	460
Total	..	..	..	..

Year 1958

Month	Max.	Min.	Mean	Acre Feet
Jan.	51	4	15	936
Feb.	2200	118	567	31,726
Mar.	272	64	116	7,210
Apr.	64	35	43	2,586
May	35	19	25	1,580
June	6980	13	309	18,566
July	3300	65	305	18,912
Aug.	100	35	57	3,562
Sept.	39	28	33	1,966
Oct.	35	19	24	1,512
Nov.	19	6	10	592
Dec.	48	6	19	1,164
Total	..	..	..	90,312

Appendix 10
Sheet 3

MORUYA RIVER AT McGREGORS CREEK

Year 1959

Month	Discharge in Cusecs Max.	Discharge in Cusecs Min.	Discharge in Cusecs Mean	Discharge for Month Acre Feet
Jan.	48	13	23	1,440
Feb.	760	19	66	3,674
Mar.	2950	65	730	45,272
Apr.	1440	82	286	17,182
May	158	28	84	5,206
June		No	Records	
July		No	Records	
Aug.		No	Records	
Sept.	120	61	80	4,816
Oct.	36000	46	3328	206,314
Nov.	6020	560	1319	[illegible]140
Dec.	720	158	372	23,050
Total	..	..	..	..

Year 1960

Month	Discharge in Cusecs Max.	Discharge in Cusecs Min.	Discharge in Cusecs Mean	Discharge for Month Acre Feet
Jan.	197	82	127	7,882
Feb.	100	64	76	4,396
Mar.	560	51	159	9,836
Apr.	140	49	77	4,646
May	49	36	46	2,830
June	49	36	44	2,654
July	17480	36	1435	88,940
Aug.	221	82	123	7,618
Sept.	1390	65	262	15,724
Oct.	164	82	108	6,692
Nov.	82	49	62	3,726
Dec.	4080	49	895	55,466
Total	..	..	..	210,410

Year 1961

Jan.	760	82	211	13,090
Feb.	100	49	69	3,858
Mar.	9220	120	866	53,696
Apr.	720	120	258	15,494
May	120	82	97	6,008
June	1340	82	264	15,866
July	4710	100	757	46,960
Aug.	3990	158	560	34,738
Sept.	1690	305	732	43,940
Oct.	2260	158	442	27,406
Nov.	60000	158	4231	253,854
Dec.	11000	400	1906	118,164
Total	..	..	..	633,074

Year 1962

Jan.	4012	340	1031	63,900
Feb.	9220	210	962	53,896
Mar.	640	210	360	22,346
Apr.	210	127	163	9,766
May	225	118	134	8,302
June	118	82	96	5,748
July	183	73	94	5,804
Aug.	171	65	93	5,796
Sept.	23000	58	1690	101,428
Oct.	375	136	197	12,240
Nov.	158	65	104	6,254
Dec.	940	65	292	18,140
Total	..	..	..	313,620

MORUYA RIVER AT McGREGORS CREEK

Month	Year 1963 Discharge in Cusecs Max.	Min.	Mean	Discharge for Month Acre Feet	Month	Year 1964 Discharge in Cusecs Max.	Min.	Mean	Discharge for Month Acre Feet
Jan.	410	109	162	10,064	Jan.	237	81	134	8,328
Feb.	760	127	241	13,474	Feb.	98	44	67	3,884
Mar.	2530	100	424	26,316	Mar.	330	44	77	4,782
Apr.	27000	118	961	57,674	Apr.	10900	44	798	47,856
May	31000	640	2450	151,874	May	450	98	193	11,962
June	1900	290	694	41,660	June	2460	98	381	22,852
July	1290	254	560	34,746	July	135	89	111	6,894
Aug.	485	144	199	12,366	Aug.	2600	58	357	22,118
Sept.	1540	89	287	17,238	Sept.	520	86	178	10,692
Oct.	560	107	232	14,400	Oct.	117	49	70	4,372
Nov.	237	89	129	7,768	Nov.	177	33	65	3,926
Dec.	5070	80	979	60,718	Dec.	49	26	36	2,272
Total	..	..	..	448,298	Total	..	..	..	149,938

Month	Year 1965 Max.	Min.	Mean	Acre Feet	Month	Year 1966 Max.	Min.	Mean	Acre Feet
Jan.	30	17	22	1,380	Jan.	20	4	11	698
Feb.	22	11	16	904	Feb.	86	3	19	1,072
Mar.	11	9	11	660	Mar.	60	13	28	1,754
Apr.	26	10	15	926	Apr.	26	10	14	848
May	19	15	16	964	May	11	9	10	610
June	30	15	17	1,046	June	450	11	78	4,692
July	26	19	21	1,284	July	54	26	32	1,968
Aug.	20	15	18	1,094	Aug.	26	20	21	1,328
Sept.	49	15	25	1,524	Sept.	410	27	87	5,232
Oct.	720	11	113	6,976	Oct.	96	28	51	3,174
Nov.	96	16	32	1,930	Nov.	34000	28	200	119,854
Dec.	370	38	71	4,390	Dec.	380	72	156	9,666
Total	..	..	..	23,078	Total	..	..	..	150,896

MORUYA RIVER AT McGREGORS CREEK.

Year 1967					Year 1968				
Month	Discharge in Cusecs			Discharge for Month Acre Feet	Month	Discharge in Cusecs			Discharge for Month Acre Feet
	Max.	Min.	Mean			Max.	Min.	Mean	
Jan.	320	36	77	4,746	Jan.	45	10	19	1,155
Feb.	198	40	68	3,822	Feb.	11	1	6	319
Mar.	68	32	46	2,830	Mar.	29	1	8	466
Apr.	40	25	32	1,918	Apr.	13	4	7	435
May	41	20	25	1,564	May	275	4	40	2,467
June	60	20	39	2,334	June	18	12	14	855
July	44	26	34	2,134	July	16	12	13	816
Aug.	2600	26	387	23,984	Aug.	12	5.8	8.7	541
Sept.	5250	112	765	45,926	Sept.	5.8	1.1	3.2	192
Oct.	206	60	99	6,148	Oct.	2.1	0.3	1.1	66
Nov.	57	28	39	2,334	Nov.	3.0	0.3	0.9	52
Dec.	29	9	18	1,120	Dec.	555	0.3	22	1,364
Total	..	..	..	98,860	Total	..	..	..	8,894

MORUYA RIVER AT WAMBAN

LOCATION:	Latitude 35°55' Longitude 150°2'.
PERIOD OF ESTABLISHMENT:	September 1959 to date.
COMPLETE YEARS OF COMPUTED RECORDS:	8 years.
ZERO OF GAUGE:	R.L. 67.85 Assumed Datum.
CATCHMENT AREA:	445 Square Miles.
CONTROL:	Gravel.
EQUIPMENT:	Pressure recorder installed July 1961. Staff gauge, range 0 to 35 feet.
CURRENT METER OBSERVATIONS:	(a) Number obtained : 68
	(b) Maximum observation in cusecs : 4,550
	(c) Minimum observation in cusecs : 6.4
MAXIMUM ESTIMATED DISCHARGE DURING PERIOD OF RECORDS:	94,000 cusecs.
MEAN DAILY DISCHARGE FOR 8 YEARS:	478 cusecs.
MEAN ANNUAL DISCHARGE FOR 8 YEARS:	349,000 acre feet.

MORUYA RIVER AT WAMBAN

Month	Year 1959 Discharge in Cusecs Max.	Min.	Mean	Discharge for Month Acre Feet	Month	Year 1960 Discharge in Cusecs Max.	Min.	Mean	Discharge for Month Acre Feet
Jan.	..	..	..	..	Jan.	256	80	158	9,766
Feb.	..	..	..	..	Feb.	108	47	69	3,980
Mar.	..	..	..	..	Mar.	1070	37	267	16,564
Apr.	..	..	..	..	Apr.	202	62	106	6,390
May	..	..	..	..	May	74	47	61	3,776
June	..	..	..	..	June	68	52	53	3,156
July	..	..	..	..	July	26000	51	1820	112,828
Aug.	..	..	..	..	Aug.	294	108	177	11,004
Sept.	No Records				Sept.	1008	94	361	21,660
Oct.	69000	80	4205	260,706	Oct.	202	94	142	8,828
Nov.	7600	852	1943	116,574	Nov.	118	68	87	5,216
Dec.	1320	220	569	35,284	Dec.	8880	62	1249	77,458
Total	..	..	..	..	Total	..	..	..	280,626

Month	Year 1961 Max.	Min.	Mean	Acre Feet	Month	Year 1962 Max.	Min.	Mean	Acre Feet
Jan.	1045	102	289	17,918	Jan.	5440	640	1546	95,862
Feb.	102	71	80	4,454	Feb.	9400	420	1312	73,478
Mar.	11200	148	1196	74,178	Mar.	1070	314	638	39,530
Apr.	1120	166	369	22,110	Apr.	340	158	207	12,424
May	166	102	127	7,872	May	305	131	157	9,752
June	2040	102	389	23,366	June	131	79	97	5,846
July	6280	132	1065	66,024	July	250	79	102	6,342
Aug.	5920	225	602	37,300	Aug.	239	79	116	7,178
Sept.	2605	400	1063	63,806	Sept.	34200	68	2654	159,232
Oct.	3530	188	620	38,418	Oct.	560	132	263	16,304
Nov.	93700	225	6721	403,250	Nov.	236	80	123	7,390
Dec.	No Records			183,600*	Dec.	1070	62	354	21,936
Total	..	..	..	942,296*	Total	..	..	..	455,274

* Estimated.

Appendix 11
Sheet 3

MORUYA RIVER AT WAMBAN

Month	Discharge in Cusecs Max. (1963)	Min.	Mean	Discharge for Month Acre Feet (1963)	Month	Discharge in Cusecs Max. (1964)	Min.	Mean	Discharge for Month Acre Feet (1964)
Jan.	460	132	217	13,478	Jan.	292	68	149	9,220
Feb.	695	148	304	17,044	Feb.	122	43	65	3,760
Mar.	4050	132	614	38,050	Mar.	830	43	120	7,446
Apr.	36000	132	1263	75,782	Apr.	17400	67	1067	64,030
May	21700	875	3187	197,570	May	555	140	246	15,236
June	2470	377	948	56,854	June	2850	170	475	28,524
July	1620	316	729	45,194	July	202	112	146	9,052
Aug.	605	152	242	14,982	Aug.	2640	77	376	23,302
Sept.	1890	108	338	20,294	Sept.	660	125	246	14,760
Oct.	625	140	308	19,092	Oct.	186	77	100	6,206
Nov.	405	125	182	10,892	Nov.	266	50	103	6,188
Dec.	8100	105	1430	88,652	Dec.	77	46	50	3,112
Total	..	..	..	597,884	Total	..	..	..	190,836

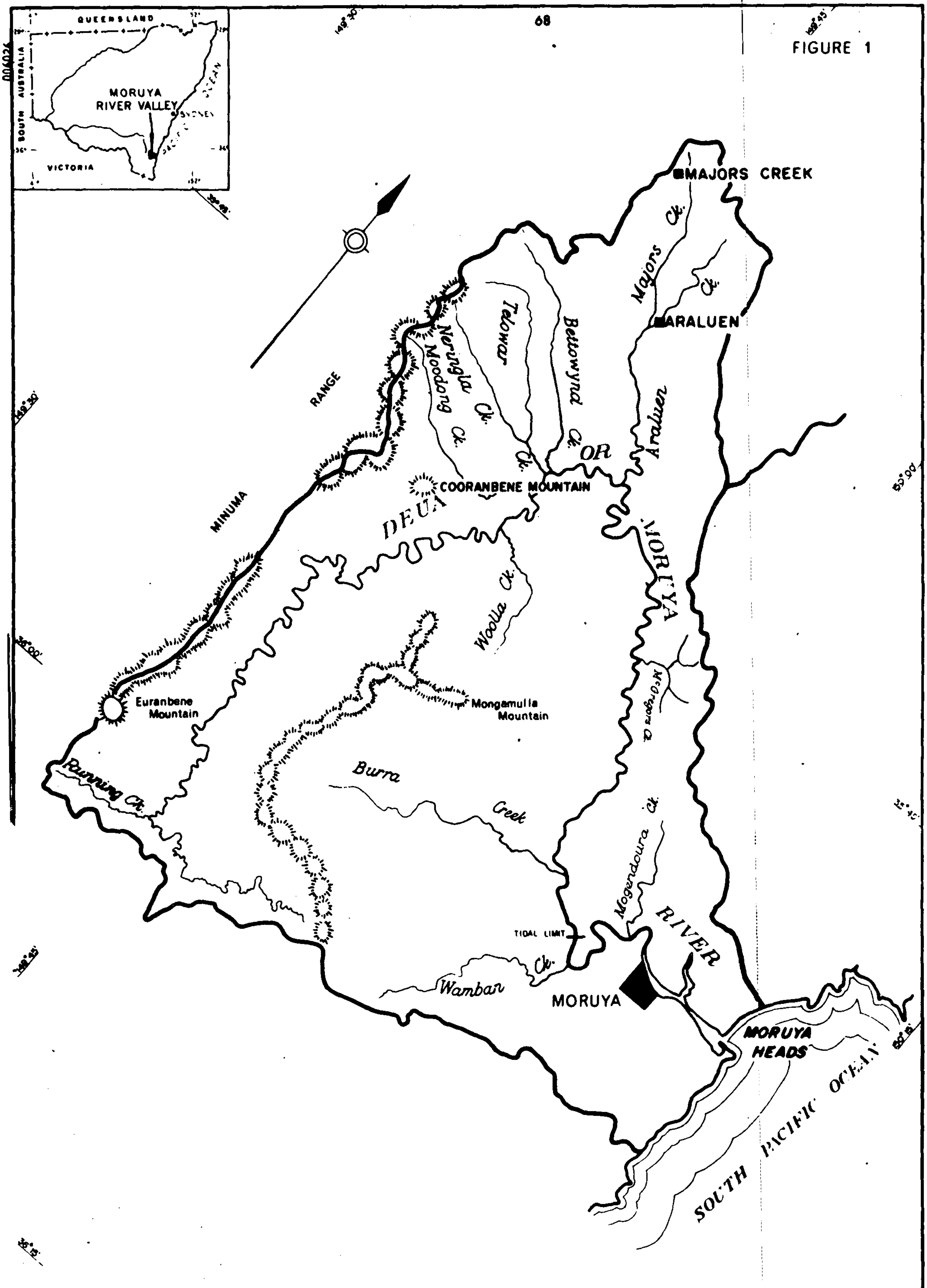
Month	Max. (1965)	Min.	Mean	Acre Feet (1965)	Month	Max. (1966)	Min.	Mean	Acre Feet (1966)
Jan.	43	24	29	1,816	Jan.	20	5	12	730
Feb.	24	15	20	1,094	Feb.	74	7	27	1,490
Mar.	15	10	12	746	Mar.	450	16	60	3,730
Apr.	27	10	16	912	Apr.	37	10	17	998
May	30	14	20	1,222	May	10	10	10	620
June	27	16	18	1,050	June	625	10	102	6,140
July	30	18	24	1,516	July	58	28	39	2,440
Aug.	25	18	21	1,286	Aug.	37	26	31	1,948
Sept.	48	18	30	1,806	Sept.	1220	37	116	6,950
Oct.	555	12	101	6,292	Oct.	102	37	61	3,794
Nov.	94	20	37	2,198	Nov.	42000	42	2572	154,336
Dec.	780	20	100	6,188	Dec.	408	102	185	11,490
Total	..	..	..	26,126	Total	..	..	..	194,666

Appendix 11
Sheet 4

MORUYA RIVER AT WAMBAN

Year 1967					Year 1968				
Month	Discharge in Cusecs			Discharge for Month Acre Feet	Month	Discharge in Cusecs			Discharge for Month Acre Feet
	Max.	Min.	Mean			Max.	Min.	Mean	
Jan.	860	52	117	7,246	Jan.	98	14	34	2,084
Feb.	385	48	80	4,480	Feb.	19	8	12	714
Mar.	80	32	47	2,892	Mar.	36	3	8	492
Apr.	42	28	35	2,076	Apr.	12	4	6	335
May	30	26	28	1,716	May	495	4	82	5,078
June	70	26	45	2,716	June	27	20	23	1,350
July	70	32	42	2,594	July	23	16	23	1,412
Aug.	2880	.32	369	22,896	Aug.	23	16	17	1,062
Sept.	6200	85	788	47,310	Sept.	16	3	7.3	438
Oct.	228	77	136	8,444	Oct.	3.2	0.3	2.1	131
Nov.	71	29	48	2,986	Nov.	0.4	0	0.2	10
Dec.	45	14	24	1,506	Dec.	111	0	12	750
Total				106,862	Total				13,856

FIGURE 1



NEW SOUTH WALES

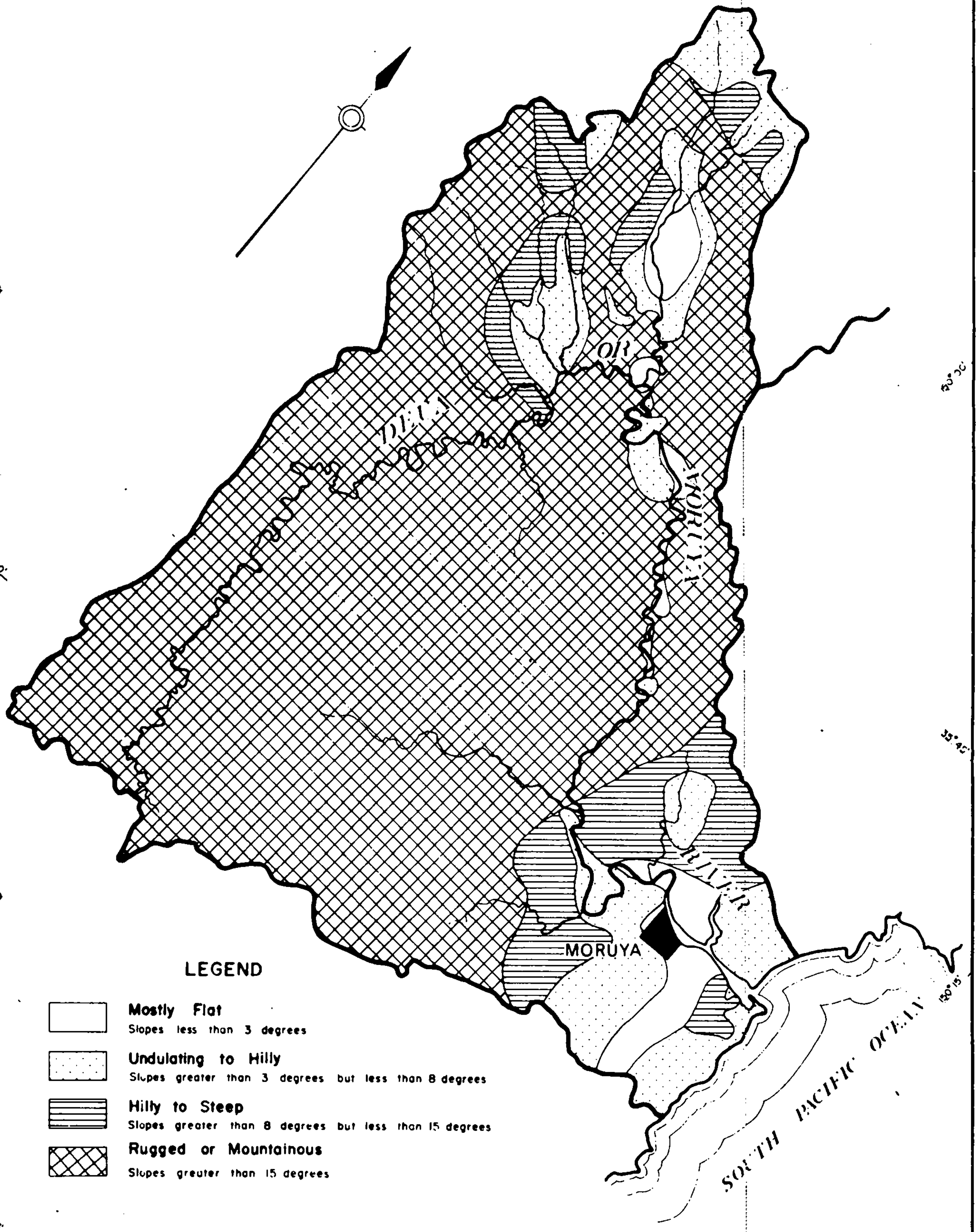
WATER CONSERVATION AND IRRIGATION COMMISSION

MORUYA RIVER VALLEY

SCALE

MILES 1 0 1 2 3 4 5 6 7 8 9 10 MILES

FIGURE 2



NEW SOUTH WALES
WATER CONSERVATION AND IRRIGATION COMMISSION

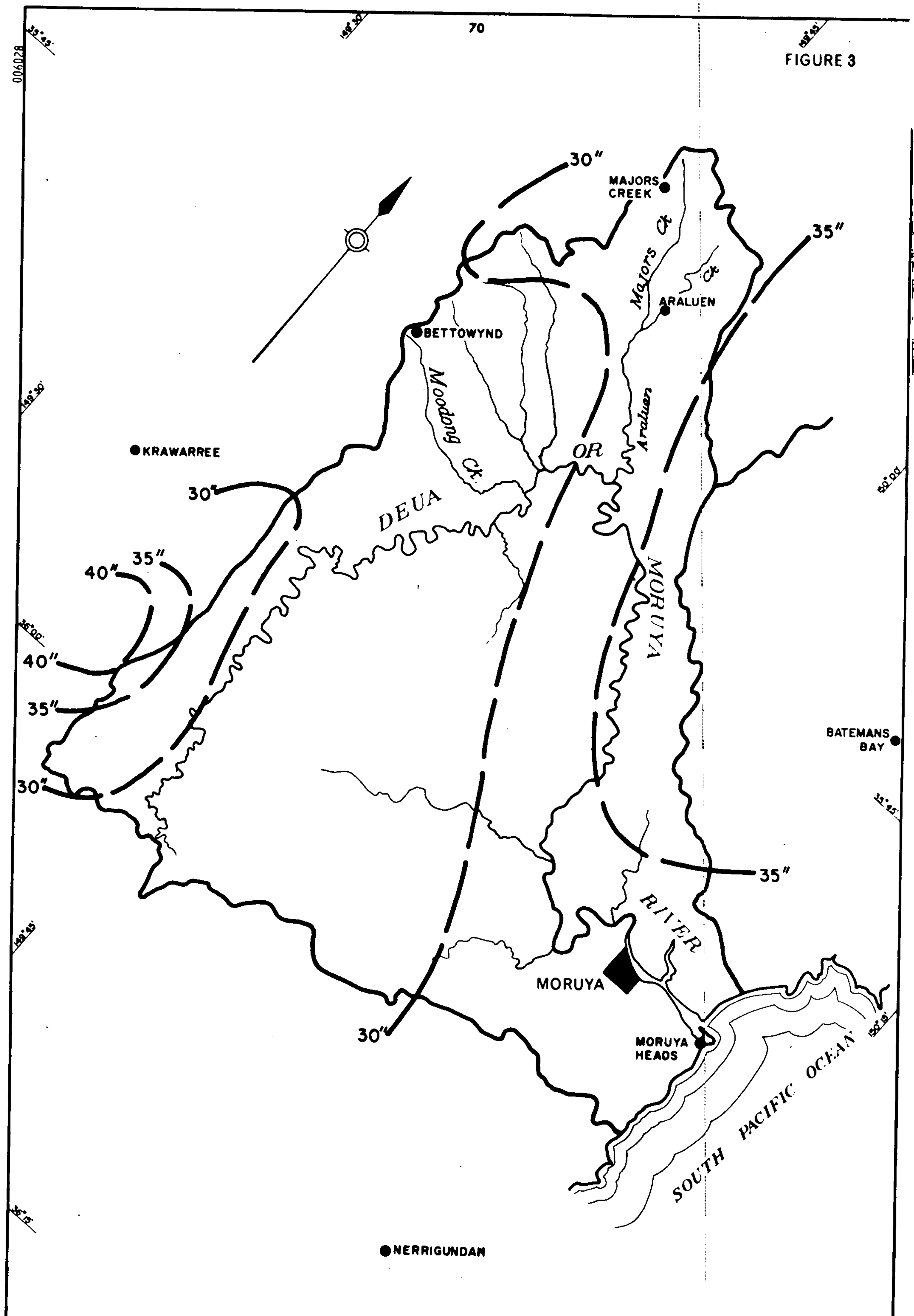
MORUYA RIVER VALLEY

LAND SLOPES

SCALE

MILES 1 0 1 2 3 4 5 6 7 8 9 10 MILES

FIGURE 3



NEW SOUTH WALES
WATER CONSERVATION AND IRRIGATION COMMISSION

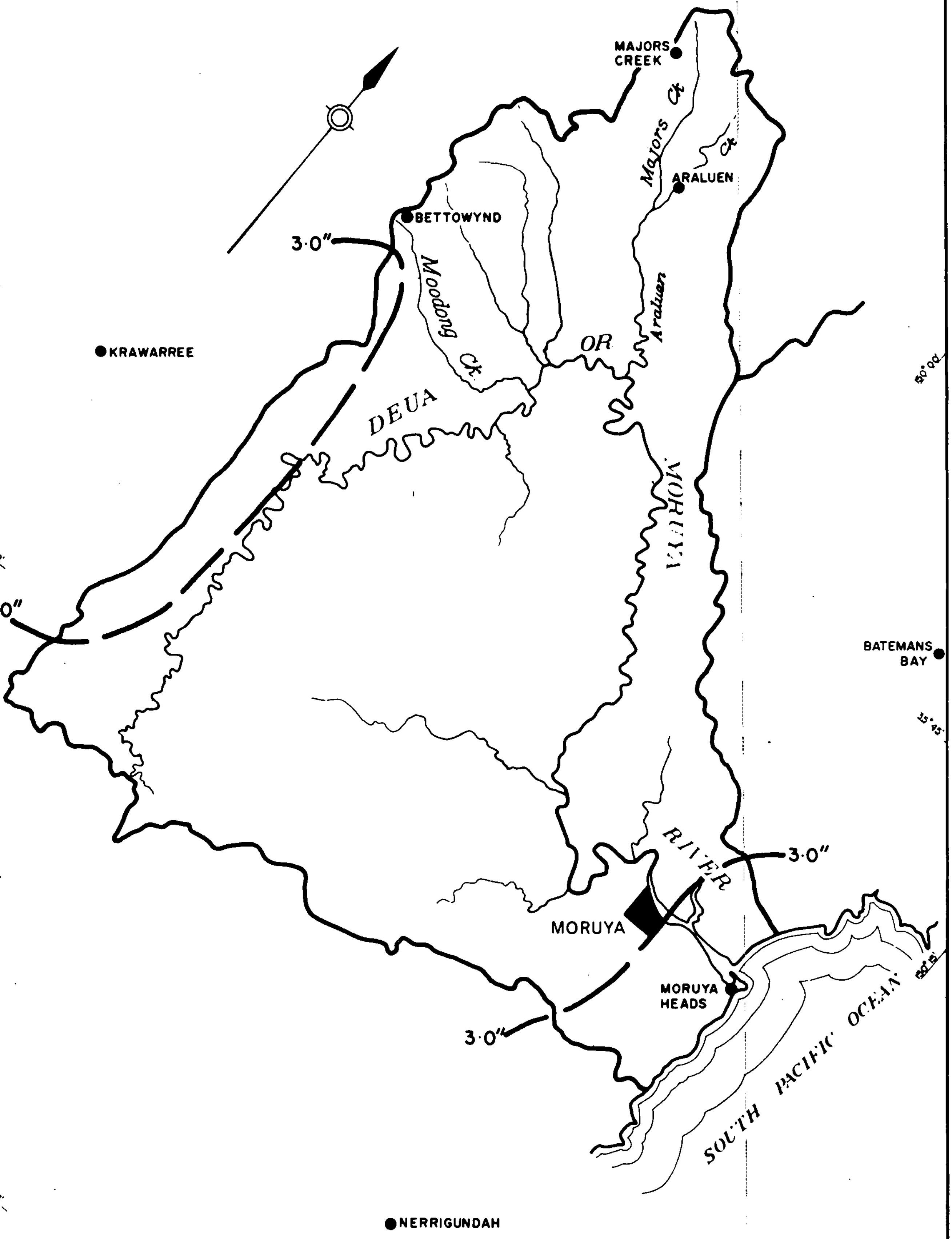
MORUYA RIVER VALLEY

ANNUAL MEDIAN RAINFALL

SCALE

MILES 1 0 1 2 3 4 5 6 7 8 9 10 MILES

FIGURE 4



NEW SOUTH WALES

WATER CONSERVATION AND IRRIGATION COMMISSION

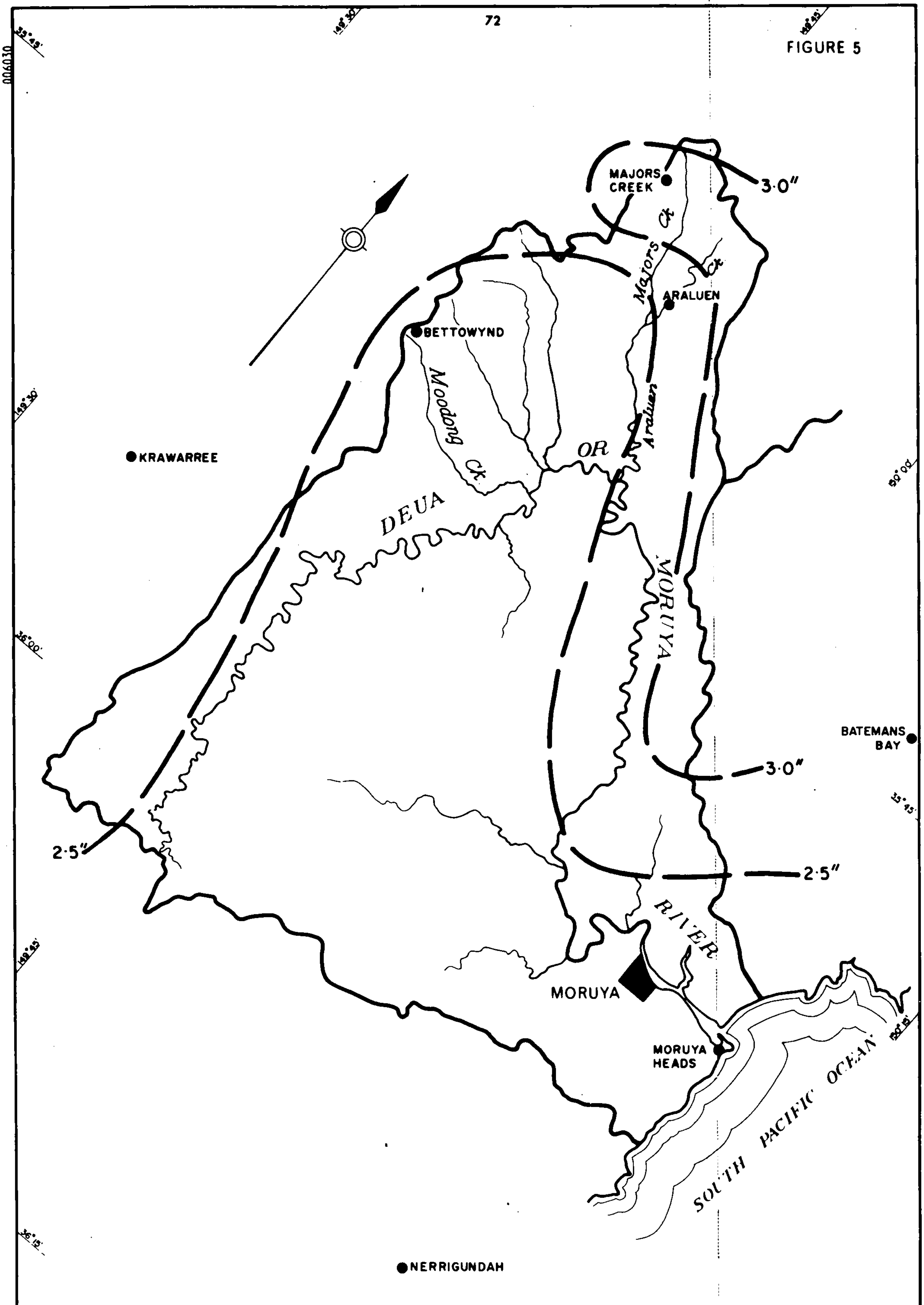
MORUYA RIVER VALLEY

JANUARY MEDIAN RAINFALL

SCALE

MILES 1 0 1 2 3 4 5 6 7 8 9 10 MILES

FIGURE 5



NEW SOUTH WALES

WATER CONSERVATION AND IRRIGATION COMMISSION

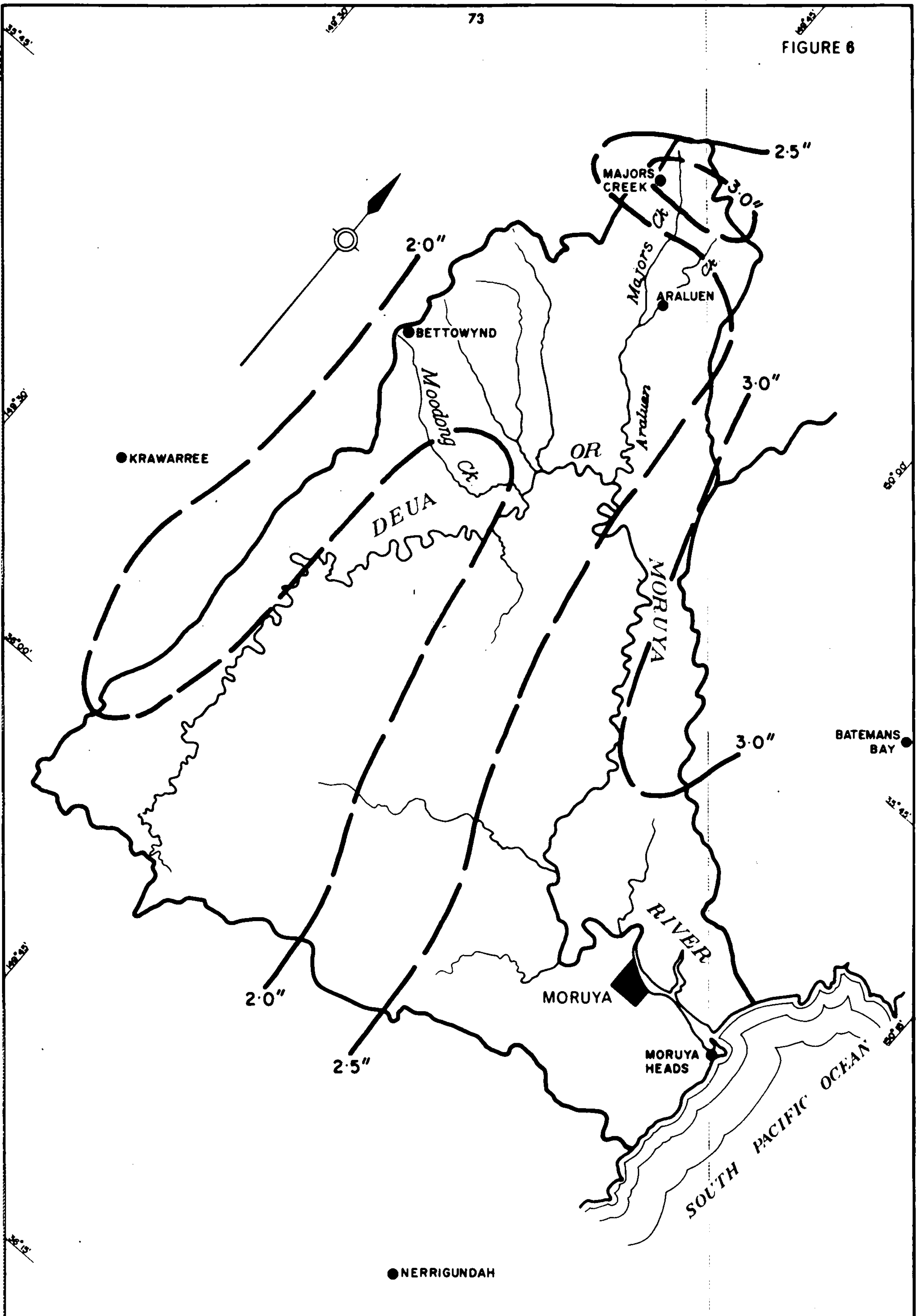
MORUYA RIVER VALLEY

FEBRUARY MEDIAN RAINFALL

SCALE

MILES 1 0 1 2 3 4 5 6 7 8 9 10 MILES

FIGURE 6



NEW SOUTH WALES
WATER CONSERVATION AND IRRIGATION COMMISSION

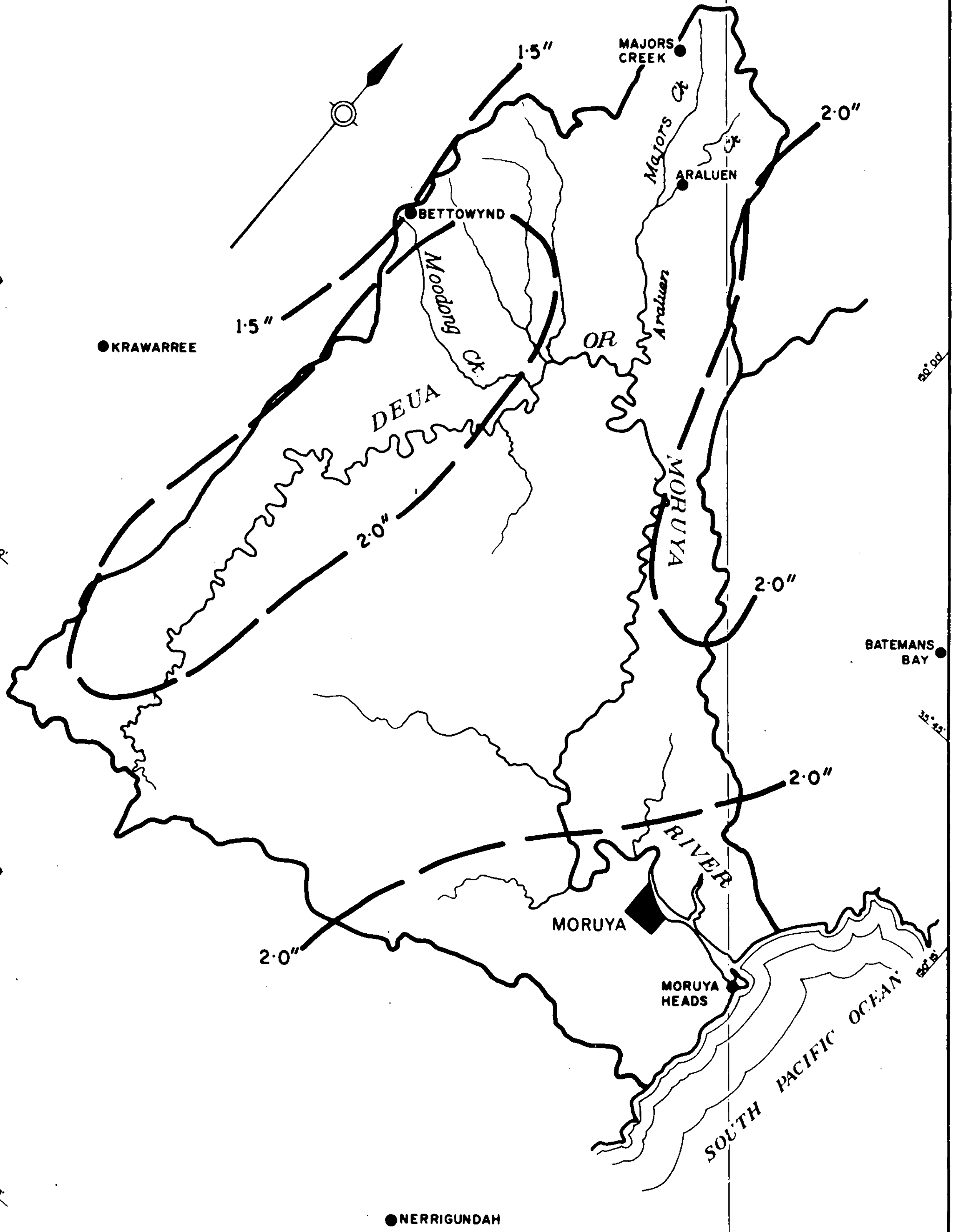
MORUYA RIVER VALLEY

MARCH MEDIAN RAINFALL

SCALE

MILES 1 0 1 2 3 4 5 6 7 8 9 10 MILES

FIGURE 7



NEW SOUTH WALES
WATER CONSERVATION AND IRRIGATION COMMISSION

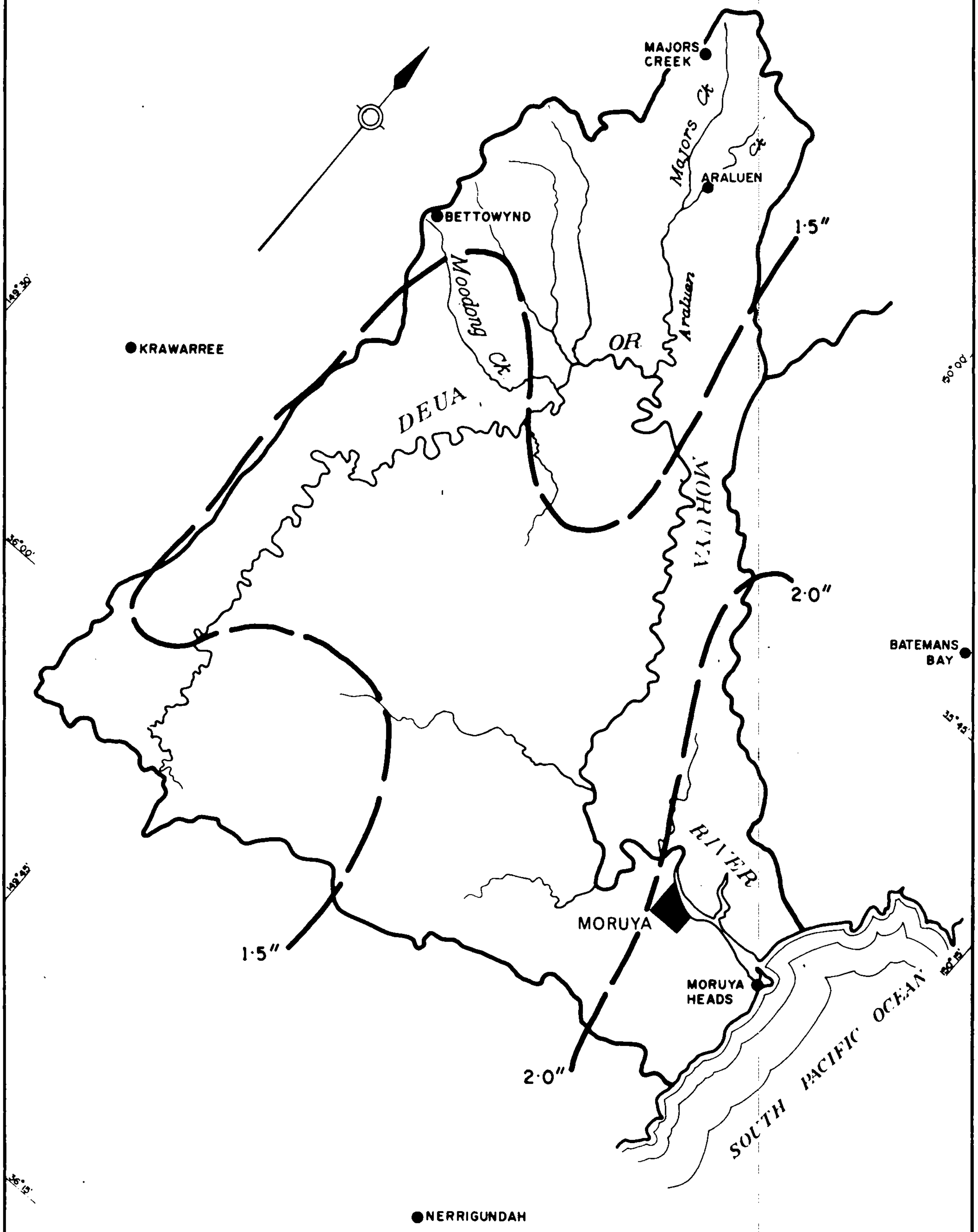
MORUYA RIVER VALLEY

APRIL MEDIAN RAINFALL

SCALE

MILES 1 0 1 2 3 4 5 6 7 8 9 10 MILES

FIGURE 8



NEW SOUTH WALES
WATER CONSERVATION AND IRRIGATION COMMISSION

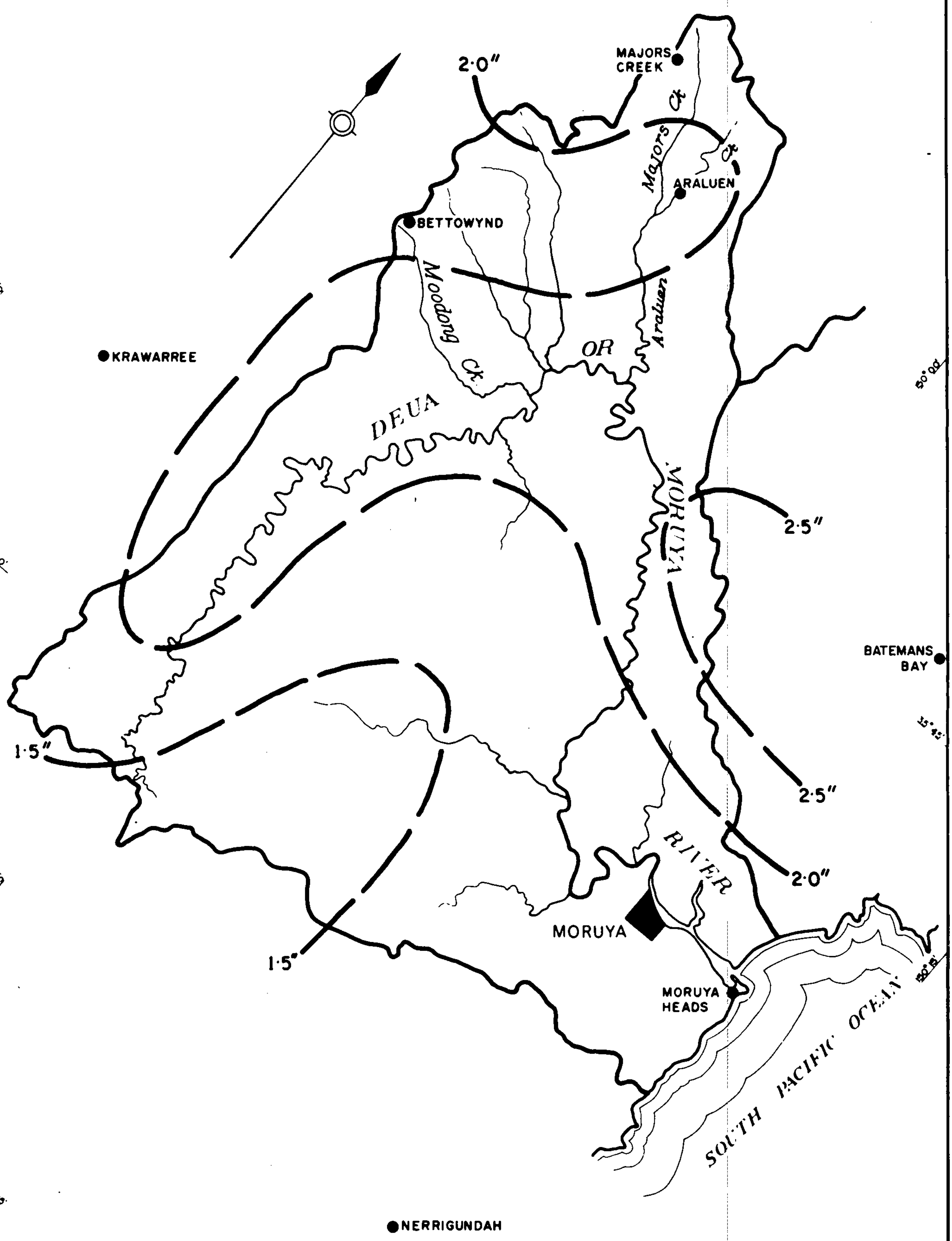
MORUYA RIVER VALLEY

MAY MEDIAN RAINFALL

SCALE

MILES 1 0 1 2 3 4 5 6 7 8 9 10 MILES

FIGURE 9



NEW SOUTH WALES

WATER CONSERVATION AND IRRIGATION COMMISSION

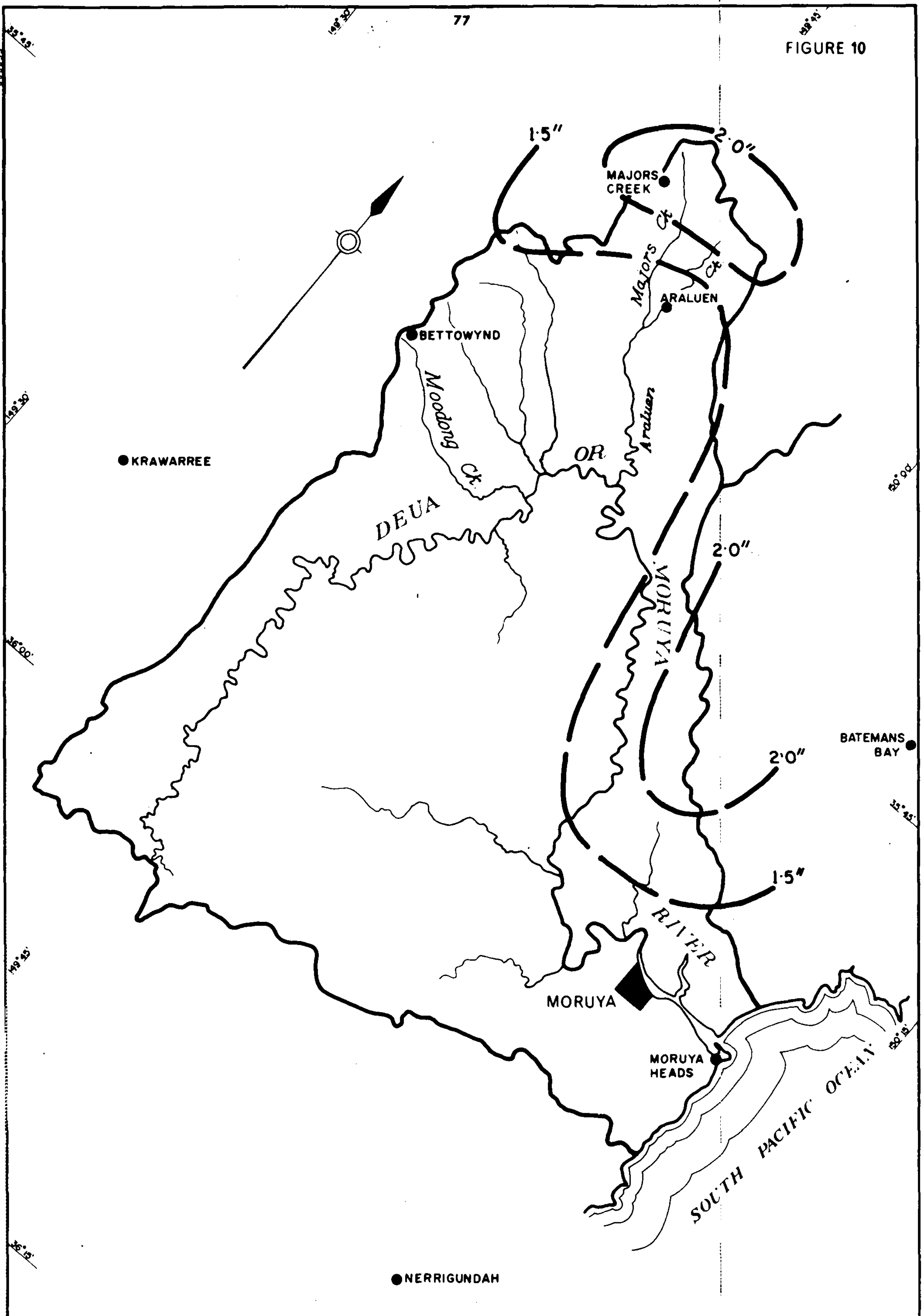
MORUYA RIVER VALLEY

JUNE MEDIAN RAINFALL

SCALE

MILES 1 0 1 2 3 4 5 6 7 8 9 10 MILES

FIGURE 10



NEW SOUTH WALES
WATER CONSERVATION AND IRRIGATION COMMISSION

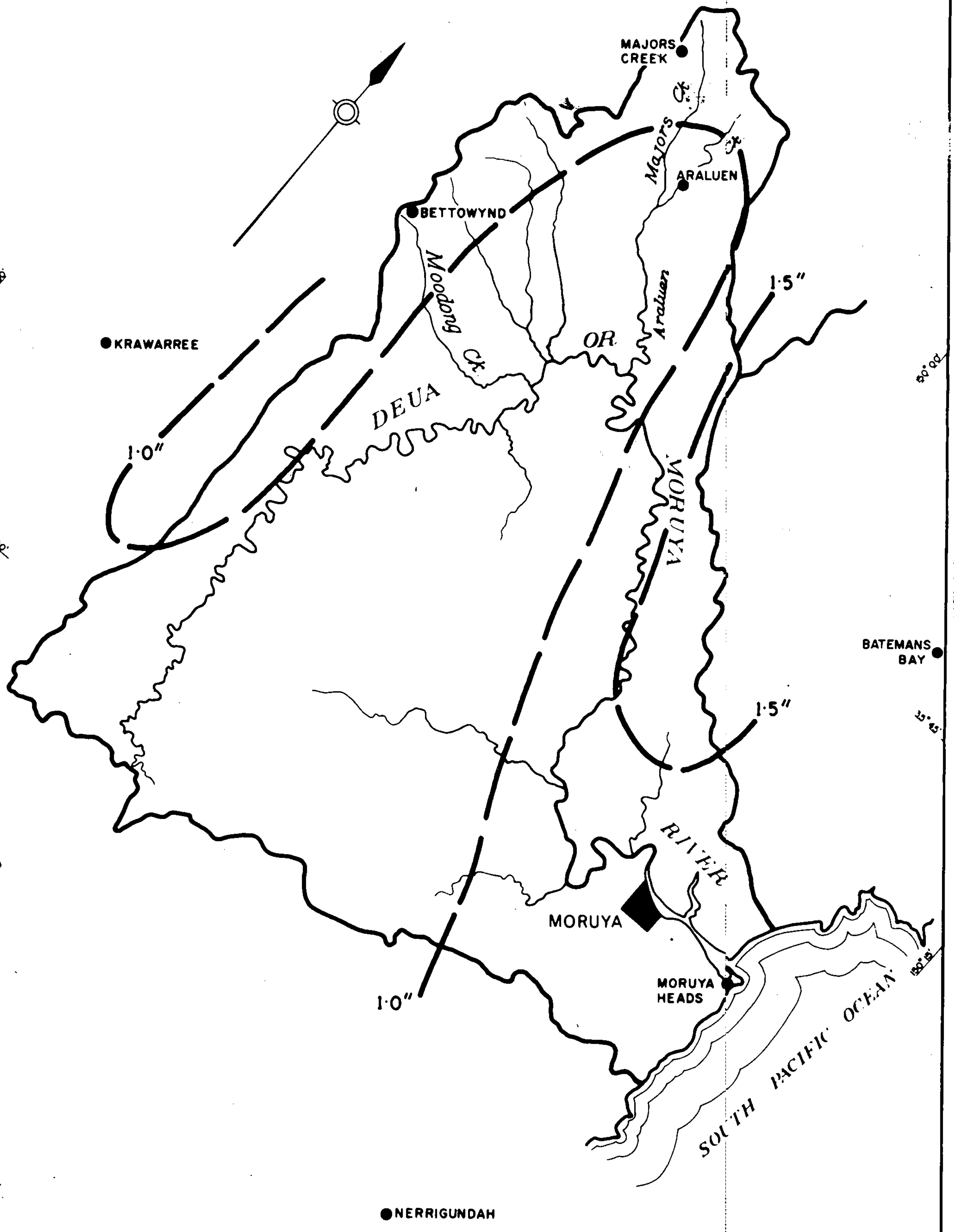
MORUYA RIVER VALLEY

JULY MEDIAN RAINFALL

SCALE

MILES 1 0 1 2 3 4 5 6 7 8 9 10 MILES

FIGURE 11



NEW SOUTH WALES
WATER CONSERVATION AND IRRIGATION COMMISSION

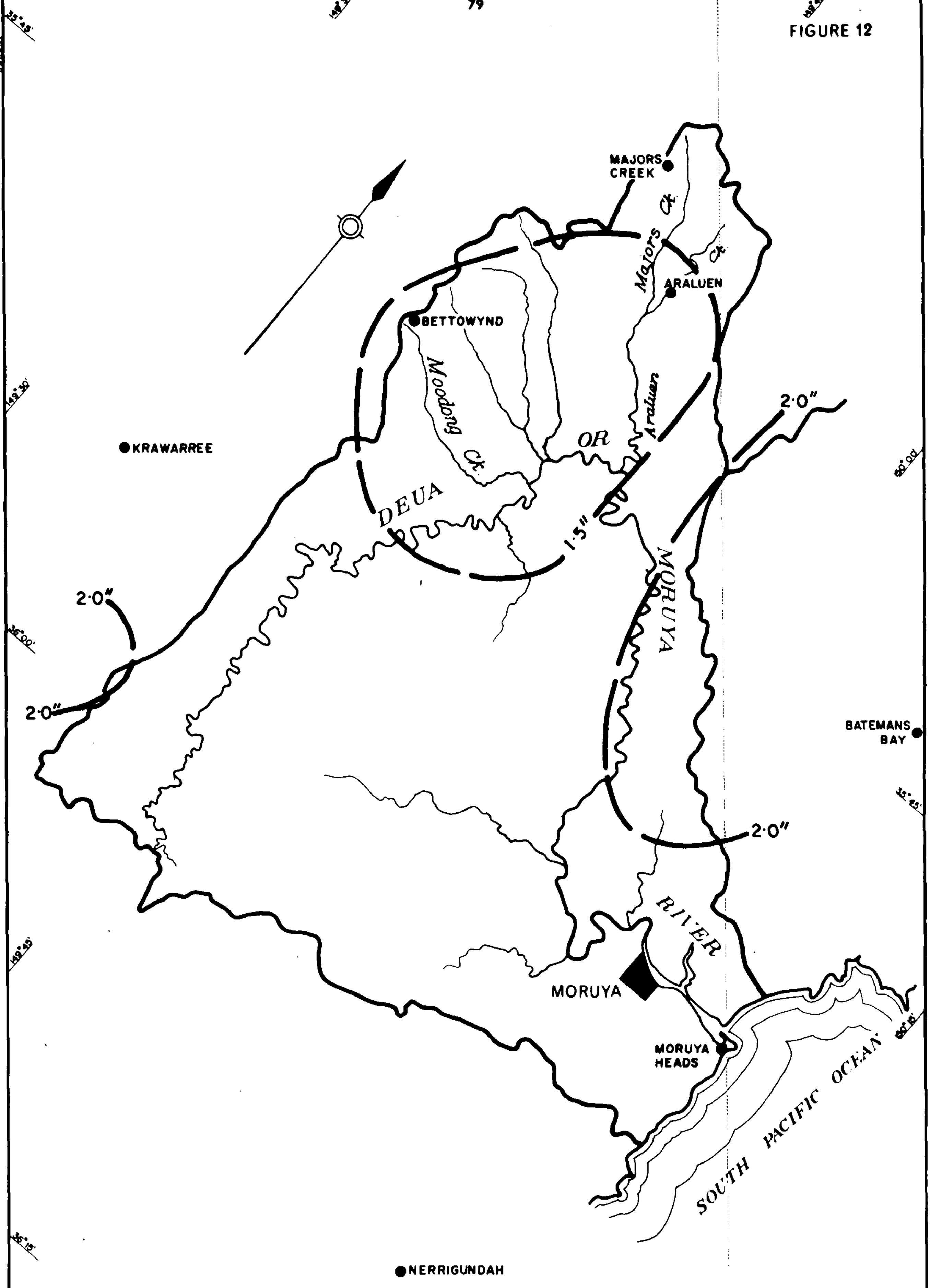
MORUYA RIVER VALLEY

AUGUST MEDIAN RAINFALL

SCALE

MILES 1 0 1 2 3 4 5 6 7 8 9 10 MILES

FIGURE 12



NEW SOUTH WALES

WATER CONSERVATION AND IRRIGATION COMMISSION

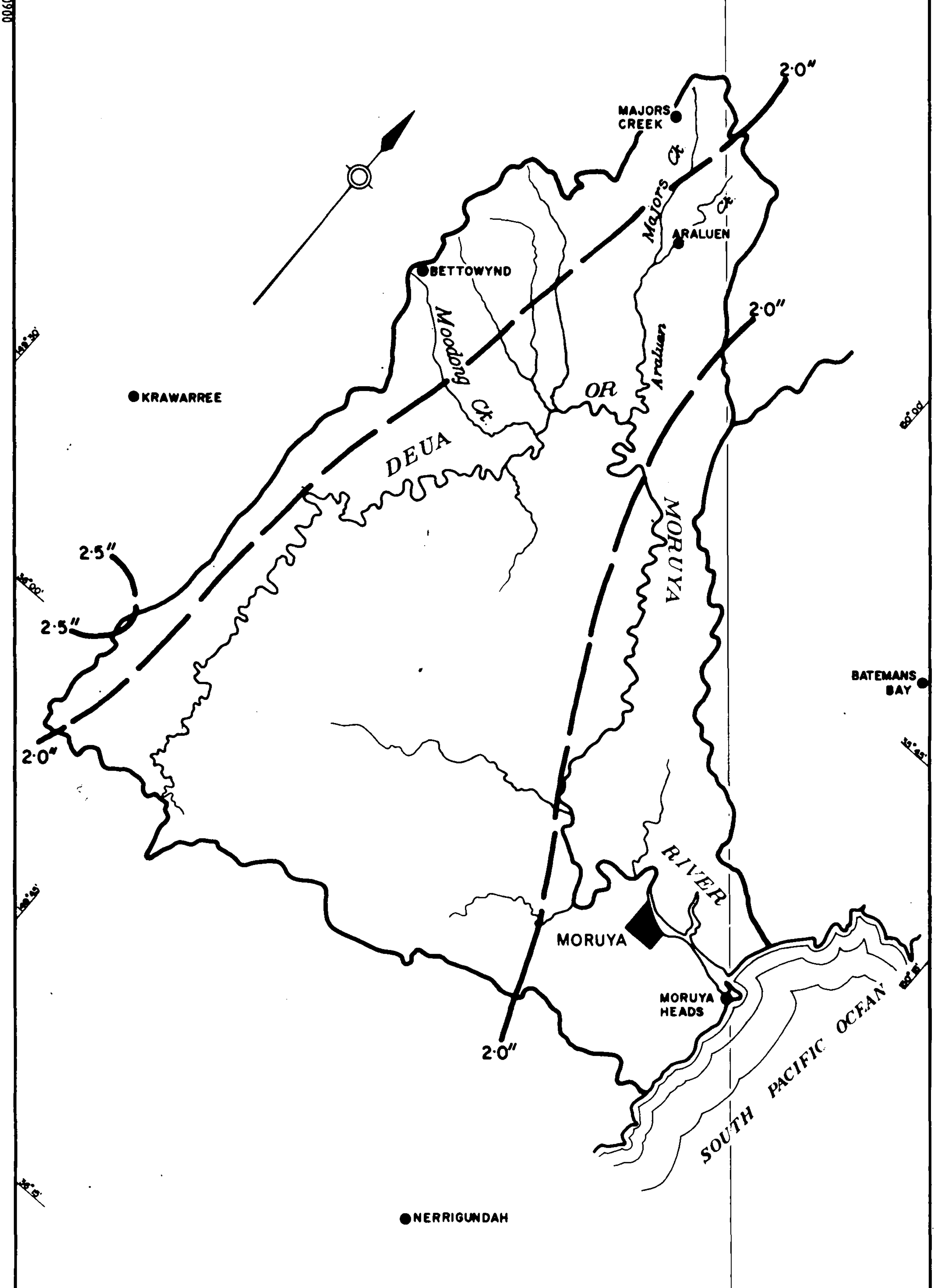
MORUYA RIVER VALLEY

SEPTEMBER MEDIAN RAINFALL

SCALE

MILES 1 0 1 2 3 4 5 6 7 8 9 10 MILES

FIGURE 13



NEW SOUTH WALES
WATER CONSERVATION AND IRRIGATION COMMISSION

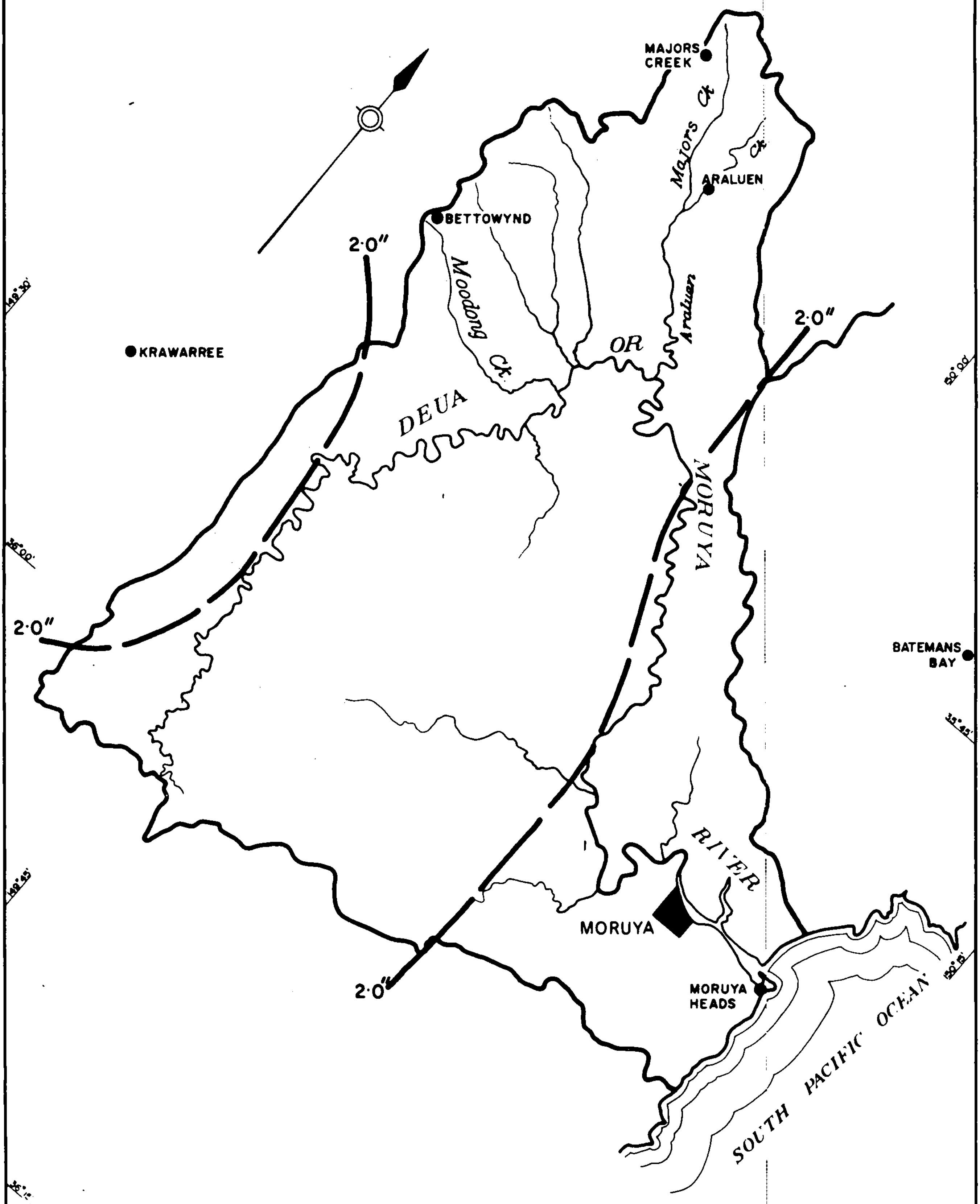
MORUYA RIVER VALLEY

OCTOBER MEDIAN RAINFALL

SCALE

MILES 1 0 1 2 3 4 5 6 7 8 9 10 MILES

FIGURE 14



NEW SOUTH WALES
WATER CONSERVATION AND IRRIGATION COMMISSION

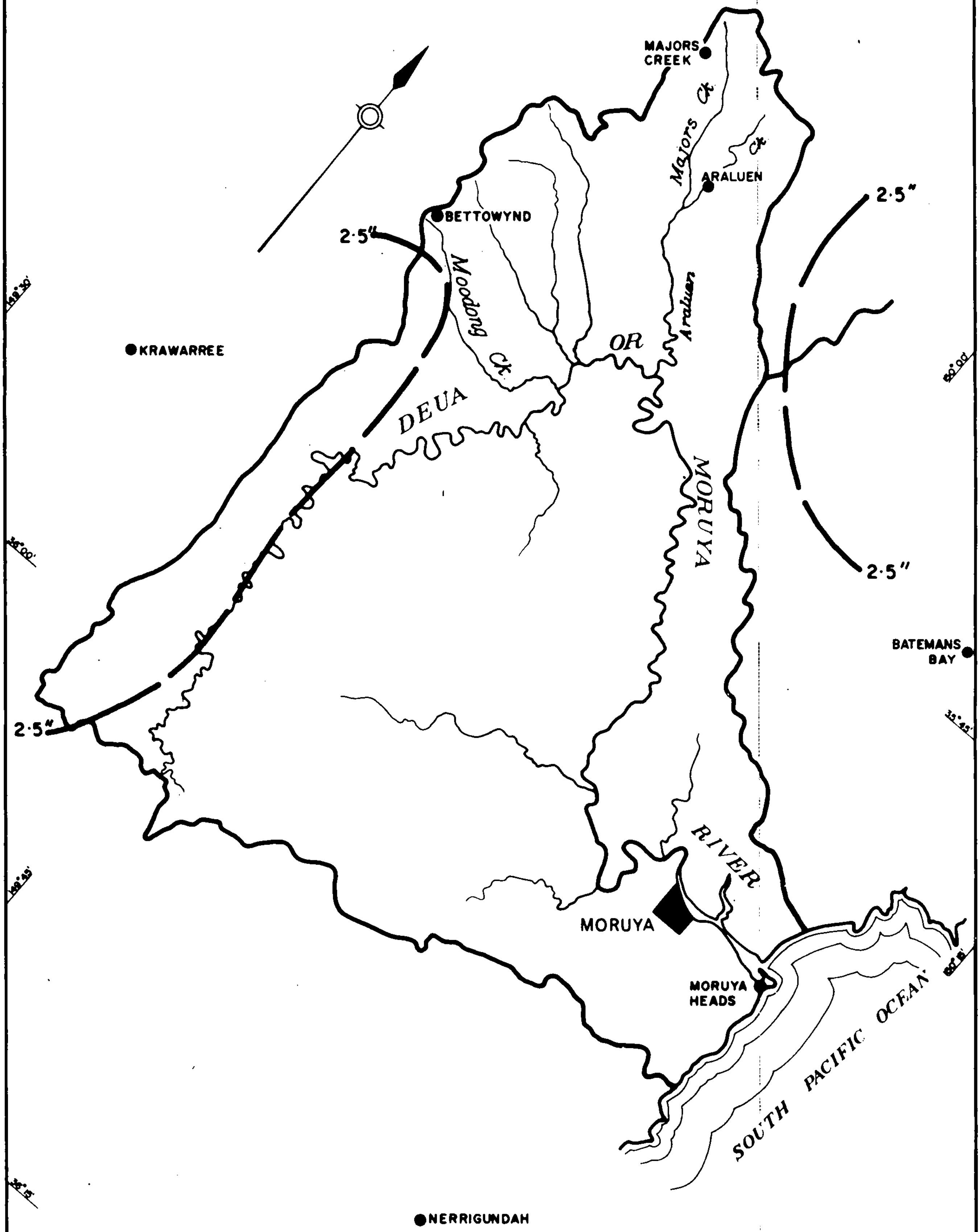
MORUYA RIVER VALLEY

NOVEMBER MEDIAN RAINFALL

SCALE

MILES 1 0 1 2 3 4 5 6 7 8 9 10 MILES

FIGURE 15



NEW SOUTH WALES
WATER CONSERVATION AND IRRIGATION COMMISSION

MORUYA RIVER VALLEY

DECEMBER MEDIAN RAINFALL

SCALE
MILES 1 0 1 2 3 4 5 6 7 8 9 10 MILES

FIGURE 16

NEW SOUTH WALES
WATER CONSERVATION AND IRRIGATION COMMISSION

MORUYA RIVER VALLEY GEOLOGICAL FORMATIONS

SCALE

Miles 2 1 0 2 4 6 Miles

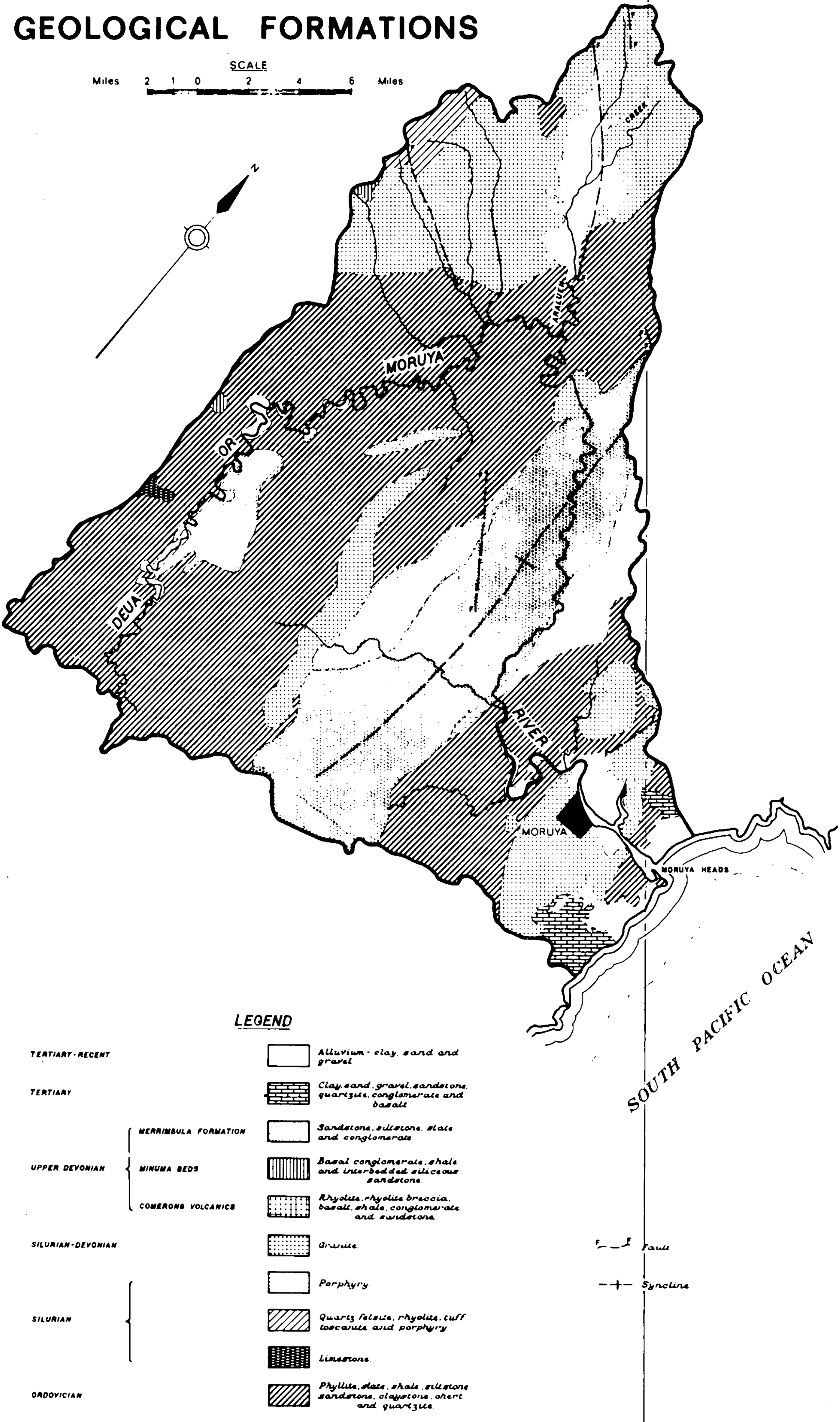
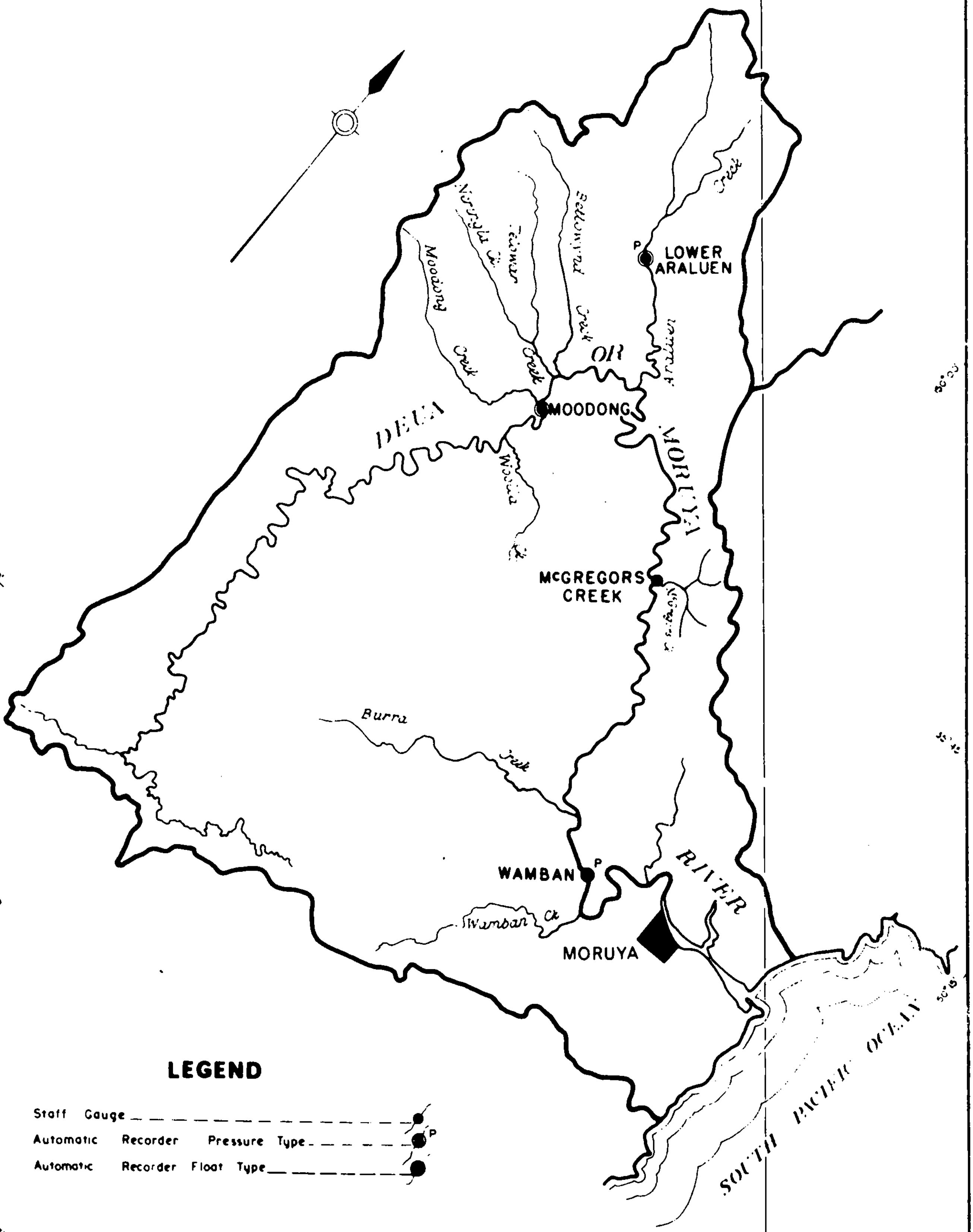


FIGURE 17



NEW SOUTH WALES
WATER CONSERVATION AND IRRIGATION COMMISSION

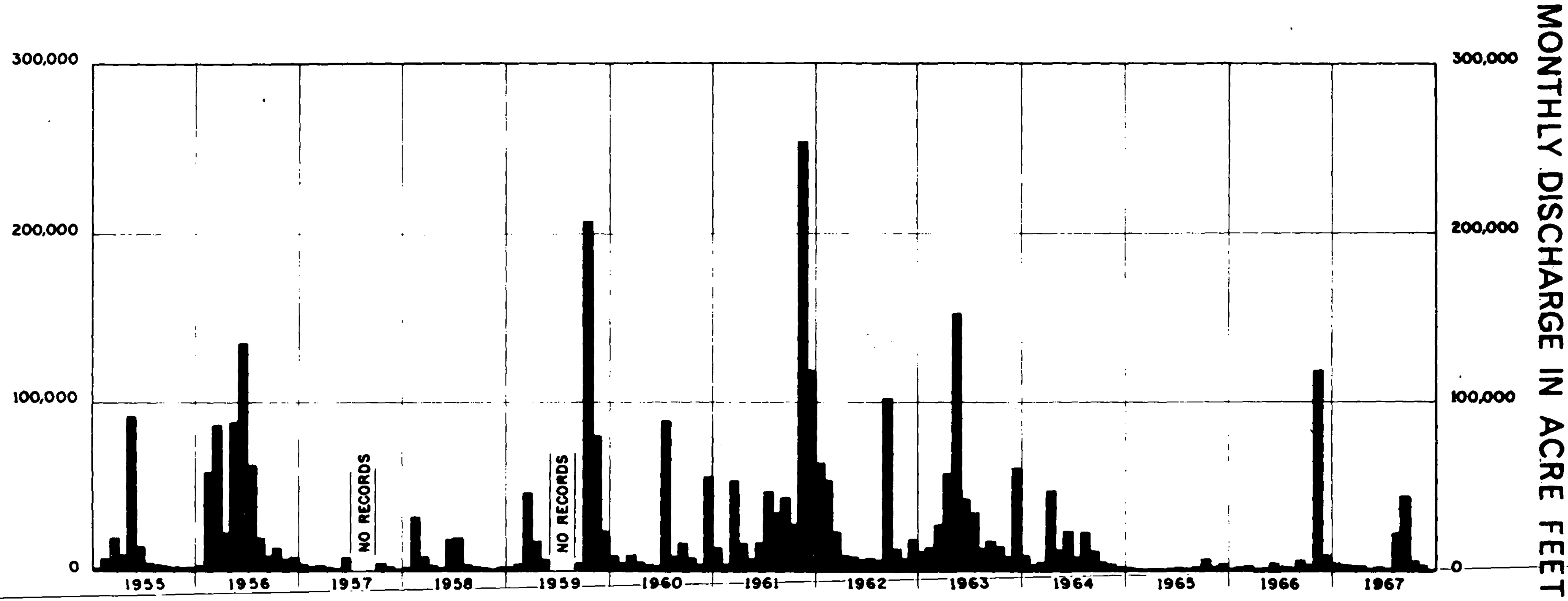
MORUYA RIVER VALLEY
GAUGING STATIONS

31st December 1969

SCALE

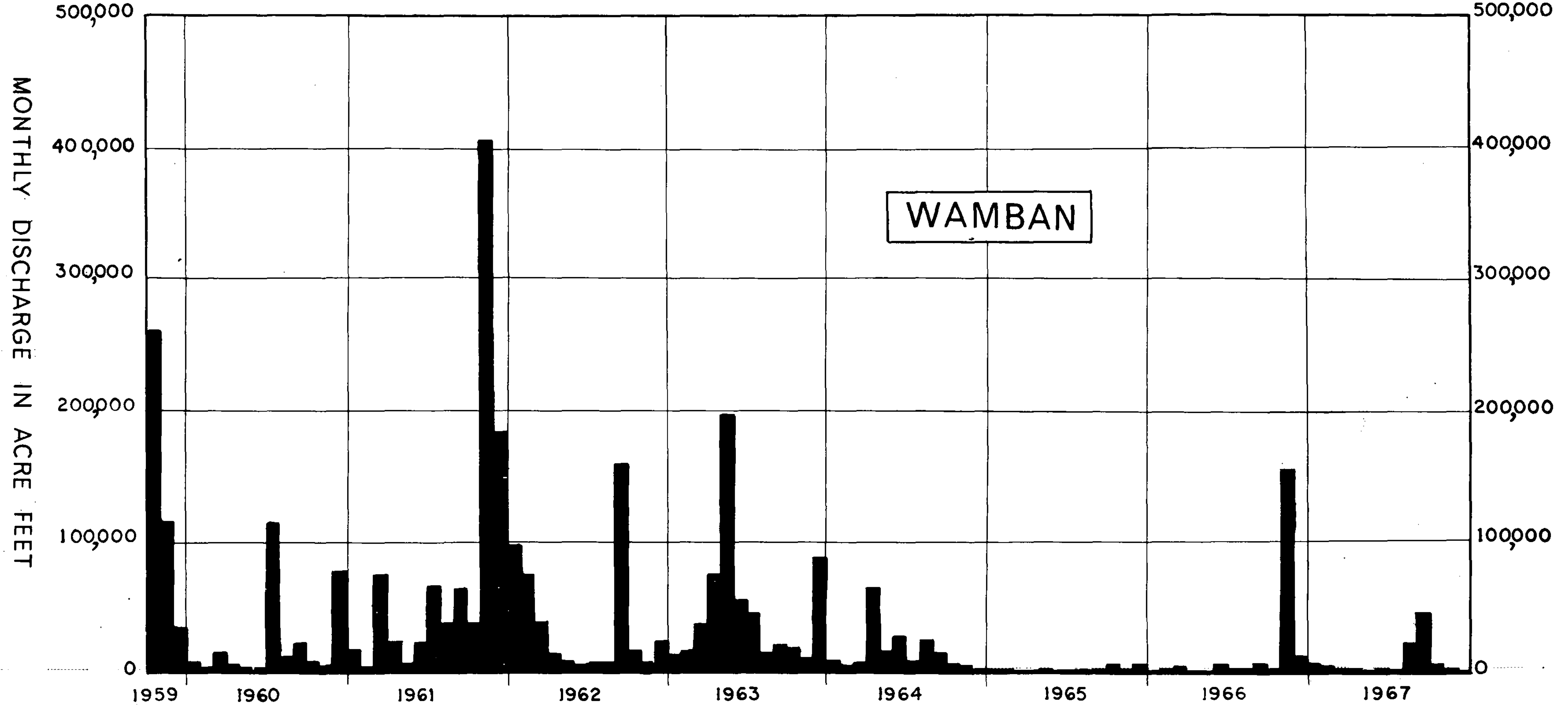
MILES 1 0 1 2 3 4 5 6 7 8 9 10 MILES

006012



HYDROGRAPH OF MONTHLY DISCHARGE
MORUYA RIVER AT McGREGORS CREEK

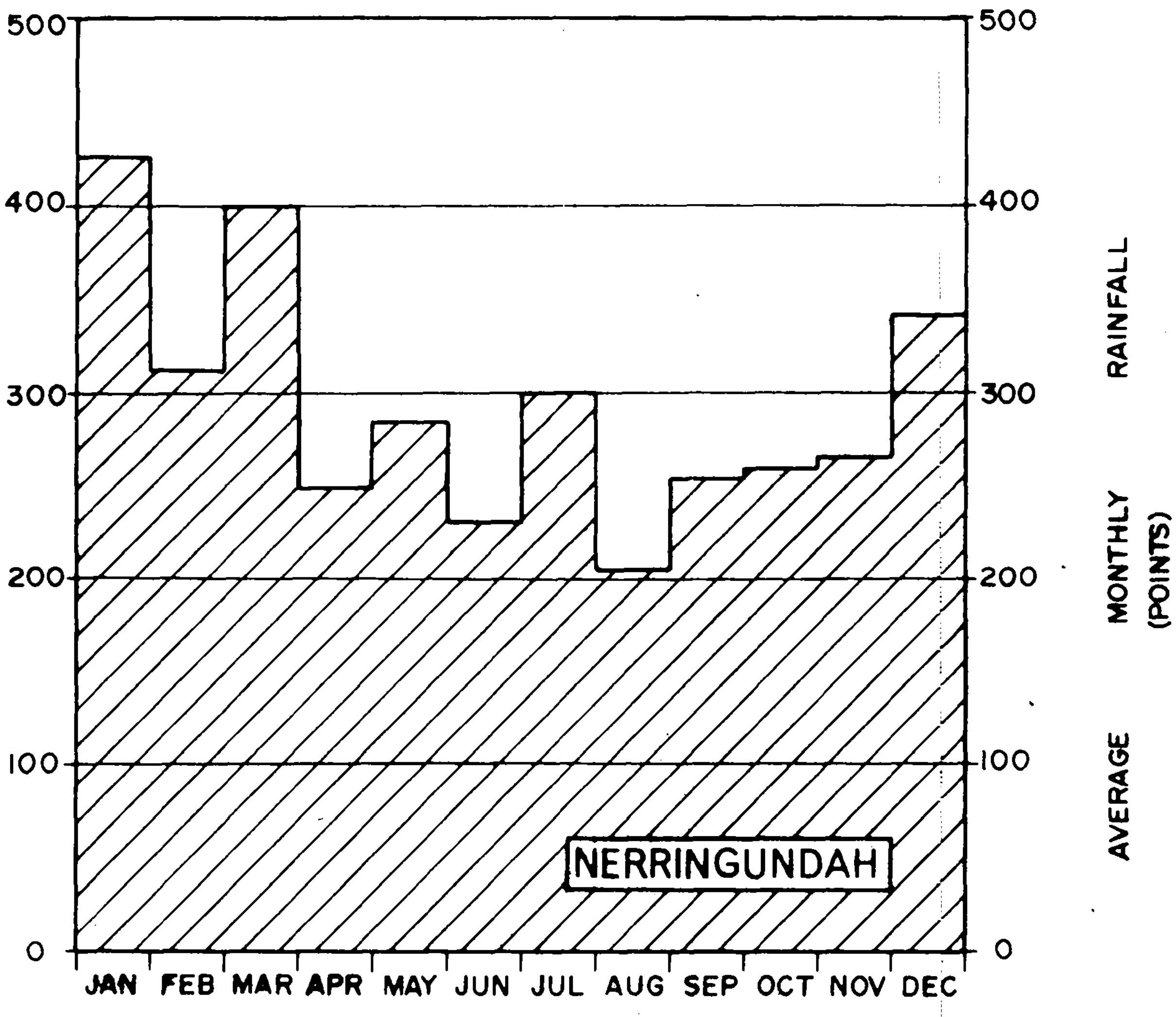
FIGURE 18



HYDROGRAPH OF MONTHLY DISCHARGES
MORUYA RIVER AT WAMBAN

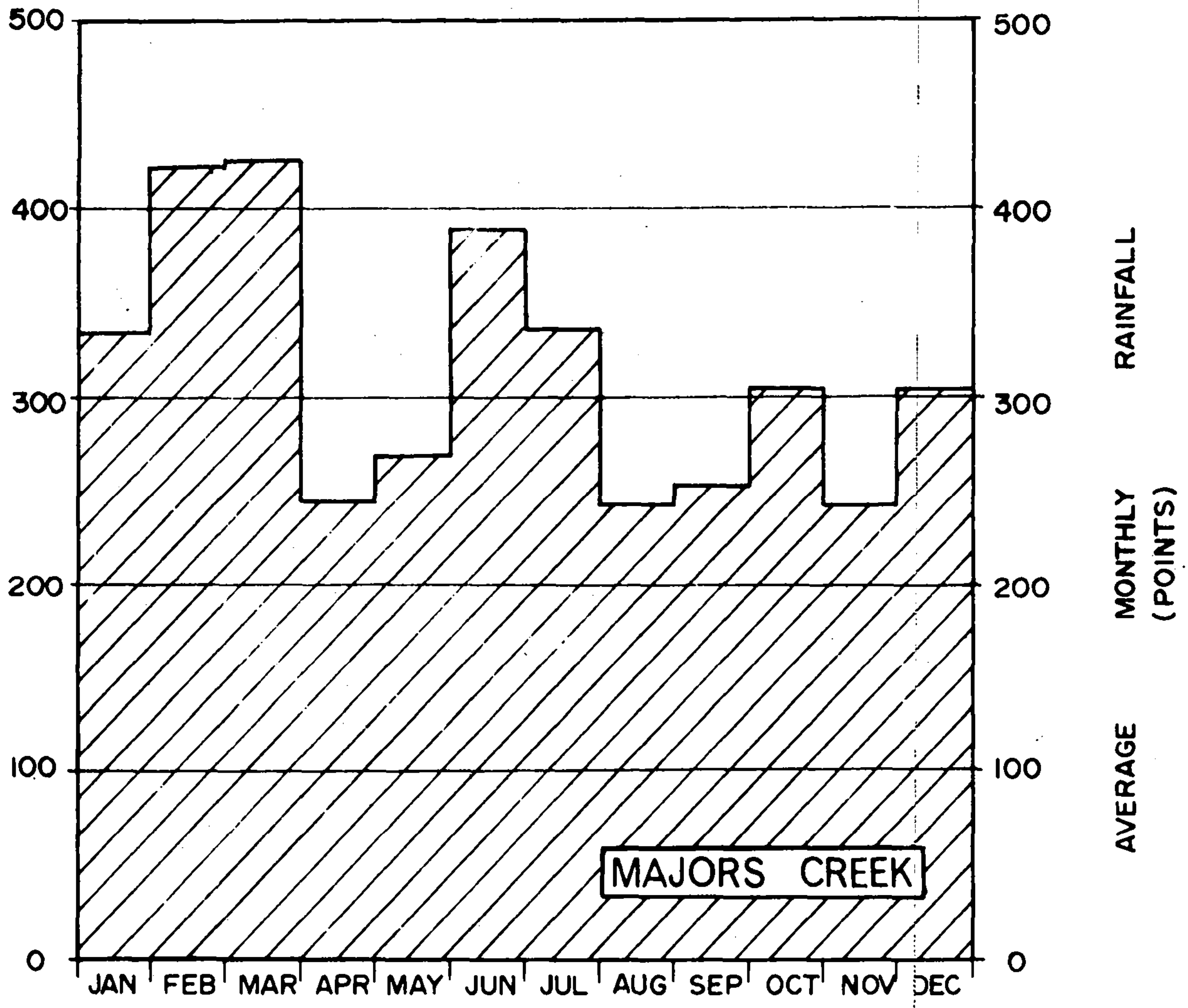
FIGURE 19

FIGURE 20

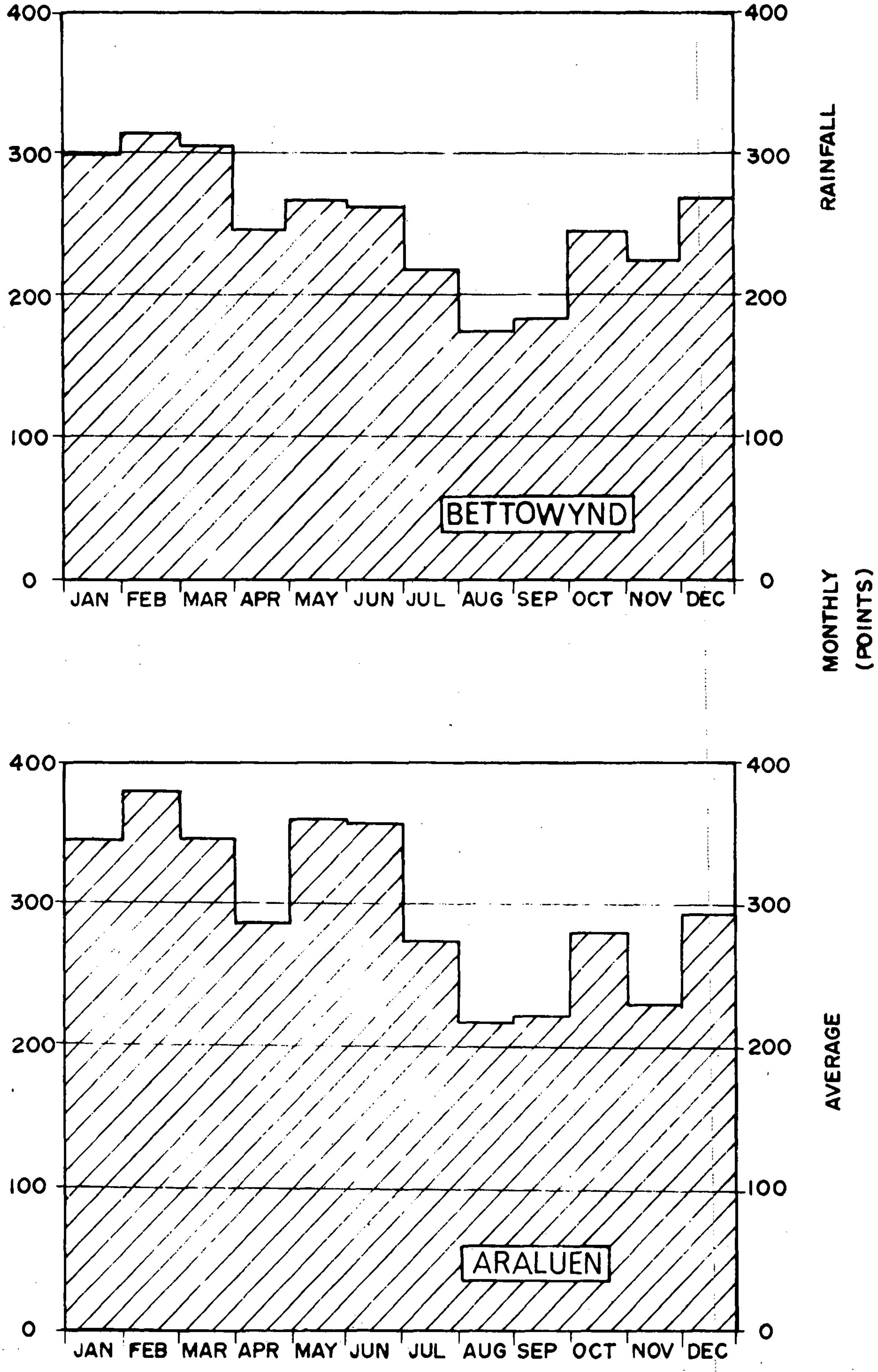


DISTRIBUTION OF AVERAGE MONTHLY RAINFALLS AT NERRINGUNDAH

FIGURE 21

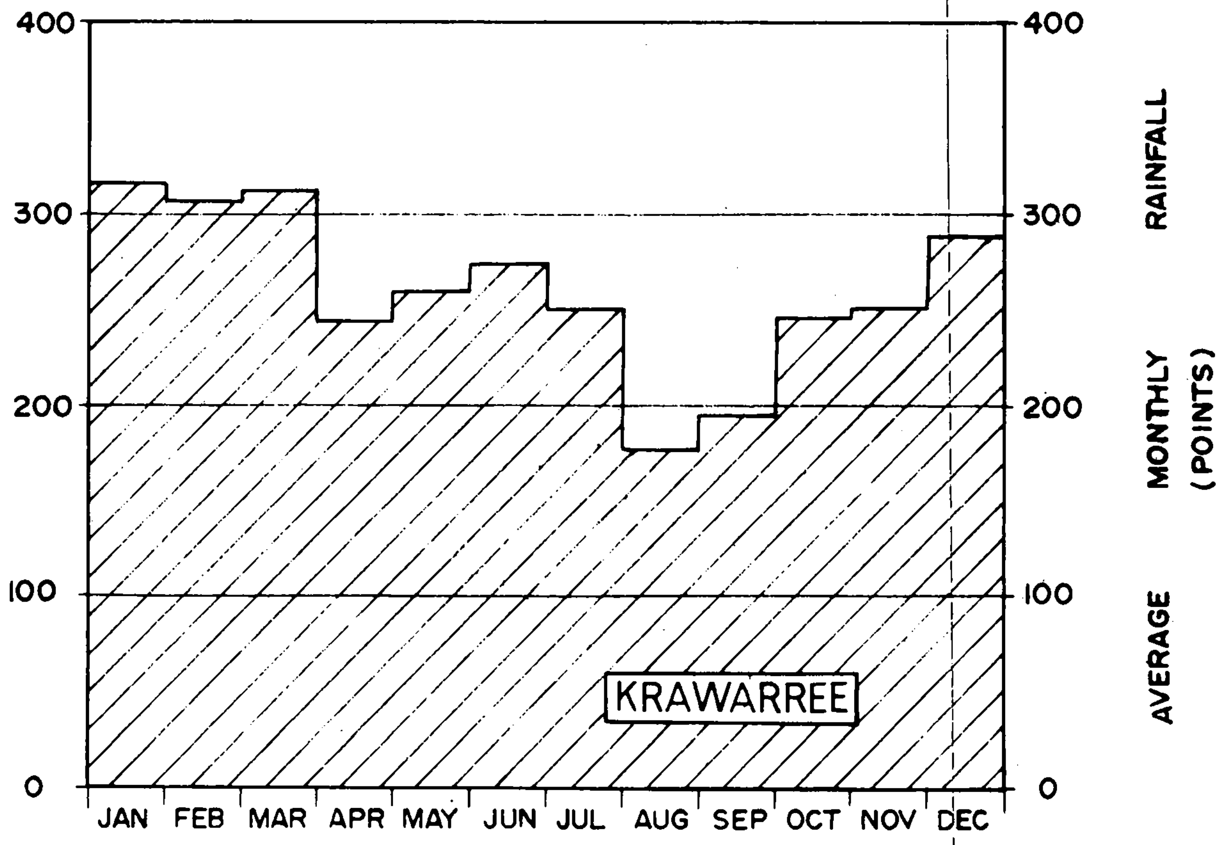


DISTRIBUTION OF AVERAGE MONTHLY RAINFALLS AT MAJORS CREEK



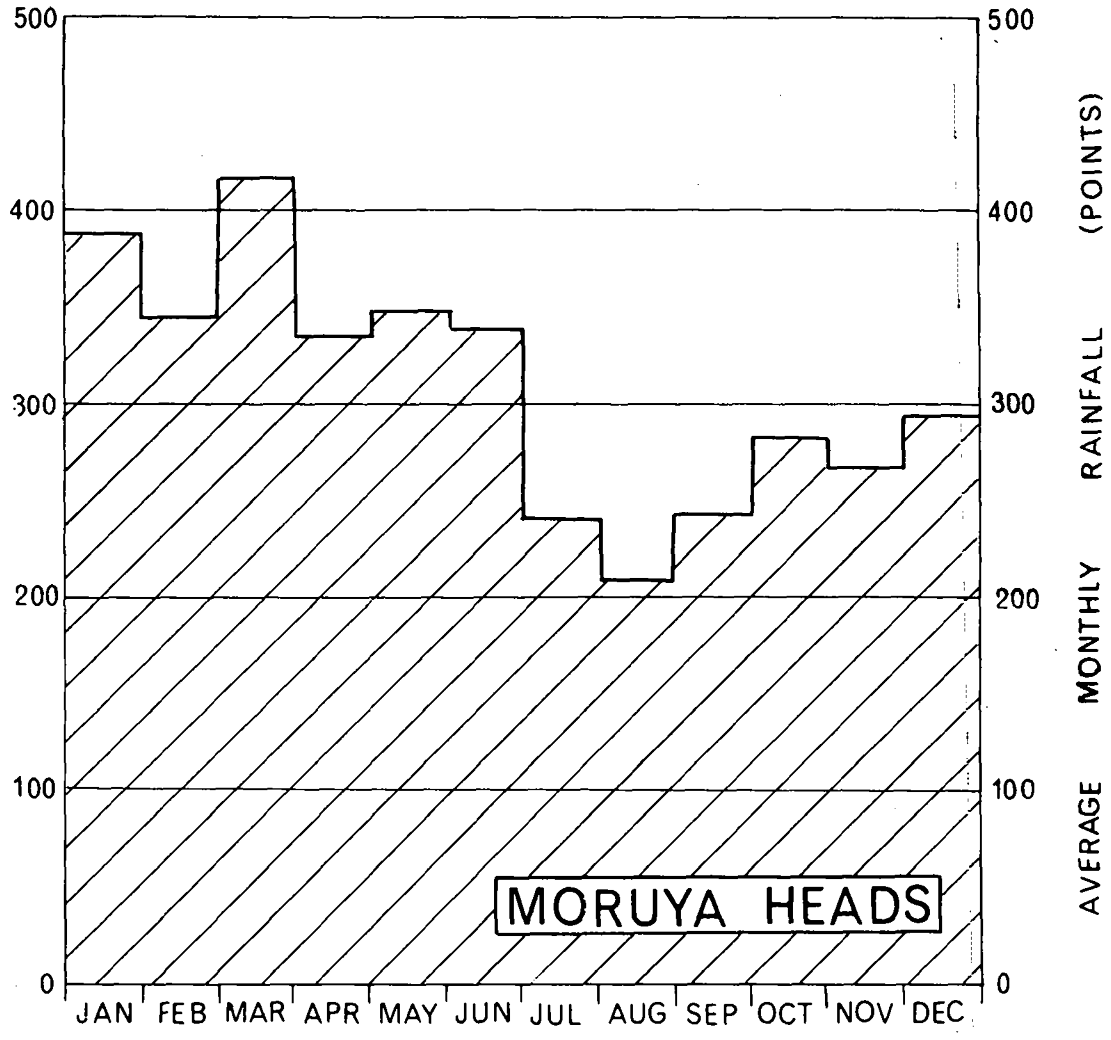
DISTRIBUTION OF AVERAGE MONTHLY RAINFALLS AT BETTOWYND AND ARALUEN

FIGURE 23



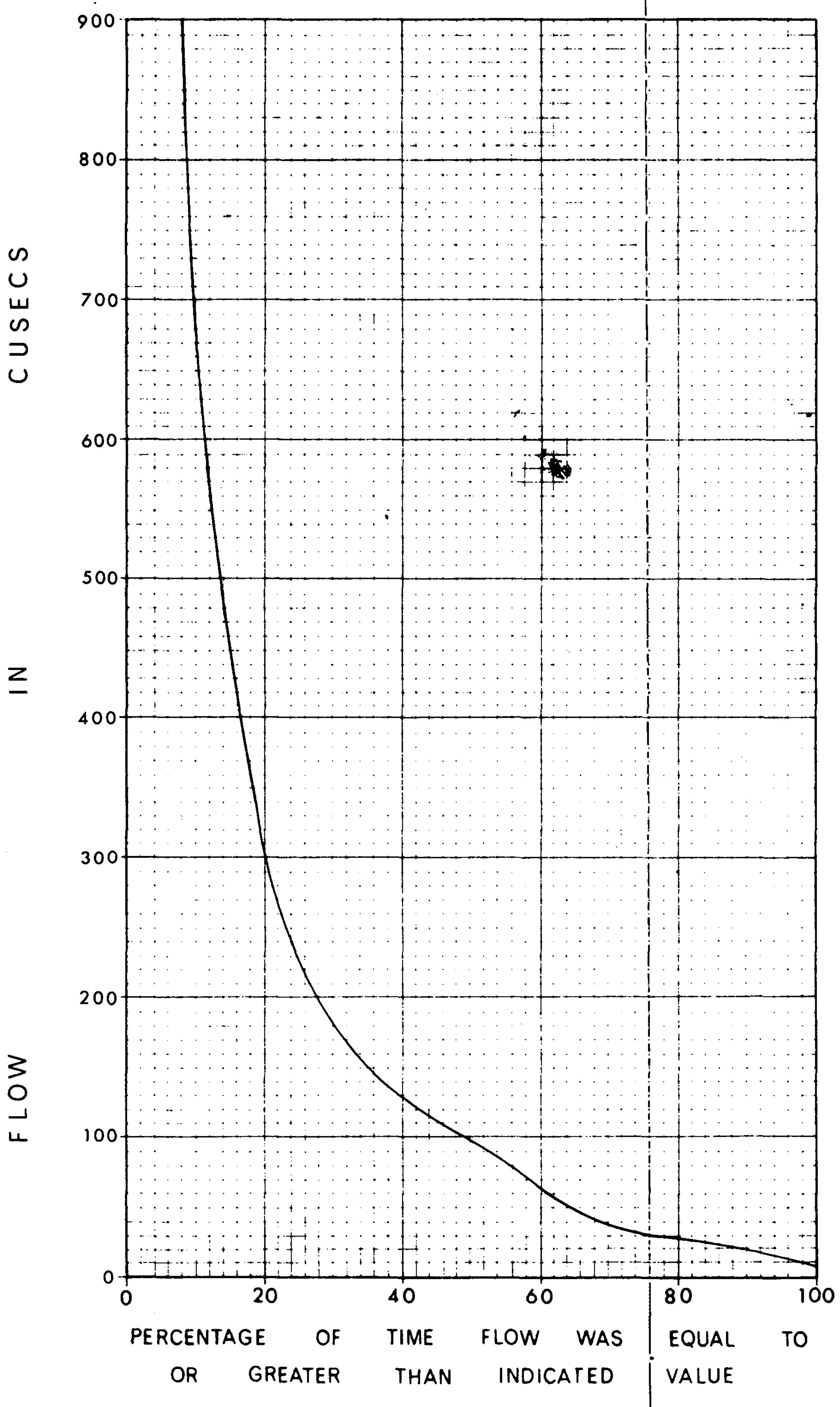
DISTRIBUTION OF AVERAGE MONTHLY RAINFALLS AT KRAWARREE

FIGURE 24



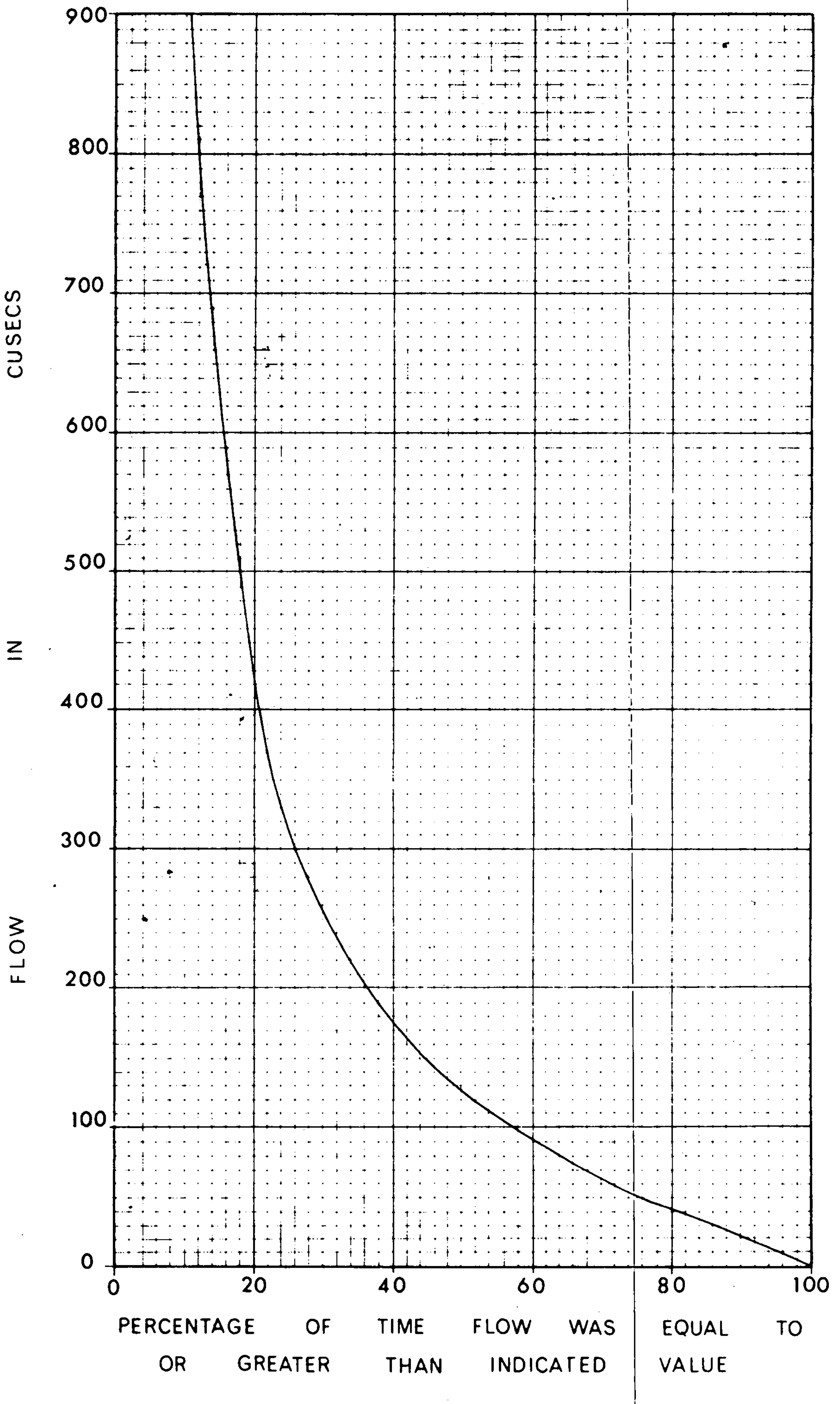
DISTRIBUTION OF AVERAGE MONTHLY RAINFALLS AT MORUYA HEADS

FIGURE 25



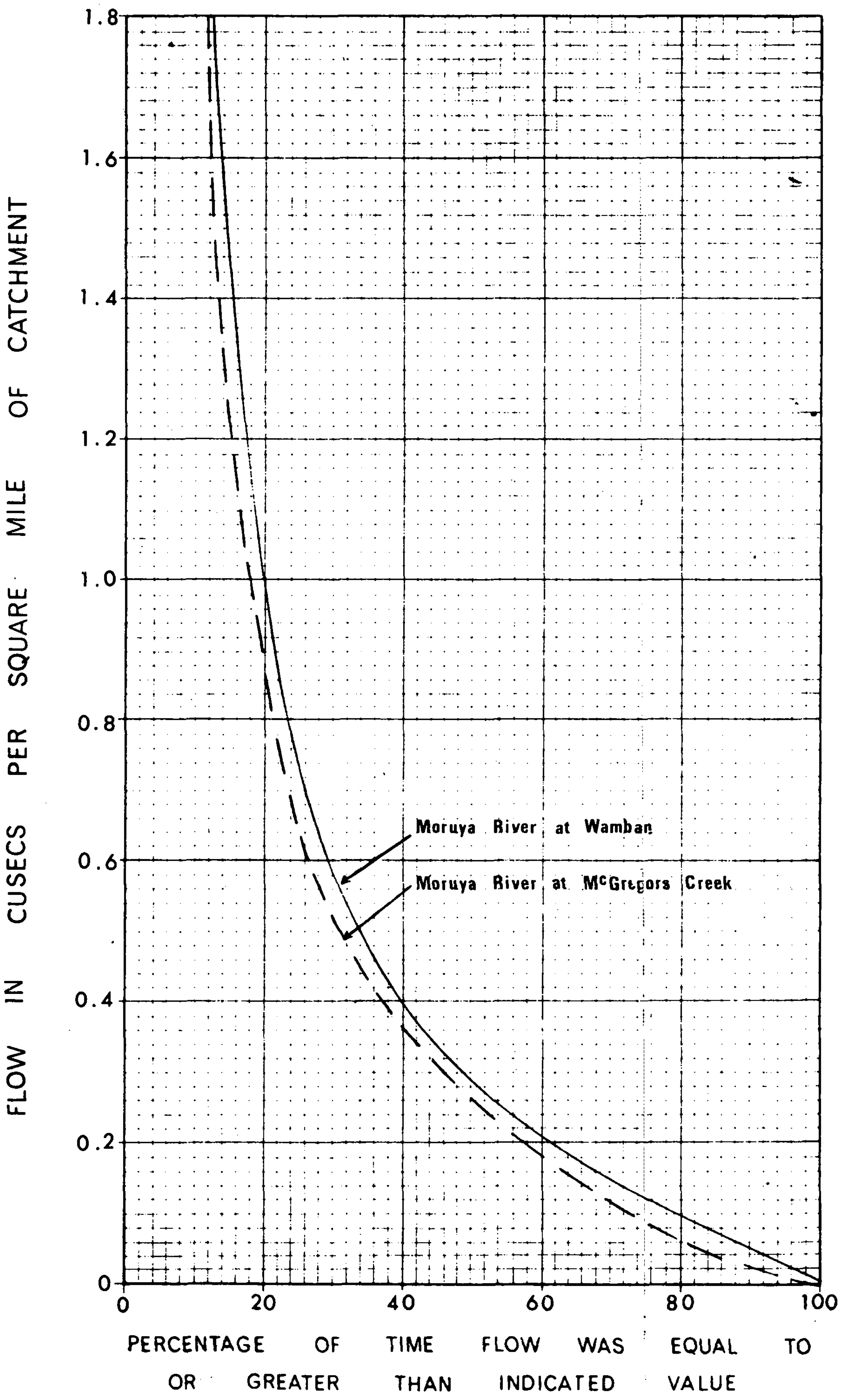
FLOW DURATION CURVE FOR MORUYA RIVER AT Mc GREGORS CREEK

FIGURE 26



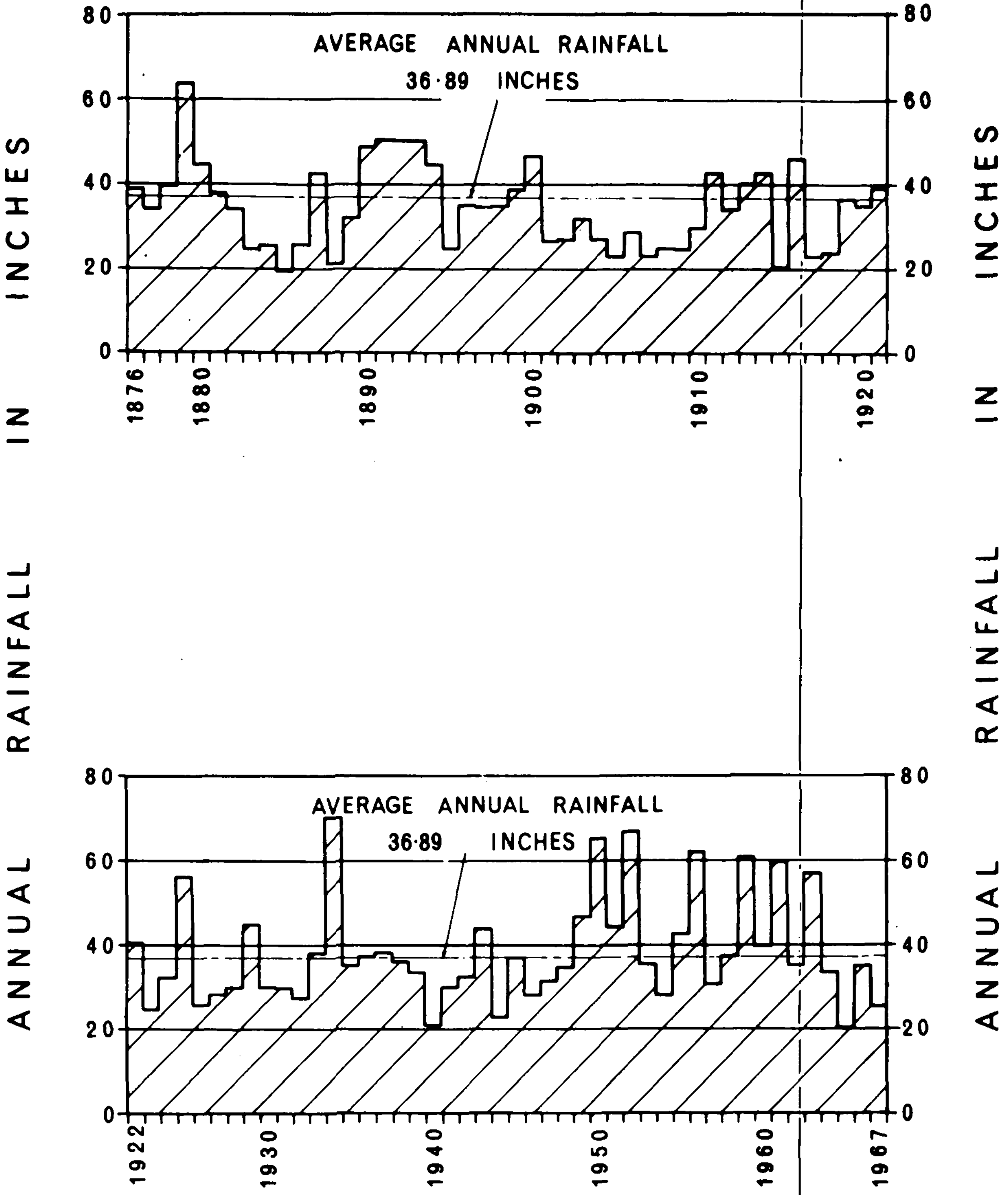
FLOW DURATION CURVE FOR MORUYA RIVER AT WAMBAN

006014



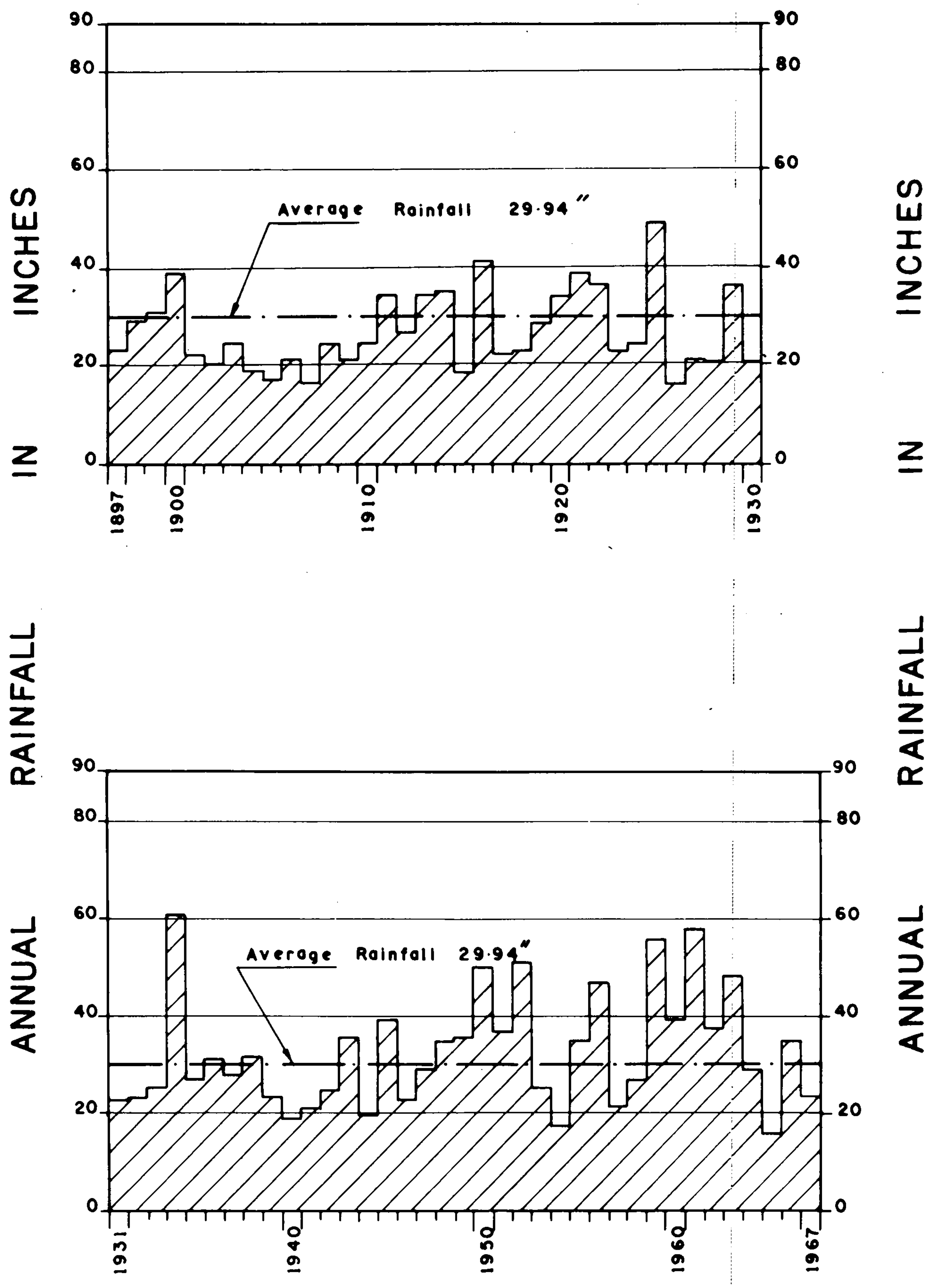
FLOW DURATION CURVE FOR MORUYA RIVER VALLEY

FIGURE 28



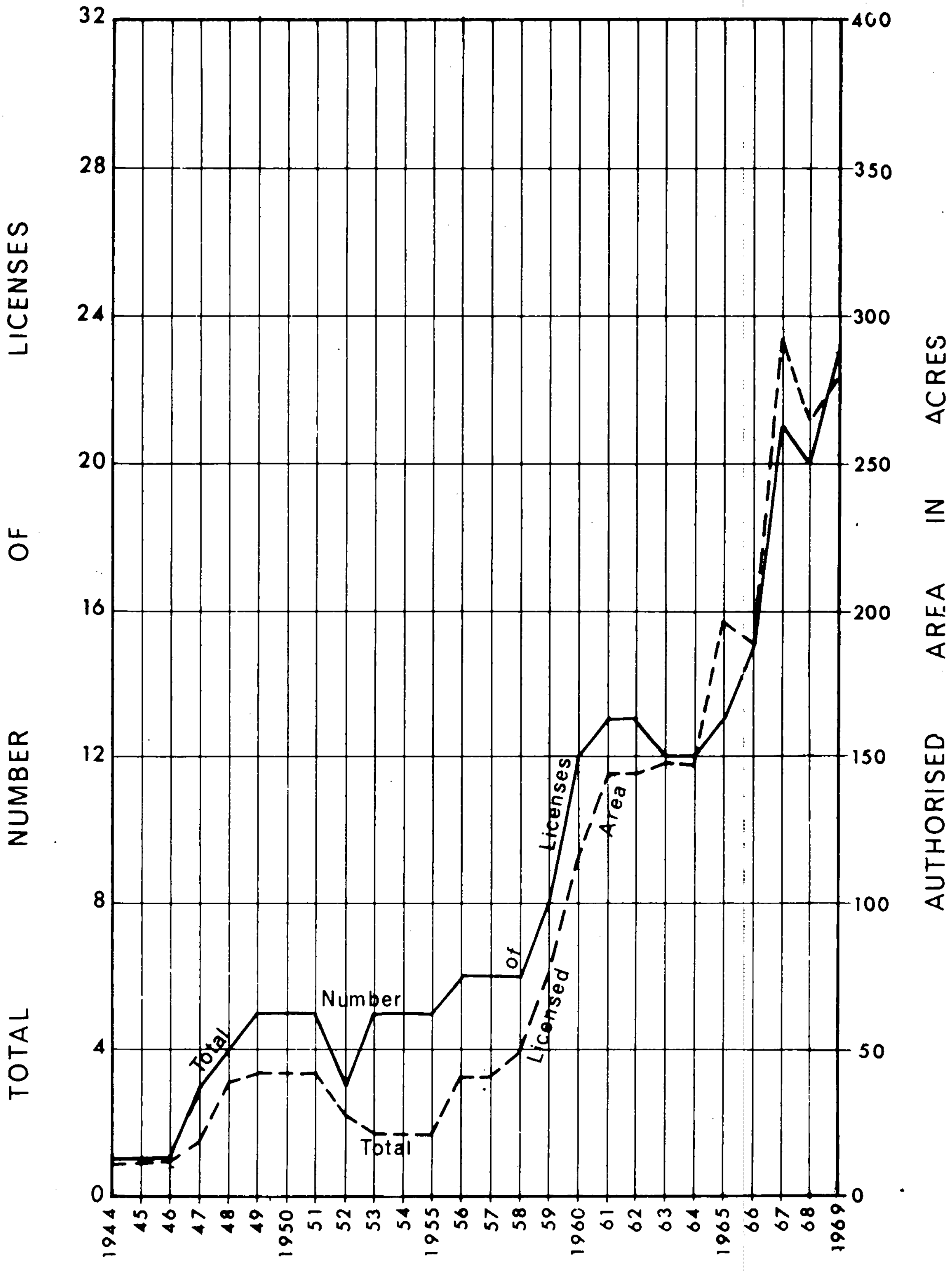
ANNUAL RAINFALL AT MORUYA HEADS

FIGURE 29



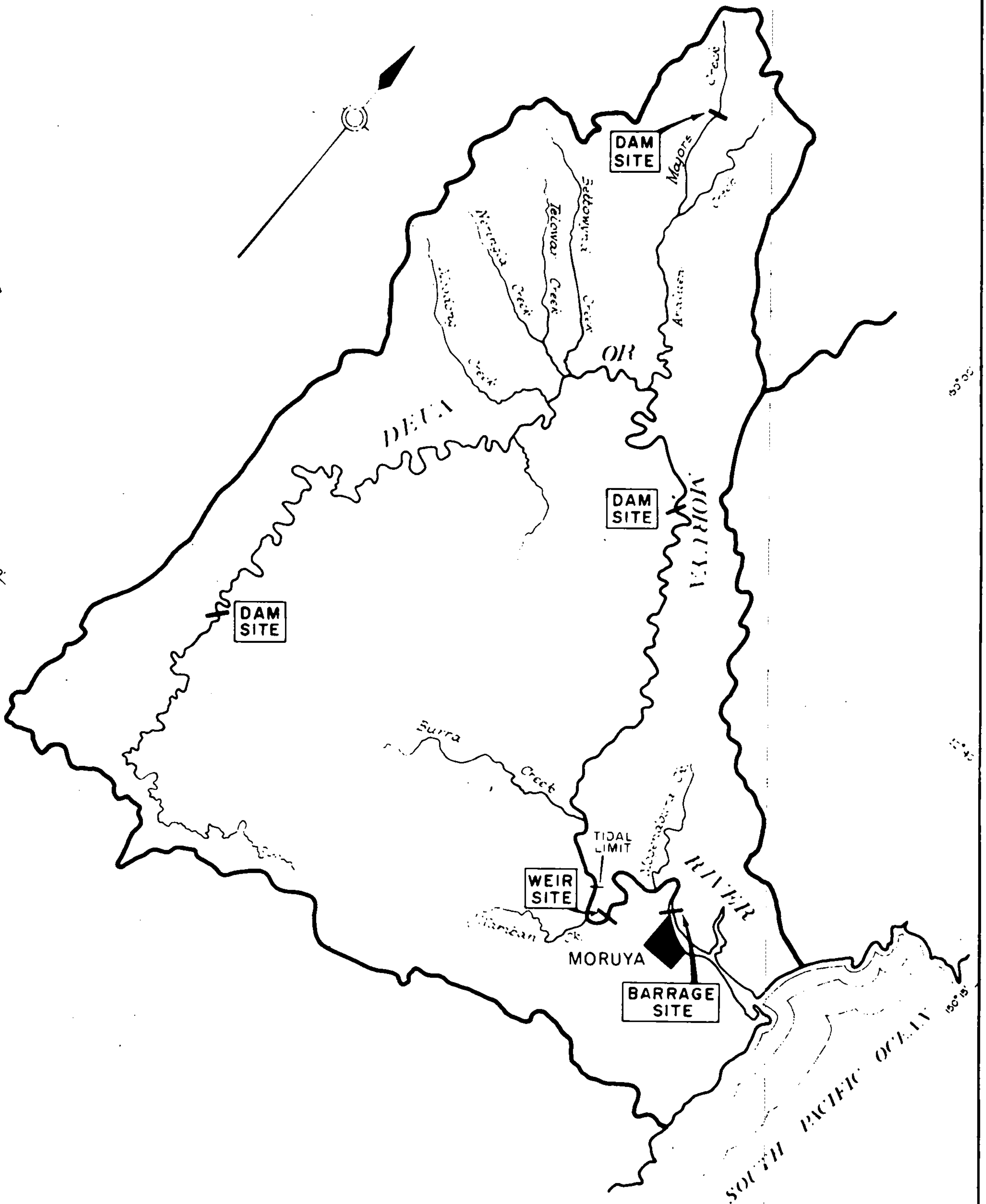
ANNUAL RAINFALL AT BETTOWYND

FIGURE 30



MORUYA RIVER VALLEY
AREA AUTHORISED FOR IRRIGATION
AND TOTAL NUMBER OF LICENSES AT
30th JUNE FOR EACH YEAR INDICATED

FIGURE 31



NEW SOUTH WALES
WATER CONSERVATION AND IRRIGATION COMMISSION

MORUYA RIVER VALLEY

BARRAGE, WEIR AND DAM SITES

SCALE

MILES 1 0 1 2 3 4 5 6 7 8 9 10 MILES