WATER RESOURCES

OF THE

TOWAMBA AND GENOA VALLEYS

SURVEY OF THIRTY N.S.W. RIVER VALLEYS

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WATER RESOURCES OF THE TOWAMBA AND GENOA VALLEYS

PREFACE

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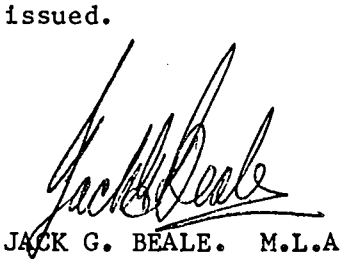
In accordance with the policy of the New South Wales Liberal-Country Party Government announced prior to its election to office at the May, 1965 State Elections, I directed the Water Conservation and Irrigation Commission to undertake a survey of the State's water resources on an individual valley basis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

The survey, which will be completed this year, involves the preparation of twenty five separate reports covering thirty major river valleys of the State and represents the largest and most comprehensive study of its type ever undertaken in Australia.

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 thirteen valleys. This report on the water resources of the Towamba and Genoa Valleys is the tenth to be issued.



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February, 1968.

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WATER RESOURCES OF THE TOWAMBA AND GENOA RIVER VALLEYS

1. INTRODUCTION

Reliable and adequate water supplies are required by mankind, not only for continued agricultural and industrial development, but for its very existence.

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.

The major part of water on Earth is contained in oceans, polar icecaps and underground resources and it has been estimated that only 0.004 percent of the total volume is contained as fresh water in lakes and streams. Furthermore the available fresh water resources are remarkably variable; river flows may vary from zero in drought periods to extremely high discharges during floods. In addition water resources are not evenly distributed over land areas, a significant proportion of this resource being located in remote, undeveloped areas.

The water resources of a continent therefore vary substantially with time and are usually unevenly located over the land areas. The aim of water conservation works is to reduce these variations by providing storage during flood periods for release during droughts and by constructing distribution works to supply flows to areas remote from river systems.

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.

In addition to the low average runoffs the prolonged duration of severe droughts and the extreme variability of flows in Australian streams makes it imperative that water conservation dams be constructed if assured water supplies are to be maintained over the full period of each drought.

Proper use of water resources is obviously of major importance to the national prosperity, the welfare of the community depending to a large extent on water resources development. Water conservation in Australia is therefore a service of prime national importance, increasing living standards and the overall national wealth.

A modern community makes heavy demands on water for domestic, industrial and agricultural purposes. While man's absolute minimum daily requirement is less than one gallon per day, the average per capita consumption in a large modern city may be of the order of 300 gallons per day. However, it should be noted that the per capita consumption figures may be somewhat misleading in that demands due to industry, home gardens, public parks and community services such as hospitals are included in computing the overall average.

Nevertheless certain industrial and other demands can be comparatively high. It requires about 300 tons of water to make a ton of steel, 2½ tons of water to grow the grain and produce a loaf of bread and over thirty tons of water to produce a normal daily diet for an adult.

Irrigation requirements are even higher than industrial demands. The overall annual water requirement of a crop is usually of the order of two to three feet and during a drought it may be necessary to provide a major proportion of this demand by irrigation. The relative magnitude of this requirement can be assessed when it is realised that a depth of three feet over an area of only one acre is equivalent to over 800,000 gallons (more than 3,500 tons).

The average annual surface water resources of the Towamba and Genoa River Valleys have been assessed as averaging about 400,000 acre feet and 360,000 acre feet respectively. The average annual rainfall over both of the valleys is about 32 inches and the surface water resources are equivalent to runoffs of about 26 percent for the Towamba Valley and 27 percent for the Genoa Valley.

On a square mile of catchment area basis the surface water resources of both the Towamba and Genoa River Valleys are nearly five times the average for New South Wales and are equivalent to about 15 percent greater than the average for coastal basins in the State.

2. PHYSIOGRAPHIC FEATURES.

The catchment areas of the Towamba and Genoa River Valleys, as adopted for the purposes of this report, are indicated at Figure 1, the total areas being about 880 square miles and about 800 square miles for the Towamba and Genoa Valleys respectively.

In the 1963 publication "Review of Australia's Water Resources" the catchment area of the Towamba River Valley was given at 850 square miles. This area, however, referred to that part of the valley within New South Wales and did not include some minor areas of the catchment within Victoria.

The Towamba and Genoa Valleys are bounded on the north by the Bega River Valley, on the west by the central eastern section of the Snowy River Valley and on the south west by the Cann and Thurra River Valleys.

The Towamba River rises in rugged country at elevations of over 3,000 feet above sea level about ten miles east of Bombala. The river travels in a south easterly direction, being joined by Stockyard and Basin Creeks on the right bank near Rocky Hall and by the Mataganah River and New Station and Scotcheys Creeks on the left bank. With the exception of a small undulating plateau area to the north of Stockyard Creek and alluvial areas along the creeks, the catchment of the Towamba River above Burragate is comprised of mountainous terrain.

The Wog Wog River rises in elevated mountainous country to the west of Burragate and travels in an easterly direction through mountainous terrain to join the Towamba River about four miles west of Towamba.

Between Burragate and Towamba, steep country prevails on the right bank of the Towamba River and undulating terrain extends for about two miles from the left bank. Although alluvial flats occur between Towamba and the tidal limit at Kiah the remainder of the Towamba River catchment consists of rugged mountainous country.

The major coastal rivers in the northern section of the Towamba Valley are the Pambula River and the Yowaka River both of which drain into Pambula Lake. The Pambula River rises in rugged country to the east of Wyndham and travels generally easterly to Pambula before turning southerly to enter

Pambula Lake. The upper catchment of the Pambula River is of rugged terrain, however, the topographic characteristics change to undulating to hilly about four miles west of Pambula and some reasonably extensive alluvial flats occur in the vicinity of that township.

The Yowaka River rises in rugged country in the vicinity of the Egan Peaks (2,900 feet) and also traverses rugged terrain in its easterly course to Pambula Lake. Apart from a somewhat limited area of hilly country which occurs to the north west of Eden, in the vicinity of Nethercote, the entire catchment of the Yowaka River is of mountainous terrain (with average slopes exceeding 15 degrees).

Although alluvial flats occur near Eden the remainder of the coastal area north to Merimbula is generally of hilly to steep land slopes.

The main southern coastal valley of the Towamba Valley is that of the Wonboyn River which rises in country to the south of Mount Imlay about fourteen miles from the coast. Narrabarba Creek is the major upper tributary of the Wonboyn River and this creek flows generally easterly through rugged terrain to join Watergums Creek about four miles east of Narrabarba. The Wonboyn River proper commences below Watergums Creek and finally enters the South Pacific Ocean in the north west sector of Disaster Bay.

The only other significant southern rivers in the Towamba Valley are the Merrica and Nadgee Rivers which rise in the Table Hills Range about five miles from the coast. The Merrica River travels north easterly to enter the southern end of Disaster Bay whilst Nadgee River travels south easterly to directly enter the ocean about five miles north of Cape Howe.

With the exception of a minor coastal strip the entire catchments of the Wonboyn, Merrica and Nadgee Rivers are characterised by rugged to mountainous terrain.

The Genoa River rises in rugged country, of elevation about 3,000 feet, to the north of Rockton and generally travels in a south easterly direction for its entire length. Some three miles below Rockton the Genoa River is joined by a northern tributary, the White Rock River, which drains a catchment of up to 3,700 feet in elevation to the north west of Mount Nungatta (3,080 feet).

The other significant tributary of the upper Genoa River is Nungatta Creek which rises to the north east of Mount Nungatta and travels generally south westerly to join the Genoa River about three miles south west of Nungatta.

With the exception of a limited area of undulating country in the vicinity of Rockton, the Genoa River traverses rugged terrain from its headwaters to a point about half way between Wangrabelle and Genoa. At this point the river enters hilly country which gradually merges with undulating terrain near the mouth of the Genoa River at Mallacoota Inlet.

The southern catchment boundary of the Genoa Valley is located relatively close to the main river channel and at no point is more than about six miles from the Genoa River. While the general elevation of the boundary above Genoa is of the order of 2,500 feet some higher peaks occur, the most notable being Mount Tennyson (3,400 feet) and Mount Kaye (3,300 feet). Below Genoa the catchment boundary is generally below 1,000 feet elevation and gradually merges with the coastal plain strip.

The major tributary of the Genoa River is the Wallagaraugh River which commences in the vicinity of Yambulla about ten miles north of Wangrabelle. Imlay Creek is the main tributary of the Wallagaraugh River and this creek drains the western slopes of Mount Imlay, joining the river about six miles north of Timbillica.

About four miles below Timbillica the Wallagaraugh River crosses the State Border and finally enters Mallacoota Inlet near Gipsy Point. In addition to the Genoa and Wallagaraugh Rivers there is a quite significant local catchment which drains directly into Mallacoota Inlet which is an expansive estuary extending some six miles both to the north east and north west of Mallacoota.

As indicated at Figure 1 the State Border extends from Cape Howe in the east to Mount Tennyson in the west and cuts across a minor section of the lower Towamba Valley and through the centre section of the Genoa Valley.

The distributions of generalised land slopes in the Towamba and Genoa River Valleys are shown at Figure 2 which indicates that the predominant topography of the valleys is of mountainous nature. With the exception of isolated minor pockets of undulating terrain in the upper catchments, lands with general slopes of less than 8 degrees are confined to the lower sections of the main streams.

The percentage distributions of land slopes in the Towamba and Genoa Valleys are as follows:-

Topography	Towamba Valley	Genoa Valley
Rugged or Mountainous	82 %	83 %
Hilly to Steep	12 %	11 %
Undulating to Hilly	5 %	6 %
Mostly Flat	1 %	0 %
Totals	100 %	100 %

3. CLIMATIC FEATURES

Rainfall

As the Towamba and Genoa Valleys extend less than 45 miles westward from the coast, the basins generally receive adequate rainfall. Spatial variation of rainfall across the basins depends mainly on orographic effects. Annual median rainfalls vary from less than 30 inches over the sheltered valleys of the upper Towamba Valley to about 40 inches over the more eastward peaks of the ranges forming the boundaries between the Towamba and Genoa Valleys. (The median rainfall is that rainfall equalled or exceeded on fifty percent of occasions).

Annual median rainfalls over the coastal areas of the basins vary from 30 to 35 inches. 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.

Monthly rainfall is rather uniformly distributed throughout the year although, on the average, each of the months December to April tend to receive slightly higher rainfall than the months from May to November. Monthly median rainfalls vary from 1½ to 2 inches per month over the low rainfall areas to more than 3 inches per month over the high rainfall areas.

Monthly and annual rainfalls recorded at Bombala, Burragate, Eden, Gabo Island, Pambula and Timbillica are given in Appendices 1 to 6 respectively.

Very heavy storm rainfalls may occur over the basins when an active depression is centred off the New South Wales coast to the north of Twofold Bay. Storms of this nature occur about twice per year on the average. The estimated extreme 24 hour rainfall within the catchment varies from about 10 to 17 inches depending on topography. The highest fall recorded for a station in the

catchment for a 24 hour period ending 9 a.m. is 16.38 inches at Burragate on the 27th February, 1919.

Highest monthly totals on record are generally less than 20 inches. Exceptional stations are Eden, Rocky Hall and Wyndham which have on record totals of 22.75 inches, 21.09 inches and 26.38 inches respectively for June 1891 and Burragate with a total of 21.56 inches in February 1919. Highest yearly totals vary between 40 and 90 inches.

The Tables at Appendix 7 show on a monthly and annual basis for Bombala, Burragate, Eden, Gabo Island, Pambula and Timbillica 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).

Minimum recorded rainfalls at Gabo Island, Pambula, and Timbillica are shown in the Tables at Appendix 8. These Tables indicate the minimum cumulative rainfalls commencing in any month of the year and continuing for up to 12 months at the selected stations.

Dry spells occur from time to time over the basin, however it is rare for these spells to exceed about 3 or 4 months. On 90 percent of occasions at least 3 inches of rain are received in any consecutive 3 month period while at least 5 inches are received in any consecutive 4 month period. Corresponding median values for these periods are about 8 inches and 11 inches respectively.

Temperature.

Temperature data are available for Bondi State Forest and Nalbaugh. These stations are representative of areas at 3,000 and 2,400 feet above mean sea level respectively. Averages for these two stations are presented in Tables 1 and 2. No records are available for the lower areas of the basin, but temperature averages in these areas may be estimated by decreasing the averages for Nalbaugh by 4 degrees for each 1,000 feet difference in elevation.

TABLE 1

BONDI STATE FOREST (Elevation 3,000 feet)

Average Temperature (^{o}F) Based on 14 Years of Records

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Average Maximum	73.6	72.7	68.9	60.2	55.8	48.2	48.0	50.9	55.9	61.5	65.3	69.8	60.0
Average Minimum	44.8	44.9	43.4	37.8	32.7	29.4	27.3	29.5	32.1	36.5	40.5	43.4	36.9
Average Daily	59.2	58.8	56.2	49.0	44.3	38.8	37.7	40.2	44.0	49.0	52.9	56.6	48.9
Extreme highest on Record 102.3^{o}F							Extreme lowest on Record 12.8^{o}F						

TABLE 2

NALBAUGH (Elevation 2,400 feet)

Average Temperature (^{o}F) Based on 20 Years of Records

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Average Maximum	77.1	75.3	70.5	62.5	57.2	51.5	50.9	53.5	58.5	63.1	67.8	74.3	63.5
Average Minimum	49.3	49.2	45.7	41.5	37.1	33.1	31.3	32.6	35.3	38.3	43.4	47.0	40.3
Average Daily	63.2	62.3	58.1	52.0	47.1	42.3	41.1	43.1	46.9	50.7	55.6	60.7	51.9
Extreme highest on Record 106.0^{o}F							Extreme lowest on Record 21.0^{o}F						

Very high temperatures in the summer months have been recorded in the valleys when north westerly winds bring hot dry air from Central Australia over the valleys. Further warming of the air occurs as it moves down the eastern slopes of the Great Dividing Range into the lower valleys. Temperatures exceeding 100 degrees can be expected on rare occasions even over the highest parts of the catchment.

On calm clear nights in winter very low over-night temperatures occur, particularly over the higher parts of the basin.

Frosts.

Frost incidence increases from almost nil on the coast to more than 100 days per year on the average over the higher parts of the hinterland where frosts can occur at anytime of the year. Severe frosts are usually confined to the months from April to November in the highest areas with the season becoming shorter at lower elevations.

Sunshine.

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

TABLE 3

Estimated Average Duration of Bright Sunshine in Hours Per Day

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
8.1	8.0	7.3	5.8	5.6	4.5	5.2	6.1	6.7	7.3	7.5	8.1	6.7

Evaporation.

Estimates of the average monthly and annual evaporation from an Australian Standard 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 in Inches from a Sunken Tank

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Evaporation	5.2	4.4	3.7	2.3	1.6	1.1	1.4	1.7	2.3	3.3	4.6	4.8	36.4
Standard Deviation	0.7	0.7	0.6	0.3	0.4	0.4	0.3	0.4	0.4	0.4	0.7	0.8	2.6

Winds.

Winds over the river basins are mainly only light or moderate but strong winds and squalls do occur occasionally. They occur usually in association with one of the three following situations:-

1. A strong westerly gradient over the valleys associated with a depression south of Gabo Island.
2. A strong east or south-easterly gradient over the valleys associated with a vigorous depression off the central New South Wales coast.
3. In association with thunderstorms and frontal squalls.

Strong westerlies affect both the valleys with mean wind speeds reaching 40 m.p.h. at times. The strong east to south easterlies may reach mean speeds as high as 50 m.p.h. about the coast; however, these winds usually moderate rapidly inland from the coast.

Table 5 gives estimated extreme wind gusts likely to be experienced at a point in the catchment for various return periods.

TABLE 5

Wind Gusts to be Expected with Given Return Periods

Return Period (Years)	10	20	50	100
Wind Gust equalled or exceeded (m.p.h.)	85	90	100	105

4. GROUNDWATER POTENTIAL

The major geological features of the Towamba and Genoa River Valleys are shown at Figure 16.

Sedimentary rocks ranging in age from Ordovician to Recent outcrop between the coast and a granite massif which parallels the coastline at distances between 12 and 18 miles.

Groundwater potential in the catchment area is largely dependent on geological and topographical influences. Since there is no record of boring in the entire district, deductions regarding groundwater potential must be based largely on geological characteristics and on experience in other geologically similar areas.

Geology

The Ordovician rocks are the oldest to be found in the catchment and it would appear that at some time they were deposited over most of the area under consideration. Their present distribution extends over an 8 to 10 mile wide band adjacent to the granite, from Mallacoota to Twofold Bay. Isolated outcrops also occur in the granite to the west. The rock types include phyllite, slate, quartzite, sandstone, mudstone, siltstone and shale. They are mostly metamorphic in character, heavily folded and exhibit a trend toward the north.

Rocks belonging to the Upper Devonian Period outcrop in the area between the granite and the coastline to the north of Twofold Bay, and the area between the older Ordovician sediments and the sea to the south of Twofold Bay. The series trend north although variations do occur near geological boundaries. Dips in comparison to the older rocks are relatively shallow and rarely exceed 30 degrees.

The Upper Devonian has been divided into 3 stages which have been named Eden, Lochiel and Merimbula (oldest to youngest). The Eden Stage consists of flows of acid volcanic rock which have been referred to collectively as the Eden Rhyolite. These flows achieve an aggregate thickness of 400 to 500 feet in the Eden district and are known to thicken to 800 feet to the north toward Moruya. The base of the Devonian is characterised by a peculiar spherulitic structure in the rhyolite. This structure is visible in the rocks along the south shore of Twofold Bay.

The Lochiel Stage consists of rhyolites, rhyolite breccias, and felsitic rocks interbedded with red freshwater and estuarine shales and sandstones. The rhyolites of this group have few or no phenocrysts and show well developed banding due to flow structure.

The Merimbula Stage consists of marine shales, sandstones, quartzites and conglomerates. The sequence is believed to be devoid of any volcanic rocks and has been estimated to be approximately 1,200 feet in thickness.

Directly overlying the Upper Devonian are Tertiary rocks. Formations of this period consist essentially of horizontally bedded, sandy sediments of fluviatile or estuarine origin. Partially consolidated sandstones, grits, conglomerates and peaty beds form old sea cliffs behind the present beaches between Merimbula and Twofold Bay and extend southwards in a discontinuous fashion to Mallacoota. In numerous localities deposits of Tertiary river gravels occur some 40 to 50 feet above present river levels.

Recent deposits comprise modern and recently abandoned beach deposits, sand dunes, estuarine and fluviatile gravels, sands, silts and clays associated with current stream and river development. These deposits are necessarily most abundant along the coastline and along the larger rivers in the area. Preliminary test boring at the site of a recently constructed bridge over the Towamba River at Kiah (on the Princes Highway) revealed a maximum thickness of sand of 100 feet in the approximate centre of the channel.

The granite massif underlies the greater part of the western half of the catchment. The intrusion as a whole cuts across the Lower Paleozoic series. Although it is essentially granodioritic in composition, more acid and more basic types are developed as well as a variety of pegmatic, aplitic and basic veins and dykes. The age of the greatest part of the intrusive is between late Devonian and Permian and it probably belongs to the orogenic epoch at the close

of the Devonian known as the Kanimbla Epoch. A small area in the north west part of the catchment area is underlain by Tertiary basalt which lies on the eroded surface of the granodiorite.

Groundwater Potential of the Various Rock Units.

There is no record of boring or well sinking in the area and assessment of groundwater potential must be based on developments in other areas under what are considered to be approximately similar geological conditions.

The quality and quantity of any underground supply from a given host rock or unconsolidated sediment may vary widely. In some cases it is not the original character of the rock but the changes which have been wrought in the upper hundred or so feet of that rock by the agents of weathering which will determine whether or not the rock will prove to be a successful aquifer.

The Ordovician rocks have suffered extensive folding and metamorphism. Consequently, few initial characteristics of the sediments as they were deposited now remain. Original porosity and permeability have disappeared but the processes of weathering have caused cracks and fractures to form in the weathered upper layer of rock. Therefore, the potential in the Ordovician rocks is limited to the weathered zone which, in most cases, would not exceed 200 feet.

Because a supply will be dependent on secondary openings (fractures due to weathering) in the rock, such factors as rainfall and area of catchment will be of prime importance. Supplies would probably be of the order of 200 gallons per hour and the quality is expected to be at least good enough for stock use.

It is likely that the Devonian series would offer less encouraging prospects than the older Ordovician. This is particularly true of the Eden Rhyolite Series which consists of a series of acid lava flows. These rocks are very hard and resistant to weathering. They have little or no original porosity or permeability and have not been much affected by weathering. The subsequent Lochiel Series consists of volcanics and interspersed sediments and probably offers rather limited prospects. The third Merimbula Stage consists entirely of lithified sediment (conglomerate, sandstone, shale) and therefore would be expected to offer the best prospects of the Devonian rock.

However it should be noted that despite the general characteristics of the rock types, it is possible that where favourable physiographic and climatological conditions exist, a successful bore may be constructed in a type of rock which

in general may have very poor prospects.

The Tertiary deposits are regarded as having a reasonable groundwater potential since they are comprised of gravel, sand, sandstone, shale and conglomerate and have undergone relatively little change since their deposition. One of the most critical factors to be taken into account in evaluating a given deposit of Tertiary sediment is its relative location. For example, it is apparent that a gravel perched on a hill slope some fifty feet above present river level will have less potential than a similar deposit located in a valley floor.

The quality and quantity of supplies from Tertiary deposits would be expected to vary, but given favourable conditions most supplies should prove at least suitable for stock use and possibly for domestic use. It is expected that the sequence of Tertiary sediment is not sufficiently thick in most cases to provide irrigation supplies; however under favourable conditions there may be exceptions.

Recent sediments appear to offer the greatest potential for large scale water usage but these beach, dune and alluvial deposits only cover a relatively small area of the catchment. Stock, domestic, and irrigation supplies should be possible from bores, spearpoints or wells in the alluvium at selected sites.

Tourist camps and beach resorts along the South Coast obtain satisfactory supplies from spearpoints installed along the beaches and limited irrigation is practised in isolated areas from spearpoints both upstream and downstream of tidal limits. Intrusion of saline water continues to be the prime factor limiting the water yield.

Beach sands and estuarine flats in the Towamba and Genoa Valleys can, no doubt, be anticipated to offer reasonable prospects. Supplies are expected to be shallow and maximum yields would be probably of the order of 1,500 to 2,000 gallons per hour on a non-continuous basis, continuous pumping rates being considerably lower. It is the fresh water alluvial deposits which are believed to have the greatest potential. Screened bores or spearpoints should be successful in obtaining supplies of underground water of the order of 8,000 to 10,000 gallons per hour from the alluvium upstream of the saline influence, which extends up the Towamba River to a point about half a mile downstream of Kiah.

Boring into the granite in the Bega Valley to the north has yielded satisfactory stock and domestic supplies of underground water. Since there is no reason to expect conditions to be different in the Towamba and Genoa Valleys, supplies suitable for stock and domestic use (approximately 200 to 300 gallons per hour) are anticipated within a depth of 150 feet at selected sites.

The Tertiary basalt in the extreme north west corner of the catchment covers a relatively small area and is of little importance for groundwater development purposes.

Groundwater Potential Summary

The Ordovician rocks are expected to yield water at least suitable for stock use. Supplies are expected to be of the order of 200 gallons per hour and maximum drilling depths about 200 feet. Of the Devonian sequence the rhyolites (lowest stage) are considered to have the least potential because they are very hard and resist weathering.

The later Lochiel and Merimbula Stages are increasingly sedimentary in character and therefore may be regarded as having some promise, however it is anticipated that supplies will be rather small, say of the order of 150 gallons per hour. Quality may pose a problem but it is felt that it should prove at lease suitable for stock in most cases.

Tertiary sediments may or may not be of conseqeunce. They are rather thin and few if any of the deposits would have an aggregate thickness of more than 100 feet. If the deposits are suitably located then stock and domestic supplies should be possible at selected sites.

The greatest potential for development is considered to be in the recent alluvial and beach and dune deposits. Where a threat of saline intrusion exists spearpoints are probably best suited for the withdrawal of the shallow upper fresh supplies. Upstream of the saline limit bores and spearpoints will be unaffected by salt water problems and supplies of the order of 8,000 to 10,000 gallons per hour should be possible.

Bores into the granite should yield stock and domestic supplies from depths less than 150 feet. However in the granite country choice of a suitable site is

regarded as very important.

5. STREAM GAUGING STATIONS.

Streamflow results from precipitation of atmospheric moisture which is carried over the land masses by the circulating weather systems of the Earth. After subtracting losses due to evaporation, transpiration and deep seepage from the total precipitation, the remainder which occurs as streamflow is normally termed runoff.

Rainfall records have been obtained for most areas of New South Wales over comparatively long periods of time. If satisfactory estimates could be made of evaporation, transpiration and deep seepage losses then it should be possible to derive accurate estimates of the remaining part of the precipitation, or runoff. Although a considerable volume of research has been undertaken in estimation of these losses no sufficiently accurate method has yet been derived for the estimation of runoff using only rainfall data.

However, various approximate methods are often employed to extend streamflow records using concurrent streamflow and rainfall information. As the application of these methods depends upon the availability of streamflow data over a reasonable period, it is apparent that the most essential basic element in water resources investigations is actual streamflow measurement. It is also desirable that these measurements extend over as long a period as possible.

Streamflow measurement involves two basic steps, the first being the measurement of river level or gauge height in relation to a fixed datum and the second being the correlation of the measured height with stream discharge.

River levels are obtained by the periodic observation of the level of the water surface on a graduated scale or staff gauge which is generally erected either on the stream bank or on bridge piers. As these measurements only indicate instantaneous water levels at a certain time, it is desirable to record the continuous variation of river height by means of either a float or a pressure actuated automatic streamheight recorder.

Stream discharge measurements are obtained by use of a current meter, to measure flow velocities, in conjunction with survey methods to determine the effective area of flow. Calculations are made combining the flow velocities, in feet per second, with cross sectional areas, in square feet, to give the discharge of the stream in cubic feet per second or cusecs.

Gauge height and discharge relationships are established by means of graphs and in channels with stable regimen these relationships tend to remain constant. These relationships are used to estimate streamflow during periods when gauge heights, but not measured discharges, are obtained at the stream gauging station, thereby allowing continuous gauge height records to be converted to continuous flow records.

Streamflow records are normally given in terms of cusecs, one cusec flowing for one day being approximately equal to two acre feet. Another unit which is frequently employed in catchment yield investigations is inches depth over the area of the catchment.

Measurement of streamflow in the Towamba Valley commenced in 1954 with the installation of a gauging station at New Building Bridge on the Towamba River. This was followed by the erection of stations on Stockyard Creek at Rocky Hall in 1960 and the Pambula River at Lochiel in 1966.

The first stream gauging station on the Genoa River was installed at Wangrabelle in 1922; however due to difficulties in operation, involving the non-availability of gauge readers and erosive changes in the river channel at the station, it was found necessary to relocate the station at various sites in the vicinity of Wangrabelle. The present station, installed in 1966, is equipped with an automatic float recorder and has a stable channel control. As Wangrabelle is situated within the State of Victoria, the streamflow station is under the control of the State Rivers and Water Supply Commission of Victoria.

An additional gauging station, equipped with a pressure actuated recorder, was established on the Genoa River at Rockton in 1965. However, this station which is within the New South Wales' section of the Genoa Valley, has a catchment area of only about one-tenth that of Wangrabelle.

The density of stream gauging stations in the combined Towamba and Genoa River Valleys is 2.9 per thousand square miles compared with corresponding figures of 2.2 stations for New South Wales and about 0.5 stations for Australia.

It is intended to expand the existing network of stream gauging stations in the Towamba and Genoa Valleys to nine stations so as to provide adequate basic data for the majority of water resources investigations which are likely to be required for the valleys.

The locations of the existing streamflow stations in the Towamba and Genoa Valleys are shown in Figure 17 and relevant operational details of each station are given in Table 6.

TABLE 6

Stream	Station	Catchment Area (Square miles)	Type of Gauge	Period of Operation
Towamba River	New Building Bridge	114	Staff Gauge	1954 to date
Stockyard Creek	Rocky Hall	28	Staff Gauge	1960 to date
Pambula River	Lochiel	50	Pressure Recorder	1966 to date
Genoa River	Rockton	30	Pressure Recorder	1965 to date
Genoa River	Wangrabelle	293	Float Recorder	1922 to 1929 1958 to date

6. CATCHMENT YIELDS.

The surface water yield, or runoff. of a catchment is dependent upon a number of factors, the main ones being annual rainfall, catchment area, topography and geology. Additional factors, which control the runoff occurring from a particular storm are rainfall intensity, vegetal cover and soil moisture conditions.

The streamflow records which have been obtained in the Towamba and Genoa Valleys have provided a reasonable volume of information for the estimation of water yield in the valleys.

Over the twelve year period commencing in 1955, the average flow of the Towamba River at New Building Bridge has been 79,900 acre feet per annum, which is equivalent to an average rate of flow of 109 cusecs (41,000 gallons per minute).

At the gauging station located on Stockyard Creek at Rocky Hall, the average flow over a six year period has been 13,200 acre feet per annum or 18 cusecs (6,800 gallons per minute).

Records of streamflow for the Genoa River at Wangrabelle indicate that the average flow at this station has been about 115 cusecs (43,000 gallons per minute).

For comparative purposes the yields at selected gauging stations in the Towamba and Genoa Valleys as indicated by available records, are given in Table 7. Details of the monthly maximum, minimum and mean flows for the gauging stations located on the Towamba River at New Building Bridge, Stockyard Creek at Rocky Hall and the Genoa River at Wangrabelle are tabulated in Appendices 9 to 11 inclusive. The streamflow data available for the remaining two recently

installed stations on the Pambula River at Lochiel and on the Genoa River at Rockton has not been included in this report as the information covers such a short period of record as to be of little hydrologic significance.

TABLE 7

Stream	Station	Complete Years of Computed Records	Average Annual Yield over Period of Complete Years of Records		
			Acre Feet per Annum	Cusecs	Gallons per Minute
Towamba River	New Building Bridge	12	79,900	109	41,000
Stockyard Creek	Rocky Hall	6	13,200	18	6,800
Genoa River	Wangrabelle	10	83,800	115	43,000

7. AVERAGE ANNUAL RUNOFF.

Based on streamflow records available for the adjoining Snowy River basin at Jindabyne, over the period from 1902 to date, estimates have been prepared of the long term average annual runoffs of the Towamba and Genoa Valleys.

These estimates indicate that the average annual surface water resources of the Towamba and Genoa Valleys are about 400,000 acre feet and 360,000 acre feet respectively. Although based on different periods of available streamflow records, the resources of each valley approximate 450 acre feet per annum per square mile.

On a square mile of catchment area basis, these resources are about 15 percent greater than the average for the coastal section of New South Wales and about five times the average for the State.

In the following Table 8 the estimated long term average annual runoffs of the Towamba and Genoa Valleys are compared with the corresponding runoffs for the Bega and Tuross Valleys.

TABLE 8

Valley	Catchment Area in Square Miles	Estimated Long Term Average Annual Runoff		
		Acre Feet per annum	Acre feet per annum per Square Mile	Percentage Runoff
Towamba River	880	400,000	450	26%
Genoa River	800	360,000	450	27%
Bega River	740	400,000	540	27%
Tuross River	840	420,000	500	28%

As indicated in Table 8, the percentage runoffs for the Towamba and Genoa Valleys are practically identical with each other and with the percentage runoffs for the Bega and Tuross Valleys.

A previous estimate of the long term average annual runoff of the Towamba Valley was given in the 1963 publication "Review of Australia's Water Resources" and was 380,000 acre feet. However, this estimate was applicable to the area of 850 square miles within New South Wales or about 30 square miles less than the total area of the valley. If allowance is made for this difference the two estimates are compatible.

The area of the Genoa River within the State of New South Wales is about 450 square miles and estimates indicate that the long term average annual runoff from this area is of the order of 240,000 acre feet. As the average rainfall over this catchment is about 32 inches, the runoff is equivalent to about 31 percent of the rainfall.

The coastal catchments of the Towamba Valley north of Eden, including the catchments of the Pambula and Yowaka Rivers, which both drain into Pambula Lake, cover a total catchment area of about 170 square miles. Estimates indicate that the average annual runoff of this section of the Towamba Valley is about 110,000 acre feet or about 36 percent of the average annual rainfall. This percentage runoff is somewhat greater than that of the whole Towamba Valley; however, as percentage yields tend to increase with a decrease in catchment area this result is in accord with hydrologic principles.

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 a valley's surface water resources could be utilised, without the construction of conservation works.

Available records for the stream gauging stations in the Towamba and Genoa Valleys indicate that the surface water resources of these valleys, in common with the majority of streams in the State, exhibit a high degree of variability. However, as the longest period of record at any streamflow station in either of the valleys is only twelve years, it is likely that the variability illustrated by the available records will become considerably greater as the period of data increases.

Annual flows of the Towamba River at New Building Bridge have varied from 9 percent to 350 percent of the mean annual flow. Somewhat similar variations are shown by the streamflow records for Stockyard Creek at Rocky Hall, the minimum annual flow being about 13 percent and the maximum annual flow about 225 percent of the mean annual flow.

Variations in the annual flows of the Genoa River at Wangrabelle have varied from 19 percent to 180 percent of the mean annual flow.

The monthly variations in streamflow always exhibit a much greater degree of variability than the annual discharges. The minimum monthly flows recorded at New Building Bridge, Rocky Hall and Wangrabelle are 1, 2 and 1 percent of the mean monthly flows and the recorded monthly maximum flows at these stations are 1,700 percent, 700 percent and 2,000 percent of the mean monthly flows respectively.

The graphs at Figure 18, showing monthly streamflow variations at New Building Bridge, Rocky Hall and Wangrabelle (since October 1958) illustrate the high degree of variability, both in magnitude and sequence, of streamflows in the valleys. However there is no evidence of any periodic trend in runoff and, as indicated at Figure 19, the distribution of average monthly rainfalls at Bombala, Eden and Timbillica is relatively uniform throughout the year.

In common with other streams in the State, the variability of instantaneous flows at any station in the valleys is of extreme proportions. An indication of the variations in recorded maximum, minimum and mean discharges at three stations in the Towamba and Genoa River Valleys is given in Table 9.

TABLE 9

Stream	Station	Period of Computed Records	Recorded Discharges		
			Maximum	Minimum	Mean
Towamba River	New Building Bridge	1954 to 1967	28,400 cusecs (10,600,000 g.p.m.)	0	109 cusecs (41,000 g.p.m.)
Stockyard Creek	Rocky Hall	1960 to 1967	1,600 cusecs (600,000 g.p.m.)	0	18 cusecs (6,800 g.p.m.)
Genoa River	Wangrabelle	1922 to 1929 1958 to 1967	9,250 cusecs (3,460,000 g.p.m.)	1 cusec (370 g.p.m.)	115 cusecs (43,000 g.p.m.)

9. PERSISTENCE OF STREAMFLOWS.

Streamflows in the Towamba and Genoa Valleys continue for relatively extended periods of time after the cessation of rainfall. This indicates that groundwater flow into the stream channels is comparatively high and persistent.

A method which has been employed to enable comparison of streamflow persistence to be made between stations, is the preparation of diagrams showing flow duration curves. These curves indicate the cumulative percentages of time that discharges have varied from the minimum flow, (which in many instances may be zero) up to the maximum discharge or any intermediate flow. Flow duration curves are constructed to show the percentages of time that flows were equal to or greater than (or alternatively equal to or less than) any particular discharge. The flow duration curves and data given in this report correspond to the percentages of time that flows were equal to or greater than a particular value.

The flow duration curve of discharge of the Towamba River at New Building Bridge is shown at Figure 20. The frequencies of flow during the period of available records at this station are given in Table 10.

TABLE 10

Percentage of Time Flow Equalled or Exceeded	Corresponding Flows	
	Cusecs	Gallons per Minute
10 %	116	43,400
30 %	40	15,000
50 %	19	7,100
70 %	8.5	3,200
90 %	4.5	1,700
100 %	0	0

The flow duration curve for Stockyard Creek at Rocky Hall, covering an overall period of six years of records, is appended at Figure 21. Flow frequency data for this station are given in Table 11.

TABLE 11

Percentage of Time Flow Equalled or Exceeded	Corresponding Flows	
	Cusecs	Gallons per Minute
10 %	31.5	11,800
30 %	10.4	3,900
50 %	6.0	2,250
70 %	3.3	1,250
90 %	1.0	370
100 %	0	0

The flow duration curve of discharge for the Genoa River at Wangrabelle is given at Figure 22 and flow frequency statistics for this station are shown in Table 12.

TABLE 12

Percentage of Time Flow Equalled or Exceeded	Corresponding Flows	
	Cusecs	Gallons per Minute
10 %	230	86,100
30 %	77	28,800
50 %	41	15,400
70 %	20	7,500
90 %	5	1,880
100 %	1	370

For comparative purposes flow duration curves for the above stations have been replotted in the form of curves of flow per square mile of catchment area and are shown at Figure 23.

Although the available records for stations are limited and the period covered by each station is different, the results follow expected patterns, the smallest catchment of Stockyard Creek at Rocky Hall exhibiting the best flow persistence.

The duration curve per square mile for the Towamba River at New Building Bridge follows a somewhat similar trend to the curve for the station on Stockyard Creek, whereas the flow per square mile curve for the Genoa River at Wangrabelle, with the largest catchment of the three stations, exhibits the poorest persistence of flow of the stations considered.

10. OCCURRENCE OF FLOODING.

Flood information for stream gauging stations in the Towamba River Valley is limited and dates from 1954 when the New Building Bridge gauge was installed. Over the period of available records, flows at this station have exceeded 10,000 cusecs (88 cusecs per square mile) on only five occasions, the maximum flow of 28,400 cusecs (249 cusecs per square mile) occurring in February, 1956.

The peak recorded flow on Stockyard Creek at Rocky Hall since commencement of records in 1960 occurred in November 1961. The maximum rate of flow was 1,600 cusecs which is equivalent to a runoff per square mile of catchment area of 57 cusecs.

In March 1928, a flood height corresponding to peak discharge of 9,250 cusecs (31 cusecs per square mile) was recorded on the Genoa River at Wangrabelle. This flow is the highest on record for the station, but in terms of discharge per square mile it is considerably less than recorded peak flows at New Building Bridge and Rocky Hall.

Details of the recorded maximum discharges at New Building Bridge, Rocky Hall and Wangrabelle are given in Table 13.

TABLE 13.

Stream	Station	Catchment Area (Square Miles)	Date	Peak Flow (Cusecs)
Towamba River	New Building Bridge	114	February, 1956	28,400
Stockyard Creek	Rocky Hall	28	November, 1961	1,600
Genoa River	Wangrabelle	293	March, 1928	9,250

Discharge information for the February 1956 flood is not available for the stations located on Stockyard Creek at Rocky Hall or the Genoa River at Wangrabelle. It could therefore be expected that, in view of the recorded high flow of the Towamba River at New Building Bridge during this flood, the discharges given in Table 13 for Stockyard Creek and the Genoa River would have been exceeded during February 1956.

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 or 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 Eden and Bombala are appended at Figure 24. The former location is considered to be representative of the rainfall regime of the coastal section whilst the latter is representative of the inland section of the valleys. These graphs indicate that the lowest calendar year rainfalls at Eden and Bombala were about 16.7 inches and 11.9 inches in 1888 and 1885 respectively.

The period from 1894 to 1910 contained only one year of above average annual rainfall and this appears to have been the most critical period for the Towamba and Genoa Valleys. As shown at Figure 24 other periods of below average rainfall have occurred, particularly from 1940 to 1945, however these periods are of shorter duration and have been relieved by the occurrence of above average rainfalls in the following years.

Since the commencement of regular recording of streamflows at the gauging stations on the Towamba River at New Building Bridge in May 1954 and Stockyard Creek at Rocky Hall in February 1960, the lowest flow over any twelve month period at both stations occurred in the period from September 1965 to August 1966 inclusive. During this twelve month period the total runoff at New Building Bridge was only about 5,000 acre feet or six percent of the average annual flow and at Rocky Hall, about 1,200 acre feet or nine percent of the average annual flow.

On the Genoa River at Wangrabelle the lowest twelve monthly flow recorded over the period of available records was about 15,000 acre feet or 18 percent of the average annual flow and occurred from February 1965 to January 1966.

Over the period of available records for the Towamba River at New Building Bridge there has been only one period of zero flow, which occurred in February, 1959 and covered a period of 4 days. Since commencement of regular recording of flows on Stockyard Creek at Rocky Hall in 1960, the stream has ceased to flow on only one occasion, in February 1966 for a period of 1 day.

At the station on the Genoa River at Wangrabelle, flow has been continuous over the entire period of records. The minimum flow recorded at the station was 1 cusec which occurred over a period of 113 consecutive days from February to June 1923.

12. THE 1964-1966 DROUGHT.

From mid 1964 to mid 1966 the Towamba and Genoa Valleys, in common with many other valleys in the State, experienced limited periods of extremely low rainfalls. The minimum twelve monthly rainfall recorded within this period at Eden commenced in November 1964 and totalled 20.08 inches. This is 32 percent more than the lowest twelve monthly rainfall since 1869 of 15.15 inches which occurred from December 1887 to November 1888.

At Bombala the lowest recorded twelve monthly rainfall during the 1964 to 1966 drought occurred from January to December 1965 and totalled 14.03 inches. This may be compared with the lowest twelve monthly rainfall since commencement of records of 11.88 inches recorded over the period from January to December 1885.

The recorded monthly rainfalls at Eden, Bombala and Pambula over the period from June 1964 to December 1967 are shown in Table 14.

TABLE 14

Monthly Rainfalls (Points)

Month	Eden	Bombala	Pambula
June 1964	322	147	297
July 1964	28	107	18
August 1964	458	461	658
September 1964	77	72	40
October 1964	281	217	244
November 1964	344	221	250
December 1964	234	182	205
January 1965	60	10	147
February 1965	56	54	26
March 1965	5	24	9
April 1965	284	98	203
May 1965	147	26	154
June 1965	217	67	184
July 1965	52	62	41
August 1965	346	404	328
September 1965	65	103	46
October 1965	198	169	228
November 1965	378	301	318
December 1965	317	85	297
January 1966	73	194	236
February 1966	265	109	212
March 1966	309	299	406
April 1966	68	63	62
May 1966	80	57	60
June 1966	560	320	584
July 1966	178	186	182
August 1966	98	80	84
September 1966	259	121	251
October 1966	432	303	307
November 1966	435	431	532
December 1966	583	628	488
January 1967	No Record	276	390
February 1967	No Record	19	51
March 1967	134	71	232
April 1967	35	3	206
May 1967	161	46	127
June 1967	488	92	381
July 1967	29	59	34
August 1967	436	330	466
September 1967	176	277	164
October 1967	225	144	80
November 1967	91	78	53
December 1967	69	54	85
Total Rainfall 1965	2,125	1,403	1,981
Total Rainfall 1966	3,340	2,791	3,404
Total Rainfall 1967	-	1,449	2,269
Minimum Twelve Monthly Rainfall During 1964-1967	2,008	1,403	1,821
Minimum Twelve Monthly Rainfall on Record	1,515	1,188	1,624

Although rainfalls in June 1964 were only slightly below average at most locations in the valleys, extremely low falls were experienced during July 1964. While reasonable rainfalls were recorded during the remainder of 1964, very low falls occurred in the first seven months of 1965.

The drought conditions in the valleys were relieved to a minor degree in August 1965 when more than three inches was recorded over the valleys. Below average falls occurred in September and October 1965 whilst about average rainfalls were experienced during the remaining two months of November and December.

Rainfalls over the valleys during the first five months of 1966 were well below average, with the exception of the month of March when an average rainfall of about three inches was experienced over the valleys. Substantial rainfalls, of above five inches, were recorded at both Eden and Pambula in June 1966, however due to the dry antecedent condition of the valleys little of this rainfall appeared as surface runoff.

During the months of July and August 1966 further low rainfalls were recorded over the valleys, however approximately average falls were experienced in September and October 1966.

In November 1966 heavy rainfalls occurred over the catchment and these were followed by additional heavy falls in December 1966.

Although below average rainfalls occurred in the first five months of 1967, quite heavy falls, particularly along coastal areas, were experienced in June 1967. Rainfall throughout the remainder of 1967 has been variable, with reasonable falls occurring in August and September and below average falls during the months of October to December 1967.

Prior to August 1964 when substantial rises in streamflows occurred, moderate flows had been experienced over the previous seven months. Flows gradually depleted over the balance of the year and into the next year, until August 1965, when minor rises occurred in the various streams in the valleys.

Streamflows again diminished during September to November 1965 but in December of that year the drought situation was temporarily relieved by further minor increases in flows. Despite these increases in flows, the valleys experienced a critical sequence of low flows during the first five months of 1966 in which period the average monthly discharge of the Towamba River at

New Building Bridge did not exceed four cusecs or about four percent of the average flow.

Minor rises in streamflows occurred in June 1966 but generally diminished during the next three months. Medium flows were experienced in October 1966 and a large flood occurred in November 1966, over 10,000 cusecs being recorded at New Building Bridge.

Although flows diminished in 1967 they did not reach the critical levels which characterised the first half of 1966.

As previously indicated, twelve monthly streamflows in the Towamba and Genoa Valleys during the 1964-1966 drought were the lowest experienced since the commencement of records at the respective stations. The total flow of the Towamba River at New Building Bridge over the twelve month period from September 1965 to August 1966 and the minimum twelve monthly flows recorded at that station during other drought periods are given in Table 15.

TABLE 15.

Period	Total Runoff Volume in Acre Feet	Average Flow	
		Cusecs	Gallons Per Minute
September 1965 to August 1966	5,000	6.8	2,600
March 1958 to February 1959	9,230	12.6	4,700
December 1954 to November 1955	10,941	15.0	5,600

In addition to very low twelve monthly flows being experienced during the 1964-1966 drought, extremely low discharges were recorded for shorter durations. While the minimum three monthly and six monthly flows which have been recorded at the stations located on the Towamba River and Stockyard Creek occurred during this drought, the corresponding flows of the Genoa River were less critical than those recorded in 1923.

The minimum three monthly and six monthly discharges for selected streamflow stations in the Towamba and Genoa Valleys during the 1964-1966 drought are shown in Table 16.

TABLE 16.

Stream	Station	Minimum Total Flow During 1964-1966 (Acre Feet)	
		Three Months	Six Months
Towamba River	New Building Bridge	410	1,730
Stockyard Creek	Rocky Hall	120	380
Genoa River	Wangrabelle	1,830	4,730

In comparison, the minimum recorded three monthly and six monthly flows of the Genoa River at Wangrabelle during 1923 were only about 180 acre feet and 580 acre feet or only 10 percent and 12 percent respectively of the corresponding 1964-1966 flows.

13. WATER REQUIREMENTS FOR CURRENT DEVELOPMENT.

Dairying is the main rural pursuit in the lower, and more developed sections of the valleys whereas beef cattle grazing is the predominant activity in the more rugged areas of the catchments.

Relatively minor areas in the valleys are sown for crops, the most popular crop being maize which is mainly used as fodder.

There are several State Forests in the valleys the largest being East Boyd State Forest which covers an area of nearly 100 square miles and is located along the coast between Twofold Bay and Disaster Bay and extends about fifteen miles inland. The predominant type of timber in the State Forests is Silvertop Ash, the next most common type being Stringybark. Although a proportion of the available timber in the State Forests is suitable for the production of sawn timber the major percentage is only suitable for either the production of wood chips or for pulping.

Recently the New South Wales Government awarded to an Australian-Japanese Consortium, the right to take timber from State Forests on the south coast of the State for use in Japan. This timber, which will consist of trees which are not suitable for sawlogs will be processed into wood chips at a factory to be established on the south-eastern shore of Twofold Bay. At a later stage the factory will be expanded to convert the wood chips into wood pulp for use in the manufacture of hardboard and paper.

It has been estimated that this new industry will process a minimum of 500,000 tons of wood chips each year and that the value of the annual export of the wood chips will amount to about $6 million.

The area authorised for irrigation by license under the Water Act in the Towamba River Valley has increased from 10 acres at June 1946 to 207 acres at

June 1967 and the total number of irrigation licenses issued over the same period has increased from 1 to 17. The variations in total number of irrigation licenses issued, and corresponding areas, over the twenty-two year period from 1946 to 1967 are indicated at Figure 25.

As yet no licenses have been issued for irrigation or water supply purposes in the entire Genoa River Valley, either in the New South Wales' or Victorian sections.

Up to June 1965 there were very few irrigation licenses in the Towamba Valley, only six being issued for a total area of 67 acres at June 1965. During the past two years the number of licenses has increased to seventeen and the licensed irrigable area to 207 acres. This area is equivalent to an average area of about 12 acres per irrigation license.

At the end of June 1967 there was a total of six water supply licenses in the Towamba Valley for the diversion of up to 90 gallons per minute for industrial and stock water supplies.

It has been estimated that the water supply demand of the proposed wood chip mill on Twofold Bay will initially be of the order of 30,000 gallons per day. Following completion of the wood pulping factory it is envisaged that the demand could rise to about 7,000,000 gallons per day.

There are no major storages located in the Towamba and Genoa River Valleys for water conservation or water supply purposes. However water supply to the towns of Candelo, Eden, Merimbula, Pambula, and Wolumla is provided by means of a district scheme in which flows are diverted from Tantawanglo Creek in the adjoining Bega Valley by means of a weir, and distributed, under gravitation, to the various localities.

As initially installed, the diversion capacity of this scheme was 600,000 gallons per day. Further works, including the installation of booster pumps, will increase the diversion capacity of the scheme to 1,000,000 gallons per day and these works are at present in their final stages of construction. In addition further investigations are in progress for the augmentation of this scheme.

The estimated maximum water requirements at the 30th June 1967 in the Towamba and Genoa Valleys, under present conditions, for irrigation under license, water supply and riparian usage (not including transmission losses) are given in Table 17.

TABLE 17.

Requirement	Estimated Maximum Demand	
	Cusecs	Gallons Per Minute
Irrigation (207 acres at 2 feet per season)	0.8	300
Town, Industrial and Stock Water Supplies	0.2	90
Riparian Usage	10.0	3,740
Totals	11.0	4,130

As indicated in Table 17, the demand for irrigation is less than one tenth of the total maximum estimated demand.

The areas authorised for irrigation on the Towamba and Genoa Rivers and their tributaries, and the estimated maximum demands for each of the main streams (including town and industrial water supplies and riparian usage but excluding transmission losses) are shown in Table 18.

TABLE 18.

Section of Valley	Area Authorised for Irrigation at 30th June 1967 (Acres)	Total Demand	
		Cusecs	Gallons Per Minute
Towamba River and miscellaneous tributaries	39	3.9	1,470
Jingo Creek	15	0.5	190
Mataganah River	57	0.6	220
Pambula River and miscellaneous tributaries	46	0.7	260
Old Hut Creek	20	0.5	190
Yellow Pinch Creek	15	0.1	40
Merimbula Creek	15	0.4	150
Wonboyn and Merrica Rivers and associated minor coastal streams	--	1.4	520
Genoa River and tributaries	--	2.9	1,090
Total Towamba and Genoa Valleys	207	11.0	4,130

The foregoing requirements given in Table 18 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 primary uses of water for irrigation in the Towamba and Genoa Valleys are in the growing of pastures and fodder crops for beef cattle production, dairying and associated pig raising. Production is adversely affected by a shortage of green fodder in dry periods and therefore assured continuity of

output could be maintained if adequate and reliable water supplies were available for the irrigation of a suitable area on each farm.

Due to the topography of the valleys irrigable areas are restricted to river frontage lands which mainly occur in isolated pockets varying in area from 10 to 40 acres. However, on two of the streams in the valleys, Pambula River and Boggy Creek, more extensive areas occur immediately above the tidal limit in each stream. The main streams are bordered by undulating country with alluvial flats and terraces, which may frequently be located at considerable heights above the stream beds. Consequently the most practical method of irrigation of these lands would be by pumping from the rivers and the use of spray irrigation systems.

Estimates of the extent of areas in the Towamba and Genoa Valleys which are considered to be topographically suitable for irrigation from streamflow are shown at Table 19.

TABLE 19.

Stream	Approximate Area Suitable for Irrigation from Streamflow (Acres)
Towamba River	1,500
Tributaries	
Jingo Creek	60
Mataganah River	250
Myrtle Creek	200
Other minor tributaries	130
Pambula River and miscellaneous tributaries	950
Old Hut Creek	40
Merimbula and Yellow Pinch Creeks	70
Boggy Creek	180
Wonboyn and Merrica Rivers and associated minor coastal streams	100
Genoa River and tributaries	1,020
Total Area	4,500

Of the total irrigable area of 4,500 acres, 4,140 acres are above tidal limits and 360 acres are below tidal limits, the latter area being situated along the Towamba and Yowaka Rivers and on Merimbula Creek.

In general the rugged topography of the valleys precludes the economical construction of farm dams and, to date, the development of this source of supply has been negligible. Where favourable sites and suitable soil types exist, the temporal rainfall pattern is such as to make farm water storages economically feasible and it is anticipated that small water supplies for future development will be provided by these works.

15. INVESTIGATIONS OF STORAGE PROPOSALS.

While detailed field investigations have not yet been carried out for the selection of storage sites in the Towamba and Genoa River Valleys, preliminary investigation indicates that there are four possible dam sites on the Towamba River between the Village of Towamba and the Mataganah River junction at the locations shown in Figure 26.

The three lower sites are located in narrow sections of the river and therefore the storage capacities available at any or all of these sites may be of limited magnitudes. At a distance of about two miles above the upstream site (No. 4) the river valley widens thus providing relatively greater storage potential than that available at the downstream sites.

The catchment areas above the No. 1 and No. 4 sites are 155 square miles and 125 square miles respectively but owing to the dearth of detailed topographic data presently available for the region it is not yet possible to estimate the likely storage potential at the respective sites or the regulated flow which might be provided.

The limited investigation which has been undertaken to date on the section of the Genoa River Valley within New South Wales, has not indicated any suitable sites for a major storage dam.

Provision has been made in the Commission's long term programme of works for the construction of a storage dam on the Towamba River. However, in order to determine the most suitable dam site and storage capacity, it will be necessary for comprehensive investigations to be undertaken, including field surveys, foundation drilling and location and testing of suitable construction materials.

16. ACKNOWLEDGMENT.

The Water Conservation and Irrigation Commission gratefully acknowledges the assistance provided by the Director, Bureau of Meteorology, in supplying the section on Climatic Features, the Rainfall Statistical Data and the Median Rainfall Maps for inclusion in this report, the New South Wales Department of Public Works in providing details of the various town water supply schemes, the New South Wales Forestry Commission in advising forestry details and

the State Rivers and Water Supply Commission of Victoria in supplying details of streamflows recorded at that Commission's station on the Genoa River at Wangrabelle.

Appendix 1
Sheet 1

BOMBALA RAINFALL STATISTICS
(Points)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
1885	188	165	104	76	14	66	57	19	126	74	215	84	1188
1886	302	198	44	151	33	11	91	161	178	238	159	313	1879
1887	445	173	182	75	101	315	151	218	198	359	549	457	3223
1888	108	251	109	3	93	20	39	208	274	76	106	723	2010
1889	412	245	15	81	314	269	84	74	163	210	401	37	2305
1890	265	339	207	101	277	677	248	116	96	213	124	103	2766
1891	267	131	83	174	32	1483	489	308	178	221	282	170	3818
1892	140	70	212	328	95	13	244	93	397	635	332	217	2776
1893	450	40	532	387	121	157	408	52	202	225	382	813	3769
1894	182	184	401	190	34	399	52	81	136	111	25	211	2006
1895	173	182	188	164	78	286	48	197	189	10	1	131	1647
1896	159	130	104	24	344	665	45	213	150	29	266	180	2309
1897	428	475	154	123	182	139	94	179	156	145	18	224	2317
1898	3	703	34	17	199	108	57	240	50	304	35	140	1890
1899	270	13	200	589	110	382	308	341	83	17	89	33	2435
1900	139	13	294	362	748	155	329	67	144	22	128	100	2501
1901	79	25	236	193	8	220	199	381	99	296	118	48	1902
1902	281	37	374	118	14	279	593	50	123	228	126	407	2630

Appendix 1
Sheet 2

BOMBALA RAINFALL STATISTICS
(Points)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
1903	45	107	94	84	138	20	151	44	277	154	114	298	1526
1904	378	143	105	44	115	86	208	148	125	119	64	55	1590
1905	355	91	236	139	141	36	141	288	96	620	1	158	2302
1906	25	44	804	12	40	27	4	188	162	276	393	224	2199
1907	199	40	123	134	141	227	17	46	30	73	220	469	1719
1908	474	139	38	132	33	147	26	358	322	131	270	132	2202
1909	240	332	60	23	20	505	306	32	106	107	14	196	1941
1910	363	25	190	13	23	215	179	7	265	155	204	297	1936
1911	537	254	446	49	123	220	200	61	226	123	34	240	2513
1912	37	99	209	100	51	135	478	41	69	60	258	327	1864
1913	44	117	644	71	777	768	98	94	182	179	225	63	3262
1914	161	18	720	238	121	52	357	18	206	54	170	353	2468
1915	301	22	69	43	50	88	73	146	357	279	37	197	1662
1916	202	310	198	72	58	84	149	137	370	341	258	348	2527
1917	384	218	80	107	89	93	38	130	191	194	286	210	2020
1918	370	168	202	187	30	85	286	129	89	220	145	86	1997
1919	3	1127	131	218	299	99	79	427	136	128	125	601	3373
1920	739	88	273	89	39	60	115	153	203	341	140	602	2842

Appendix 1
Sheet 3

BOMBALA RAINFALL STATISTICS
(Points)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
1921	237	389	210	355	117	78	63	68	97	226	324	443	2607
1922	264	305	66	46	110	142	972	288	421	155	62	383	3214
1923	249	5	78	8	38	181	199	48	559	280	295	312	2252
1924	336	229	127	199	59	115	96	79	101	86	368	568	2363
1925	270	171	144	224	1116	135	363	78	46	210	83	89	2929
1926	510	0	283	124	138	209	123	121	141	133	91	151	2024
1927	373	69	84	191	316	24	244	66	220	440	161	179	2367
1928	181	517	785	207	101	407	55	45	139	107	42	352	2938
1929	90	686	79	135	204	113	41	480	135	188	700	260	3111
1930	41	203	90	57	204	544	72	99	134	329	132	398	2303
1931	224	81	274	170	320	287	155	92	180	241	370	68	2462
1932	20	309	280	210	241	77	576	388	229	192	185	282	2989
1933	216	19	71	88	159	384	240	163	230	266	318	520	2674
1934	1317	307	134	473	47	455	453	444	96	339	416	198	4679
1935	419	543	92	586	64	59	56	111	140	190	194	374	2828
1936	269	373	139	266	49	462	132	130	78	75	106	622	2701
1937	224	153	325	51	77	310	110	146	222	396	148	307	2469
1938	499	181	381	81	62	90	192	348	213	131	207	10	2395

BOMBALA RAINFALL STATISTICS
(Points)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
1939	298	179	517	417	115	120	102	617	95	186	261	39	2946
1940	180	100	2	556	151	122	28	88	375	39	258	317	2216
1941	538	57	177	207	55	170	82	131	128	86	188	148	1967
1942	25	258	402	44	167	199	138	59	184	295	518	101	2390
1943	527	98	49	158	241	119	25	399	188	401	168	307	2680
1944	57	2	149	443	699	44	61	102	29	292	76	109	2063
1945	401	264	134	379	170	257	105	70	91	223	170	122	2386
1946	128	418	227	128	268	590	26	111	101	180	289	146	2612
1947	44	261	367	347	6	72	118	126	75	117	215	383	2131
1948	305	332	60	359	238	94	28	10	90	321	138	525	2500
1949	302	154	391	20	277	555	201	44	129	251	352	98	2774
1950	391	632	585	272	265	135	156	106	88	644	312	182	3768
1951	185	788	3	161	42	530	163	391	411	255	337	53	3319
1952	33	181	303	559	155	932	170	214	108	483	586	584	4308
1953	137	194	46	54	704	121	71	260	85	188	117	146	2123
1954	213	370	3	68	28	215	83	29	93	211	632	232	2177
1955	141	259	284	15	197	148	33	35	133	321	65	489	2120
1956	742	538	460	145	468	691	326	93	160	253	206	88	4170

Appendix 1
Sheet 5

BOMBALA RAINFALL STATISTICS
(Points)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
1957	1	250	126	31	100	246	592	400	80	135	110	233	2304
1958	203	281	83	80	51	246	140	78	262	132	196	311	2063
1959	99	263	233	194	35	376	431	137	392	599	286	365	3410
1960	507	52	330	71	288	167	541	54	333	204	201	564	3312
1961	298	192	700	120	101	165	420	224	382	169	488	367	3626
1962	506	238	151	105	117	24	49	60	211	149	93	436	2139
1963	545	338	156	206	377	174	290	110	153	88	220	240	2897
1964	18	164	85	546	126	147	107	461	72	217	221	182	2346
1965	10	54	24	98	26	67	62	404	103	169	301	85	1403
1966	194	109	299	63	57	320	186	80	121	303	431	628	2791

Appendix 2
Sheet 1

BURRAGATE RAINFALL STATISTICS
(Points)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
1900	NO RECORDS										79	83	
1901	140	80	191	216	15	192	185	1029	166	295	159	73	2741
1902	363	83	371	102	10	259	1209	71	121	307	140	1006	4042
1903	42	171	123	80	264	198	478	117	563	148	272	372	2828
1904	282	371	108	265	99	105	400	330	140	101	59	45	2305
1905	210	96	183	262	505	105	190	188	213	923	39	179	3093
1906	36	99	1056	25	105	15	75	405	209	267	187	324	2803
1907	391	71	318	174	90	389	0	156	13	110	167	427	2306
1908	178	157	60	159	112	224	63	568	334	222	182	33	2292
1909	273	477	32	55	10	811	334	36	187	110	30	323	2678
1910	808	137	258	8	4	272	181	3	217	205	193	299	2585
1911	1549	424	877	23	129	270	183	166	366	446	126	224	4783
1912	30	132	442	100	82	269	815	32	105	71	248	348	2674
1913	93	235	798	450	1027	1156	81	31	343	310	155	20	4699
1914	88	9	1233	694	63	0	578	0	387	141	232	326	3751
1915	69	39	63	134	43	89	59	150	793	167	13	69	1688
1916	237	435	252	42	0	76	182	64	670	628	372	574	3532
1917	308	177	83	188	0	129	19	96	98	59	622	167	1946

Appendix 2
Sheet 2

BURRAGATE RAINFALL STATISTICS
(Points)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
1918	717	387	101	0	0	284	581	85	69	175	168	77	2644
1919	0	2156	339	116	408	0	0	311	126	83	373	766	4678
1920	795	37	92	229	0	0	90	160	135	571	149	679	2937
1921	101	673	208	398	178	130	47	73	103	194	276	494	2875
1922	575	404	0	0	130	104	1440	359	399	156	53	144	3764
1923	73	25	0	30	18	203	170	47	815	260	200	292	2133
1924	318	225	227	272	50	139	186	85	63	52	307	680	2604
1925	354	325	165	119	2019	290	280	81	0	146	77	94	3950
1926	640	0	375	254	136	201	64	80	180	103	20	105	2158
1927	504	37	67	315	328	0	219	93	140	379	135	17	2234
1928	246	516	1254	136	115	482	36	0	90	52	30	0	2957
1929	55	1450	204	432	155	0	15	660	46	266	503	134	3920
1930	25	148	185	45	263	441	145	65	47	493	97	325	2279
1931	152	88	279	238	365	96	46	0	122	146	130	43	1705
1932	12	181	367	299	336	23	444	262	314	177	160	283	2858
1933	287	0	167	106	249	311	193	170	181	200	281	515	2660
1934	1280	761	50	1122	177	520	606	432	24	230	217	162	5581
1935	299	532	0	439	0	63	13	29	187	306	141	247	2256

Appendix 2
Sheet 3

BURRAGATE RAINFALL STATISTICS
(Points)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
1936	246	318	427	293	0	481	212	219	61	33	68	671	3029
1937	189	84	417	25	48	449	48	159	122	345	0	353	2239
1938	257	358	328	25	39	70	159	638	91	177	296	22	2460
1939	409	159	360	514	104	105	49	912	0	111	334	0	3057
1940	188	84	14	530	112	0	0	16	303	23	130	298	1698
1941	329	139	182	223	0	149	0	84	143	66	150	50	1515
1942	19	267	425	26	142	82	108	0	18	459	817	0	2363
1943	243	30	27	62	194	90	0	283	74	336	81	144	1564
1944	88	5	64	189	1619	0	0	0	26	85	0	0	2076
1945	431	71	126	870	0	543	199	0	10	174	199	0	2623
1946	157	399	204	0	0	764	0	0	103	NO RECORDS			
1947	0	420	150	652	0	150	21	141	75	155	270	478	2512
1948	407	212	17	379	480	315	22	10	26	275	73	264	2480
1949	302	139	346	13	380	630	299	0	304	185	670	70	3338
1950	374	940	863	635	260	302	318	245	54	777	255	99	5122
1951	210	841	0	0	43	901	111	554	541	196	229	104	3730
1952	0	84	367	860	106	1630	192	138	0	633	490	411	4911
1953	270	144	27	17	1302	52	NO RECORDS						

BURRAGATE RAINFALL STATISTICS
(Points)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
1954							NO RECORDS						
1955	33	297	481	17				NO RECORDS					
1956	517	1766						NO RECORDS					
1957-1960							NO RECORDS						
1961	92	265	579	46	135	162	753	220	629	N.R.	903	481	
1962	433	490	150	198	81	16	90	230	390	68	130	829	3105
1963	230	243	256	495	936	490	460	N.R.	278	396	209	N.R.	
1964	66	137	76	1043	53	183	0	964	14	282	181	242	3241
1965	51	6	9	114	38	107	57	369	41	205	300	206	1503
1966	212	129	230	54	39	447	197	85	174	307	717	639	3230

EDEN RAINFALL STATISTICS
(Points)

Appendix 3
Sheet 1

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
1869		NO	RECORDS		899	307	24	54	171	499	487	216	
1870	306	77	1963	1216	690	244	729	121	142	507	295	467	6757
1871	457	1235	150	254	1200	564	79	69	153	827	239	147	5374
1872	419	115	192	103	29	83	143	92	261	383	321	322	2463
1873	511	1653	68	889	40	715	88	166	207	184	810	47	5378
1874	292	880	775	214	360	589	471	275	245	144	137	167	4549
1875	81	238	144	410	1778	223	140	151	96	360	168	572	4361
1876	381	78	153	100	208	240	449	115	436	463	698	171	3492
1877	25	30	370	147	516	190	274	45	613	325	50	499	3084
1878	52	830	330	39	133	109	23	17	188	81	648	251	2701
1879	437	330	410	108	537	63	207	458	703	205	465	123	4046
1880	112	561	398	473	309	214	529	133	233	273	274	177	3686
1881	153	228	362	202	225	363	47	131	127	452	343	310	2943
1882	143	74	120	316	330	381	16	259	16	521	217	213	2606
1883	504	218	96	299	272	26	215	52	319	384	222	102	2709
1884	308	125	191	785	405	130	98	134	43	336	106	38	2699
1885	684	155	100	95	38	208	91	3	75	40	185	232	1906
1886	560	287	659	265	93	35	173	381	100	268	149	280	3250

Appendix 3
Sheet 2

EDEN RAINFALL STATISTICS
(Points)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
1887	572	281	177	261	108	595	177	169	133	324	597	307	3701
1888	110	103	281	2	103	77	29	210	186	30	77	454	1662
1889	302	128	25	264	501	348	118	120	155	229	330	140	2660
1890	131	384	631	132	543	784	547	196	284	238	173	99	4142
1891	433	204	55	502	50	2275	595	496	342	243	508	192	5895
1892	362	117	234	431	120	302	195	135	748	1045	380	99	4168
1893	886	153	268	943	174	262	464	55	303	216	392	957	5073
1894	338	171	840	361	90	618	43	44	320	73	34	91	3023
1895	667	206	98	62	178	157	41	395	192	24	2	146	2168
1896	128	435	74	16	439	931	36	431	302	203	270	187	3452
1897	399	407	137	151	141	295	61	150	162	105	16	183	2207
1898	32	1885	41	7	427	182	105	314	76	187	55	140	3451
1899	305	14	102	531	230	370	262	817	169	158	156	55	3169
1900	223	49	248	260	1392	361	258	77	147	53	217	69	3354
1901	171	157	217	402	23	334	149	834	230	205	91	58	2871
1902	601	51	337	102	51	230	868	492	57	311	106	1050	4256
1903	31	10	123	45	285	176	522	103	419	98	147	158	2117
1904	344	293	236	222	130	93	582	187	133	179	19	174	2592

Appendix 3
Sheet 3

EDEN RAINFALL STATISTICS
(Points)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
1905	175	50	99	385	583	129	192	213	251	811	15	242	3145
1906	28	38	1024	42	252	28	64	239	160	215	148	134	2372
1907	275	142	414	119	210	764	6	351	15	112	180	532	3120
1908	143	211	128	252	56	169	85	291		NO RECORDS			
1909							NO RECORDS						
1910	717	77	389	0	14	194	275	35	223	338	192	147	2601
1911	1661	177	845	47	155	214	58	200	174	111	129	202	3973
1912	31	102	508	116	282	472	817	116	89	61	241	272	3107
1913	115	135	688	266	961	960	133	37	344	347	164	64	4214
1914	87	8	988	688	163	29	560	2	368	148	249	323	3613
1915	220	23	86	610	88	71	44	262	596	245	51	88	2384
1916	190	571	566	217	64	153	235	88	540	327	428	412	3791
1917	300	239	187	202	311	197	52	152	170	59	866	109	2844
1918	782	247	105	173	92	365	673	178	40	224	160	101	3140
1919	0	1553	170	128	705	48	72	634	259	104	296	789	4758
1920	795	24	265	124	51	38	81	252	268	439	119	552	3008
1921	120	498	112	369	246	274	70	75	113	311	200	485	2873
1922	513	152	39	19	174	117	567	521	849	145	59	144	3299

Appendix 3
Sheet 4

EDEN RAINFALL STATISTICS
(Points)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
1923	123	54	32	87	14	257	258	53	620	361	210	210	2279
1924	299	345	301	211	124	148	222	93	122	149	359	655	3028
1925	287	355	120	91	1259	282	261	60	40	127	105	62	3049
1926	810	0	744	289	205	157	81	240	191	139	37	221	3114
1927	390	52	101	524	327	33	236	18	250	360	207	30	2528
1928	364	826	942	200	162	579	49	27	94	111	66	60	3480
1929	36	1210	191	540	227	113	19	682	134	261	393	239	4045
1930	55	135	218	65	424	790	439	111	98	533	82	545	3495
1931	155	134	748	340	402	282	286	31	113	135	132	132	2890
1932	14	371	332	487	316	31	580	315	606	337	398	406	4193
1933	1900	15	242	104	288	248	257	314	147	256	306	474	4551
1934	1013	674	85	1347	140	813	476	424	91	273	346	192	5874
1935	339	575	108	602	81	204	85	115	246	309	304	327	3295
1936	161	261	338	276	139	210	428	441	51	58	165	662	3190
1937	569	153	445	21	51	621	57	236	275	485	101	806	3820
1938	457	595	362	78	66	378	182	215	205	306	602	41	3487
1939	439	157	469	613	183	177	76	932	59	148	342	32	3627
1940	150	90	36	472	206	31	28	44	494	62	285	550	2448

EDEN RAINFALL STATISTICS
(Points)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
1941	484	133	274	484	36	145	38	142	371	82	155	123	2467
1942	16	199	451	55	158	139	117	24	68	493	1409	40	3169
1943	460	74	56	108	280	307	6	554	140	323	142	426	2876
1944	74	3	122	302	838	37	131	251	18	308	28	102	2214
1945	383	306	102	657	167	540	163	151	99	191	216	94	3069
1946	285	496	283	157	146	1054	30	167	178	167	545	201	3709
1947	60	379	126	1095	130	325	88	206	110	178	306	634	3637
1948	792	201	116	716	478	187	78	15	73	385	93	255	3389
1949	609	439	370	32	613	963	348	37	412	402	661	148	5034
1950	496	1456	1440	923	476	359	560	344	199	559	237	124	7173
1951	274	595	25	102	229	1160	176	797	613	325	193	158	4647
1952	42	134	889	907	346	1155	190	254	48	1092	1101	441	6599
1953	344	154	112	87	1081	85	27	402	69	267	213	263	3104
1954	497	594	13	94	50	258	146	179	75	168	534	155	2763
1955	127	427	306	28	334	64	172	23	145	314	106	403	2449
1956	390	1131	1131	171	1190	859	271	92	190	427	156	215	6223
1957	9	349	84	38	85	201	524	764	99	150	110	195	2608
1958	352	365	81	72	45	207	81	284	476	269	196	527	2955

Appendix 3
Sheet 6

EDEN RAINFALL STATISTICS
(Points)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
1959	163	179	657	170	83	395	405	98	434	859	400	396	4239
1960	169	115	344	35	310	287	533	60	767	320	384	739	4063
1961	187	221	1038	193	118	236	834	293	799	150	847	856	5772
1962	498	281	161	166	230	25	109	429	374	163	181	789	3406
1963	256	226	331	344	806	934	533	208	378	224	383	557	5180
1964	55	385	51	1104	112	322	28	458	77	281	344	234	3451
1965	60	56	5	284	147	217	52	346	65	198	378	317	2125
1966	73	265	309	68	80	560	178	98	259	432	435	583	3340

Appendix 4
Sheet 1

PAMBULA RAINFALL STATISTICS
(Points)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
1909	268	610	87	16	8	888	306	32	73	133	12	195	2628
1910	931	50	482	0	0	276	345	0	207	204	200	241	2936
1911	1830	153	936	16	204	205	162	140	173	64	173	222	4278
1912	52	157	399	70	153	481	809	12	43	49	354	351	2930
1913	41	105	602	259	851	1005	92	0	385	397	85	42	3864
1914	90	17	1255	895	45	0	598	0	342	171	305	201	3919
1915	197	32	149	384	52	120	69	219	580	231	28	116	2177
1916	194	465	268	155	48	57	178	83	547	456	313	346	3110
1917	319	218	208	246	297	243	40	129	140	74	811	143	2868
1918	1233	257	57	67	96	245	620	117	70	177	208	154	3301
1919	7	1361	132	151	665	33	53	351	273	90	232	778	4126
1920	691	26	210	91	0	45	130	194	175	355	129	637	2683
1921	130	343	163	335	257	209	51	77	90	219	238	767	2879
1922	441	294	42	47	237	279	688	329	615	144	68	284	3468
1923	101	94	18	37	14	231	142	47	594	290	224	323	2115
1924	287	462	248	229	109	148	199	70	66	139	298	878	3133
1925	414	265	201	129	1265	332	160	90	16	86	150	56	3164
1926	463	3	602	213	103	182	76	214	223	143	14	235	2471
1927	364	38	76	506	261	0	177	16	195	294	207	64	2198

Appendix 4
Sheet 2

PAMBULA RAINFALL STATISTICS
(Points)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
1928	289	553	1006	147	133	937	51	28	84	118	231	119	3696
1929	50	1240	127	490	122	54	26	539	138	274	437	254	3751
1930	37	109	366	128	505	621	439	58	85	473	58	307	3186
1931	107	89	427	238	333	156	169	14	135	99	121	105	1993
1932	22	197	365	350	230	33	485	215	658	280	355	381	3571
1933	1081	0	296	127	298	283	269	286	149	218	320	526	3853
1934	1237	732	172	1554	199	763	442	511	103	320	259	102	6394
1935	284	547	109	699	69	149	48	25	179	229	253	236	2827
1936	271	252	439	249	157	214	333	569	62	18	213	1030	3807
1937	646	176	589	0	59	612	42	217	237	500	38	691	3807
1938	487	536	259	51	160	278	218	240	220	439	420	20	3328
1939	681	121	515	563	190	156	67	876	16	154	427	37	3803
1940	152	69	50	497	128	49	0	45	327	37	269	480	2103
1941	497	91	331	329	21	138	22	115	292	121	109	146	2212
1942	28	292	463	58	129	128	76	17	75	703	1346	11	3326
1943	348	64	42	85	318	207	0	594	83	292	132	200	2365
1944	56	6	178	313	1037	27	110	148	24	282	14	102	2297
1945	477	117	112	817	147	545	135	41	87	199	224	132	3033

Appendix 4
Sheet 3

PAMBULA RAINFALL STATISTICS
(Points)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
1946	317	436	251	135	100	879	63	157	145	118	697	141	3439
1947	51	495	143	583	50	246	59	190	125	192	364	700	3198
1948	609	211	28	548	666	346	29	6	42	395	129	231	3240
1949	444	381	498	30	499	831	302	26	401	271	786	57	4526
1950	492	1188	1436	858	473	324	577	377	124	565	263	151	6828
1951	260	493	33	92	100	1180	112	699	654	373	165	95	4256
1952	81	124	733	818	287	1274	201	213	43	1085	734	394	5987
1953	495	62	82	88	1150	53	18	320	53	264	217	182	2984
1954	320	728	0	95	31	191	85	82	80	210	504	101	2427
1955	155	505	231	41	455	65	161	18	130	357	122	374	2614
1956	331	1291	1380	167	1537	978	416	62	224	330	176	137	7029
1957	12	518	123	29	56	200	545	888	109	105	113	184	2882
1958	343	407	181	48	69	328	100	197	348	191	47	496	2755
1959	158	137	813	104	130	399	439	92	307	719	401	265	3964
1960	169	50	319	30	239	196	656	53	863	302	412	906	4195

PAMBULA RAINFALL STATISTICS
(Points)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
1961	233	276	1240	139	57	161	720	302	796	161	950	724	5759
1962	517	389	315	138	154	19	63	418	438	97	198	856	3602
1963	466	217	377	402	947	852	464	261	357	188	421	550	5502
1964	11	279	61	1460	121	297	18	658	40	244	250	205	3644
1965	147	26	9	203	154	184	41	328	46	228	318	297	1981
1966	236	212	406	62	60	584	182	84	251	307	532	488	3404

Appendix 5
Sheet 1

TIMBILLICA RAINFALL STATISTICS
(Points)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
1909					NO	RECORDS				126	10	258	
1910	705	219	224	5	47	558	271	158	224	311	347	228	3297
1911	1325	433	1224	45	164	552	245	262	177	201	118	182	4928
1912	77	94	505	135	148	526	793	174	108	107	258	136	3061
1913	70	82	766	341	767	1221	120	234	470	281	212	61	4625
1914	92	8	849	716	177	90	772	60	394	133	194	385	3870
1915	584	16	105	164	98	178	55	319	582	331	88	119	2639
1916	183	839	274	112	91	117	430	117	810	284	590	324	4171
1917	262	187	198	235	33	302	76	201	180	136	806	168	2784
1918	641	265	158	120	106	593	576	466	112	225	174	143	3579
1919	0	1013	188	137	890	98	248	1066	414	179	238	767	5238
1920	993	89	357	140	225	62	91	436	317	697	176	704	4287
1921	120	571	144	487	228	153	130	225	105	197	196	511	3067
1922	487	325	94	48	195	90	1007	375	529	158	123	212	3643
1923	108	20	25	67	82	349	333	126	719	297	652	223	3001
1924	392	315	365	306	118	115	262	183	197	203	345	431	3232
1925	456	474	175	315	1048	374	577	155	86	144	144	33	3981
1926	680	0	593	413	187	218	101	372	190	157	113	251	3275

Appendix 5
Sheet 2

TIMBILLICA RAINFALL STATISTICS
(Points)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
1927	352	84	93	528	596	69	435	168	367	352	251	38	3333
1928	412	501	961	301	198	562	180	66	86	208	80	63	3618
1929	45	1051	138	487	406	351	239	406	148	202	471	226	4170
1930	20	174	65	61	289	911	354	192	181	477	314	567	3605
1931	158	78	446	346	173	235	352	150	172	285	140	306	2841
1932	8	220	313	529	331	110	728	385	199	239	401	349	3812
1933	1230	40	186	110	470	424	237	310	178	264	237	561	4247
1934	1056	650	88	931	164	1020	354	553	135	418	331	210	5910
1935	372	970	51	645	182	152	73	168	232	339	106	544	3834
1936	368	252	202	395	136	556	465	162	63	104	261	848	3812
1937	359	139	591	98	114	791	124	232	329	564	62	398	3801
1938	396	372	1413	182	101	215	403	282	164	124	276	25	3953
1939	243	115	463	434	134	186	157	837	123	232	225	59	3208
1940	114	74	12	446	325	91	72	53	546	79	133	461	2406
1941	626	10	348	359	84	289	274	325	159	126	109	129	2838
1942	30	162	502	29	228	224	226	68	133	389	1653	72	3716
1943	388	68	37	165	252	387	21	415	231	266	225	493	2948
1944	64	7	199	626	958	56	121	189	117	275	41	71	2724
1945	410	136	256	535	254	422	264	289	102	234	227	24	3153

Appendix 5
Sheet 3

TIMBILLICA RAINFALL STATISTICS
(Points)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
1946	385	479	273	438	501	991	122	401	283	242	282	276	4673
1947	11	238	161	1017	15	223	226	228	145	155	395	314	3128
1948	731	123	9	1106	622	242	75	18	98	347	90	365	3826
1949	568	454	384	77	462	726	543	56	395	327	599	118	4709
1950	257	1044	859	909	775	458	402	260	162	730	315	164	6335
1951	204	514	21	137	193	1109	421	874	856	272	263	141	5005
1952	60	65	858	1051	437	1260	313	475	117	794	752	440	6622
1953	256	100	125	39	1237	173	112	540	119	341	256	127	3425
1954	307	660	15	42	130	578	334	121	71	125	743	94	3220
1955	129	189	194	5	409	195	177	60	130	359	207	727	2781
1956	614	928	511	128	1205	1185	281	266	218	497	189	70	6092
1957	7	254	115	60	216	280	484	588	133	271	264	214	2886
1958	310	418	157	113	49	239	125	167	498	265	148	219	2708
1959	145	357	549	176	54	728	699	156	507	868	380	445	5064
1960	152	50	210	39	448	607	797	118	725	394	380	396	4316

TIMBILLICA RAINFALL STATISTICS
(Points)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
1961	195	176	1114	137	394	237	1047	468	812	165	639	704	6088
1962	398	351	67	274	179	53	82	471	348	280	300	1328	4131
1963	378	316	171	339	723	539	750	199	314	248	598	394	4969
1964	27	336	74	907	164	385	123	572	105	310	238	242	3483
1965	68	39	55	224	141	140	242	414	63	259	769	276	2690
1966	162	733	248	133	138	923	389	129	303	1004	716	953	5831

Appendix 6
Sheet 1

GABO ISLAND RAINFALL STATISTICS
(Points)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
1859			NO RECORDS			297	217	193	311	39	214	447	
1860	264	205	184	403	214	420	312	183	195	264	444	194	3282
1861	499	931	33	414	229	68	234	361	159	149	297	N.R.	
1862							NO RECORDS						
1863	233	698	170	176	151	1133	286	476	584	369	429	207	4912
1864	236	65	937	298	101	404	1242	295	225	609	176	405	4993
1865	165	62	146	99		NO RECORDS			218	63	118	204	
1866			NO RECORDS			551	939	240	324	182	405	555	
1867	166	202	103	480	1708	158	277	326	298	97	0	53	3868
1868	285	133	66	147	70	271	347	413	154	218	373	151	2628
1869	245	646	0	400	475	479	102	190	375	699	508	161	4280
1870	218	56	NO RECORDS		294	528	313	232	129	230	522	194	
1871	260	568	319	185	745	431	206	169	376	472	305	86	4122
1872	98	382	342	399	96	131	568	458	407	277	276	252	3686
1873	382	873	288	433	199	423	384	196	204	189	944	37	4552
1874	245	560	531	47	795	591	239	279	645	86	255	197	4470
1875	59	195	14	457	797	395	296	273	133	396	161	487	3663
1876	170	100	213	204	155	376	622	150	315	347	544	94	3290

Appendix 6
Sheet 2

GABO ISLAND RAINFALL STATISTICS
(Points)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
1877	96	38	129	378	772	174	305	63	531	382	67	90	3025
1878	47	366	319	79	65	202	148	183	161	132	190	108	2000
1879	642	329	367	209	749	339	256	468	622	562	515	135	5193
1880	74	596	764	638	1151	401	355	286	121	499	130	152	5167
1881	64	327	468	328	196	607	221	89	98	588	417	261	3664
1882	157	59	152	406	479	660	373	379	76	387	168	149	3445
1883	261	567	176	240	624	42	400	7[illegible]	221	379	248	81	3315
1884	145	186	275	373	192	142	162	403	190	777	195	229	3269
1885	141	221	202	222	112	400	228	46	143	158	324	250	2447
1886	221	550	246	660	284	126	420	420	194	299	175	363	3968
1887	316	207	233	215	345	752	487	188	438	519	552	304	4556
1888	249	230	724	72	480	172	102	259	172	175	40	475	3150
1889	268	638	66	205	432	1231	207	211	327	375	248	89	4297
1890	58	482	337	287	376	837	659	192	170	370	290	218	4276
1891	317	354	33	550	175	1182	487	461	366	388	277	200	4790
1892	115	98	265	587	203	487	267	278	661	585	424	256	4226
1893	777	30	88	725	368	234	505	205	431	141	586	1050	5140
1894	597	201	319	405	139	473	232	501	372	181	106	124	3650

GABO ISLAND RAINFALL STATISTICS
(Points)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
1895	224	171	157	191	174	391	491	331	358	164	45	160	2857
1896	234	216	197	77	475	1235	309	989	370	375	175	172	4824
1897	632	613	287	243	284	268	130	240	168	93	20	116	3094
1898	39	650	76	46	735	128	226	188	101	283	120	211	2803
1899	548	11	69	720	443	326	519	489	233	462	135	70	4025
1900	202	26	268	791	1178	335	302	134	562	79	57	164	4098
1901	349	27	82	474	105	546	244	448	157	127	82	64	2705
1902	179	39	200	116	78	422	512	404	269	343	106	728	3396
1903	310	28	154	223	825	284	455	86	349	125	348	319	3506
1904	296	393	71	105	335	396	37	462	329	308	99	44	3208
1905	402	194	119	288	891	263	218	135	440	732	61	341	4084
1906	76	82	831	83	175	111	316	213	156	355	341	251	2990
1907	197	67	183	225	284	580	89	295	142	129	218	531	2940
1908	100	158	112	197	143	419	212	390	942	387	73	61	3194
1909	316	711	162	94	111	1161	356	184	180	194	55	237	4061
1910	624	162	269	19	135	781	470	109	260	543	434	257	4063
1911	1007	493	1500	176	463	665	250	160	193	325	229	269	5730
1912	106	224	429	213	188	642	530	504	286	149	359	167	3797

GABO ISLAND RAINFALL STATISTICS
(Points)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
1913	159	80	1063	440	1296	886	272	283	332	286	408	118	5623
1914	84	14	337	652	391	100	533	62	516	117	242	409	3457
1915	423	57	103	345	368	118	101	456	434	380	104	186	
1916	244	506	213	360	197	238	418	151	338	203	971	521	4360
1917	201	182	460	274	105	267	99	273	241	209	458	157	2926
1918	412	228	321	352	206	703	587	384	214	322	195	148	4072
1919	9	466	325	323	786	167	321	484	674	124	132	430	4241
1920	599	46	309	328	447	152	122	575	192	336	106	313	3525
1921	94	238	131	331	401	251	201	436	181	394	187	351	3196
1922	409	265	152	69	357	229	322	343	690	275	61	197	3369
1923	195	19	21	132	146	208	301	210	437	253	532	166	2620
1924	404	250	253	371	283	300	232	139	161	104	400	326	3223
1925	279	215	118	452	610	430	582	205	108	159	180	27	3365
1926	630	13	305	358	345	280	204	360	252	273	111	275	3406
1927	186	104	164	584	552	152	559	215	298	310	190	129	3443
1928	285	465	486	275	189	254	131	80	101	296	122	64	2748
1929	53	673	136	447	374	226	341	348	166	158	305	360	3587
1930	65	139	172	181	237	520	445	251	166	392	198	383	3149

GABO ISLAND RAINFALL STATISTICS
(Points)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
1931	151	111	563	393	234	301	427	182	135	307	107	209	3120
1932	11	205	419	386	240	167	454	265	215	524	290	352	3528
1933	815	75	121	90	465	290	321	188	142	218	165	452	3342
1934	684	532	55	820	443	972	342	367	65	385	232	152	5049
1935	347	530	147	773	183	311	148	138	514	348	69	553	4061
1936	294	221	145	633	167	502	396	98	65	166	234	648	3569
1937	444	44	403	150	123	756	202	264	461	605	80	539	4071
1938	436	285	1018	207	115	385	314	232	114	118	282	34	3540
1939	90	108	420	678	379	284	334	652	121	254	312	117	3749
1940	120	59	6	408	800	207	182	99	366	114	188	263	2812
1941	491	89	306	321	99	315	470	352	179	178	188	126	3114
1942	37	150	356	53	385	230	199	57	364	309	702	77	2919
1943	297	46	65	171	183	958	44	357	234	179	236	224	2994
1944	77	102	228	492	824	115	238	298	118	215	77	94	2878
1945	220	138	194	384	278	187	316	282	171	186	244	39	2639
1946	193	454	250	360	352	947	213	585	318	273	397	174	4516
1947	48	138	249	931	64	418	237	313	198	151	295	353	3395
1948	834	143	18	622	556	213	93	44	74	378	129	266	3370

Appendix 6
Sheet 6

GABO ISLAND RAINFALL STATISTICS
(Points)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
1949	674	454	336	303	544	884	203	109	249	318	677	139	4890
1950	166	1210	887	479	829	542	368	276	215	588	287	198	6045
1951	165	332	52	149	168	1141	410	758	480	300	215	114	4284
1952	34	97	375	417	1029	1064	377	261	100	528	397	433	5112
1953	183	160	190	64	766	225	161	587	74	271	223	134	3038
1954	540	474	45	46	144	606	300	177	92	183	518	68	3193
1955	74	69	137	39	252	232	165	206	167	286	224	450	2301
1956	690	562	478	160	1202	598	187	264	187	437	247	122	5134
1957	17	252	144	119	260	205	571	409	186	216	240	220	2839
1958	323	426	107	97	90	221	155	321	503	458	145	216	3062
1959	72	166	591	197	280	668	662	93	319	483	197	601	4329
1960	115	82	541	92	469	418	405	185	629	294	330	337	3897
1961	145	151	1020	240	474	247	1202	298	674	293	181	494	5419
1962	430	232	35	239	243	113	126	691	212	271	154	820	3566
1963	369	310	115	325	649	707	859	328	414	230	454	270	5030
1964	22	465	101	460	199	265	221	357	141	329	176	195	2931
1965	91	48	80	276	60	125	301	560	106	222	787	125	2781
1966	185	426	233	148	208	413	440	98	363	456	387	1041	4398

STATISTICAL RAINFALL DATA
(Points)

Station	Rainfall Statistic	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Bombala (Period 80 years)	Minimum	1	0	2	3	6	11	4	7	29	10	1	10	1188
	10%	33	22	46	23	30	37	34	41	78	73	38	64	1880
	30%	160	102	97	77	58	102	75	75	103	132	124	147	2150
	50%	245	182	167	133	116	156	135	119	147	199	195	228	2393
	70%	361	262	274	204	192	265	206	194	203	254	269	351	2772
	90%	510	513	511	414	342	554	451	391	369	392	400	560	3406
	Maximum	1317	1127	804	589	1116	1483	972	617	559	644	700	813	4679
Burragate (Period 52 years)	Minimum	0	0	0	0	0	0	0	0	0	23	0	0	1515
	10%	21	27	15	16	0	0	0	0	15	61	30	5	1777
	30%	100	84	100	78	43	90	49	62	74	138	130	77	2306
	50%	246	165	188	189	106	171	152	107	131	181	164	202	2676
	70%	355	373	347	294	180	291	200	220	213	277	249	328	3094
	90%	694	735	843	647	458	604	580	564	498	548	455	677	4693
	Maximum	1549	2156	1254	1122	2019	1630	1440	1029	815	923	817	1006	5581
Eden (Period 93 years)	Minimum	0	0	13	0	14	25	6	2	15	24	2	30	1662
	10%	34	33	55	36	50	37	29	33	58	76	53	61	2410
	30%	151	129	117	103	125	157	81	99	115	159	147	141	2901
	50%	300	204	234	202	208	240	172	169	186	245	210	202	3295
	70%	436	363	368	367	329	363	273	272	282	325	328	382	3814
	90%	704	828	843	757	766	841	564	511	602	501	600	647	5296
	Maximum	1900	1885	1963	1347	1778	2275	868	932	849	1092	1409	1050	7173

STATISTICAL RAINFALL DATA
(Points)

Station	Rainfall Statistic	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Gabo Island (Period 85 years)	Minimum	9	11	6	19	64	42	44	44	65	79	20	27	2301
	10%	51	35	61	75	114	136	128	91	101	126	71	69	2828
	30%	137	104	137	196	195	234	217	188	167	201	143	151	3184
	50%	221	201	202	303	335	326	314	273	215	294	215	218	3506
	70%	347	328	322	405	463	553	406	358	351	375	290	320	4071
	90%	631	564	644	655	824	951	543	502	515	526	456	525	5074
	Maximum	1007	1210	1500	931	1296	1235	1202	989	942	777	971	1050	6045
Pambula (Period 56 years)	Minimum	7	0	0	0	0	0	0	0	16	18	12	11	1993
	10%	34	30	42	30	28	33	25	13	43	82	44	57	2208
	30%	152	110	133	88	100	150	67	54	85	145	152	141	2879
	50%	288	235	250	149	154	223	151	135	147	219	228	227	3271
	70%	461	433	424	334	284	332	306	238	290	294	319	372	3807
	90%	763	729	957	817	880	903	605	576	600	481	708	770	3579
	Maximum	1830	1361	1436	1554	1537	1274	809	888	863	1085	1346	1030	7029
Timbillica (Period 55 years)	Minimum	0	0	9	5	15	53	21	18	63	79	41	24	2406
	10%	24	18	32	41	71	90	76	64	100	126	100	60	2783
	30%	127	99	135	119	146	193	129	166	133	202	186	140	3218
	50%	307	220	199	235	198	302	264	232	181	266	251	228	3716
	70%	400	381	396	435	407	553	407	377	333	328	334	396	4186
	90%	715	875	858	908	821	1003	759	561	627	524	644	704	5507
	Maximum	1325	1051	1413	1106	1237	1260	1047	1066	856	868	1653	1320	6622

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

Station	Number of Months	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Gabo Island	1	9	11	6	19	64	42	44	44	65	79	20	27
	2	98	40	91	154	286	219	137	118	231	113	134	117
	3	185	172	235	369	466	350	211	329	281	229	175	211
	4	319	318	507	563	654	424	575	521	397	268	364	302
	5	513	526	670	884	755	802	651	637	436	491	493	387
	6	721	827	991	1030	1051	919	767	676	648	691	625	639
	7	968	1037	1198	1309	1173	1035	806	978	848	807	758	871
	8	1174	1267	1484	1446	1237	1074	1292	1296	964	885	979	1036
	9	1341	1553	1708	1512	1290	1513	1532	1357	1042	1254	1280	1242
	10	1627	1777	1849	1565	1792	1707	1578	1490	1464	1555	1490	1409
	11	1851	2227	1888	1999	2084	1846	1734	1841	1829	1765	1927	1695
	12	2301	2501	2322	2327	2130	2280	2141	2006	2035	2110	2180	1919
Pambula	1	7	0	0	0	0	0	0	0	16	18	12	11
	2	62	106	55	0	45	49	35	48	80	145	116	127
	3	213	149	69	136	175	94	77	104	218	292	217	149
	4	250	163	300	266	222	296	281	250	308	347	234	308
	5	264	372	402	408	425	458	502	398	482	544	565	534
	6	495	502	484	483	586	605	558	496	679	709	602	548
	7	637	583	564	774	818	707	665	693	905	746	616	779
	8	684	871	774	1119	964	821	862	1058	1260	760	847	921
	9	1266	1202	1278	1293	992	1018	1227	1408	1375	991	989	968
	10	1354	1355	1379	1321	1284	1383	1577	1603	1579	1133	1036	1354
	11	1623	1715	1534	1568	1668	1733	1765	1671	1579	1180	1521	1391
	12	1993	1743	1944	1881	1805	1913	1840	1957	1624	1642	1818	1660

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

Station	Number of Months	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Timbillica	1	0	0	9	5	15	53	21	18	63	79	41	24
	2	71	45	57	52	208	135	93	116	167	212	112	77
	3	153	112	174	320	314	216	191	317	374	321	188	161
	4	220	194	427	495	541	433	538	440	407	394	373	259
	5	302	543	600	693	792	758	620	503	482	556	484	432
	6	651	616	850	908	928	799	683	548	715	646	555	514
	7	984	935	1170	1163	1234	870	728	935	839	713	637	863
	8	1110	1359	1361	1542	1443	1[illegible]0	1314	1495	1242	795	986	1193
	9	1488	1548	1736	1744	1488	1416	1616	1571	1324	1144	1319	1246
	10	1810	1831	1980	1789	1687	1672	1845	1699	1673	1477	1445	1562
	11	1945	2055	2125	2046	2118	2134	2073	2023	1773	1603	1840	1871
	12	2406	2238	2394	2531	2218	2362	2297	2249	1826	1966	2096	2004

TOWAMBA RIVER AT NEW BUILDING BRIDGE

LOCATION:	Latitude 36°58' Longitude 149°33'
PERIOD OF ESTABLISHMENT:	May 1954 to date.
COMPLETE YEARS OF COMPUTED RECORDS:	12
ZERO OF GAUGE:	R.L. 68.88 Assumed Datum.
CATCHMENT AREA:	114 square miles.
CONTROL:	Gravel.
EQUIPMENT:	Staff gauge, range 0 to 25 feet.
CURRENT METER OBSERVATIONS:	(a) Number obtained : 78
	(b) Maximum observation in cusecs : 997
	(c) Minimum observation in cusecs : 1.6
MAXIMUM ESTIMATED DISCHARGE DURING PERIOD OF RECORDS:	28,400 cusecs.
MEAN DAILY DISCHARGE FOR 12 YEARS:	109 cusecs.
MEAN ANNUAL DISCHARGE FOR 12 YEARS:	79,900 acre feet.

TOWAMBA RIVER AT NEW BUILDING BRIDGE

Year 1954

Month	Discharge in Cusecs			Discharge for Month Acre Feet
	Max.	Min.	Mean	
Jan.	..	..	..	..
Feb.	..	..	..	..
Mar.	..	..	..	..
Apr.	..	..	..	..
May	..	..	..	..
June	43	8	14	852
July	20	8	10	594
Aug.	11	6	8	498
Sept.	13	5	8	468
Oct.	13	1	5.2	322
Nov.	285	5	37	2,196
Dec.	13	3	6	352
Total	..	..	..	..

Year 1955

Month	Discharge in Cusecs			Discharge for Month Acre Feet
	Max.	Min.	Mean	
Jan.	8	0.5	2.5	157
Feb.	73	5	11	598
Mar.	20	5	9	556
Apr.	8	3	4	262
May	865	13	81	5,030
June	43	13	24	1,414
July	20	13	13	834
Aug.	13	5	9	562
Sept.	5	5	5	300
Oct.	73	4	10	638
Nov.	8	2	4	238
Dec.	155	1.5	18	1,095
Total	..	..	..	11,684

Year 1956

Jan.	155	5	25	1,566
Feb.	28400	8	1951	113,100
Mar.	1550	67	415	25,700
Apr.	325	67	126	7,594
May	3320	67	450	27,900
June	18600	79	1216	73,000
July	1005	91	257	15,950
Aug.	105	67	75	4,666
Sept.	67	56	57	3,404
Oct.	325	45	64	3,980
Nov.	67	34	37	2,216
Dec.	34	15	24	1,494
Total	..	..	..	280,570

Year 1957

Jan.	15	15	15	930
Feb.	34	9	19	1,048
Mar.	34	9	14	842
Apr.	9	9	9	540
May	23	9	10	622
June	105	9	21	1,288
July	5730	15	395	24,500
Aug.	4860	23	412	25,600
Sept.	160	34	54	3,252
Oct.	34	15	25	1,570
Nov.	34	15	18	1,056
Dec.	15	9	10	642
Total	..	..	..	61,900

TOWAMBA RIVER AT NEW BUILDING BRIDGE

Year 1958

Month	Discharge in Cusecs			Discharge for Month Acre Feet
	Max.	Min.	Mean	
Jan.	67	5	12	772
Feb.	56	15	27	1,494
Mar.	15	9	12	726
Apr.	23	9	11	656
May	9	9	9	558
June	670	9	32	1,926
July	91	9	19	1,198
Aug.	15	9	10	594
Sept.	67	9	19	1,144
Oct.	23	5	12	742
Nov.	56	3	8	486
Dec.	34	5	10	612
Total	..	..	..	10,908

Year 1959

Month	Discharge in Cusecs			Discharge for Month Acre Feet
	Max.	Min.	Mean	
Jan.	15	3	6	350
Feb.	9	0	4	242
Mar.	160	3	22	1,350
Apr.	67	5	16	982
May	5	5	5	310
June	670	5	37	2,236
July	3780	9	178	11,000
Aug.	79	23	36	2,220
Sept.	735	15	55	3,270
Oct.	13100	23	694	43,100
Nov.	670	56	128	7,700
Dec.	105	23	47	2,888
Total	..	..	..	75,666

Year 1960

Jan.	56	23	35	2,152
Feb.	23	15	17	998
Mar.	67	9	22	1,340
Apr.	15	9	11	684
May	45	9	15	924
June	120	9	17	1,002
July	10500	9	543	33,700
Aug.	45	23	28	1,756
Sept.	250	15	71	4,284
Oct.	91	23	38	2,354
Nov.	34	15	21	1,258
Dec.	1470	15	96	5,980
Total	..	..	..	56,432

Year 1961

Jan.	45	15	19	1,156
Feb.	56	9	13	726
Mar.	615	15	66	4,088
Apr.	56	23	29	1,754
May	34	15	18	1,118
June	140	15	34	2,062
July	2740	34	271	16,800
Aug.	505	45	101	6,260
Sept.	3090	91	463	27,800
Oct.	85	50	69	4,250
Nov.	No Records			58,700*
Dec.	No Records			58,900*
Total	..	..	..	183,614*

* Estimated.

TOWAMBA RIVER AT NEW BUILDING BRIDGE

Year 1962

Month	Discharge in Cusecs			Discharge for Month Acre Feet
	Max.	Min.	Mean	
Jan.	No Records			11,300*
Feb.	835	85	209	11,700
Mar.	180	67	87	5,394
Apr.	67	50	52	3,136
May	58	44	50	3,104
June	50	34	36	2,168
July	50	23	28	1,764
Aug.	130	23	34	2,118
Sept.	1090	15	105	6,298
Oct.	34	15	23	1,408
Nov.	34	15	19	1,122
Dec.	405	12	73	4,528
Total	..	..	..	54,040*

Year 1963

Month	Discharge in Cusecs			Discharge for Month Acre Feet
	Max.	Min.	Mean	
Jan.	210	17	31	1,908
Feb.	210	23	50	2,818
Mar.	105	23	30	1,842
Apr.	No Records			4,800*
May	No Records			15,900*
June	1800	67	445	26,700
July	895	85	203	12,600
Aug.	210	51	69	4,270
Sept.	440	44	83	4,980
Oct.	155	38	58	3,620
Nov.	240	33	53	3,170
Dec.	955	27	137	8,520
Total	..	..	..	91,128*

Year 1964

Month	Discharge in Cusecs			Discharge for Month Acre Feet
	Max.	Min.	Mean	
Jan.	38	18	26	1,640
Feb.	51	18	21	1,170
Mar.	18	11	15	905
Apr.	5400	11	338	20,300
May	No Records			3,400*
June	210	34	65	3,870
July	34	34	34	2,100
Aug.	9480	15	712	44,200
Sept.	180	34	68	4,090
Oct.	34	23	28	1,750
Nov.	50	15	24	1,440
Dec.	31	17	21	1,300
Total	..	..	..	86,165*

Year 1965

Month	Discharge in Cusecs			Discharge for Month Acre Feet
	Max.	Min.	Mean	
Jan.	21	10	13	820
Feb.	10	6.7	6.9	388
Mar.	6.6	4	6.1	378
Apr.	13	5.2	6.5	390
May	9.0	6.1	6.2	384
June	10	6.1	6.6	398
July	11	5.2	8.7	540
Aug.	130	7	24	1,460
Sept.	7	4	6.7	400
Oct.	39	3.3	9	556
Nov.	10	2.5	7.1	424
Dec.	300	2	18	1,080
Total	..	..	..	7,218

* Estimated.

TOWAMBA RIVER AT NEW BUILDING BRIDGE

Month	Year 1966 Discharge in Cusecs			Discharge for Month Acre Feet	Month	Year 1967 Discharge in Cusecs			Discharge for Month Acre Feet
	Max.	Min.	Mean			Max.	Min.	Mean	
Jan.	8.5	1	2.6	160	Jan.	85	10.8	23	1,410
Feb.	8.5	1	1.8	102	Feb.	18	5.6	10	558
Mar.	23	1	3.9	240	Mar.	10.8	4.4	6.2	385
Apr.	2	1	1.1	68	Apr.	8.2	3.3	4.3	257
May	2	1.2	1.8	111	May	10.8	3.3	4.6	286
June	155	2	17	1,050	June	38	5.6	10.4	625
July	23	4	7.4	460	July				
Aug.	7	5.5	5.7	356	Aug.				
Sept.	67	5.3	11	680	Sept.				
Oct.	210	53	27	1,290	Oct.				
Nov.	10500	7	493	29,600	Nov.				
Dec.	405	30	79	4,890	Dec.				
Total	..	..	..	39,007	Total	..	..	..	..

STOCKYARD CREEK AT ROCKY HALL

LOCATION:	Latitude 36°57' Longitude 149°30'
PERIOD OF ESTABLISHMENT:	February 1960 to date.
COMPLETE YEARS OF COMPUTED RECORDS:	6
ZERO OF GAUGE:	R.L. 94.69 Assumed Datum.
CATCHMENT AREA:	28 square miles.
CONTROL:	Rock.
EQUIPMENT:	Staff gauge, range 0 to 5 feet.
CURRENT METER OBSERVATIONS:	(a) Number obtained : 51
	(b) Maximum observation in cusecs : 46
	(c) Minimum observation in cusecs : 0.4
MAXIMUM ESTIMATED DISCHARGE DURING PERIOD OF RECORDS:	1,600 cusecs.
MEAN DAILY DISCHARGE FOR 6 YEARS:	18 cusecs.
MEAN ANNUAL DISCHARGE FOR 6 YEARS:	13,200 acre feet.

STOCKYARD CREEK AT ROCKY HALL

Year 1960

Month	Discharge in Cusecs			Discharge for Month Acre Feet
	Max.	Min.	Mean	
Jan.	..	..	..	..
Feb.	..	..	..	..
Mar.	20	2.5	5	310
Apr.	4.5	2.2	3.1	185
May	9.2	2.1	3.9	245
June	81	2.8	9.2	550
July	332	6.2	45	2,760
Aug.	15	7.1	9.6	598
Sept.	90	6.6	28	1,650
Oct.	25	8.4	12	729
Nov.	11	6.9	8	478
Dec.	125	6	17	1,060
Total	..	..	..	..

Year 1961

Month	Discharge in Cusecs			Discharge for Month Acre Feet
	Max.	Min.	Mean	
Jan.	14	4.5	6.5	402
Feb.	7.2	3.7	4.7	261
Mar.	100	4.8	18	1,100
Apr.	11	5.7	7	419
May	16	5.4	6.8	422
June	85	5.4	12	712
July	No Records			4,400*
Aug.	209	10	27	1,670
Sept.	466	23	85	5,110
Oct.	23	12	16	1,010
Nov.	1600	8.8	126	7,610
Dec.	1000	18	107	6,620
Total	..	..	..	29,736*

Year 1962

Jan.	496	25	49	3,040
Feb.	1300	18	66	3,680
Mar.	46	13	21	1,270
Apr.	15	9.4	12	711
May	24	8.4	11	674
June	8.4	6.9	7.8	471
July	12	6.3	7.5	463
Aug.	22	6.3	8.1	501
Sept.	125	5.7	20	1,170
Oct.	10	4.7	6.3	391
Nov.	12	3.1	4.9	293
Dec.	100	2.5	16	1,010
Total	..	..	..	13,674

Year 1963

Jan.	20	3.7	6.5	406
Feb.	29	4	9.2	517
Mar.	22	3.4	6.1	378
Apr.	81	3.4	6.1	365
May	408	14	55	3,390
June	408	19	70	4,200
July	193	20	58	3,590
Aug.	47	12	19	1,160
Sept.	100	10	20	1,200
Oct.	45	8.8	14	879
Nov.	35	7.6	10	624
Dec.	118	8	25	1,550
Total	..	..	..	18,259

* Estimated.

STOCKYARD CREEK AT ROCKY HALL

Year 1964

Month	Discharge in Cusecs			Discharge for Month Acre Feet
	Max.	Min.	Mean	
Jan.	8.8	6	7.1	439
Feb.	30	4.8	7.1	410
Mar.	6.3	3.5	4.4	272
Apr.	286	3.8	34	2,070
May	12	4.5	7.1	442
June	35	4.5	12	745
July	8.6	5	6.2	383
Aug.	720	4.5	48	2,950
Sept.	41	8.6	15	919
Oct.	12	5.6	8.1	505
Nov.	15	3.8	5.8	348
Dec.	10	3.8	4.4	271
Total	..	..	..	9,754

Year 1965

Month	Discharge in Cusecs			Discharge for Month Acre Feet
	Max.	Min.	Mean	
Jan.	4.7	2	2.5	154
Feb.	2.7	1.5	1.9	106
Mar.	1.9	1.1	1.2	74
Apr.	6.2	1.1	2	118
May	1.8	1.3	1.5	94
June	3.8	1.2	1.7	99
July	3.5	1.5	1.8	115
Aug.	47	1.3	5.8	362
Sept.	2.7	1	1.8	107
Oct.	7.3	0.7	1.7	109
Nov.	7.3	0.8	1.8	107
Dec.	41	0.3	3.4	208
Total	..	..	..	1,653

Year 1966

Jan.	2	0.1	0.3	20
Feb.	2	0	0.5	30
Mar.	4	0.2	1.2	73
Apr.	0.5	0.2	0.3	19
May	1.1	0.3	0.5	29
June	46	0.4	4	242
July	20	0.8	2.6	159
Aug.	4.1	0.8	1.5	93
Sept.	16	1	2.7	160
Oct.	112	1	9.2	571
Nov.	1000	1.3	56	3,330
Dec.	90	4.1	19	1,190
Total	..	..	..	5,916

Year 1967

Jan.	16.7	2.2	4.6	288
Feb.	3.3	0.9	1.3	74
Mar.	2.4	0.8	1.1	68
Apr.	2.4	0.7	1	60
May	4.4	0.7	1.2	76
June	9.4	1.2	2.8	165
July				
Aug.				
Sept.				
Oct.				
Nov.				
Dec.				
Total	..	..	..	..

GENOA RIVER AT WANGRABELLE

LOCATION:	Latitude 37° 23' Longitude 149° 29'		
PERIOD OF ESTABLISHMENT:	April 1922 to June 1929 October 1958 to date		
COMPLETE YEARS OF COMPUTED RECORDS:	10		
CATCHMENT AREA:	293 square miles		
CONTROL:	Concrete Bar		
EQUIPMENT:	Automatic Recorder (Float type) installed April 1966.		
CURRENT METER OBSERVATIONS:	(a) Number obtained	:	59
	(b) Maximum observation in cusecs	:	1,087
	(c) Minimum observation in cusecs	:	4.7
MAXIMUM ESTIMATED DISCHARGE DURING PERIOD OF RECORDS:	9,250 cusecs		
MEAN DAILY DISCHARGE FOR 10 YEARS:	115 cusecs		
MEAN ANNUAL DISCHARGE FOR 10 YEARS:	83,800 acre feet		

REMARKS:

Records supplied by State Rivers and Water Supply Commission of Victoria.

Station 1 which was finally abandoned in 1929, was at the ford near Wangrabelle.

Station 2 which was established in October 1958 and abandoned in March 1966 was located 4 miles upstream from Station 1.

Station 3 was established in April 1966 and is located downstream of Wangrabelle Creek junction.

GENOA RIVER AT WANGRABELLE

Year 1922

Month	Discharge in cusecs			Discharge for Month Acre Feet
	Max.	Min.	Mean	
Jan.	..	..	..	..
Feb.	..	..	..	..
Mar.	..	..	..	..
Apr.	..	..	..	..
May	10	7	8.3	514
June	10	7	8.8	524
July	7500	7	504	31,000
Aug.	2880	66	617	38,000
Sept.	365	10	177	10,500
Oct.	265	112	160	9,810
Nov.	148	13	93	5,530
Dec.	21	4	13	789
Total				

Year 1923

Month	Discharge in cusecs			Discharge for Month Acre Feet
	Max.	Min.	Mean	
Jan.	5	2	3.2	199
Feb.	3	1	2	113
Mar.	1	1	1	61
Apr.	1	1	1	60
May	1	1	1	61
June	2.5	1	1.5	88
July	50	2	24	1,470
Aug.	5	3	3.9	238
Sept.	3770	3	353	21,000
Oct.	445	2	56	3,460
Nov.	736	2	73	4,320
Dec.	66	37	48	2,940
Total	..	..	..	34,010

Year 1924

Jan	37	16	27	1,656
Feb.	66	16	42	2,440
Mar.	26	16	21	1,285
Apr.	26	16	21	1,238
May	26	19	22	1,331
June	22	13	19	1,137
July	66	7	25	1,549
Aug.	66	10	29	1,797
Sept.	66	10	43	2,574
Oct.	66	43	56	3,437
Nov.	66	7	28	1,659
Dec.	112	50	71	4,395
Total	..	..	..	24,498

GENOA RIVER AT WANGRABELLE

Year 1927

Month	Discharge in cusecs			Discharge for Month Acre Feet
	Max.	Min.	Mean	
Jan.	..	..	..	..
Feb.	..	..	..	..
Mar.	..	..	..	..
Apr.	..	..	..	..
May	..	..	..	..
June	..	..	..	..
July	..	..	..	..
Aug.	..	..	..	..
Sept.	..	..	..	..
Oct.	..	..	..	..
Nov.	77	15	44	2,624
Dec.	41	10	23	1,414
Total				

Year 1928

Month	Discharge in cusecs			Discharge for Month Acre Feet
	Max.	Min.	Mean	
Jan.	43	2	20	1,219
Feb.	175	13	79	4,560
Mar.	9250	132	1025	63,000
Apr.	327	59	151	8,970
May	525	45	97	5,950
June	5220	43	473	28,200
July	465	66	215	13,200
Aug.	59	27	40	2,450
Sept.	27	24	25	1,490
Oct.	24	21	23	1,400
Nov.	24	21	21	1,260
Dec.	21	21	21	1,290
Total	..	..	..	132,989

Year 1929

Jan.	21	7	13	787
Feb.	8000	7	2530	140,315
Mar.	327	53	72	4,400
Apr.	53	45	46	2,750
May	1030	45	252	15,500
June	175	81	87	5,190

GENOA RIVER AT WANGRABELLE

Year 1958

Month	Discharge in cusecs			Discharge for Month Acre Feet
	Max.	Min.	Mean	
Jan.	..	..	..	..
Feb.	..	..	..	..
Mar.	..	..	..	..
Apr.	..	..	..	..
May	..	..	..	..
June	..	..	..	..
July	..	..	..	..
Aug.	..	..	..	..
Sept.	..	..	..	..
Oct.	..	..	..	..
Nov.	..	..	..	..
Dec.	121	9	27	1,650
Total				

Year 1959

Month	Discharge in cusecs			Discharge for Month Acre Feet
	Max.	Min.	Mean	
Jan.	27	4.6	8.1	501
Feb.	27	3.6	14	757
Mar.	247	5.4	39	2,390
Apr.	123	8.2	25	1,530
May	9	4.9	6.3	389
June	1300	6.4	100	5,980
July	3380	38	384	23,800
Aug.	869	84	182	11,300
Sept.	4990	53	284	17,000
Oct.	3140	94	423	26,300
Nov.	1520	67	247	14,800
Dec.	420	60	149	9,270
Total	..	..	..	114,017

Year 1960

Jan.	565	26	77	4,760
Feb.	37	18	23	1,350
Mar.	105	14	21	1,280
Apr.	16	7	11	664
May	299	9.6	44	2,700
June	1310	4	153	9,190
July	1340	85	345	21,400
Aug.	152	43	78	4,850
Sept.	1430	36	264	15,900
Oct.	746	42	130	8,070
Nov.	150	60	87	5,210
Dec.	615	36	111	6,880
Total	..	..	..	82,254

Year 1961

Jan.	67	16	28	1,730
Feb.	32	10	15	819
Mar.	2110	15	157	9,710
Apr.	38	23	29	1,670
May	150	23	48	2,970
June	336	25	83	4,970
July	2290	46	512	31,800
Aug.	2240	78	279	17,300
Sept.	3620	82	529	31,700
Oct.	191	58	109	6,740
Nov.	2390	47	240	14,400
Dec.	1840	67	190	11,800
Total	..	..	..	135,609

GENOA RIVER AT WANGRABELLE

Year 1962

Month	Discharge in cusecs			Discharge for Month Acre Feet
	Max.	Min.	Mean	
Jan.	650	62	160	9,940
Feb.	1930	78	256	14,300
Mar.	179	52	88	5,430
Apr.	124	37	52	3,120
May	143	36	55	3,380
June	47	23	35	2,080
July	58	23	30	1,880
Aug.	186	25	45	2,810
Sept.	690	23	92	5,490
Oct.	70	28	38	2,380
Nov.	88	15	31	1,850
Dec.	2690	14	301	18,700
Total	..	..	..	71,360

Year 1963

Month	Discharge in cusecs			Discharge for Month Acre Feet
	Max.	Min.	Mean	
Jan.	135	24	44	2,750
Feb.	201	26	56	3,140
Mar.	50	20	26	1,590
Apr.	424	15	27	1,640
May	3520	56	371	23,000
June	1080	88	253	15,200
July	2590	87	823	51,000
Aug.	520	73	128	7,940
Sept.	858	66	154	9,200
Oct.	1830	64	156	9,700
Nov.	1920	49	173	10,400
Dec.	1130	51	221	13,700
Total	..	..	..	149,260

Year 1964

Jan.	60	23	40	2,350
Feb.	247	22	51	2,950
Mar.	38	16	24	1,460
Apr.	1490	17	202	12,200
May	106	42	64	3,990
June	740	42	176	10,500
July	106	40	59	5,660
Aug.	4640	33	350	21,700
Sept.	468	68	15	9,050
Oct.	86	55	64	3,990
Nov.	78	23	48	2,890
Dec.	72	22	30	1,840
Total	..	..	..	78,580

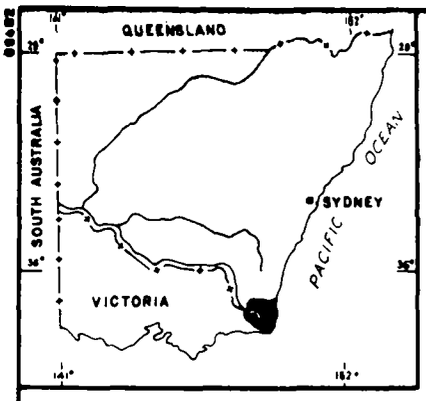
Year 1965

Jan.	26	13	18	1,120
Feb.	15	6.8	9.6	536
Mar.	11	4.6	6.8	419
Apr.	53	5.5	15	874
May	15	11	12	769
June	73	10	17	1,020
July	26	14	18	1,130
Aug.	371	14	51	3,140
Sept.	26	9.6	16	977
Oct.	49	7.5	14	858
Nov.	430	10	46	2,740
Dec.	242	6	36	2,240
Total	..	..	..	15,823

GENOA RIVER AT WANGRABELLE

Year 1966					Year 1967				
Month	Discharge in cusecs			Discharge for Month Acre Feet	Month	Discharge in cusecss			Discharge for Month Acre Feet
	Max.	Min.	Mean			Max.	Min.	Mean	
Jan.	7.5	2.9	4.3	269	Jan.	300	52	10	6,170
Feb.	120	2.3	20	1,120	Feb.	66	16	26	1,460
Mar.	40	7.7	20	1,230	Mar.	54	11	17	1,040
Apr.	14	4.0	5.7	341	Apr.	55	10	19	1,120
May	13	5.2	7.8	483	May	74	9	21	651
June		No Records			June	171	20	31	930
July	980	19	110	6,790	July				
Aug.	213	24	59	3,680	Aug.				
Sept.		No Records			Sept.				
Oct.		No Records			Oct.				
Nov.		No Records			Nov.				
Dec.	3560	132	500	31,100	Dec.				
Total	..	..	..		Total	..	..	..	

FIGURE 1



NEW SOUTH WALES

WATER CONSERVATION AND IRRIGATION COMMISSION

TOWAMBA AND GENOA RIVER VALLEYS

MILES 5 4 3 2 1 0 5 10 15 20 MILES

SCALE

149°30' 150°00' 36°30' 37°00' 37°30'

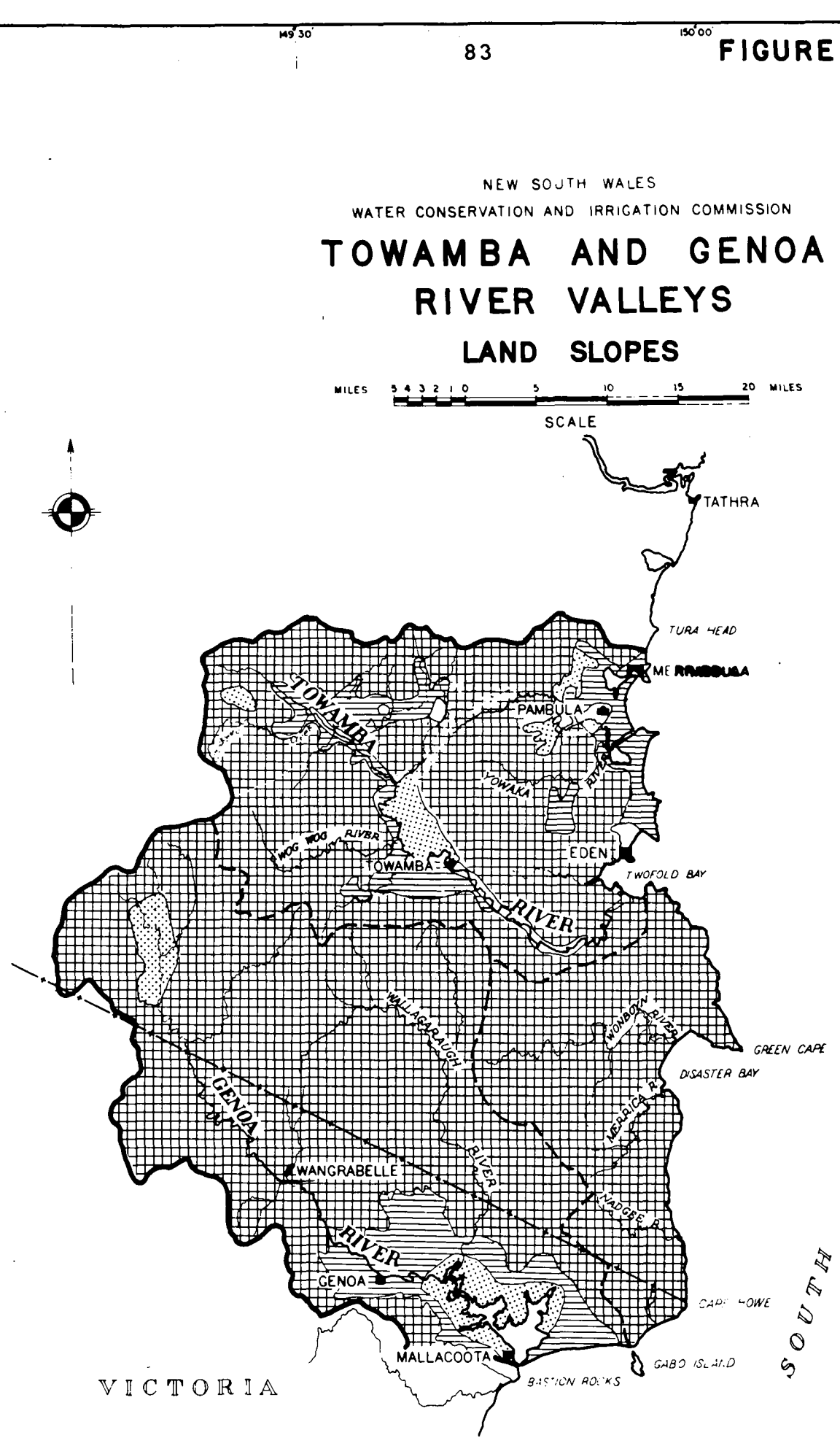
TATHRA
CANDELO
WOLUMLA
TURA HEAD
MERIMBULA
Merimbula Creek
PAMBULA RIVER
PAMBULA
PAMBULA LAKE
BOMBALA
WYNDHAM
ROCKY HALL
TOWAMBA
MATAGANAB
New Station Ck
Stockyard Creek
Boun Ck
Scotchman Ck
BURRAGATE
EGAN PEAKS
YOWAKA
Old Hut Ck
NETHERCOTE
EDEN
TWOFOLD BAY
WOG WOG RIVER
TOWAMBA
ROCKTON
WHITE ROCK R.
RIVER
KIAH
MT IMLAY
Imlay Creek
MOUNT TENNYSON
MT NUNGATTA
Nungatta Creek
YAMBULLA
NUNGATTA
WALLAGARAUGH RIVER
NARRABARBA
Narrabarba Creek
WONBOYN RIVER
GREEN CAPE
DISASTER BAY
Wadbuma Creek
MERRICA R.
GENOA
MOUNT KAYE
WANGRABELLE
TIMBILLICA
TABLE HILLS
NADGEE R.
RIVER
GENOA
GYPSY POINT
MALLACOOTA INLET
CAPE HOWE
MALLACOOTA
GABO ISLAND
BASTION ROCKS
VICTORIA
SOUTH PACIFIC OCEAN

FIGURE 2

NEW SOUTH WALES
WATER CONSERVATION AND IRRIGATION COMMISSION

TOWAMBA AND GENOA RIVER VALLEYS

LAND SLOPES



LEGEND

Mostly Flat
Slopes less than 3 degrees

Undulating to Hilly
Slopes greater than 3 degrees but less than 8 degrees

Hilly to Steep
Slopes greater than 8 degrees but less than 15 degrees

Rugged or Mountainous
Slopes greater than 15 degrees

FIGURE 3

NEW SOUTH WALES

WATER CONSERVATION AND IRRIGATION COMMISSION

TOWAMBA AND GENOA RIVER VALLEYS

ANNUAL MEDIAN RAINFALL

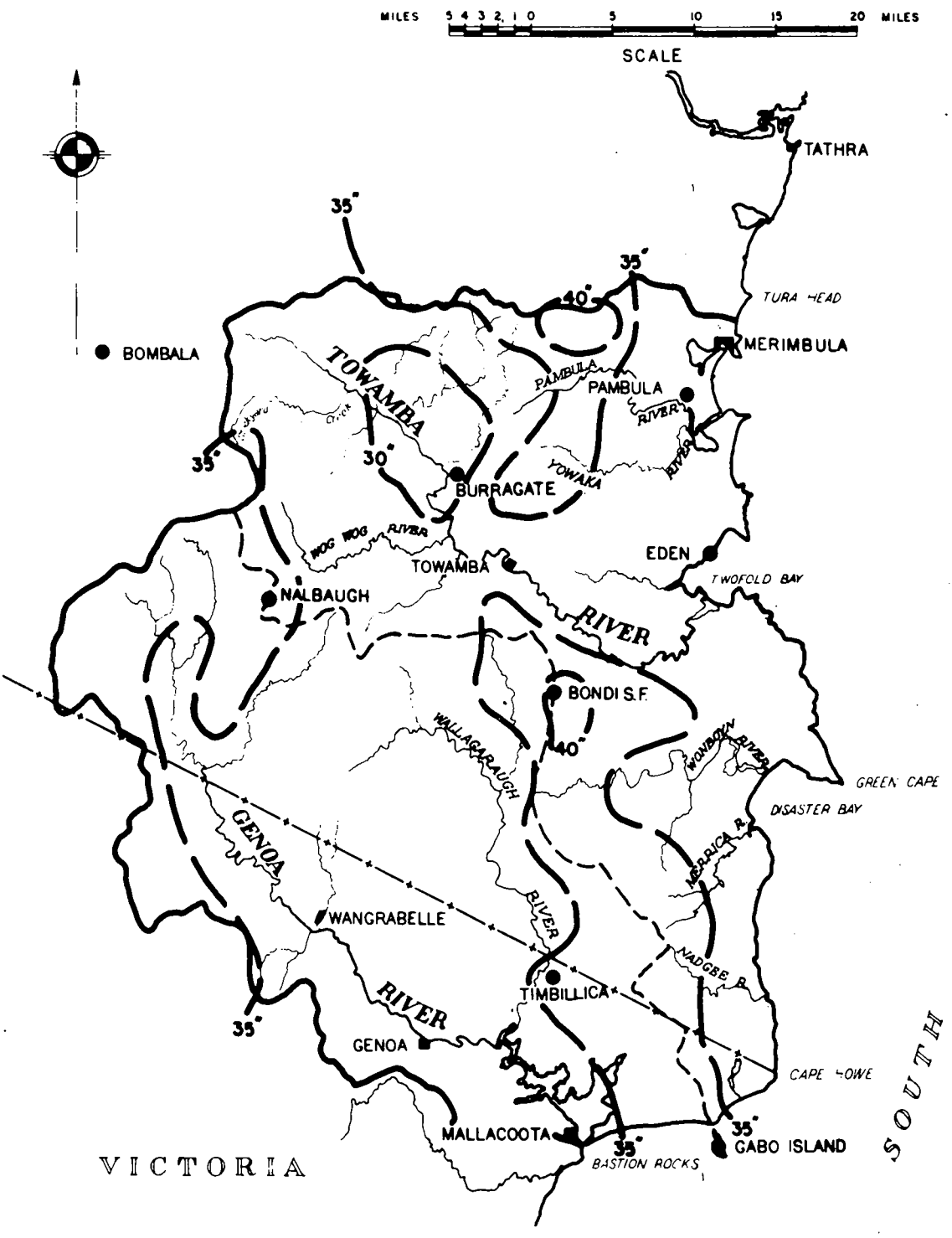


FIGURE 4

NEW SOUTH WALES
WATER CONSERVATION AND IRRIGATION COMMISSION

TOWAMBA AND GENOA RIVER VALLEYS

JANUARY MEDIAN RAINFALL

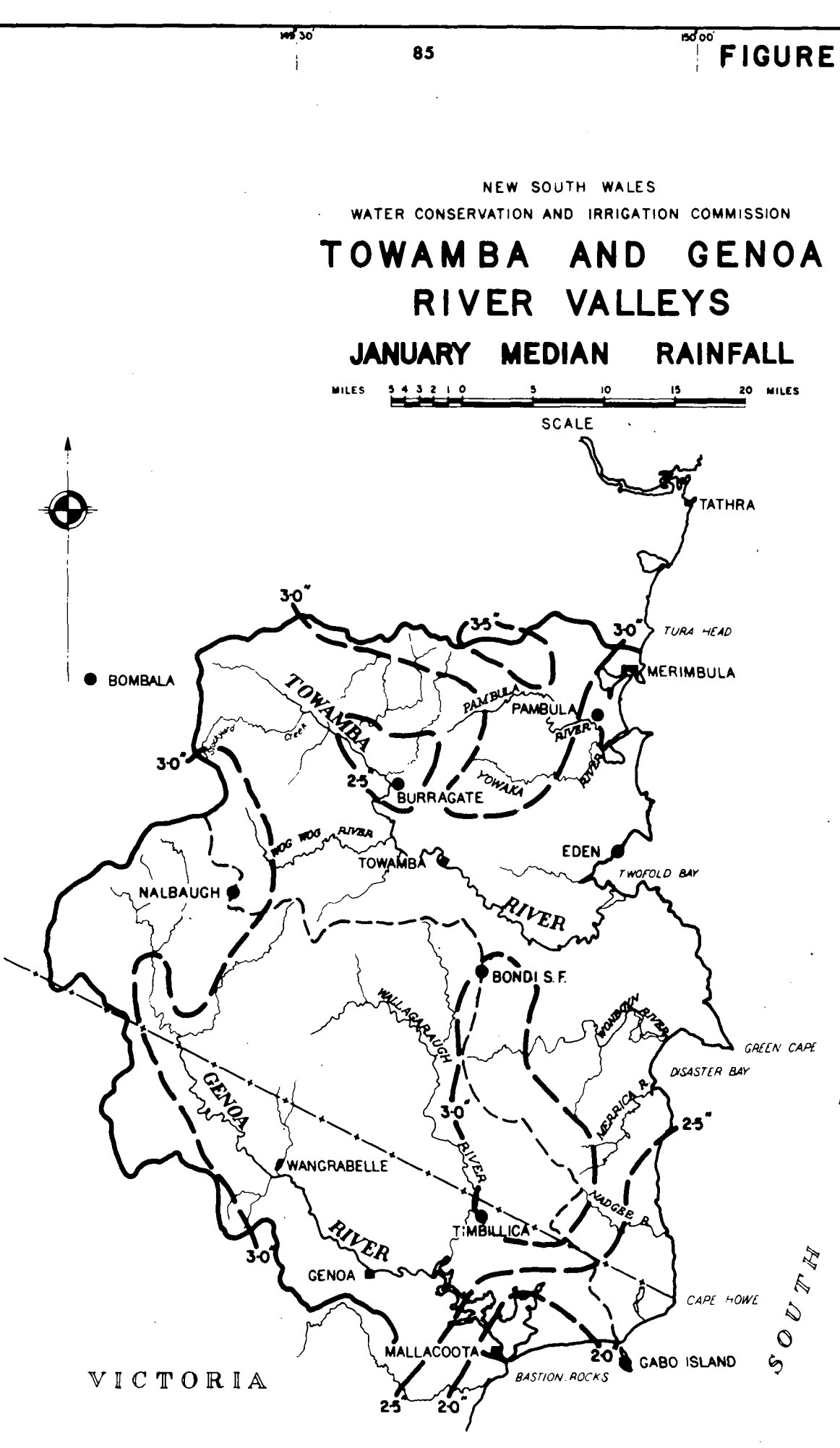


FIGURE 5

NEW SOUTH WALES
WATER CONSERVATION AND IRRIGATION COMMISSION

TOWAMBA AND GENOA RIVER VALLEYS

FEBRUARY MEDIAN RAINFALL

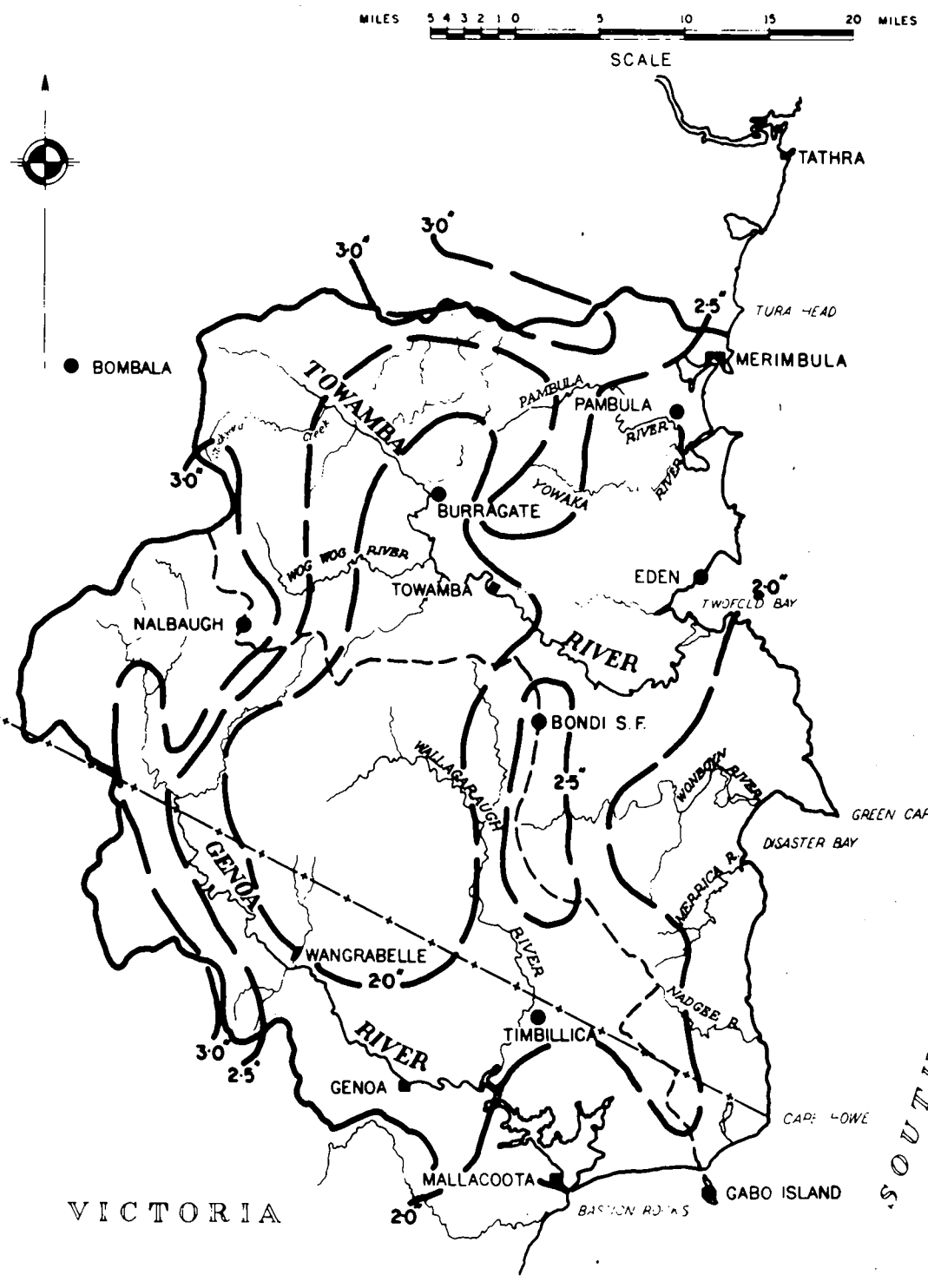


FIGURE 6

NEW SOUTH WALES
WATER CONSERVATION AND IRRIGATION COMMISSION

TOWAMBA AND GENOA RIVER VALLEYS

MARCH MEDIAN RAINFALL

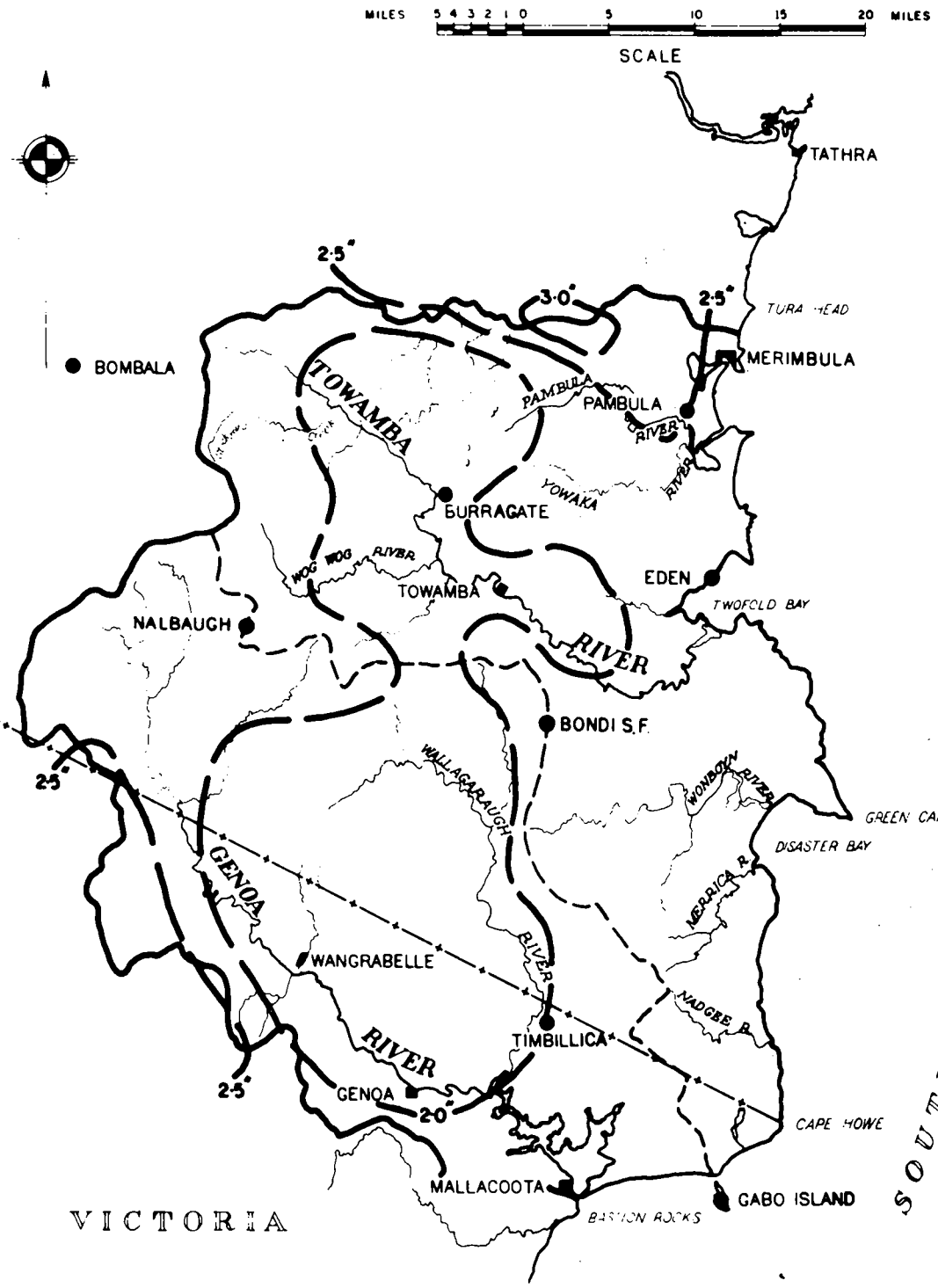


FIGURE 7

NEW SOUTH WALES
WATER CONSERVATION AND IRRIGATION COMMISSION

TOWAMBA AND GENOA RIVER VALLEYS

APRIL MEDIAN RAINFALL

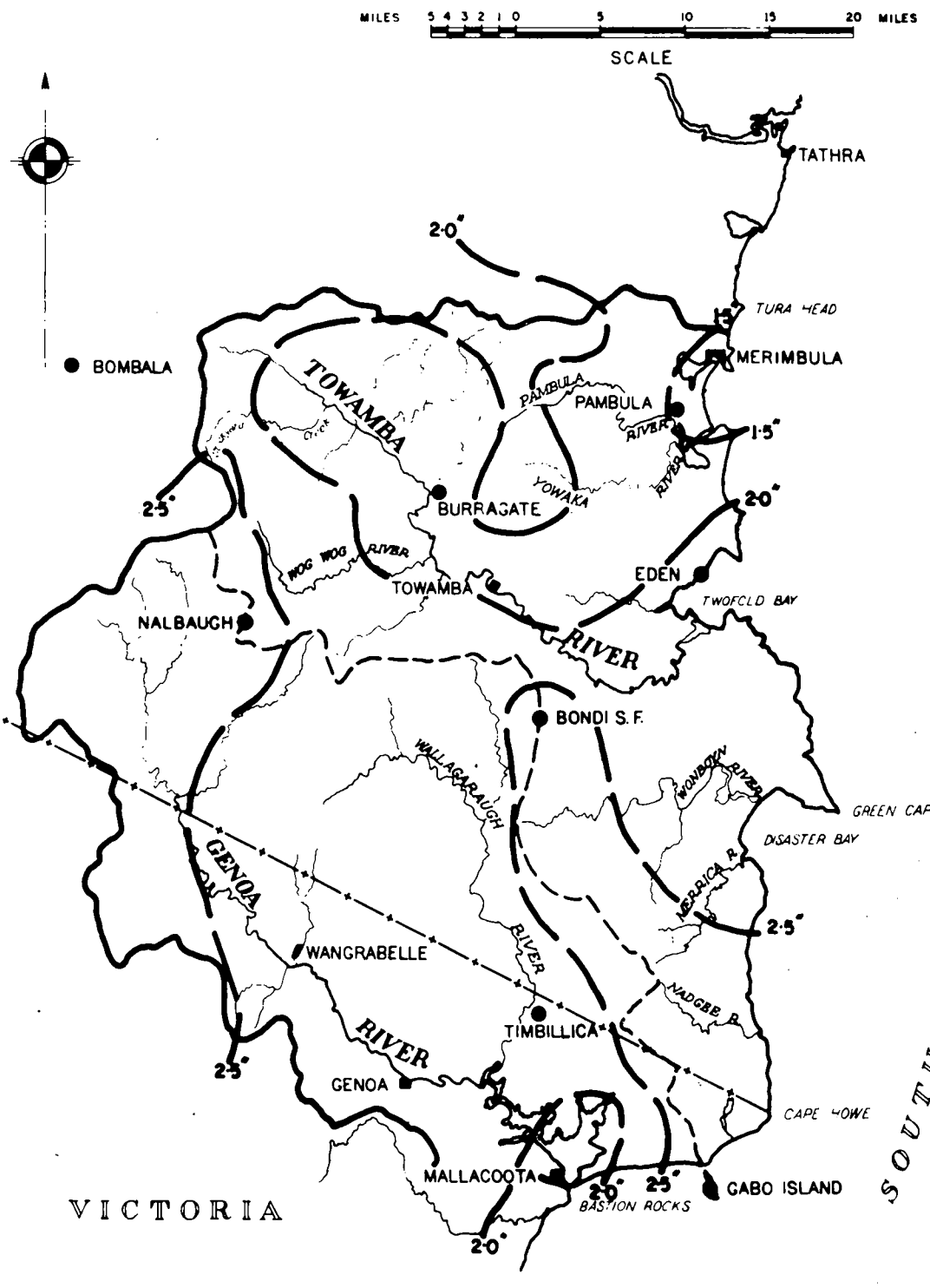


FIGURE 8

NEW SOUTH WALES
WATER CONSERVATION AND IRRIGATION COMMISSION

TOWAMBA AND GENOA RIVER VALLEYS

MAY MEDIAN RAINFALL

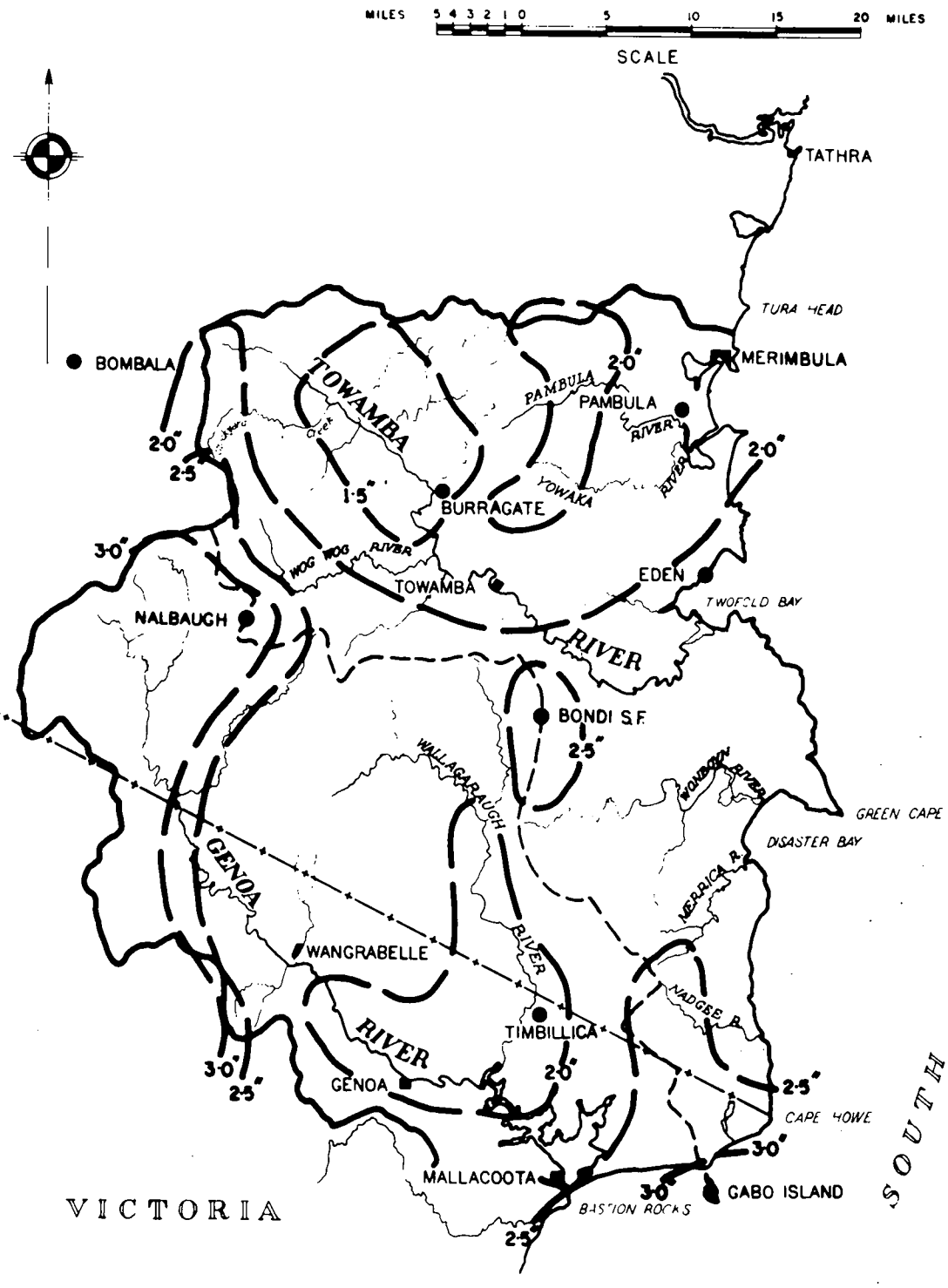


FIGURE 9

NEW SOUTH WALES

WATER CONSERVATION AND IRRIGATION COMMISSION

TOWAMBA AND GENOA RIVER VALLEYS

JUNE MEDIAN RAINFALL

MILES 5 4 3 2 1 0 5 10 15 20 MILES

SCALE

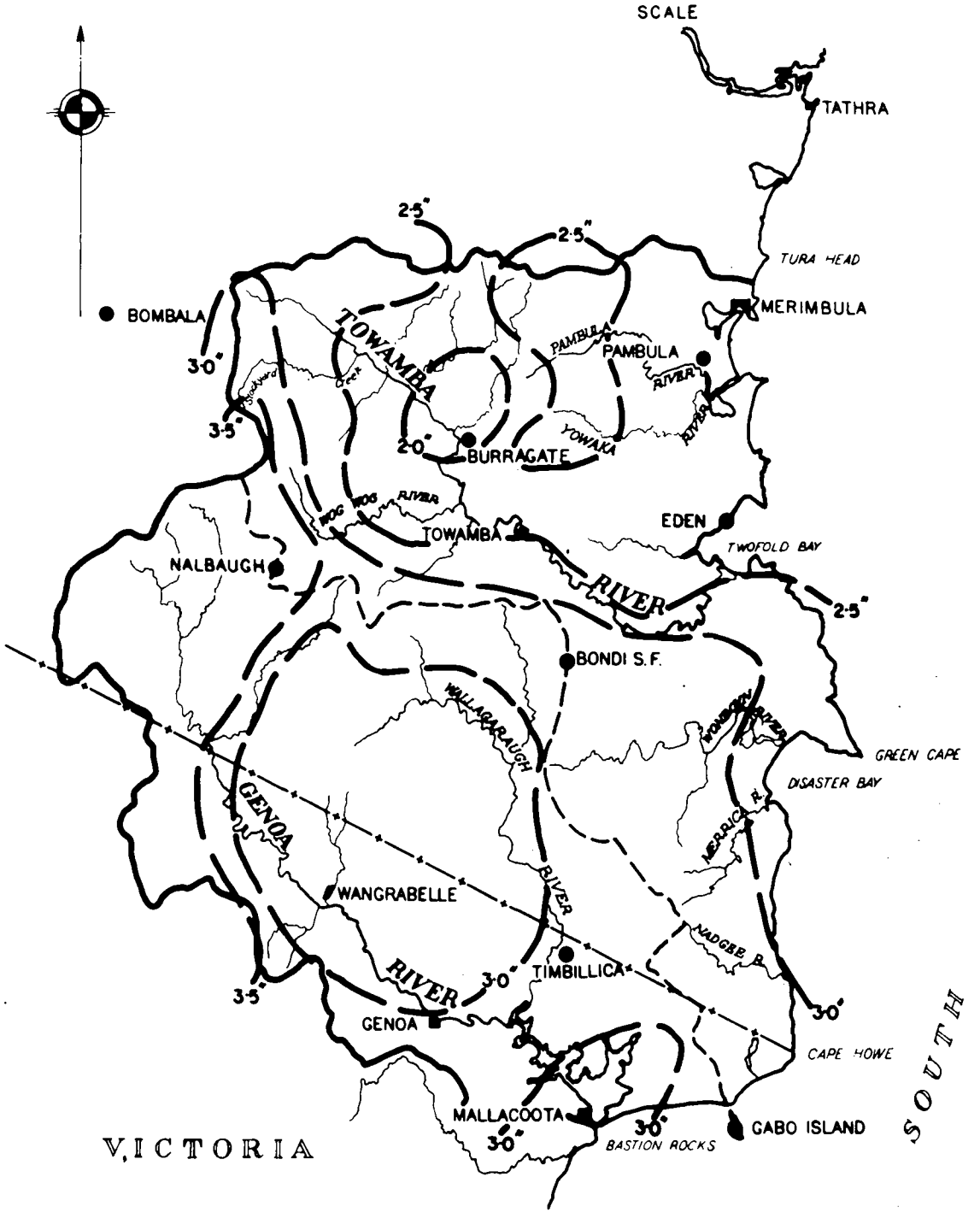


FIGURE 10

NEW SOUTH WALES
WATER CONSERVATION AND IRRIGATION COMMISSION

TOWAMBA AND GENOA RIVER VALLEYS

JULY MEDIAN RAINFALL

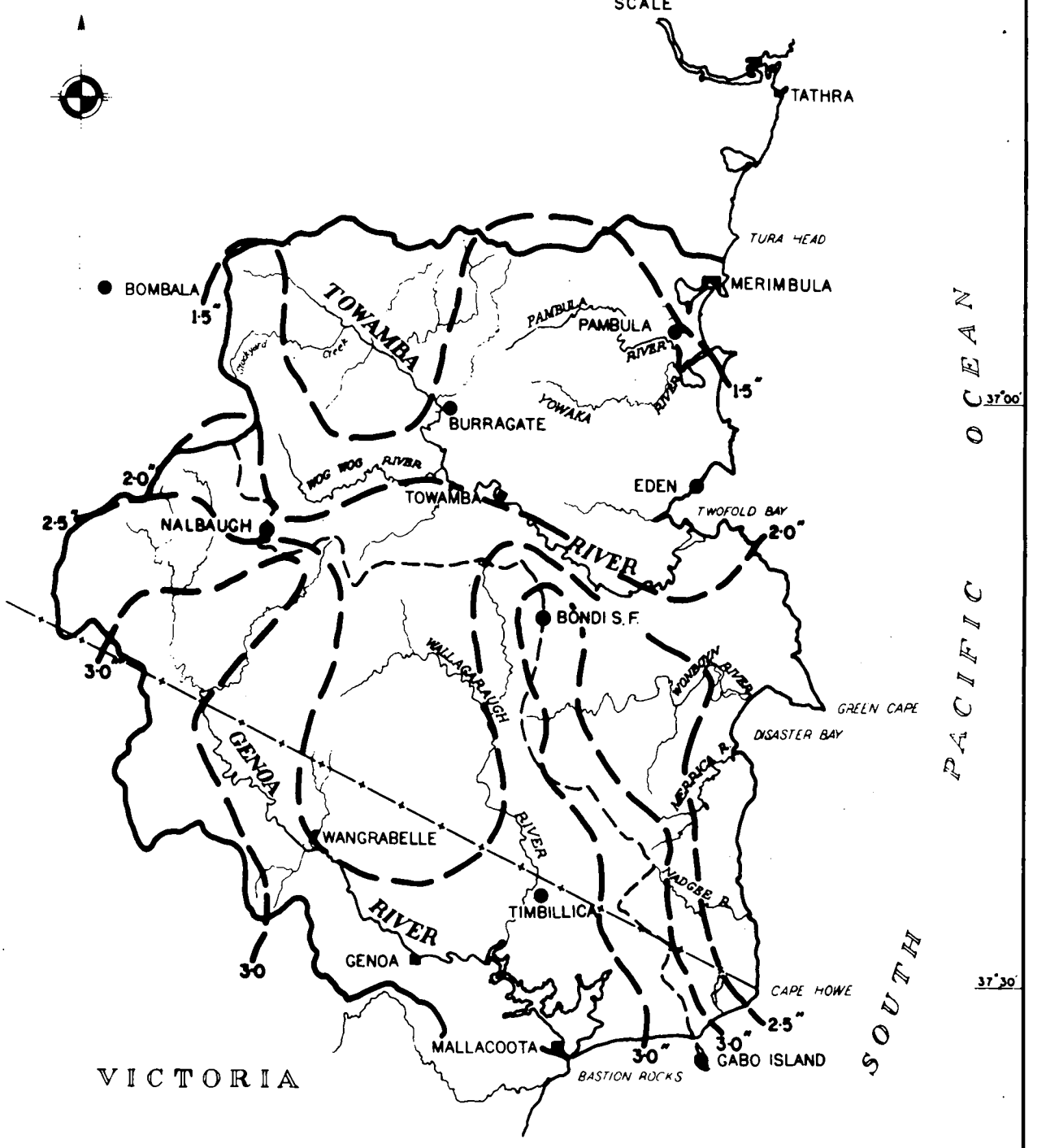


FIGURE 11

NEW SOUTH WALES
WATER CONSERVATION AND IRRIGATION COMMISSION

TOWAMBA AND GENOA RIVER VALLEYS

AUGUST MEDIAN RAINFALL

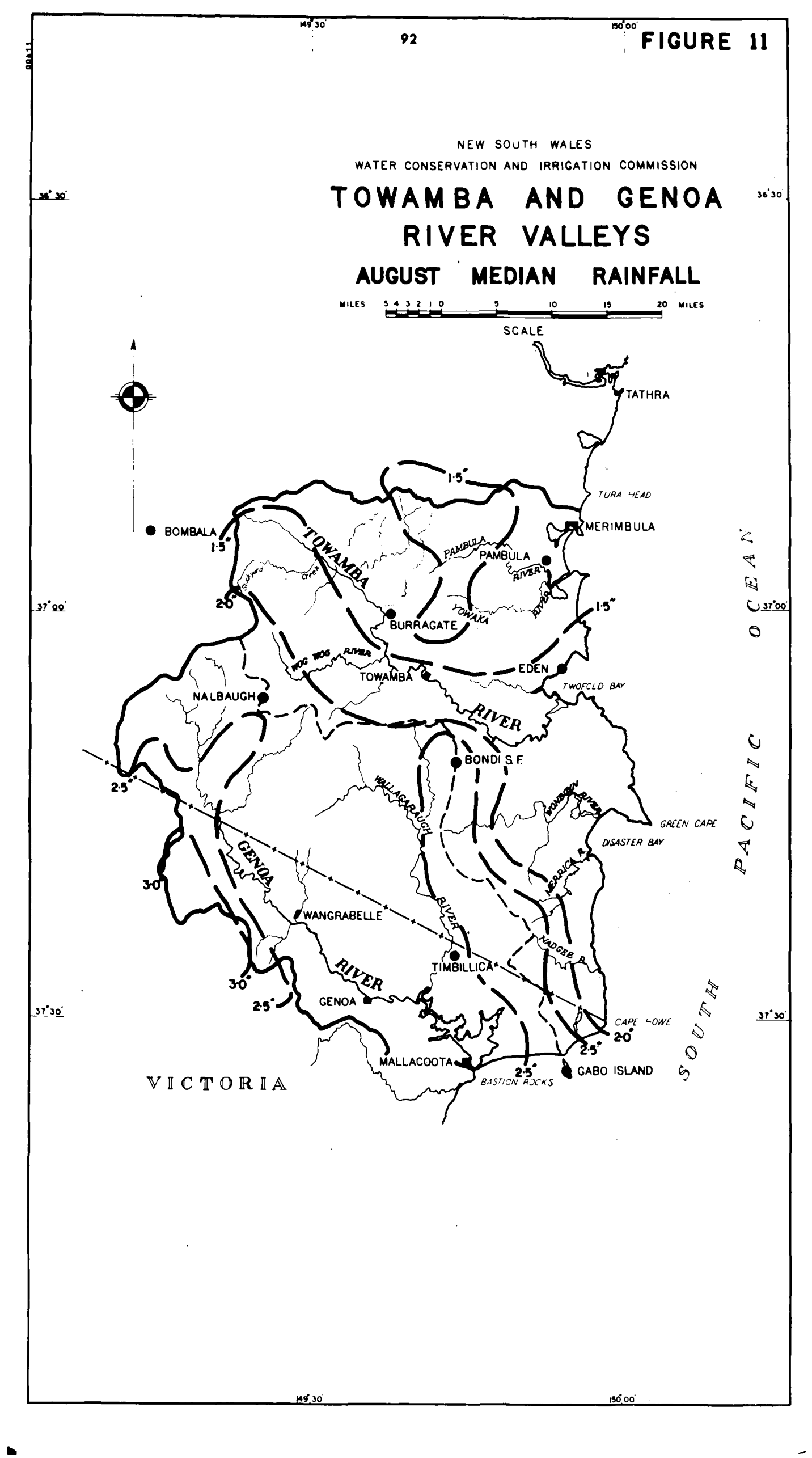


FIGURE 12

NEW SOUTH WALES
WATER CONSERVATION AND IRRIGATION COMMISSION

TOWAMBA AND GENOA RIVER VALLEYS

SEPTEMBER MEDIAN RAINFALL

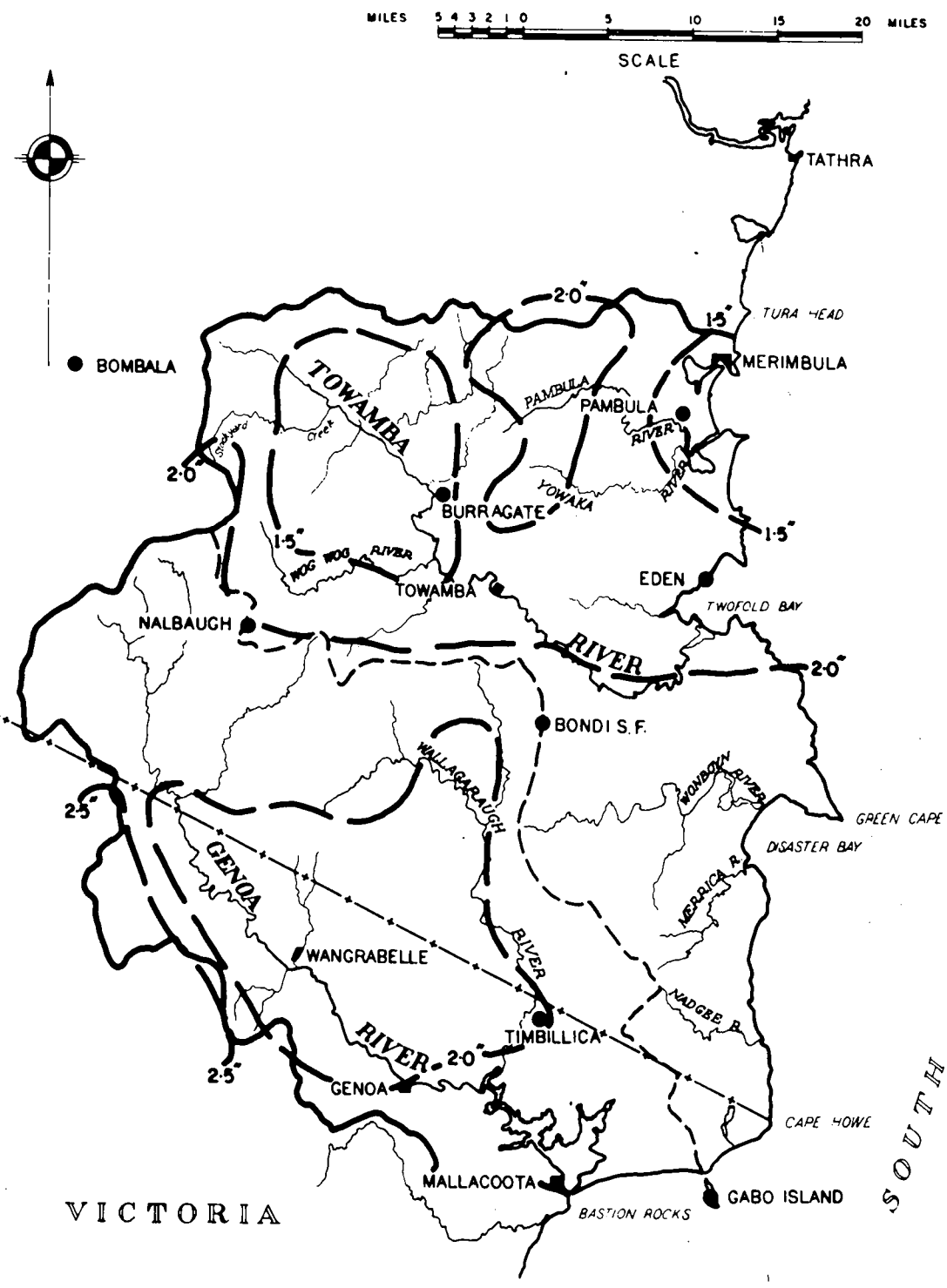


FIGURE 13

NEW SOUTH WALES
WATER CONSERVATION AND IRRIGATION COMMISSION

TOWAMBA AND GENOA RIVER VALLEYS

OCTOBER MEDIAN RAINFALL

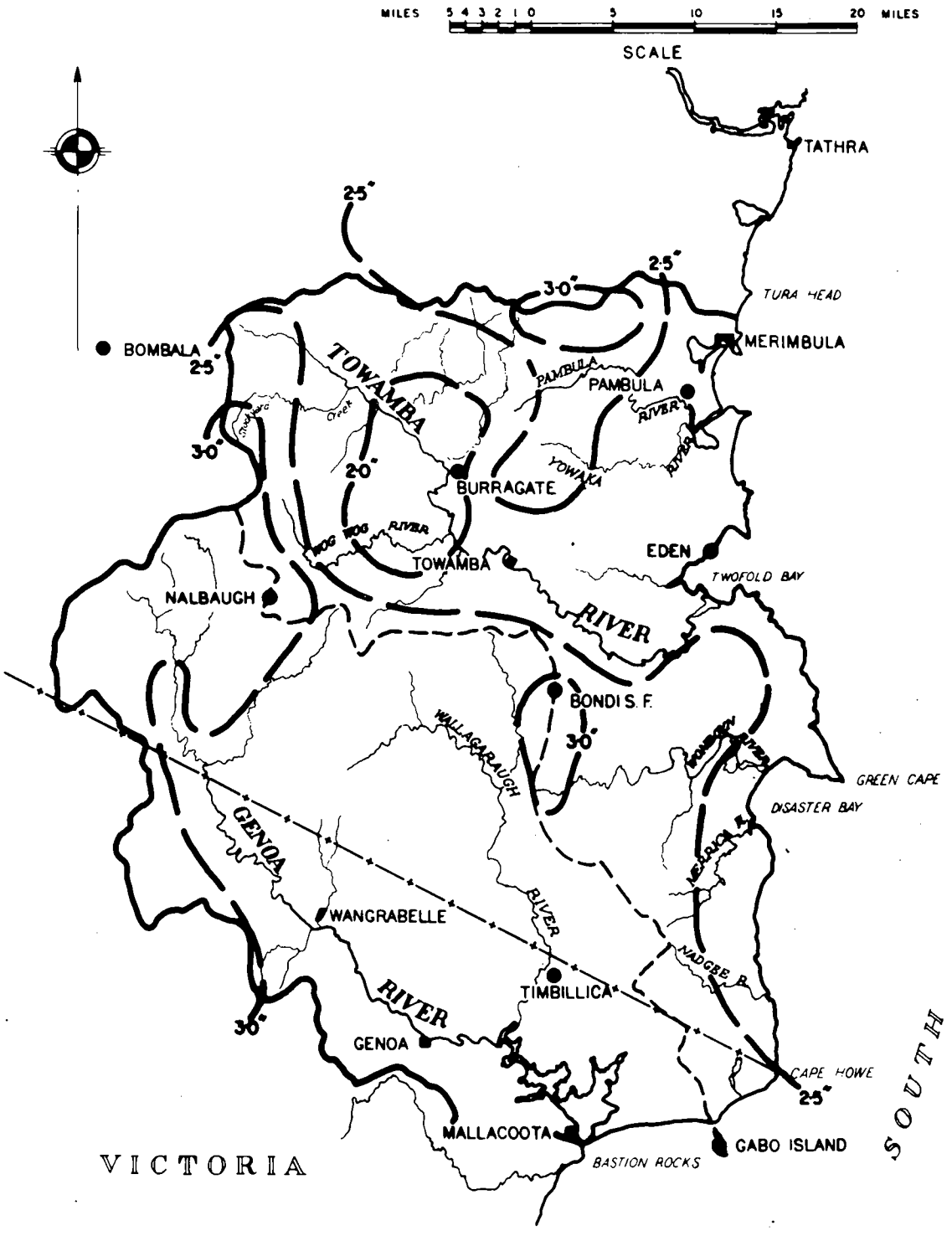


FIGURE 14

NEW SOUTH WALES
WATER CONSERVATION AND IRRIGATION COMMISSION

TOWAMBA AND GENOA RIVER VALLEYS

NOVEMBER MEDIAN RAINFALL

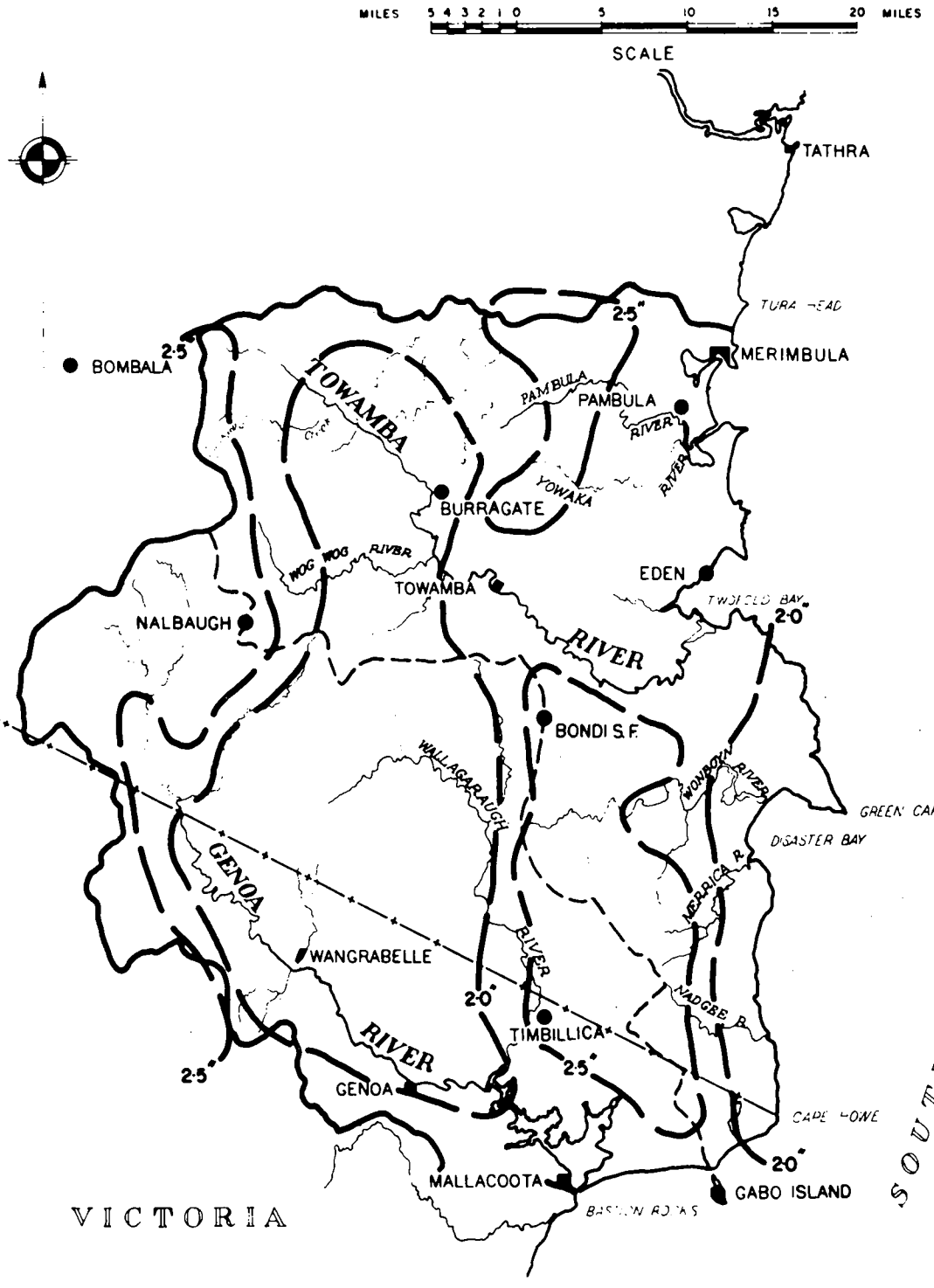


FIGURE 15

NEW SOUTH WALES
WATER CONSERVATION AND IRRIGATION COMMISSION

TOWAMBA AND GENOA RIVER VALLEYS

DECEMBER MEDIAN RAINFALL

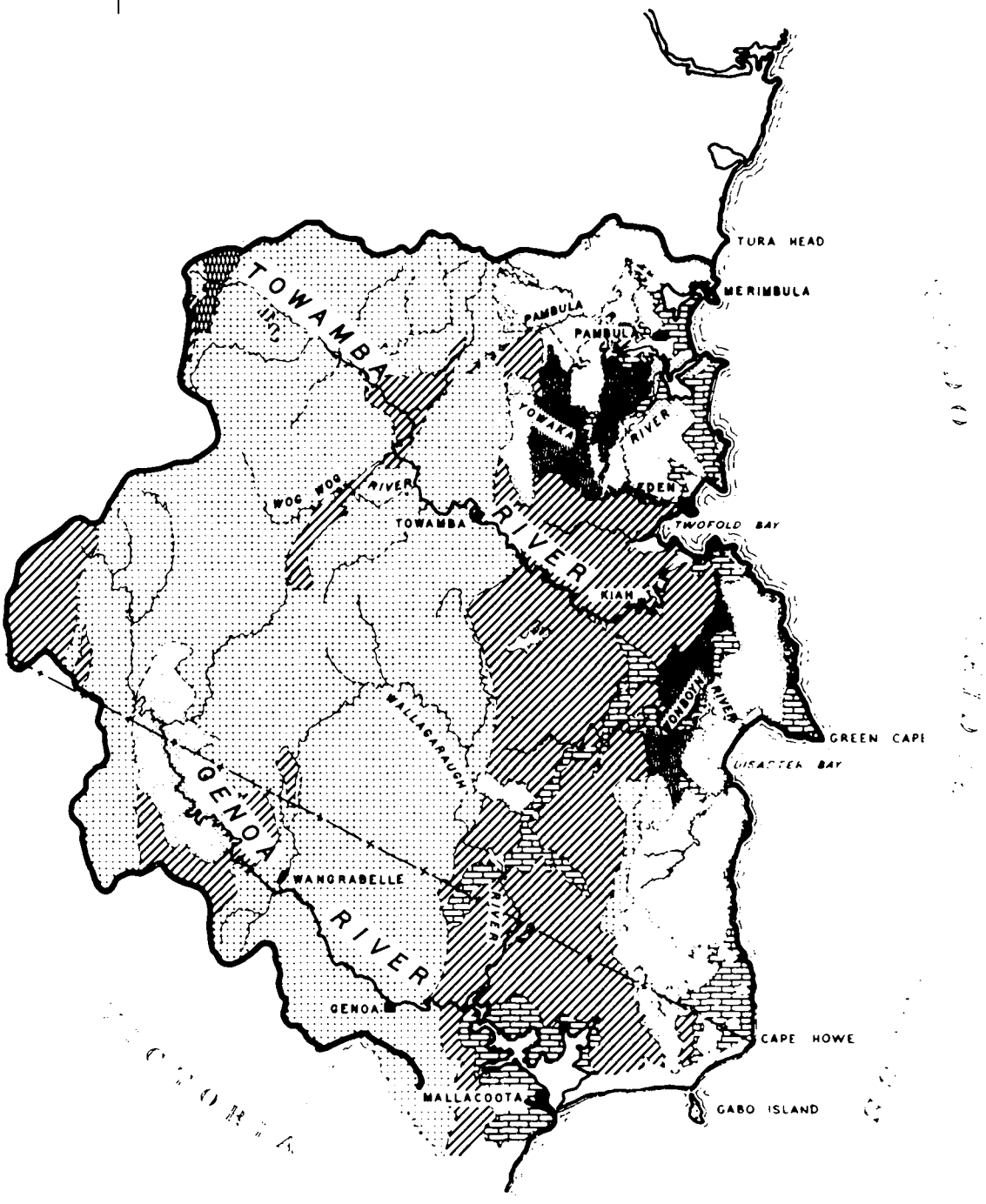
FIGURE 16

NEW SOUTH WALES
WATER CONSERVATION AND IRRIGATION COMMISSION

TOWAMBA AND GENOA RIVER VALLEYS GEOLOGICAL FORMATIONS

N

SCALE
Miles 5 0 5 10 15 20 Miles



LEGEND

TERTIARY - RECENT		Alluvium - clay, sand and gravel
TERTIARY		Gravel, sand, sandstone shale and conglomerate
DEVONIAN	MERIMBULA FORMATION	Conglomerate, sandstone, quartzite and shale
	LOCHIEL FORMATION	Interbedded volcanics basalt, rhyolite felsite, conglomerate, sandstone and shale
	EDEN RHYOLITE	Interbedded volcanics - rhyolite, rhyolite conglomerate and breccia and felsite
ORDOVICIAN		Phyllite, slate, quartzite, sandstone mudstone, siltstone and shale

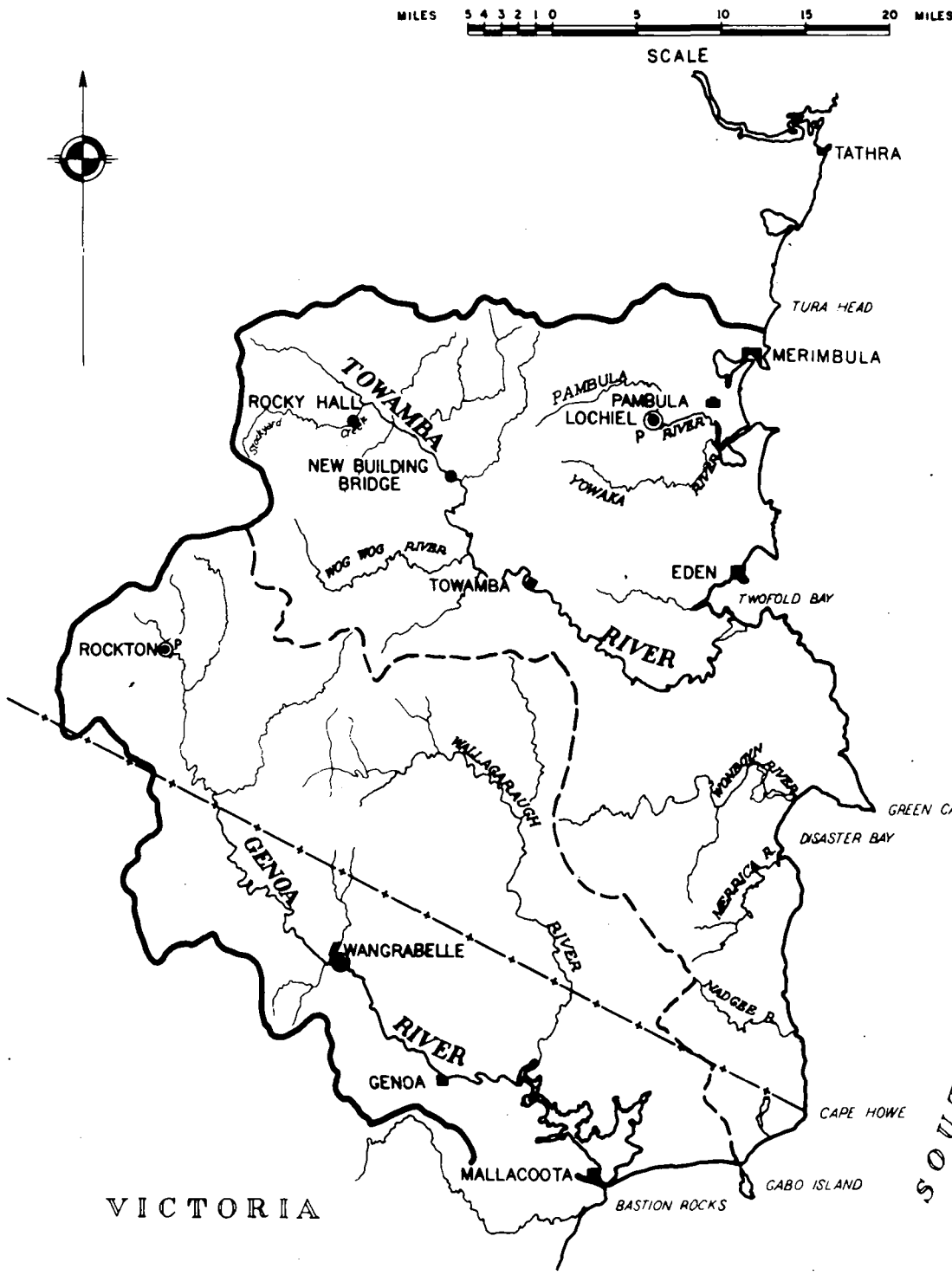
IGNEOUS
Basalt
Granite
State boundary

FIGURE 17

NEW SOUTH WALES
WATER CONSERVATION AND IRRIGATION COMMISSION

TOWAMBA AND GENOA RIVER VALLEYS

GAUGING STATIONS



LEGEND

STAFF GAUGE .....

AUTOMATIC RECORDER [float type] .....

AUTOMATIC RECORDER [pressure type] ..... P

STATE BOUNDARY .....

FIGURE 18

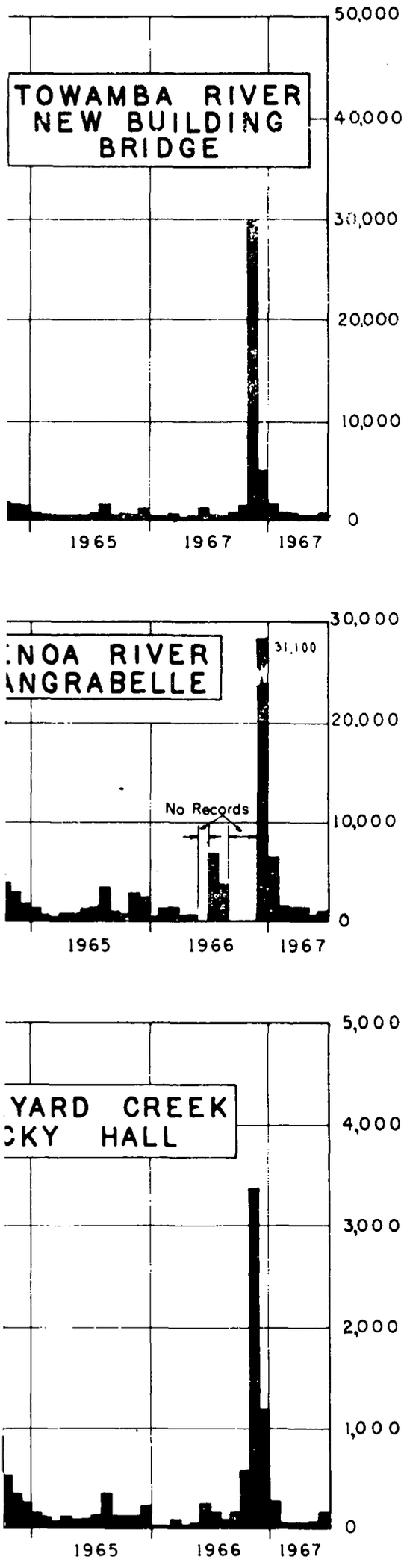
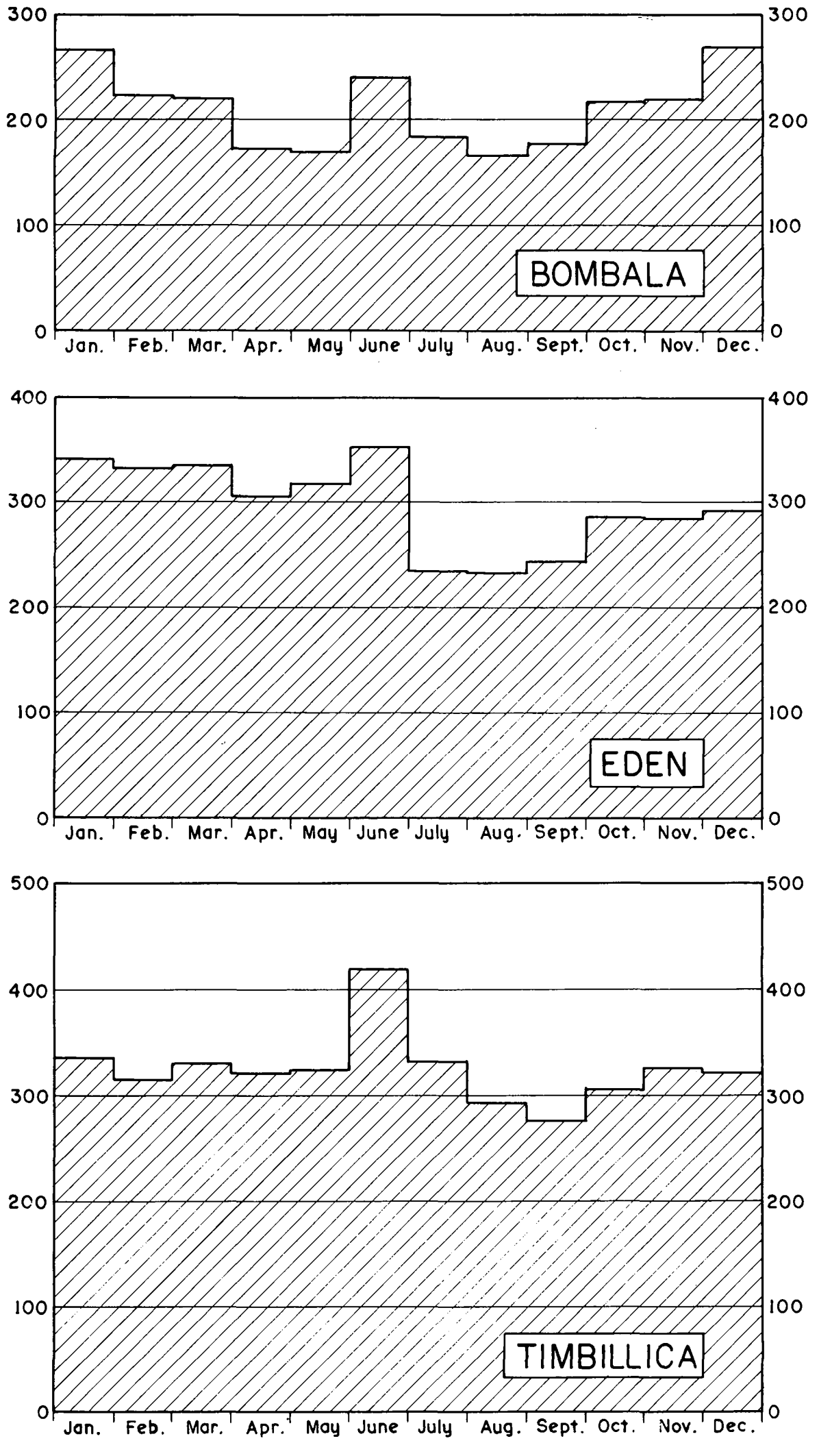

TOWAMBA RIVER
NEW BUILDING
BRIDGE
50,000
40,000
30,000
20,000
10,000
0
1965
1967
1967
NOA RIVER
NGRABELLE
31,100
30,000
20,000
10,000
0
No Records
1965
1966
1967
YARD CREEK
CKY HALL
5,000
4,000
3,000
2,000
1,000
0
1965
1966
1967
MONTHLY DISCHARGE — ACRE FEET

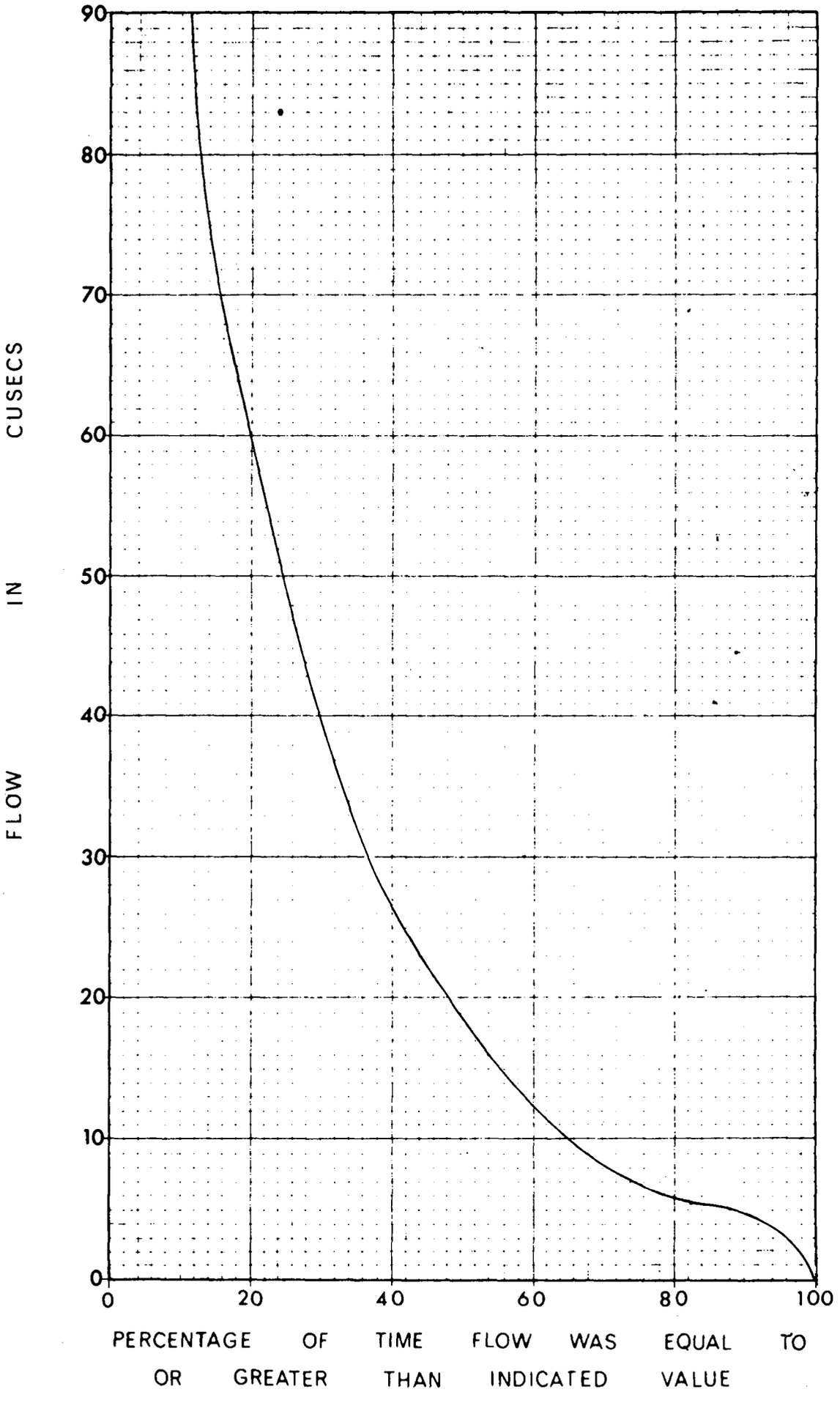
FIGURE 19



DISTRIBUTION OF AVERAGE MONTHLY RAINFALLS AT BOMBALA , EDEN AND TIMBILLICA

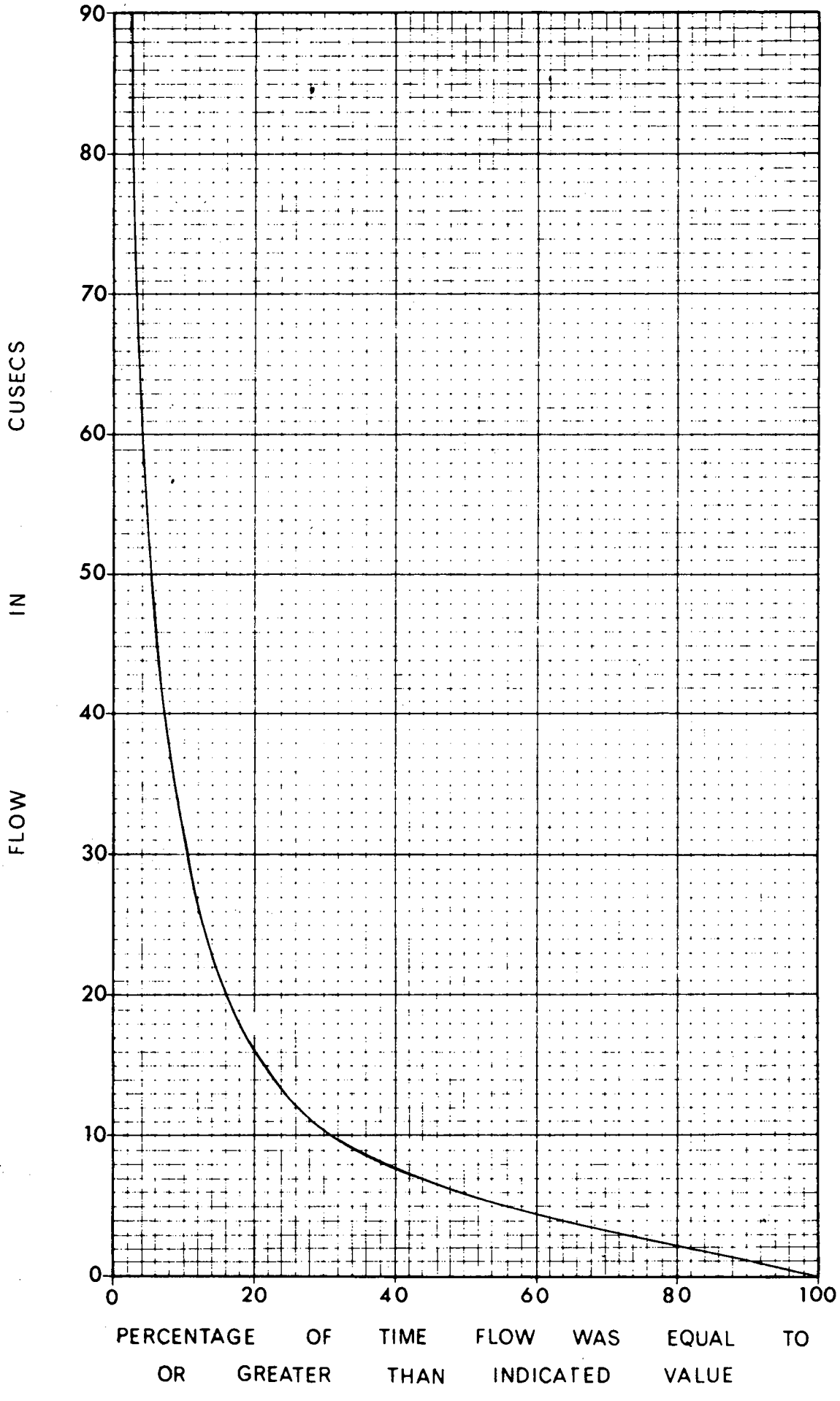
FIGURE 20

00418



FLOW DURATION CURVE FOR TOWAMBA RIVER AT NEW BUILDING BRIDGE

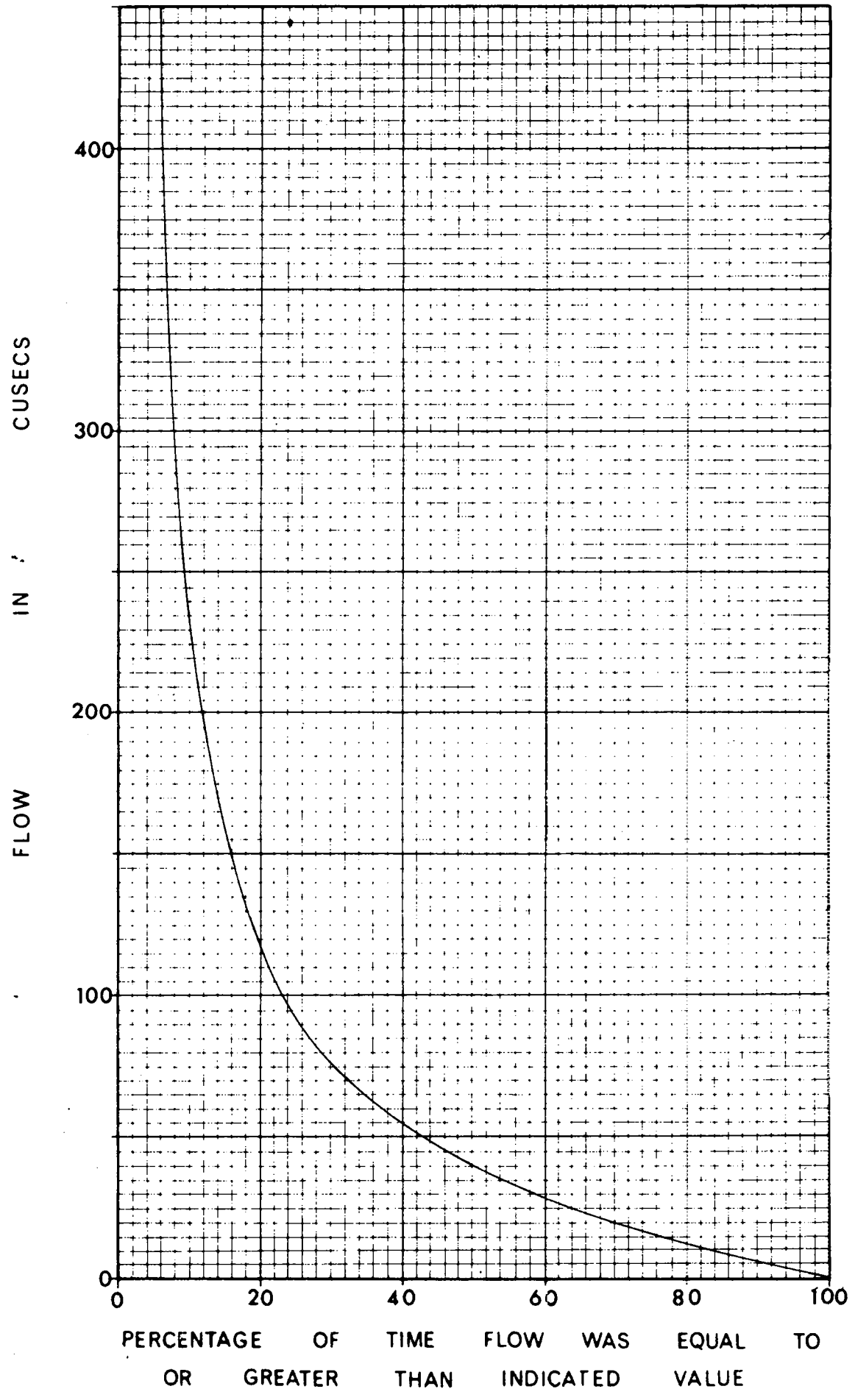
FIGURE 21



FLOW DURATION CURVE FOR STOCKYARD CREEK AT ROCKY HALL

FIGURE 22

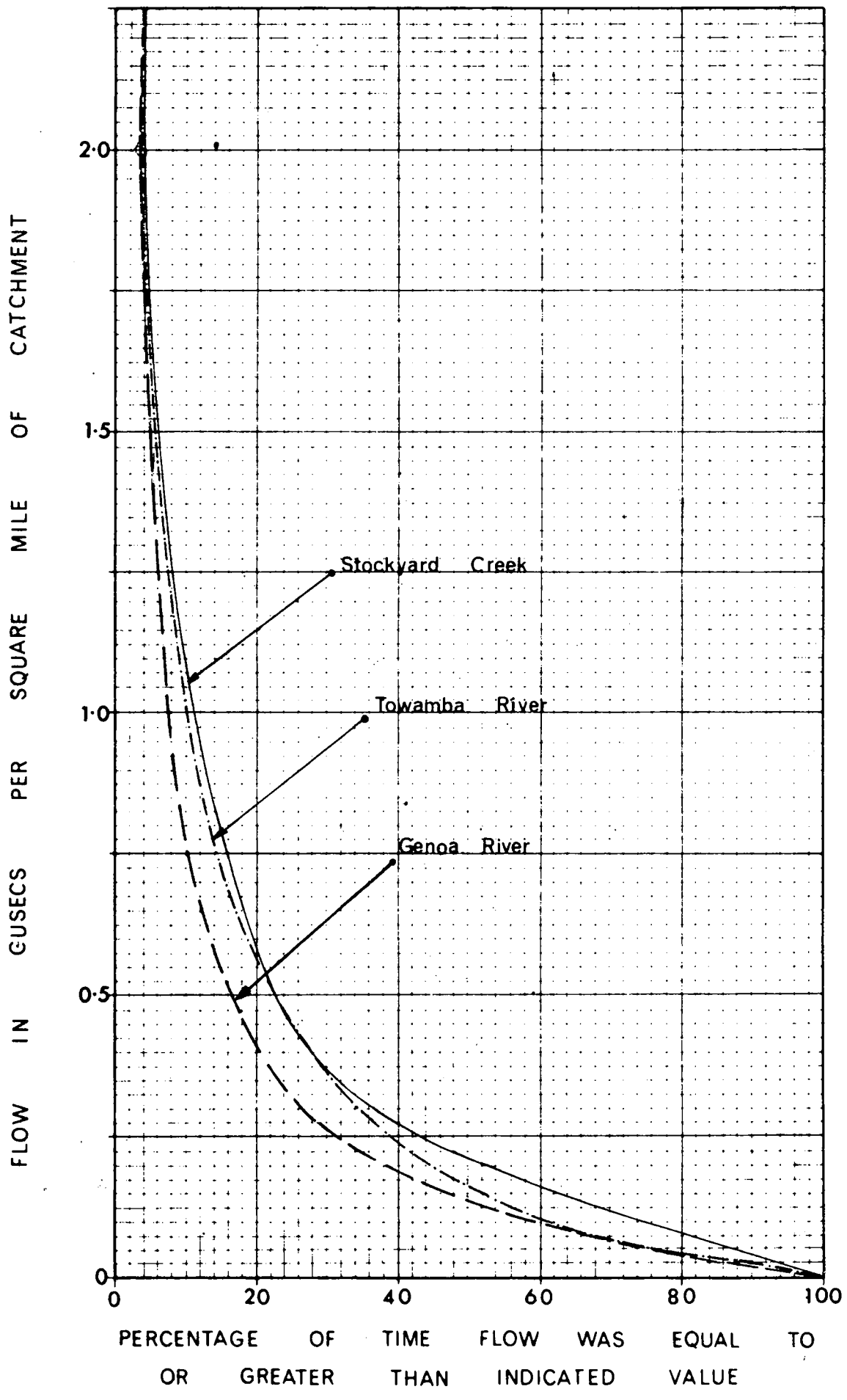
00420



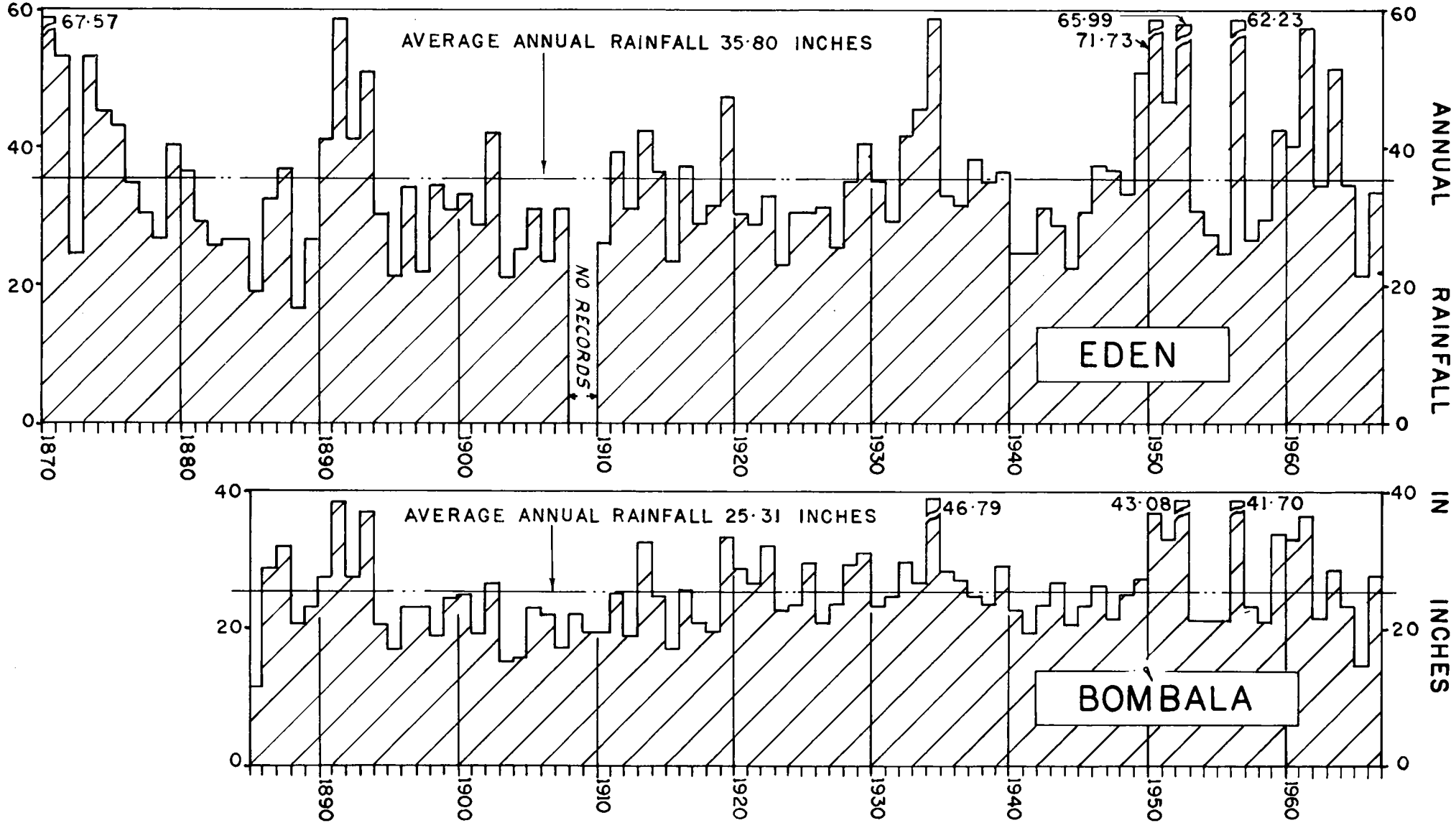
FLOW DURATION CURVE FOR GENOA RIVER AT WANGRABELLE

FIGURE 23

00421



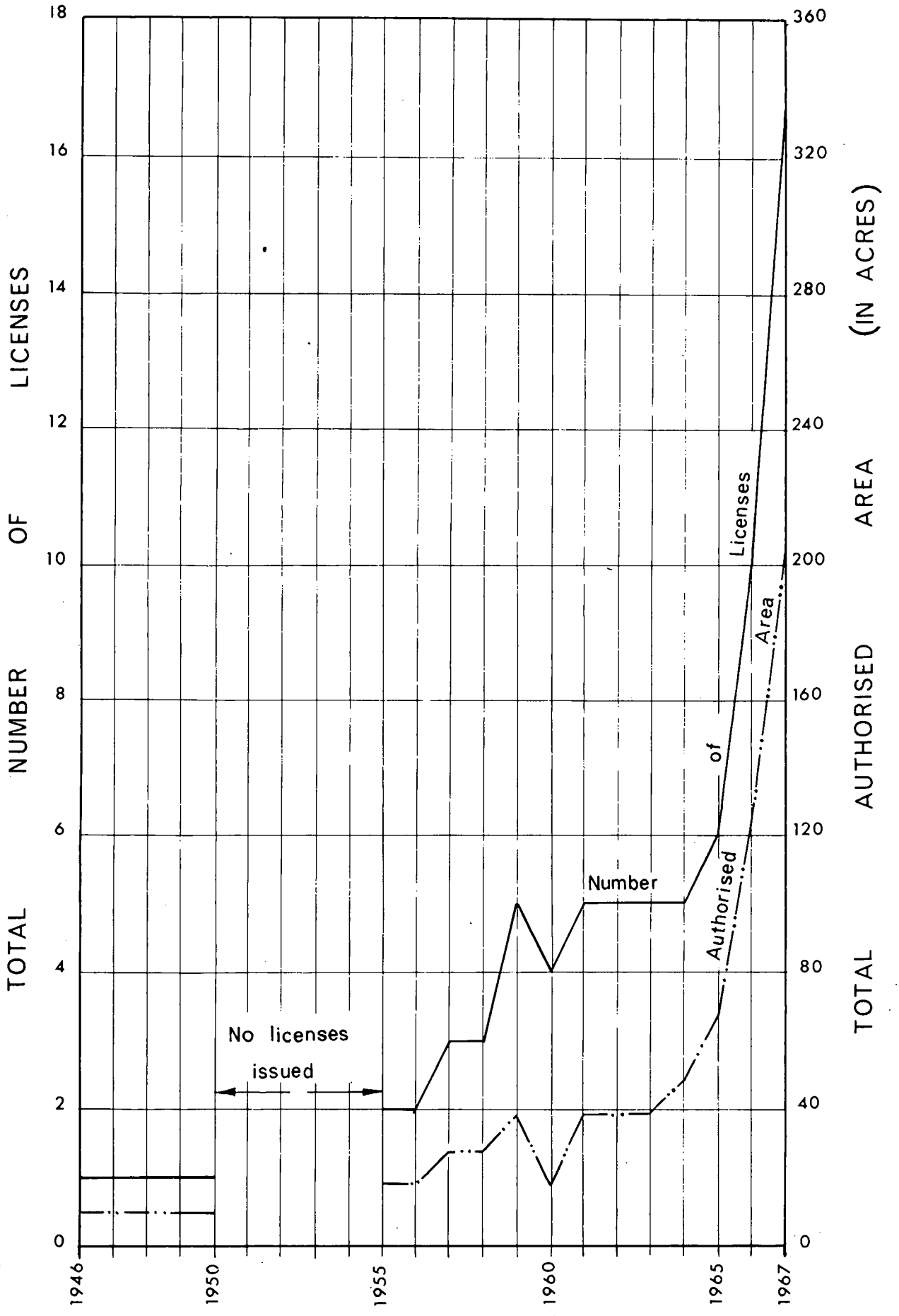
FLOW DURATION CURVES FOR GENOA RIVER, STOCKYARD CREEK AND TOWAMBA RIVER



ANNUAL RAINFALLS AT EDEN AND BOMBALA

FIGURE 24

FIGURE 25



TOWAMBA RIVER VALLEY

AREA AUTHORISED FOR IRRIGATION AND TOTAL NUMBER OF LICENSES AT 30TH JUNE FOR EACH YEAR INDICATED

FIGURE 26

NEW SOUTH WALES
WATER CONSERVATION AND IRRIGATION COMMISSION

TOWAMBA AND GENOA RIVER VALLEYS

WATER CONSERVATION DAM SITES