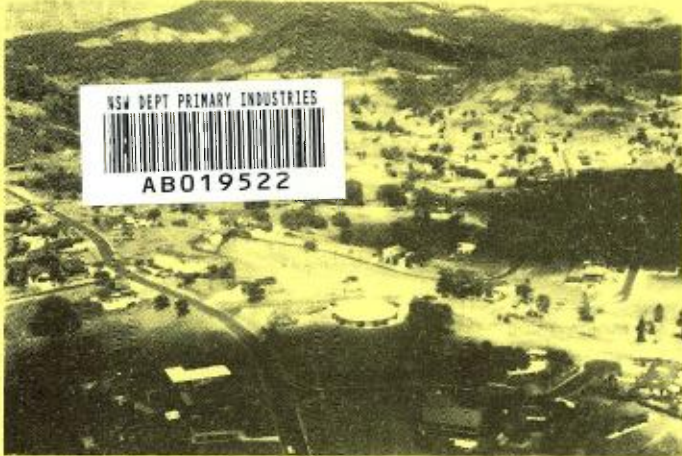




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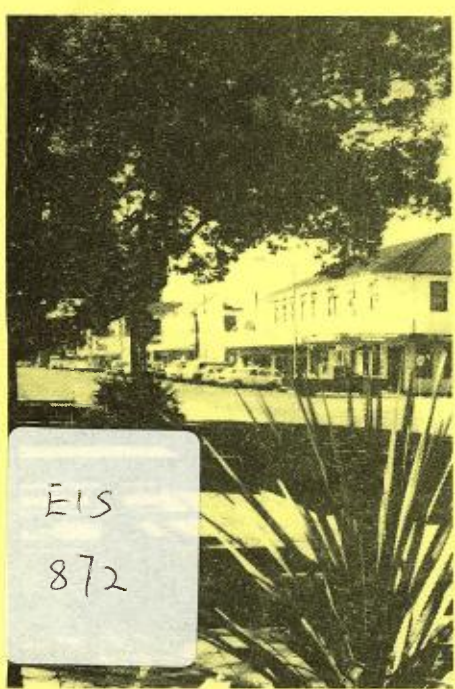


BYRON SHIRE ENVIRONMENTAL STUDY

WORKING PAPER No. 3 - NATURAL ENVIRONMENT

prepared by
PLANNING WORKSHOP PTY. LTD.
for
BYRON SHIRE COUNCIL

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NATURAL ENVIRONMENT

Prepared for
BYRON SHIRE COUNCIL

by
PLANNING WORKSHOP PTY LTD
346 Kent Street Sydney 2000

August 1983

EIS 872

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1. INTRODUCTION

The natural resources of the Shire provide the foundation upon which the physical, economic and social growth and development of the Shire are based and this requires careful consideration and investigation as part of the planning process leading up to the preparation of a Local Environmental Plan for the urban centres and rural areas of the Shire.

A description of the natural environment and an assessment of future economic and land use planning implications is important for the following reasons:

- * It will enable the physical constraints to urban growth and expansion to be identified and incorporated into structure plans for future growth in the Shire.
- * It will enable the economic resources of the Shire to be identified and protected, thus permitting and encouraging economic growth in the Shire. (This refers to features of the environment that contribute to the attractiveness of the Shire and therefore to potential for tourism, as well as agricultural, extractive materials, estuaries and timber resources).
- * It will enable areas of visual and environmental significance to be identified and managed for present and future generations of residents and visitors to the Shire.

This working paper discusses in turn the major components of the natural environment of the Shire. The discussion proceeds logically, where possible from a description of the resource through an analysis of importance or potential to an assessment of planning implications. The assessment of planning implications is, of course, the most important aspect of the paper as it is from this that policies for the management of the natural environment can be identified.

2. LAND FORM

2.1 Introduction

Byron Shire is renowned for its coastal and rural scenic beauty, which can be attributed to the diversity of land forms and associated features of the landscape. This is a result of the underlying rock structure, its location at the junction of land and sea, climate and the processes of erosion and deposition.

The topography of the Shire can be broadly divided into five land form units:

- * Coastline.
- * Coastal lowlands.
- * Coastal ridges.
- * Undulating volcanic plateau.
- * Mountain ridges and valleys.

Figure 1 highlights these units. A clear impression of the major landform units in the Shire can be obtained from an analysis of slopes and elevation (Figures 2 and 3).

2.2 Coastline

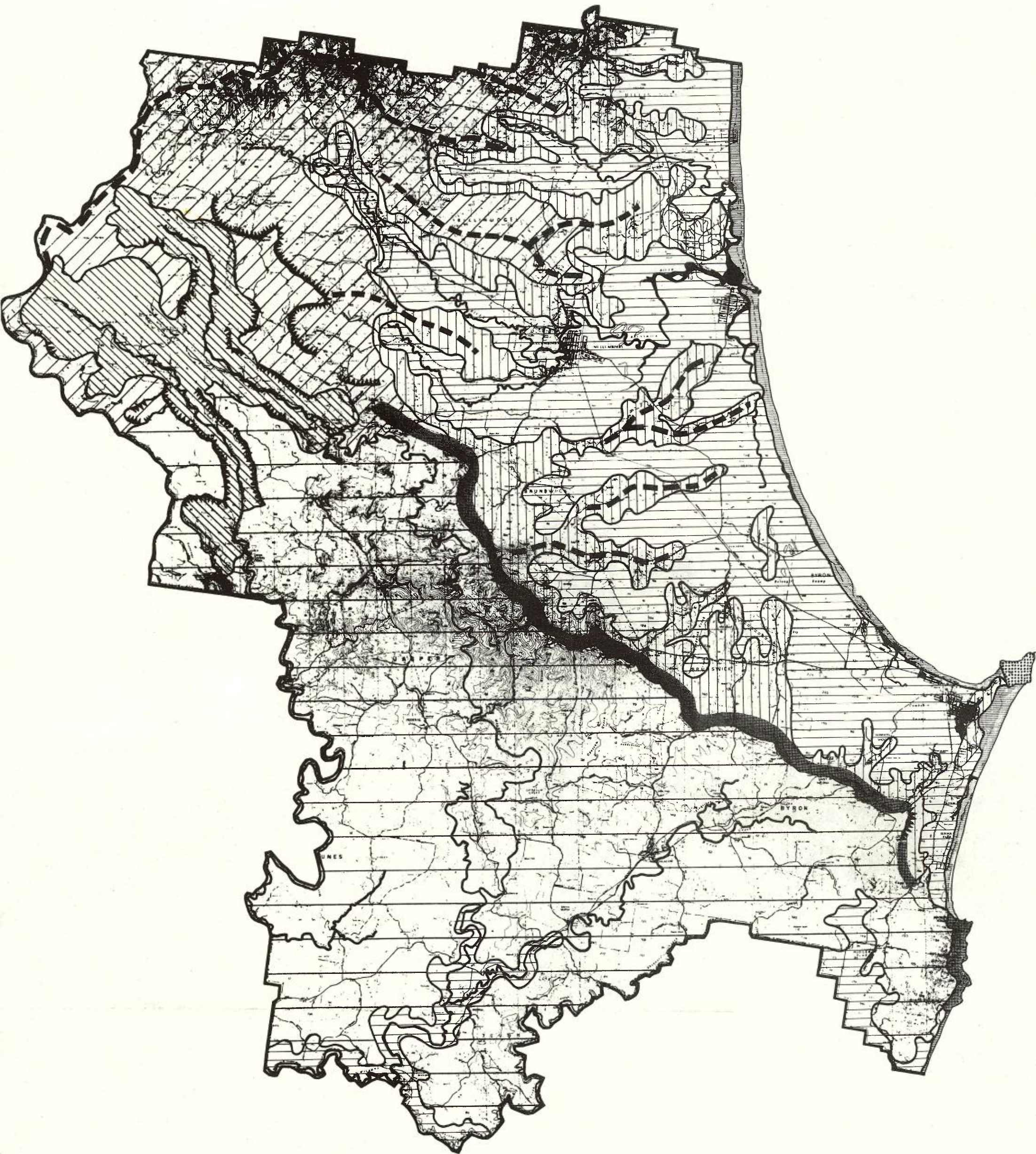
Coastal processes are mainly responsible for the distinctive features of beaches, dunes and headlands. With exception of the headlands of Cape Byron (122 metres) and Broken Head (103 metres), with slopes of 15 to 25 degrees, the elevation of the land is low with slopes averaging between 0 and 5 degrees.

Coastal dune development is variable. In the vicinity of Tallow Beach, mining operations have, in some cases, lowered the dune profile, however, the main back dunes which are vegetated, are in excess of 40 metres in height. Urban development has assisted in reduction of dune height as land subdivision and associated road works extend.

The coastline north of Cape Byron reflects the dominant south-easterly swell condition which refract around Byron and Julian Rocks. The waves refract across the bed of the Bay to produce a hooked region in the south which smoothes out to the north.

An extensive system of shoreline parallel ridges spaced from 150 metres to 180 metres apart lies between Cape Byron and Brunswick Heads. These were formed when barrier building sands moved on shore during a period in which there was a rise in sea level. The average elevation of the ridges is 5 metres to 6 metres above present sea level.

North of Brunswick Heads, the ridge system is narrow and discontinuous, generally varying in height from 3 metres to 9 metres above sea level. An eroded dune scarp 2 metres to 6 metres high backs the present day beach. At Brunswick Heads, a low but well developed fore-dune extends 2 kilometres to the south and is the result of localised accretion behind the breakwater.



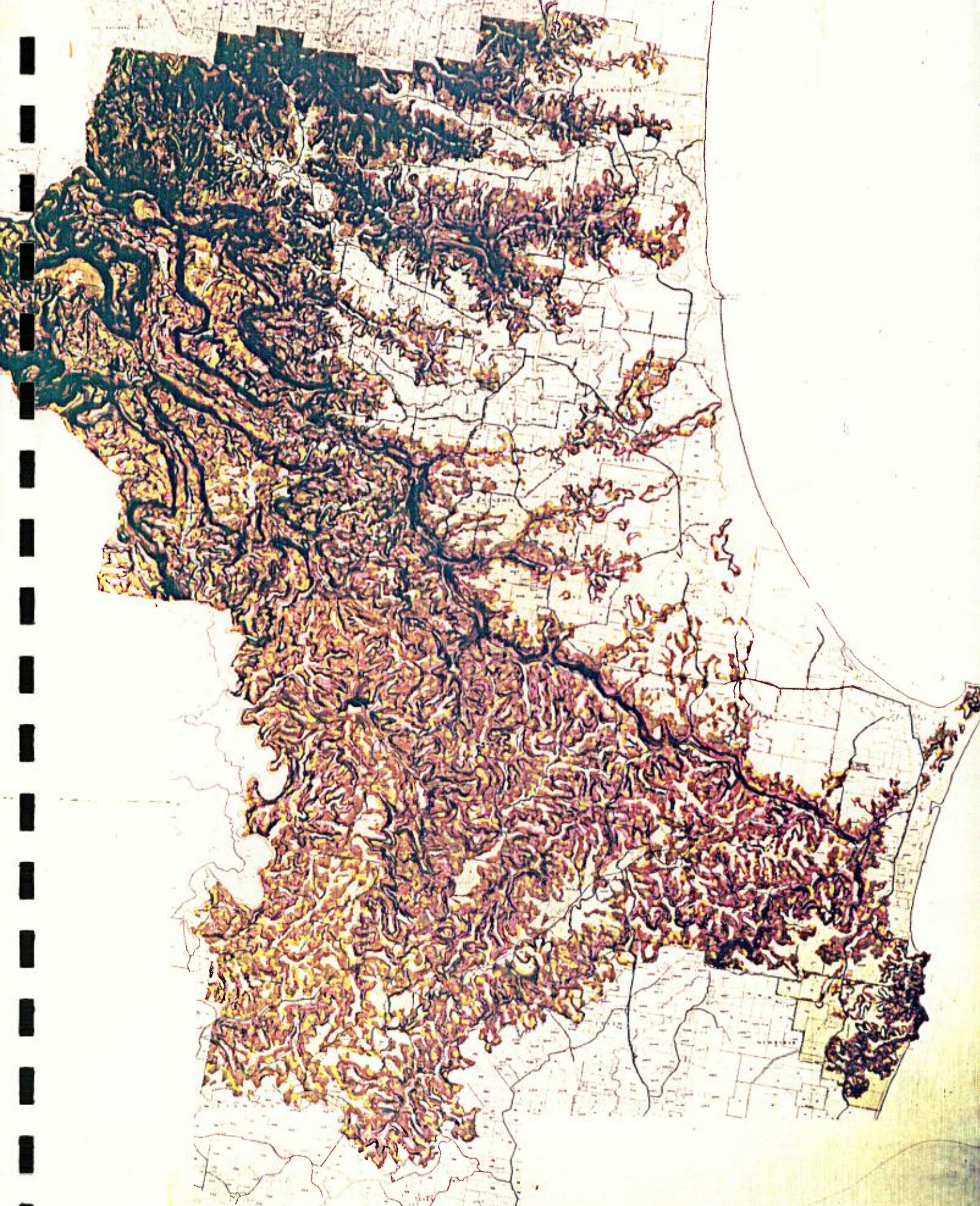
BEACH & DUNES		RIDGES	
COASTAL & RIVER FLATS		CLIFFS	
COASTAL HILLS & RIDGES		RIVERS & CREEKS	
UNDULATING TO HILLY		VALLEYS -	
MOUNTAINOUS		CONTAINED AREAS	
COASTAL ESCARPMENT			
PROMONTORY			








BYRON SHIRE ENVIRONMENTAL STUDY
LANDFORMS 1

0 5km



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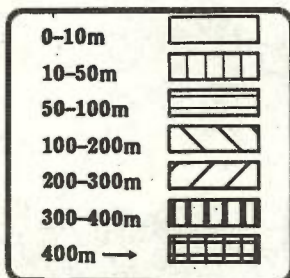
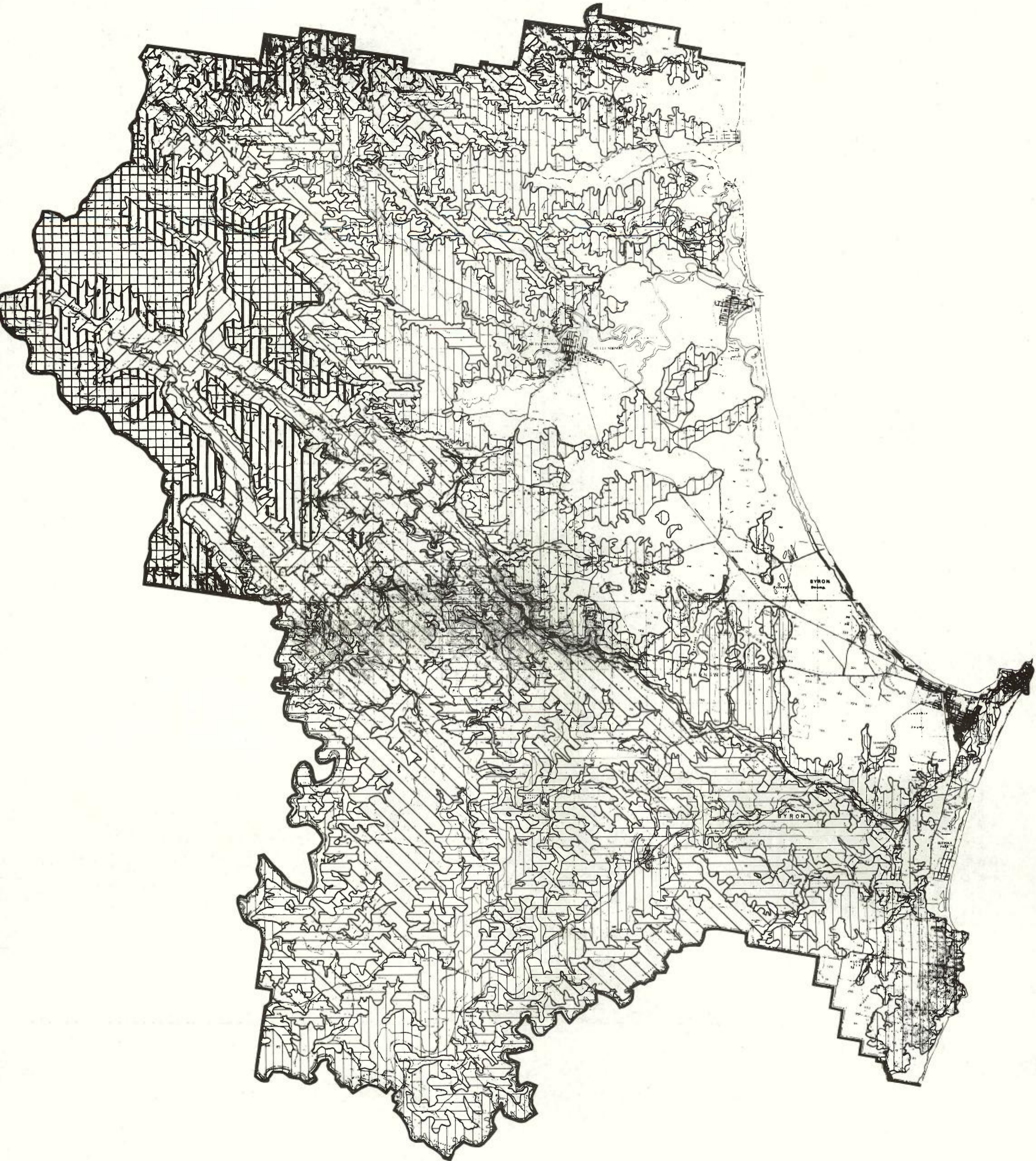


PERCENTAGE SLOPE			
0 - 5		20 - 25	
5 - 10		25 - 33	
10 - 15		33+	
15 - 20			

BYRON SHIRE ENVIRONMENTAL STUDY
SLOPES

0  10 km 

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BYRON SHIRE ENVIRONMENTAL STUDY
ELEVATION **3**

0 5km

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2.3 Coastal Plain

The coastal plain is a low lying area with an upper elevation of 10 to 20 metres and having slopes varying from 0 - 5 per cent. It is situated between the base of the escarpment, coastal ridges and the coastal dune system. The coastal plain is made up of stream alluvium and sand deposited from off-shore in earlier periods of history. As the land is low lying, there are several areas of surface water, i.e., Cumbebin Swamp and Belongil Swamp. There is an extensive heathland north of the Belongil Swamp extending to the Brunswick River. This heathland grows largely on an extensive hind dune system exhibiting a clearly defined dunal system with dunal swales strongly aligned in a north-south direction parallel to the coastline. Substantial portions of the alluvial plains are subject to periodic flooding and as such, these locations are an integral part of the surface water hydrologic system.

In general, these locations are poorly drained and the water table is frequently at or just below the land surface. Thus, development of this land almost always requires floodproofing involving drainage and filling of the site. In addition, restriction of the flood plain by filling for development has the effect of increasing flood levels elsewhere.

Originally, much of the coastal plains were covered by coastal forests apart from heathland and swamp areas. (It is often told how an early family in the district sheltered their horse drawn buggy in the hollow log of one such fallen tree). Over the past century, land uses have included dairying and grazing. Presently the area is subject to intense competition from a variety of urban uses such as residential and industrial development, tourist and recreational uses, extractive resource exploitation and transportation corridors.

2.4 Coastal Ridges

As shown on Figures 2 and 3, most of the coastal ridges lie in an east-west orientation. These ridges are characterised by variable slopes which are a result of extensive fluvial actions. The ridges range in height from 50 metres, adjacent to the coastal dune system, to 110 metres inland. They are predominantly higher in the north of the Shire.

Ridges in the north of the Shire are heavily vegetated with Eucalypt forests, while close to the south have been previously cleared for dairying and grazing. Many such ridges enjoy commanding coastal views and coastal breezes, thus enhancing their potential as desirable areas to live in a still predominantly rural landscape.

2.5 Undulating Volcanic Plateau

The undulating volcanic plateau covering the majority of the south western portion of the Shire has resulted from long term erosion of the massive volcanic lava flows originating from the Mount Warning Plug. This plateau of rolling hills and headwaters of part of the Richmond River System extends to the neighbouring Shires to the south and west, namely Ballina Shire and Lismore City.

The eastern boundary of the plateau is sharply defined by the coastal escarpment which gives the picturesque backdrop to the coastal settlements of the Shire. This escarpment has resulted from weathering forces where the basalt has given way to earlier and softer rocks, in addition to fluctuating sea levels in past geological eras. The elevation of the escarpment varies from approximately 100 to 250 metres above sea level.

The general elevation of the plateau area varies from 50 to 150 metres above sea level although there are some ridge systems that are higher than this. The predominant soil association within the plateau is the red volcanic or krasnozem soils. Such soils have a strong reputation for being well drained and having the potential to be quite fertile. Consequently, much of the plateau area is sought after for horticultural crops.

The original vegetation of the plateau was the extensive "big scrub" rainforest which yielded many highly prized softwood timbers such as cedar, teak, rosewood and black bean. Extensive clearing of this rainforest happened in days of earlier settlement by white people and the plateau had a reputation for producing high quality dairy products once grazing grasses such as kikuyu and paspalum were introduced. Future land uses for the plateau appear to be horticultural (tropical fruit, orchards), although dairying is again increasingly becoming more viable. It is said that this combination of type and climate on the plateau is unique in the world and therefore is a resource to be protected where possible.

2.6 Mountain Ranges and Valleys

Simply speaking, the Shire is divided in thirds between the coastal plains and plateau area discussed above, and the mountain and valley land form unit in the north-west of the Shire. The dramatic variation in relief of the landscape and its forest covered slopes creates a spectacular backdrop when viewed from the coastal areas of the Shire.

The mountain ranges in question constitute the easterly portion of the Nightcap Ranges, the dominant peaks being Mount Jerusalem (800 metres), Mount Boogarum (640 metres), and Mount Peak (600 metres). The only other peak of visual significance is Mount Chincogan (307 metres), which stands isolated, to the north of the village of Mullumbimby.

In some sections of the ranges, sheer cliff faces feature and in one particular area give rise to two major waterfalls. Many slopes are in excess of 25 degrees and can be considered too steep for profitable agricultural purposes, except for bananas in selected areas. Slopes are well drained and heavily dissected, and consequently the removal of vegetation cover increases the risk of erosion and slumping.

In the central western portion of the Shire between the mountainous area and the volcanic plateau to the south is situated Wanganui Gorge through which Coopers Creek flows. The spectacular gorge, with near vertical slopes some 90 metres in depth, has formed from the erosive action of running water, which attacked the soft and more acidic rocks such as rhyolite. Minyon Falls, located just outside the Shire boundary, is a result of this landform development.

2.7 Planning Implications

The Shire's landforms constitute a valuable resource for both the Shire's major industries - tourism and agriculture. Consideration of changes of land use and further development should have regard to the following:

- * Development should be of a type compatible with the maintenance and enhancement of the existing rural and scenic character of the Shire.
- * The coastline and coastal plain, being generally flat and comprising in part wetlands and dunal heath land, is characterised in part by factors that can be interpreted as being a constraint to future intensive urban development. These include:
 - ✓ . land instability associated with coastal erosion and the stability of the dunal system;
 - ✓ . inundation associated with high water tables and flood liability;
 - . environmental significance and sensitivity;
 - ✓ . drainage problems.
- * *also Wanganui* The coastal ridges provide excellent opportunities for rural/coastal living. It is important however, to recognise that they are visually prominent from the main transport routes and other public places. Such prominence needs to be considered when rural residential or urban development is being considered.
- * The undulating volcanic plateau area with its diversity in land forms and its extensive road network provides an ideal rural living environment. The area also contains some high quality agricultural land and is the focus of the agricultural base of the Shire. There is a need to rationalise these often conflicting demands for the use of the land.
- * The mountain ranges and valleys are visually prominent, steep and heavily timbered. The alignment of the valleys is such that, in many areas they can be considered as bushfire prone. Those areas are generally more isolated with limited alternative access. Future development in these areas should take these factors into consideration.

3. GEOLOGY

3.1 Geological Setting

Byron Shire has a complex geologic history. The oldest or basement rocks of the Shire are the meta sediments of the Neranleigh-Ferndale Group which are part of the 'Brisbane Metamorphic Series'. These rocks are of Paleozoic age and consist of generally thinly bedded, fissile siltstones and mudstones with minor occurrences of more massive units such as sandstones and conglomerates, which have been extensively deformed. The basement rocks are exposed in a number of localities along the coast including Cape Byron and Broken Head, and at the base of the coastal escarpment.

M The basement rocks are overlain in part by lacustrine sediments of mesozoic age, which form the eastern margin of the Clarence-Moreton Basin. This sedimentary sequence consists of, in order of decreasing age, units of the Evans Head Coal Measures, the Marburg Formation, the Walloon Coal Measures and the Kangaroo Creek sandstone. These sediments consist of conglomerates, sandstones, siltstones, shale and carbonaceous shale.

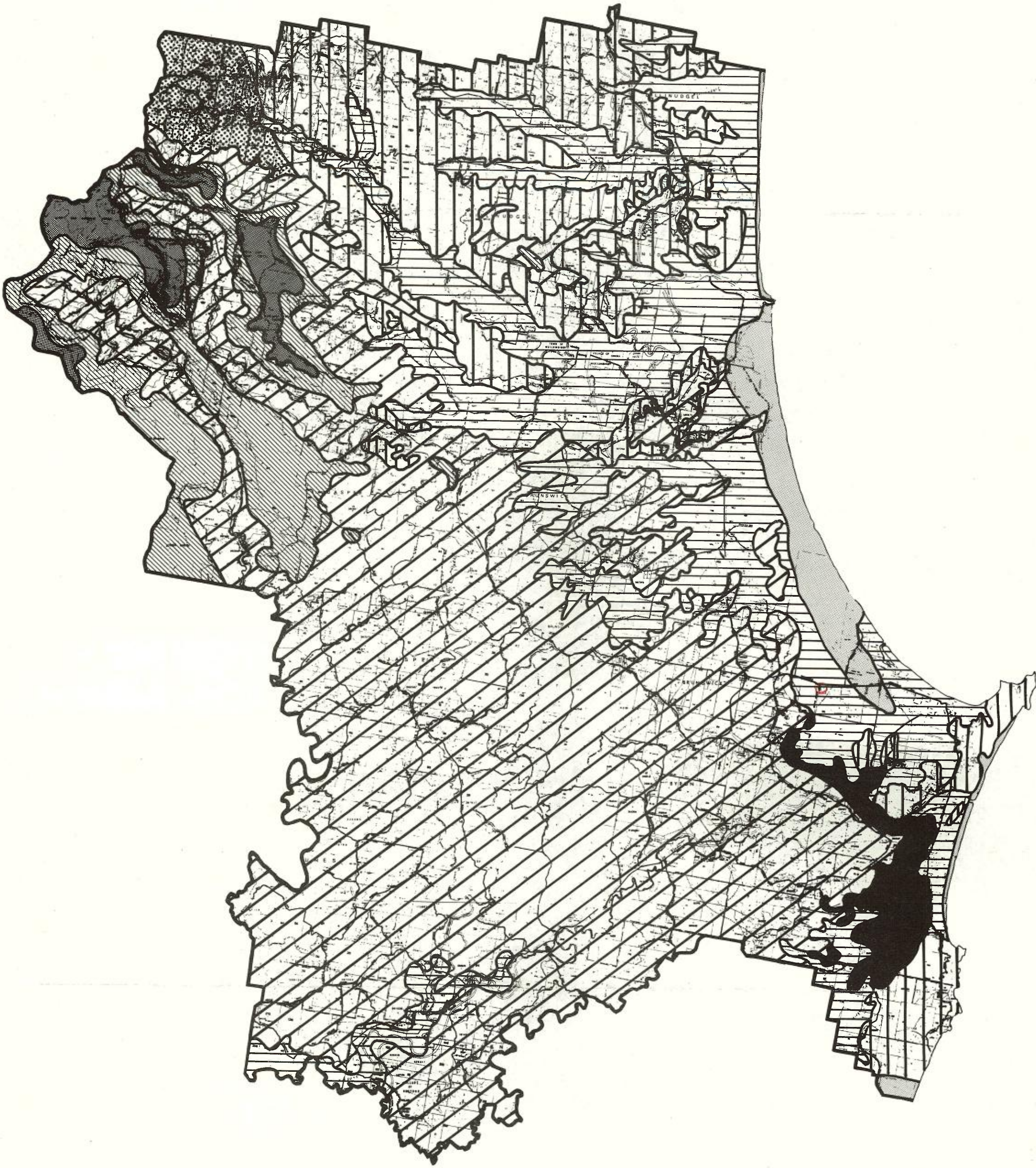
The 'Macpherson Volcanics' overlies the ^{M.S.} ~~mesozoic~~ ^{metasomatic} sedimentary sequence. These 'volcanics' consist of a sequence of lava flows. It is estimated that the first flow occurred about 21-23 million years ago and consisted of an olivine rich, low viscosity basalt now known as the 'Lismore Basalt'. The second major flow occurred approximately 10,000 years later and consisted of a highly viscous acid flow, which solidified to form rhyolite. Volcanic activity in the area ceased about 10 million years ago, with the 'Blue Knob' basalt forming the last flow.

Differential uplift and erosion occurred following the cessation of volcanic activity. The uplift resulted in the rejuvenation of creek and river systems which actively eroded their channels. During the Quaternary Period, alluvial deposition occurred. The sediments consist of sequences of fluvial and marine sediments resulting from fluctuations in sea levels.

As the sea levels fell, streams reacted by increasing the down cutting of bedrock. Streams carried down eroded material, which was deposited, partly filling valleys. High sea levels, brought marine sediments into the valley embayments. Thus, the coastal plain was formed and the final action was the topping of the surface at the heads of valleys with further material brought down by stream.

3.2 Stratigraphy

Stratigraphic succession and the surface geology of Byron Shire is illustrated on Figure 4. Figure 4 is based on the ^{Sheet} 1:250,000 geological map series and Table 3.1 is based on this and reports supplied by the Department of Mineral Resources. The geological units are arranged in ascending stratigraphic sequence.



	Pzn	NERANLEIGH FERNVALE 'GROUP'		R-jb	BUNDAMBA GROUP INCLUDING MARBURG FORMATION
	Rc	IPSWICH COAL MEASURES - CHILLINGHAM VOLCANICS		Tg	GRAVEL, SAND, GREYBILLY
	Tlb	LISMORE BASALT		Qs	ALLUVIUM - RECENT
	Tnr	NIMBIN RHYOLITE		Qa	ALLUVIUM - OLDER
	Tnb	BLUE KNOB BASALT			


} LAMINGTON VOLCANICS

BYRON SHIRE ENVIRONMENTAL STUDY
GEOLOGY

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Table 3.1: Geological Units - Byron Shire

	Stratigraphic Unit	Geological Time		Million Years Before Present Time	Composition	Economic Value
		Era	Period			
P zn	Neranleigh Fernvale 'Group'	Palaeozoic	Silurian	400-430	Metamorphic: Greywacke Slate Phyllite Quartzite	Surface exposures easily weathered allowing use for road construction materials. Useful as ceramic raw material under certain conditions.
Rc	Ipswich Coal Measures - Chillingham Volcanics	Mesozoic	Triassic	180-230	Rhyolite Tuff	Thinly bedded or highly jointed units have high potential for road construction materials.
R-Jb	Bundamba Group including Marburg Formation	Mesozoic	Triassic-Jurassic	135-230	Sedimentary: Sandstone	Source of massive rock - thinly bedded members allow possibility of small scale use for road construction.
	Lamington Volcanics	Cainozoic	Tertiary	2.5-63		Potential for several classes of resource materials.
Tnb	Blue Knob Basalt				Basalt and Andesite Rhyolite, Obsidian, Tuff Pitchstone, Agglomerate Basalt (agglomerate, bole)	<ol style="list-style-type: none"> 1. aggregate production 2. massive rock - rip rap 3. diatomite possibility 4. small scale potential for perlite and ceramic clay
Tnr	Nimbin Rhyolite					
Tlb	Lismore Basalt					
Tg		Cainozoic	Tertiary		Gravel, Sand, Sandstone, Greybilly	Potentially valuable as raw material for white and decorative gravel.
Qs	Alluvium	Cainozoic	Quaternary	0-2.5	Beach and Dune Sand	 Potential for heavy mineral sands and valuable groundwater storage areas. Construction sand from back dune areas.
Qa	Alluvium	Cainozoic	Quaternary		River Gravels, Alluviums Sand and Clay	

3.3 Economic Geological Resources

Economic geological resources refer to geological materials, such as mineral fuels, metallic minerals, non-metallic minerals and construction materials which can be utilised by man.

The need to define the potential mineral resources and construction materials sources in the Shire arises from the need to ensure that deposits of economic significance are retained in sufficiently large units to provide for possible anticipated future demands. Many of these resources may be easily sterilised by allowing other uses to be established on or near these resources. For instance, subdivision of land for residential or rural-residential purposes can effectively alienate important geological deposits.

The main source of information on these resources in Byron Shire is provided by reports from the Department of Mineral Resources and the Byron Shire Council.

Figure 5 illustrates the economic geological resources in the Shire.

3.3.1 Mineral Resources

Heavy Mineral Sands

The mining of heavy minerals in coastal areas in the Shire has been the major mining activity undertaken to date; however, at present, this activity is declining. Chestnut and Swane (Department of Mines, 1980), note that:

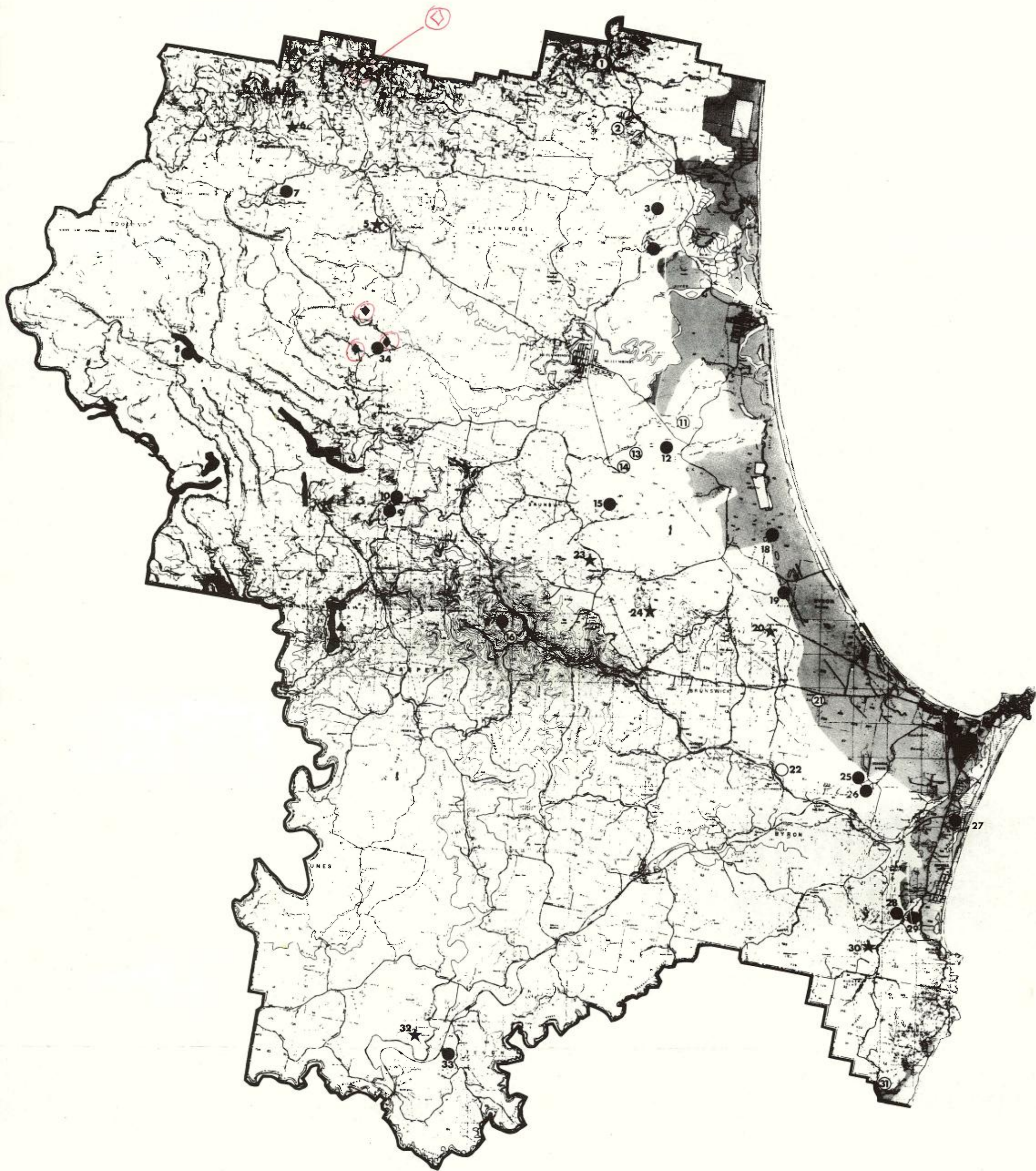
"How important it will be in the future is not predictable with any certainty, although it seems unlikely that it will ever again reach the peak production achieved in the late 1960's".

Much of the coastal sandy alluvium deposits within the Shire form a potential source of heavy mineral sands. Areas are currently held under lease (but requiring development consent) by two companies, Currumbin Minerals Pty Ltd and Associated Minerals Consolidated Ltd. These leases extend from the northern Shire boundary to just south of Broken Head. The lands include both beach and fore-dune areas and hind-dune areas.

Perlite

Perlite is a volcanic glass which expands on heating to form a foam-like material used principally as an insulating material and lightweight aggregate.

Eight known deposits of perlite occur within or immediately below the Nimbin rhyolite outcrop in the north-west of the Shire.



PERLITIC ROCKS		QUARRIES:		15
KNOWN PERLITE DEPOSITS		CURRENTLY OPERATING		14
KNOWN OLD COPPER/SILVER WORKINGS		NOT NOW IN USE		5
MANGANESE RHODONTITE		POTENTIAL SITE		
MINERAL SANDS		REFER TO REPORT FOR DESCRIPTION		
QUATERNARY SAND AND SANDY SEDIMENTS				
CURRENT MINING LEASES				

BYRON SHIRE ENVIRONMENTAL STUDY
ECONOMIC GEOLOGICAL
RESOURCES

0 5km

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Limited exploration of deposits in the Nightcap Range was undertaken during the 1970's. Much of the perlite was found to contain mineral grains and rock fragments which render it unsuitable for many applications. In addition, a number of the deposits are located in areas which are environmentally sensitive or would be difficult to quarry. Nevertheless, the Nightcap Range area is still regarded as having moderate potential for perlite and warrants more detailed investigations. Increased acceptance and demand for perlite could lead to renewed interest in the area.

The two most significant known deposits within Byron Shire are the Wilsons Creek and Goonengerry deposits. Neither of these deposits have been tested in any detail. The Goonengerry deposit is small but contains some high grade perlite. The Wilsons Creek Deposit appears to be somewhat smaller than shown on the plan and contains a larger proportion of lower grade material. The site would also be difficult to quarry. Both these deposits require further testing to adequately assess their potential.

The other known deposits of perlite within Byron Shire appear to have little potential because of small size and/or low quality and occur for the most part in areas which are environmentally sensitive and which would be difficult to mine.

Diatomite

Diatomite is a soft chalk-like siliceous sediment, which is used primarily as a filter aid in thermal and sound installation. A deposit, the Snow Queen Mine, which has been worked in the past, is situated near Tintenbar, a short distance to the south of Byron Shire. The deposit is of high purity and is considered to have economic potential. Diatomite occurs within the Lismore Basalt which also crops out over much of Byron Shire. There are no known occurrences of diatomite within Byron Shire but the basalt covered areas can be considered to have low/moderate potential.

Detailed investigation of these basalt areas would be necessary to assess the area's potential.

Opal

Small amounts of precious opal were won during the 1920's ^{from} and deposits in the Lismore Basalt at Tintenbar, just south of the Shire. Although some ^{of} extractive stones were produced, much of the material tended to craze on exposure to the air or during the cutting process. Some potential exists for the discovery of similar deposits within the Basalt areas of Byron Shire; however, the likelihood of economically significant deposits being found is considered to be low. At present an opal/clay deposit is being worked on lands to the west of Tintenbar Village.

Rhoda^onite

Rhoda^onite is a low grade gemstone derived from manganese. It is used primarily in making tiles, slates and similar high quality household fittings. Within the Shire there is one rhoda^onite lease currently held on lands west of Mullumbimby. The extent of this resource is not accurately known.

Other Minerals

In the past, small scale copper and silver workings have operated in the Mullumbimby Creek area west of Mullumbimby, however, it is considered that the economic potential of remaining deposits is very low.

3.3.2 Construction Materials

Mineral resources in the form of construction materials such as road base, aggregate, gravel, sand, and hailstone are essential for any future growth in the Shire. The location, extent and quality of reserves and potential impact of retrieving such resources, needs to be established so as to reserve the most favourable areas within the Shire for such purposes.

Figure 5 shows location of 34 quarry sites within the Shire. The quarry sites are listed in categories identifying those currently operating, those not now operating and potential sites. The accompanying tables (Tables 3.2, 3.3, 3.4) list the Shire's quarries in the above categories to show the type of reserves extracted, estimate of reserves, quality of resource, and general remarks pertaining to each quarry.

Byron Shire is not well endowed with a wide range of well located, cheaply retrievable construction materials. As can be seen from Figure 5, the majority of the Shire's quarries are located along the coastal strip. This coastal strip contains a large proportion of the population of the Shire and it is likely that future population growth will be concentrated mainly in this area. Strong competition between a wide range of possible land uses is envisaged in the future. The following assessment of the future supply of the various construction materials has been compiled by Council officers.

Road Base

Within the Shire there appear to be adequate reserves of road base for the next 20 years. The majority of the road base material is supplied from the Myocum and James Quarries. Myocum Quarry is located on the Manse Road to the south east of Mullumbimby, while the James Quarry is near Nashua. The northern segment of the Shire is well serviced by Myocum Quarry, while the western portions of the Shire seem to be adequately serviced by both quarries. The south eastern coastal portion of the Shire is poorly serviced in terms of the larger haulage distances involved in supplying this area.

Aggregate

The Lismore Basalt which covers most of the Shire is the major potential source of aggregate. Although there are obviously large quantities of this material, the number of sites potentially suitable for quarrying is limited by the depth of weathering, which is often excessive, and because of environmental constraints and topographic position of the deposits. The present needs of aggregate for bitumen and concrete are being met by importing crushed basalt from outside the Shire.

Sand

Sand resources within the Shire are confined to the coastal Quaternary Sediments, particularly the beach and dune deposits and estuaries. Due to the lack of a major river within the Shire, adequate reserves of river sand are lacking.

Locations for the extraction of beach dunal sand are limited due to strong competition for such coastal land and environmental considerations.

General Fill

A complete shortage of general fill exists within the Shire. The most recognised sources of general fill such as road reserves and private quarries are dwindling rapidly. The bulk of general fill material presently supplied is lower grade hailstone extractions from Batson's Quarry near Broken Head. A potential source of general fill exists when a new quarry for other construction materials is opened. Overburden from a new quarry can be utilised for general fill, being the surface material covering such reserves. *commonly*

Groyne Construction Material

An investigation of possible sources of breakwater stone in the Brunswick Heads-Byron Bay Region was undertaken by the Department of Public Works in 1979 (unpublished report GS 1979/336). Six potential quarry sites in the Lismore Basalt (within about 10 kilometres of the coast) were identified and tested. The two preferred sites were found to be Myocum and Borrowdale's Quarry. These sites require careful consideration if any proposed change in land use would prevent or restrict extraction. ✓

Table 3.2: Quarries Currently Operating

Map Ref. No.	Common Name	Material		Operating Status	Estimated Reserves	Quality of Material	Remarks
		Type	Suitability For				
3	O'Donnell	Chert ¹	Base ²	DMR lease	5 years	Variable quality	Present major source - limited reserves. Visual considerations because sited on high hill.
4	Mudge's Pit	Chert	Base	Private	In excess of 20 years	Very good Quality	Major future site. Visual considerations because sited on high hill.
7	Palmwoods	Chert	Base	Private	Significant 10 years	High quality	
8	Wilson's Creek	Decomposed Basalt	Sub Base	In limited Use. Private	Not Significant	Average quality.	
9	Parkers Pit	Chert	Base	Private	15-20 years	Good quality	Significant future for western areas of Shire.
10	Donaghy's Pit	Chert	Base	Council owned and operated	10 years	High quality	
12	Keech's Pit	Chert	Sub Base	DMR lease	5 years	Fair quality	High quality material lower down. Visual advantages because not located on ridge line.
15	Myocum	Chert	Base	Heavy Use Council owned and operated	10 years	High quality	Best quarry in Shire servicing major areas.
17	Scarrabelotti	Chert	Base	DMR lease	5 years at most	Good quality	Uneconomical - excessive over-burden.
18	Wards Sand	Sand	General Construction	Crown lease	5 years	Good quality	Major source of sand.
19	Batson	Sand and top soil	Construction and landscaping	Crown lease	Long future	Good quality	Major source of sand.
25	Frisco	Hailstone	Construction	Private	10 years	Good	Significant current use.
26	Morrison	Hailstone	Construction	Occasional use. Private	Limited	Good	Environmental constraints.
27	Batsons Sand Pit	Sand	General Construction	Private on Crown lease	5 years	Good	Limited life.

Table 3.2: Quarries Currently Operating (cont'd)

Map Ref. No.	Common Name	Material		Operating Status	Estimated Reserves	Quality of Material	Remarks
		Type	Suitability For				
28	Batsons	Hailstone	Concrete, Roadbase, Fill	Heavy use Private	Not quantified	Very good to to variable	Quarry has wide range of material. Very heavy use for concrete, road base and fill. Unknown life - needs investigations to detail extent of deposits.
29	Batsons	Hailstone	Concrete, Roadbase, Fill	Heavy use Private	Not quantified	Very good to to variable	Quarry has wide range of material. Very heavy use for concrete, road base and fill. Unknown life - needs investigations to detail extent of deposits.
33	James	Chert	Base	Lease. Council operated	5 years	Good quality	Significant deposit - possible further reserves.
34	Mullumbimby Creek	Chert	Base	Private	10 years	Good quality	Few access problems - can be overcome.

Notes:

1. **Chert** is a resulting material from deep weathering of the Neranleigh-Fernvale Group. Other materials resulting from such weathering of this metamorphic group includes shale, mudstone, sandstone, greywacks.
2. **Base** and **Sub-base** are used for the construction of roads. Base is the layer of compressed material on which the wearing surface (sprayed bituminous seal or asphaltic concrete) is laid. The Chert used for Base is of a higher quality than that used for sub-base. **Sub-base** is the layer of compressed material over which the base layer is laid. Sub-base can also be used for the surface material of unsealed gravel roads.

Table 3.3: Existing Quarries - Not Now in Use

Map Ref. No.	Common Name	Material		Operating Status	Estimated Reserves	Quality of Material	Remarks
		Type	Suitability For				
1	Gallaghers	Chert	Base	Private	20 years	Good quality	May be useful for development of Ocean Shores.
2	Yelgun	Chert	Sub-base	Private. Not used for 15 yrs	Small deposit	Variable quality	Access difficult.
11	Borrowdales	Massive Basalt	Sea Groyne	Private (ex. PWD)	Significant deposits	Good	Was used for Brunswick Harbour Works. Development constraints - No. 23 Myocum site preferred.
13	Ubergang	Chert	ase and Sub-base	Private	5-10 years	Range of qualities	Intended for private development.
14	Ubergang	Chert	Base and Sub-base	Private	5-10 years	Range of qualities	Intended for private development.
16	Old Scarrabolotti	Decomposed Basalt	Sub-base	Private	Limited future	Average	
21	Island Quarry	Columnar Basalt	Aggregate ³	Crown lease			
22	Boyles Hill	Columnar Basalt	Aggregate	Private	Small Pit		Considered environmentally unacceptable.
31	Schaeffer	Chert	Base and Sub-base	Private Not used for 10 years	5 years	Average quality	Existing scar needs restoration. Considered excessive environmental impact.

Note:

3. **Aggregate:** Aggregate is used in concrete and bitumen, and is derived from the crushing of basalt.

Table 3.4: Potential Quarry Sites

Map Ref. No.	Common Name	Material		Operating Status	Estimated Reserves	Quality of Material	Remarks
		Type	Suitability For				
5	Settlement	Chert	Base	New current application Previous quarry	Dependent on resolution of environmental considerations	Good quality	Subject to strong debate including environmental consideration.
6	McIlwraith	Chert	Subject to testing	Current application	Not tested - possibly extensive	Subject to testing	Subject to environmental considerations.
20	Quarry Lane	Columnar Basalt	Aggregate	Potential site	Most significant deposit identified remaining in Shire - subject to site test	To be tested	Various options for landuse. Potential deposits to be quantified.
23	Summauer	Massive Basalt	Sea Groynes	Potential site	Extensive	Good	Considered more favourable than Barrowdales Quarry for groyne construction material. PWD not prepared to resume property.
24	Tullochs Pit	Chert	Sub-base	Current Application	10 years	Fair - Good	Development approval subject to strong debate.
30	Armstrong	Hailstone		Potential site	Unknown extent	Good	Settlement close by. Unknown extent of reserves. Environmentally sensitive.
32	Unnamed	Chert	To be tested	Potential site	Unknown	Unknown	Untested/adjacent to significant deposit. Requires investigation and drilling. House adjacent.

3.4 Planning Implications

3.4.1 Mineral Sands

As can be seen from Figure 5, much of the coastal Quaternary sandy alluvium has potential for the mining of heavy minerals. Existing leases are located primarily in close proximity to the coastline.

The Department of Mineral Resources has informed Council that "future mineral sand mining operations in the Shire will, subject to the granting of all necessary consents, probably occur within areas south of Cape Byron to Tallow Creek and south of Brunswick Heads to a point well north of Belongil Creek".

Mineral sands are an important resource to the Shire. However, decisions on future sand mining activity in the Shire should be preceded by thorough environmental investigations including investigation in the effects of mining on the coastal impact zone (erosion hazard area).

3.4.2 Construction Material

✓ The supply of good quality, economically recoverable construction material is essential for the future growth of the Shire. As mentioned above, the majority of the Shire's quarries are located along the coastal belt. As this is the area where further population growth is likely to be located, there is a need to properly assess the quality of the resource, the available supply and likely need to ensure that good resources are not unnecessarily sterilized by urban development and that urban or rural residential development is not unduly affected by mining activity.

The location of construction material reserves within the Shire will be taken into consideration in determining the future urban growth of the Shire. The existence of such a resource is not seen as a total constraint to development. Factors that need to be taken into consideration include:

- * The identification of a suitable buffer around quarry sites.
- * The timing of urban development.
- * Potential access to quarry sites.

The operation of quarries in the Shire ^{will} should be preceded by thorough environmental investigation as required under the Environmental Planning and Assessment Act, 1979.

*width +
fossiliferous sand ore*

4. SOILS

4.1 Description of Soils

Consideration of the distribution of soils and their constituent properties is essential in identifying the suitability of land for various purposes. The characteristics of soils with regard to fertility, drainage, septic tank suitability, shrink/swell potential (suitability for building foundation), susceptibility to erosion and degree of slope stability need to be assessed.

This chapter aims to identify the major soil associations within the Shire, together with their inherent characteristics and hence their suitability for various land use purposes. Soil fertility is discussed in a later section identifying the agricultural capability of land within the Shire.

Much of the information within this section originates from the Soil Conservation Service Technical Bulletin for the Casino Soil Conservation District (Harte, 1982).

Figure 6 displays the dominant soil types in the Shire. This Soils Map was compiled from a combination of the following:

- * **Field survey:** The district was traversed by vehicle and sampling and field description took place wherever necessary.
- * **Previous surveys:** Information from soil survey work already completed for the area was extracted and collated. The work of McGarity (1956) on the krasnozems and chocolate soils was most valuable.
- * **Geological Mapping:** Geological Maps (Department of Mineral Resources) were used in determining some soil type boundaries. Boundaries between the basalt soils and the soils developed on sediments are quite accurate, while some boundaries between soil units within the sedimentary areas are more general and diffuse.

Soils within the Shire are distributed primarily on the basis of the underlying rock types. This is apparent when comparing the Shire's Geological Map (Figure 4) with the Shire's Soil Map (Figure 6).

The major soil associations within the Shire fall into four main groups. The dominant soil types within each group are listed in Table 4.1.

Table 4.1: Dominant Soil Types in Byron Shire

Soil Associations	Major Soil Types
1. Soils on volcanic rocks	Krasnozem soils Brown podzolic soils Chocolate soils*
2. Soils on Sediments	Hard setting duplex soils with yellow, brown and red subsoils Red podzolic soils of good structure Yellow and red podzolic soils of poor structure
3. Soils of Alluvial deposits	Gleyed podzolic soils Black earths and weisenboden soils*
4. Sands	Ground water podsols/ calcarceous sands Siliceous sands (regosols)

* Associated soils

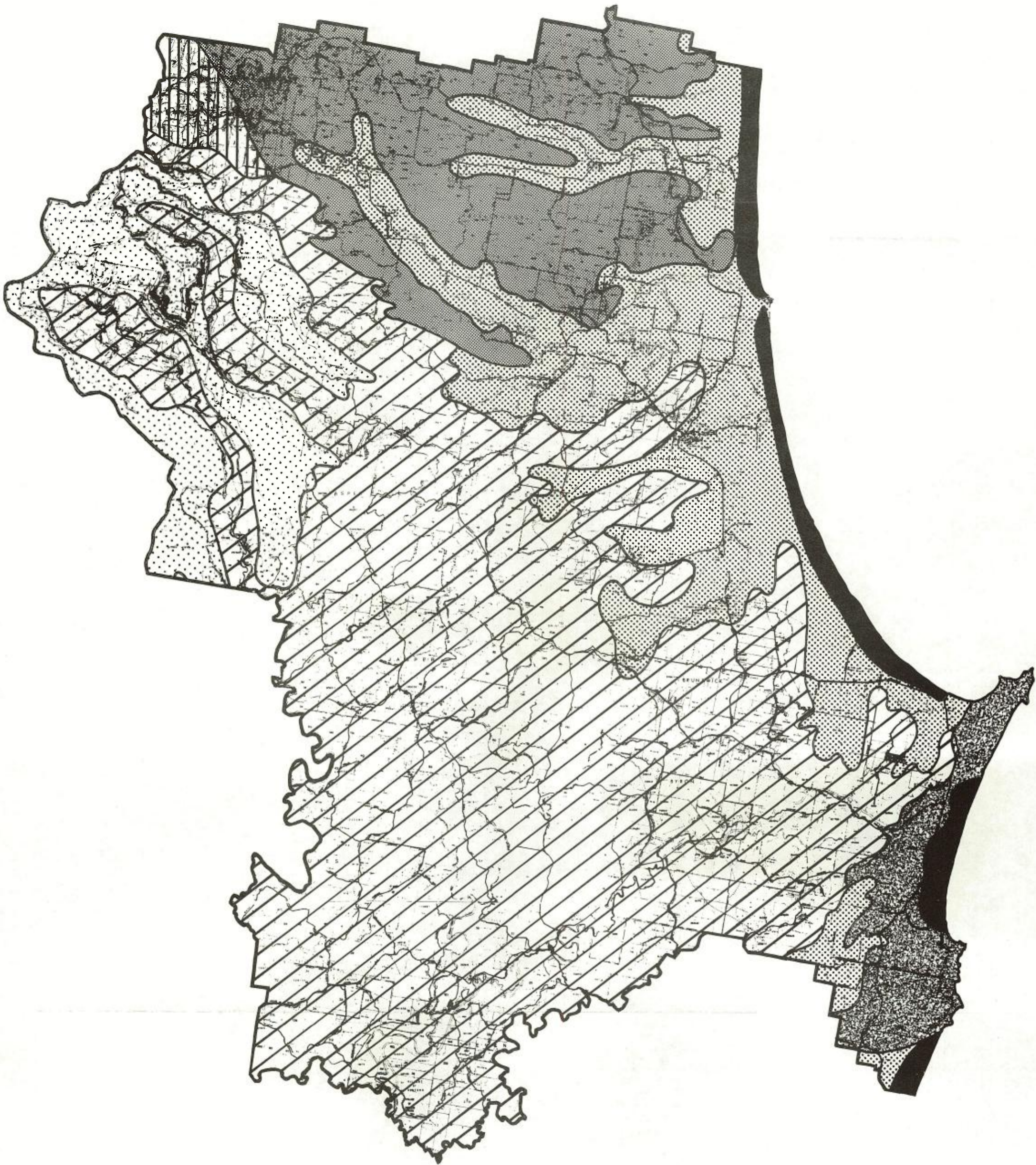
4.1.1 Soils on Volcanic Rocks

Krasnozem Soils (Underlying rock-basalt)











The soils of this group form the largest association within the Shire. The krasnozems are basalt derived and occur in areas of low relief and high rainfall (generally exceeding 1,180 mm per annum).

Krasnozem soils have reddish uniform to gradational textured profiles which may be several metres deep. These soils are characterised by a red-brown to red clay loam of good friable structure, generally 0-25 cm in depth, overlying a well structured red to red-brown clay. The reddish colouring is derived from high proportions of aluminium and iron sesquioxides which, in addition to high organic matter, results in the strongly aggregated clay component which typifies these soils.

The characteristics of the krasnozems depend in part on their topographic position, inherent drainage and composition of the underlying bedrock.



SOURCE: SOIL CONSERVATION SERVICE OF N.S.W.

SOILS ON VOLCANIC ROCKS		HARD SETTING DUPLEX SOILS WITH RED, YELLOW AND BROWN SUBSOILS	
KRAZNOZEMS		SOILS ON ALLUVIAL DEPOSITS	
BROWN PODZOLIC SOILS		DARK ALLUVIAL LOAMS WITH GLEYED CLAY SUBSOILS	
SOILS ON SEDIMENTS		SANDS	
YELLOW AND RED PODZOLIC SOILS OF POOR STRUCTURE			
RED PODZOLIC SOILS OF GOOD STRUCTURE			

BYRON SHIRE ENVIRONMENTAL STUDY

DOMINANT SOIL TYPES

BYRON SHIRE

0  5km

6
↑

Prepared by PLANNING WORKSHOP PTY. LTD. 346 KENT ST., SYDNEY
For BYRON SHIRE COUNCIL

Riddler (1983) found that:

"The deeper red krasnozem soils, (Gn4.11) are generally associated with the level to moderately steep slope along the southern and eastern margins of the Shire. They cover also the slopes as a colluvial mantle of varying thickness and are present in the upper catchment areas of the streams (Eltham Clay, Gn4.31).

On the steeper more dissected terrain the soils are generally shallower with many boulders and frequent rock outcrops. The soil is either reddish brown throughout (Bangalow Clay Loam, Gn4.11) or has a brown surface soil overlying a red subsoil which may pass into pallid mottled clays in places especially just below ridge crest in the south west (Alphadale Clay Loam, Gn4.11).

On the low foothills and valleys a brown to dark reddish brown friable porous earthy clay is present. On the upper slopes the soil passes into weathered rock; (Caniabah Clay loam, Gn4.11, Chocolate soils). Down slope the texture becomes finer, darker in colour, and more pedal in structure. The deeper subsoil is usually a relatively impermeable grey clay (Caniabah Clay, Ug5.16, Black earth).

On the broad valley floors between these low basaltic hills the soils are dark seasonally cracking clays, pellic vertisols. The soils occur in a complex with Black earths, sometimes calcareous, (Pelican Clay, Ug5.16; Springgrove Clay, Ug5.14) in better drained sites and Wiesenboden (Ug.5.4) in the wetter, poorly drained sites (Pelican Clay, UG5.16, Tomki Clay, Ug5.4)".

Although initial fertility of the krasnozem soils is moderate to good, applications of nitrogen and phosphorus in reasonable quantities are necessary to maximise productivity. Phosphorous fixation is also a problem. Due to leaching, bases are rapidly lost and soils are acidic.

The erosion risk associated with krasnozem soils varies from moderate to severe with these soils being susceptible to both sheet and gully erosion. In their natural condition, krasnozem soils on undulating to moderately steep land tend to present a moderate erosion risk. In steeper areas, or where krasnozems have been disturbed by vegetation removal or repeated cultivation, the associated erosion risk is severe. Krasnozem soils are also prone to mass movement, especially in areas of deep colluvium material on steep slopes.

Mass movement generally results from disturbance of the soil profile by construction, clearing etc., and/or from increases in the soil moisture. The clay minerology of krasnozem soils is dominated by Kaolinite, which is a very simple structured clay that does not absorb large amounts of water or undergo extensive shrink swell. As a result, these soils generally have a small plastic index and a typical liquid limit of 25-30,

which indicate that soils will not fail until close to the liquid limit. Increases in the soil moisture status, to above the liquid limit, may occur during, or immediately following, high intensity rainfall or be triggered by factors such as sillage pits and septic absorption fields, changes in the drainage pattern, seepage lines etc.

In summary, the characteristics of krasnozems are as follows:

- * Drainage - well drained.
- * Soil fertility - initially high.
- * Septic tank suitability - poor to good depending on topographic position.
- * Shrink soil potential - low (i.e. suitable for building foundations).
- * Mass movement - potential for mass movement on slopes, especially if slope disturbed or soil moisture status increased.
- * Erosion - problem on moderate to steep slopes due to high rainfall.

Chocolate Soils

This association is found in the strongly dissected properties of the basalt plateau generally to the west and north of the krasnozems in areas where the average annual rainfall is less than 1,180 mm. It may also occur as part of a catenary sequence with the krasnozems.

According to Harte (1982), the chocolate soils are darker in colour than the krasnozems, and have a closed ped fabric. These soils are more plastic with the clay mineralogy being dominated by montmorillonite and illite. Profiles are generally quite shallow (less than 2 metres), but are reasonably well structured.

The A horizon is typically comprised of a dark brown clay loam which gradually merges to a dark brown to brown clay subsoil. Carbonates are generally not present in the solum, and subsoils are acid to neutral.

Chocolate soils are relatively fertile, however, these soils are generally found in areas of steep topography. As such, these soils present a severe sheet erosion and mass movement risk.

Associated soils within the Chocolate Soil Association include prairie soils, black earths, weisenbodens, reddish chocolate soils and krasnozems.

Brown Podzolic Soils

The brown podzolic soil association has formed on the acid volcanic rocks (Rhyolite) which outcrop within a large area of the main volcanic shield in the north west of Byron Shire.

Brown podzolics form the dominant soil type within the association. These soils are characterised by a dark loam A horizon grading into a reddish brown light to medium clay. The A horizon generally contains a high proportion of organic matter with a deep litter layer forming the A horizon. The A horizon's soft setting typically has a crumb structure. It reaches a depth of 25 centimetres.

The boundary between the A and B horizon is abrupt. The structure of the B horizon varies from good to moderate, and with a moderate ped structure. Slight mottling occurs in the lower part of this horizon. The brown podzolics are acid, with acidity increasing with depth.

Moderate weathering and strong leaching are the main formation processes of the brown podzolic soils. This is accompanied by translocation of some iron oxides and clay from topsoil to subsoil, mineralisation of organic matter and removal of bases by leaching, leaving strongly acid subsoils.

The soils of this association are used mainly for timber production. High acidities limit their use for crops and grazing. The brown podzolics do not represent a high erosion risk if they are retained under natural cover of forest and leaf litter.

4.1.2 Soils of the Sedimentary and Weakly Metamorphosed Rocks

Soils derived from these rock types generally have texture contrast (duplex) profiles with sandy to clay loam A horizons overlying a clay B horizon which may vary in colour from red through to grey. The clay subsoils are generally pedal, but may be massive where the parent rock material has a high proportion of sand, or in fine textured sediments where the subsoil is permanently waterlogged.

Harte (1982) has classified these duplex soils into the following 3 associations on the basis of soil structure.

Yellow and Red Podzolic Soils of Poor Structure

These soils have formed the phyllites and mud stones of the Neranleigh Series which occurs as highly metamorphosed and faulted sediments in the northern portion of the Shire where the topography is steep to hilly. These sediments and the characteristic soils to which they give rise are clearly visible in road cuttings along the Pacific Highway from a point just north of the Mullumbimby turn-off.

These soils are typically characterised by a clay loam to silty clay loam A₁ horizon overlying a silty clay subsoil B horizon. The A₂ horizon is generally absent and soil reaction trends are acidic. These soils are strongly leached and steeply weathered. Subsoil (B horizon) structure is generally weak to moderate. The main characteristics which distinguish this association from other associations in the Shire is the greasy or talcy consistence of the clayey subsoils.

The colour of the soils is variable, especially in the B horizon. The A horizon is generally dark, however it may bleach on drying. The B

horizon ranges from yellow to red to grey, depending on the concentration of free iron oxides and soil drainage conditions. The greater the concentration of the free iron oxides, the redder the soil. Red podzolic also occur on the better drained areas, with yellow mottled and grey podzolics occurring in poorly drained situations.

On the footslopes and drainage lines, partial subsoil saturation may cause mottling and gleying due to a concentration of hydrated oxides. Soils in these situations can be highly dispersible due to concentrations of exchangeable sodium.

In terms of agricultural productivity, these soils have inherently lower concentrations of nitrogen, phosphorous and potassium and other trace elements. Their structure also restricts infiltration. This structure combined with the ease of detachability of subsoil material render these soils highly erodible. Consequently, high rainfall and the steep slope topography of the northern part of the Shire, produce a severe soil erosion hazard once the vegetation cover is removed. In areas where subsoil clays are dispersible, the erosion hazard is increased.

4.1.3 Soils of Alluvial Deposits

Dark Alluvial Loams with Gleyed Clay Subsoils

Within the Shire, soils of this association occur mainly in the coastal lowlands, or the lowlying drainage plains and swamps, and intrude westwards up some river valleys (e.g. Main Arm of the Brunswick River). This association consists mainly of gleyed podzolics. Soils are the result of alluvial and colluvial deposits of Recent and Pliocene Ages. Parent materials are diverse, ranging between basalt and sandstone from the eroding catchments to the west. However, because this land unit in recent geological times inundated by the sea, tidal action would have contributed to the composition of these soils.

High water tables and restricted drainage have been a major influence on soil formation with water tables often occurring within one metre of the surface. Topsoils are characteristically very dark to black silt loams to clay loams overlying light to medium heavily mottled and gleyed greyish to yellowish brown clay subsoil.

These high water tables are responsible for the concentration of hydrated oxides which produce the greyish to yellowish brown mottlings of the B horizon. The clayey subsoils of these gleyed podzolics are generally massive and comprised of Kaolinitic clays from which all bases and some silica have been removed by bleaching.

Associated soils include ground water podzols. These soils are found under similar conditions but differ in that they are coarsely graded soils exhibiting uniform to gradational texture profiles. Decaying sea shells can be a feature where the soils occur adjacent to tidal streams and swamps, and the deep subsoils are often alkaline. Pans of iron oxides and organic matter overlying yellow-brown sand may be present in the ground water podzols.

Where these soils are or have been well drained, they are used for dairying, beef production and cane growing. Nitrogen and phosphorous deficiencies are usual and applications of several important trace elements will be required in many cases to ensure optimum production.

Erosion hazard is not a problem, however, scouring velocities on constructed channels and waterways carrying tidal waters should be regarded with caution.

Red Podzolic Soils with Good Structure

Soils forming this association occur in the hilly to steep corner in the far north western portion of the Shire. The dominant soil type is a duplex soil with whole coloured red subsoil which is quite well structured. These soils are generally hard setting, acidic and have an unbleached A₂ horizon. Typically these soils have a chocolate brown loam A horizon overlying a reddish light to light medium clay B horizon.

A deep litter layer (As) horizon is usually present, resulting in an organic rich A horizon. These soils are strongly leached, with the red colour resulting from the release of free ferric oxides from clay minerals.

Compared to the adjacent yellow and red podzolic soils within this part of the Shire, these soils possess more favourable physical characteristics, and are less prone to sheet and gully erosion and more suitable to agriculture. Mass movement can be a problem where steep country is unwisely cleared.

Hard Setting Duplex Soils with Yellow-Red and Brown Subsoils

These soils occur between Cape Byron and Broken Head within the Shire, on the sandstones, siltstones, and mudstones of the Walloon Coal measures and the sandstones of the Marburg Formation.

Topsoils vary from sandy loams to loam while subsoils range between clays and sandy clays. Where relief is good and drainage reasonable, a hard setting podzolic consisting of a well structured red, yellow or brown B₁ horizon overlying a mottled B₂ horizon is common. In poorly drained situations, a hard setting duplex soil with a yellow mottled subsoil exists.

These soils are used extensively for grazing, dairying and where alluvial deposits are expansive enough adjacent to major watercourses, cash crops are often grown. As with many soils of the area nitrogen and phosphorous as well as several trace elements including sulphur and molybdenum are deficient.

A hard setting nature and a dispersible deep subsoil in many cases means that erodability is high. The degree of erodability will depend on soils structure, colour, depth of profile and many other factors, all of which are quite variable within the soil types. Due to deeply incised and steep topographies, erodability hazard is very high once vegetation is removed.

4.1.4 Soils Formed on Sands

A number of soils have formed on the Quaternary sand deposits along the eastern margins of the Shire.

Ground Water Podsoles and Calcereous Sands

The ground water podsoles result mainly from deposition of fine sands by fluctuating tide. Profile differentiation, aside from organic matter incorporated into the topsoil, may include a cemented dark pan or organic matter and iron oxides at variable depths or the occasional band of muddy sand resulting from deposition of heavier materials by floods. These soils are regularly inundated and often support mangrove communities.

The calcereous sands are usually associated with the groundwater podsoles and differ in that deposits of decaying sea shells occur at depth. Subsoils are strongly alkaline.

This soil type is characterised by poorly drained areas, vegetated with heath and banksia associations.

Regosols

These soils constitute well drained dunal formations that are often the barrier between the groundwater podsoles and the ocean. Sands are generally coarse and apart from accumulation of some organic matter, there is little profile differentiation. However, sea shell deposits or sand rock occasionally occur at depth.

4.2 Protected Lands

Protected lands are those lands within catchment areas notified under the Soil Conservation Act 1938, that have a slope generally in excess of 18 degrees. Prescribed streams which are rivers, creeks, effluents or lakes which are prescribed within provisions of Section 26D of the Water Act, 1912, are also protected.

These lands have been prescribed in order to encourage good tree cover on land most prone to erosion, i.e. steep slopes and river banks. This will contribute to the preservation of the state's soil resource.

The Catchment Areas Protection Board is responsible for the administration of protected land and prescribed stream erosion control measures.

Protected lands in Byron Shire have been identified on a series of maps held at the offices of the Soil Conservation Service. A detailed survey of protected lands in coastal catchments was undertaken in 1980. Protected lands on inland catchments are held on parish maps held by the Soil Conservation Service.

Protected streams within Byron Shire include:

- * Brunswick River including Christmas Creek, Kings Creek, Mullumbimby Creek;
- * Benny Creek;
- * Coopers Creek;
- * Byron Creek;
- * Wilsons Creek;
- * Wilsons River;
- * Skinners Creek;
- * Mooball Creek;
- * Emigrant Creek.

Legislation provides control over the removal or injuring of trees on protected lands or in the bed of streams or within 20 metres of the banks of a prescribed river or lake.

With respect to prescribed streams, the Water Resources Commission or the Department of Public Works are consulted prior to the consideration of an application to destroy trees.

Consent must be obtained from the Catchment Protection Board prior to the removal or injuring of trees. Conditions may be attached to such consents.

4.3 Agricultural Capability¹

The Soil Conservation Service of New South Wales has developed a rural capability classification scheme designed to identify and rank the usefulness of rural land for agriculture. Agricultural Capability Maps are currently being prepared for areas of New South Wales as part of a state-wide programme.

1. These sections on Agricultural and Urban Capability are all based on a report by G. Atkinson of the Soil Conservation Service of New South Wales entitled "The Use of Soil Survey Information for Rural and Urban Planning - The Coffs Harbour Study". A more detailed account of capability assessment can be found in Charman, P.E.V. (ed) (1978) "Soils of New South Wales - Their Characterisation, Classification and Conservation", Technical Handbook No. 3, Soil Conservation Service of New South Wales and Hannam, I.D. and R.W. Hicks, (1980) "Soil Conservation and Urban Land Use Planning", Journal of Soil Conservation Service of New South Wales, 36, 134-145.

Factors taken into consideration in determining rural capability include both generalised and specific criteria such as climate, landform, slope elevation, soil type, susceptibility to inundation or erosion and soil chemistry. All these factors taken together in assessing the capability of land and ranking it on an 8 point classification system. As the land class decreases from higher to lower, the limitations to use, risks of damage and need for soil conservation become greater.

The agricultural capability of the land is used as an input by the Department of Agriculture in determining the agricultural suitability of rural lands. It is on the basis of agricultural suitability that prime agricultural land is determined. Agricultural suitability will be discussed in more detail below. Agricultural Capability is shown on Figure 7.

4.4 Urban Capability

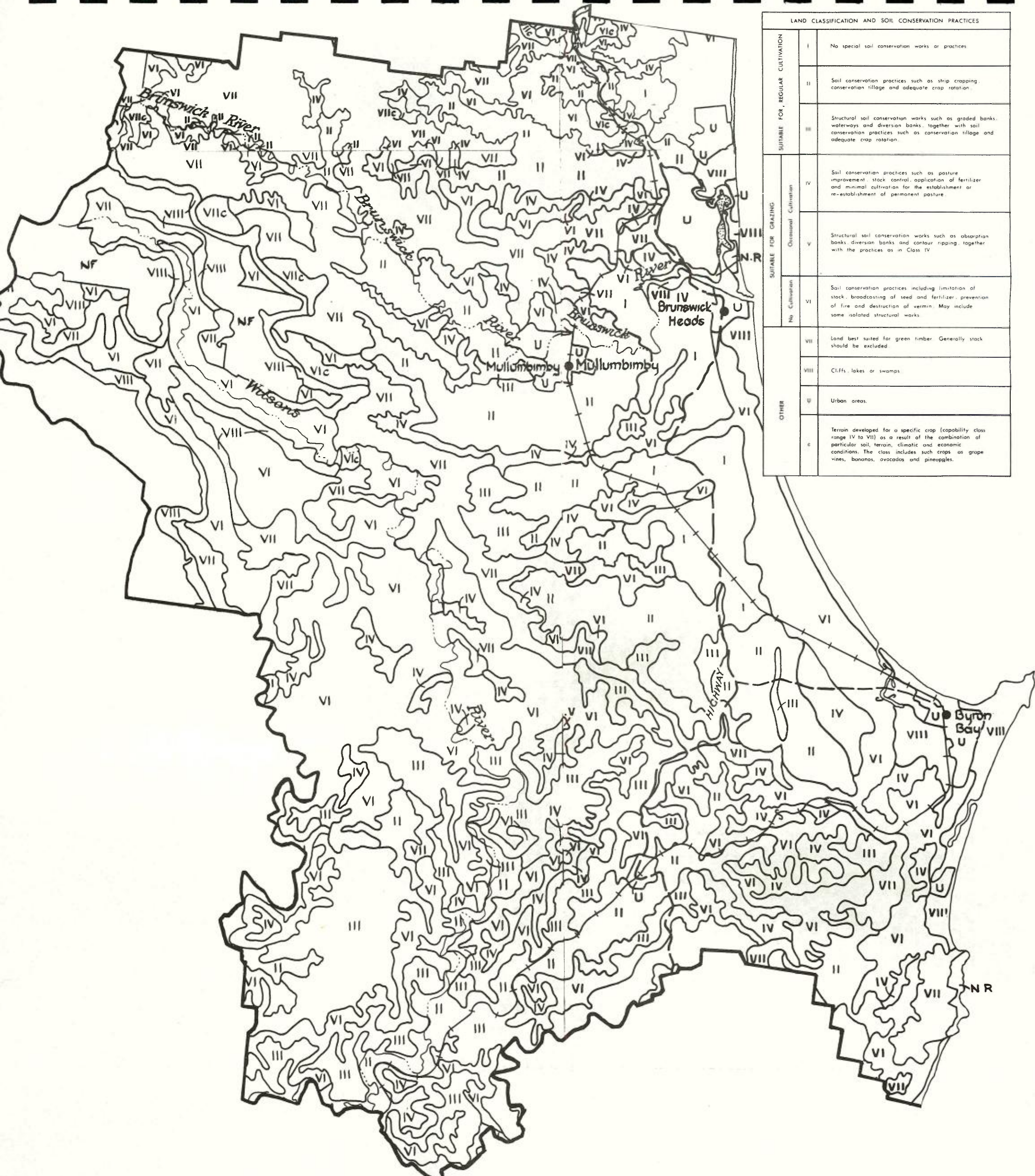
The Soil Conservation Service also prepares urban capability assessments which are designed to determine the suitability of the land for various forms of urban development. Thus, the engineering qualities of the soil are more important in this regard than the ability of the soil to grow crops.

Urban capability assessments require information on topsoils and subsoils to determine:

- * Engineering suitability for building foundations, storage reservoirs, sewerage disposal facilities, embankments etc.
- * Location of roads, railways, pipelines etc.
- * Erosion hazard during the construction phase and possible drainage earths required.

Soil properties investigated by the Service in relation to urban development include:

- * Susceptibility to mass movement (discussed above for Byron Shire as a whole).
- * Shrink-swell potential related to movement and failure which affects location of roads, building foundations and other rigid structures.
- * Bearing strength and stability to determine the capacity of the soil to carry foundations.
- * Dispersibility and erodability of the soil to determine necessary erosion controls and the suitability for septic tank systems. Tests of erodibility include the Emerson Aggregate Stability Test, dispersal index and particle size analysis.



LAND CLASSIFICATION AND SOIL CONSERVATION PRACTICES		
SUITABLE FOR REGULAR CULTIVATION	I	No special soil conservation works or practices.
	II	Soil conservation practices such as strip cropping, conservation tillage and adequate crop rotation.
	III	Structural soil conservation works such as graded banks, waterways and diversion banks, together with soil conservation practices such as conservation tillage and adequate crop rotation.
SUITABLE FOR GRAZING	IV	Soil conservation practices such as pasture improvement, stock control, application of fertilizer and minimal cultivation for the establishment or re-establishment of permanent pasture.
	V	Structural soil conservation works such as absorption banks, diversion banks and contour ripping, together with the practices as in Class IV.
OTHER	VI	Soil conservation practices including limitation of stock, broadcasting of seed and fertilizer, prevention of fire and destruction of vermin. May include some isolated structural works.
	VII	Land best suited for green timber. Generally stock should be excluded.
OTHER	VIII	Cliffs, lakes or swamps.
	U	Urban areas.
	c	Terrain developed for a specific crop (capability class range IV to VIII) as a result of the combination of particular soil, terrain, climate and economic conditions. The class includes such crops as grape vines, bananas, avocados and pineapples.

SOURCE: SOIL CONSERVATION SERVICE OF N.S.W.

BYRON SHIRE ENVIRONMENTAL STUDY
LAND CAPABILITY 7



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 For BYRON SHIRE COUNCIL

- * Permeability of the soil to determine the extent of drainage works required to remove run-off for highly impermeable soils and to protect ground water quality for highly permeable soils.
- * Salinity and fertility, important for revegetation programmes.

It is highly desirable that urban capability assessments be undertaken for the major urban release areas in Byron Shire.

Rural Residential Capability

Soil characteristics are important in determining the location of rural residential zones and within such zones, the layout and density of rural residential development. Areas requiring investigation include:

- * Susceptibility to mass movement.
- * Suitability for foundation material.
- * Suitability for onsite disposal of sewage effluent.
- * Susceptibility to erosion.

4.5 Planning Implications

The description of soils given above outlines some of the characteristics of the soils of Byron Shire from an assessment of existing information. Section 4.4 outlined the type of information required to assess the suitability of land for urban and rural residential development. However, given the level of detail of existing soils information, particularly engineering qualities, it is possible only to make generalised statements about the qualities and properties of broad soil types. Clearly there is a need for more work to be done to assess the suitability of land for urban development from a soils point of view, particularly given the potential in krasnozem soils for mass movement and failure.

It is recommended therefore that for the urban and rural residential release areas identified that further investigations be carried out to determine the capability of the land for more intensive development. This is seen as a necessary step in the preparation of development concept plans for these areas. Such studies can be undertaken by developers wishing to proceed, or by the Soil Conservation Service of New South Wales. It is suggested that the Service be approached to establish a programme for the investigation of the urban capability of areas recommended for growth on the structure plan.

5. LAND STABILITY

5.1 Mass Movement

Mass movement includes the downslope movement of colluvial material, rock fall and the movement of deep subsoils on slopes of various gradients. The most common triggering agent is infiltration of water into the soil, reducing shear strength and increasing slope load.

All soils have the potential for mass movement. A number of factors contribute to make a specific site prone to mass movement. Climatic, topographical, and geological features including rainfall, slope, soil type, and underlying rock type, play a major role in the potential for mass movement. However, actions by man including the clearing of vegetation, removal of material from the toe of a slope, building of structures, installation of sullage and septic absorption fields, all contribute to the potential for mass movement.




Areas prone to movement are often recognisable ^{from} features of a prior earth movement. These features include slip scars, terracette formations, groups of trees which have died due to no apparent cause, tree trunks which have developed a bend following displacement by a slip movement, and the lateral displacement of fence posts or telegraph poles. Perched water tables in seepage zones and plastic clays are hazard signs in areas where slope failure is known to occur.

Figure 8 - Land Stability - identifies those areas in the Shire that have a history of slip occurrence.

A direct relationship exists between cleared slopes and potential for mass movement. Removal of vegetation off steeply sloping areas renders them subject to increased direct precipitation and increased intake into the soil profiles. The former effect often results in soil erosion. Erosion can be mitigated to some extent by special drainage and catchment works which further encourage infiltration into soil profile. Increased soil moisture results in soil creep and where the land slope is in excess of about 20 per cent, and the soil and subsoil are sufficiently thick to allow mass movement, large scale land slides may occur.

Therefore, clearing much of the presently steeply sloping, timbered areas of the Shire could result in widespread soil creep and land slippage. These effects would arise irrespective of bedrock lithology, but they are likely to have the most marked physical expression in areas where thick soils are developed over easily weathered shales and volcanic rocks. Although such soil movements may not unduly affect the value of land for farming purposes, the potential for increase in soil erosion, and also for increased stream siltation, is such that clearing should be undertaken with caution, if not actually discouraged.



SLIP PRONE LAND	
COASTAL IMPACT ZONE	
LAND PRONE TO INUNDATION	

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LAND STABILITY		
		
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5.2 Rock Fall

The occurrence of rock fall in Byron Shire is not a widespread constant hazard. It is a natural phenomena often precipitated by soil movement along a particular portion of the escarpment. The only locality within the Shire with a known history of rock fall is the escarpment area at Montecolum. Other locations where isolated rock falls have occurred include areas along the escarpment at Wilsons Creek and Coorabell.

Within the Shire, rock fall results from joint block separation of the outcropping rock strata. Rock fall has occurred at Montecollum, and along the escarpment at Wilsons Creek and Coorabell and the eastern escarpment of the Koonyum Range. Although there have been no reported rock falls affecting Palmwoods, the location of the settlement at the base of the escarpment is potentially hazardous. It is recommended that a safety zone be retained around the top and base of each cliff line and that no development occur within this zone.

5.3 Coastal Erosion

5.3.1 Introduction

The coastline of the Shire is one subject to a natural long term rate of coast retreat. Under adverse cyclonic weather conditions, high energy ^{wave} coarse action erodes the sand on the beaches and foredunes. At times of calm seas, the reverse occurs with sand, deposited at sea by a general northward sand movement carried back onto the beach, and with favourable winds this sand is carried onto the foredune areas.

Stated simply, the long term rate of coastal erosion is due to the fact that on average, the short to medium term fluctuations are imbalanced with more sand being eroded than replaced. In other words, there is more sand leaving the region than entering it. This natural imbalance in the sediment budget has been attributed to both an offshore current loss and an unfavourable coastline alignment relative to the dominant wave condition.

5.3.2 Available Information

Investigations into the nature and extent of the coastal erosion in the Shire were undertaken by the Department of Public Works, Coastal Engineering Branch in 1978 culminating in a report entitled "Byron Bay - Hastings Point Erosion Study" by A.D. Gordon, D.B. Lord and M.W. Nolan. This study identified a long term rate of coastal erosion which varied for different parts of the coastline from Byron Bay to the north. For policy formulation and management purposes, 50 year and 100 year erosion hazard lines were identified in this study.

At the present time no detailed information on the erosion line is available for the area extending south from Cape Byron.

The Department of Public Works is currently undertaking a study to re-assess the erosion hazard in the Shire. It is expected that this study will:

- * Provide more precise information on the rate of erosion for various parts of the Shire - particularly for that part of the coastline south of Cape Byron.
- * Provide a more detailed account of the erosion risk for Byron Bay township, taking into consideration Council's commitment to maintain the structural adequacy of the Jonson Street groyne.
- * Establish and identify for policy and management purposes an erosion impact zone - an area that would be subject to a threat from coastal processes within the expected life time of any development.

5.4 Planning Implications

5.4.1 Mass Movement and Rock Fall

Areas identified as being susceptible to mass movement will not be considered for more intensive development. Applications for development within these areas should be accompanied by sufficient geotechnical information to enable Council to assess the safety and stability of the proposed development.

It is recommended that the Soil Conservation Service be approached to initiate a programme of Urban Capability Assessment on land designated for future urban or rural residential development in order to identify other more localised unstable areas.

5.4.2 Coastal Erosion

The Coastal Engineering Branch of the Department of Public Works has provided, and will continue to provide, technical advice on coastal erosion and coastal land stability and will assist Council in the preparation of alternative management strategies for mitigating erosion.

Currently, the Department's policy recommendation to Council and other Government Departments with responsibilities or interests in the area are as follows:

- * No permanent development should occur within at least the area falling inside the 50 year hazard line for the area identified as the Coastal Impact Zone. If development approval is given then there should be a requirement that any building created in the risk area is capable of being removed and relocated elsewhere.

- * The extent of the Coastal Impact Zone can be affected by the construction of protective works in the area. There are a number of options available for the construction of protective works, along the Shire's coastline. In the event that a protective works programme is developed which assesses the impact of those works on other parts of the region, then the Department of Public Works will re-assess its Erosion Impact Zones.

For the purposes of developing a structure plan for the future growth of the Shire, it has been assumed that no further growth will be located within the Coastal Impact Zone as defined by the Public Works Department.

The same principle will apply within reason for the existing village areas of the Shire, particularly Suffolk Park, Byron Bay, New Brighton, and South Golden Beach. Until such time as agreement has been reached on the financing, construction and maintenance of protective works, the management recommendations of the Department of Public Works will be incorporated into this study.

6. AGRICULTURAL RESOURCES

6.1 Introduction

The farm lands of Byron Shire are an important feature of the Shire's physical, economic and social structure.

It is important that such areas be identified and properly managed as an important natural and economic resource.

Working Paper No. 5 on the Demand for Rural Land discusses in an economic framework, the justification for the preservation and protection of good agricultural land. The major conclusions of this discussion were that there does not appear to be any strong or immediate economic reason for the protection of good quality agricultural land, particularly if such land is being put to a higher density use such as urban development, if such development is orderly and economic. Nevertheless, the importance of a depletable and often non-recoverable resource in the future development of the Shire and the region is recognised and therefore the preservation and management of good quality agricultural land is important. The future urban growth of the Shire should therefore have regard to the location of good agricultural land and where possible, such land should be given consideration in the development of policies for the future growth of the Shire.

The Department of Agriculture has assisted Council in the preparation of the Local Environmental Study and Local Environmental Plan by undertaking an Agricultural Land Suitability Survey. A report entitled "Agricultural Land Suitability Study - Draft Report" has been prepared by the Department and this forms the basis of this section.

6.2 Agriculture in Byron Shire

The report of the Department of Agriculture gives a detailed description of the nature of agriculture in Byron Shire. The Department states that:

"The Shire of Byron has only limited areas of good agricultural land. In the southern western part of the Shire, there are areas of rich red krasnozems soils forming part of the original "big scrub" soils characteristic of the Alstonville area. However, much of the remaining western part of the Shire consists largely of steep forested mountainous country of virtually no agricultural importance. The eastern portion of the Shire consists of some tracts of good agricultural land on gently undulating country interrupted by moderate to steep ridges having generally limited agricultural value.

As well, much of the eastern portion contains lowlying poorly drained land. In the south of the Shire around Bangalow, are extensive areas of volcanic soils forming part of the heavily dissected basalt Alstonville plateau."

Agriculture has been an important contribution to the economic base of the Shire. The following facts summarised from the Department of Agriculture's report highlight this:

- * Agricultural holdings in the Shire total some 33,000 hectares (59 per cent of the total area of the Shire).
- * Agriculture has been estimated to have a total value of approximately \$20 million. Growth in the value of production was 100 per cent in the 5 years to 1982.
- * Byron Shire has in excess of 2,000 rural ratepayers, 25 per cent of which produce the majority of the agricultural value of production.
- * Direct full-time agricultural employment is estimated to be 822 and evidence suggests that the traditional agricultural employment decline is stabilising.
- * The average value of production in the Shire is \$263 per hectare compared with \$48 for New South Wales, \$366 in Tweed Shire and \$385 in Ballina. Other than Tweed, Ballina and Coffs Harbour, this is the highest level of productivity on the North Coast.
- * As horticultural industries continue to grow and as recent plantings mature, the contribution of agriculture to the economy is expected to grow.

Agricultural land use in the Shire is diverse, including extensive grazing to intensive and very specialised horticultural pursuits (including vegetable growing), dairying, pigs and poultry. Figure 9 shows generally the distribution of agricultural enterprises in the Shire which is largely a result of soil type, climate and market forces. Longer term trends in particular industries are discussed below, again summarising the findings of the Department of Agriculture.

6.2.1 Horticulture

Horticulture includes the growing of tropical fruit, nuts and vegetables. Within the Shire, horticulture is undertaken in two main areas:

- * Banana growing mainly in the hilly country to the north west of the Shire.
- * Sub-tropical tree crops on the deep rich krasnozems soils of the Clunes, Federal and Ewingsdale areas. The soils and climatic conditions on this plateau country "give this area the capacity to produce the widest range of sub-tropical fruits and out-of season vegetable crops of any part of the state" (Department of Agriculture (1983) p.39).

A summary of the major horticultural industries in the Shire, their location, size and impact is shown in Table 6.1.

Table 6.1: Horticultural Industries - Byron Shire

Product	Total Area (ha)	No. of Growers	Estimated Potential Value (\$M)	Location	Comments
Bananas	555	240	5.00	Main Arm, Mullumbimby, The Pocket, Yelgun	Industry declining, soil erosion problems.
Macadamias	314	23	1.62	Clunes, Eureka, Federal, Yelgun	Future strong. Expensive land precluding more development. Viable in long term on 10-12 hectares
Avocados	157	83	5.06	Deep krasnozems of plateau area	Difficult to grow. Disease and market problems.
Guavas	33	7	0.2	Eureka	Markets uncertain.
Lychees	26	28	0.62	Upper valleys, Clunes/Eureka area	Susceptible to wind damage. Market stable.
Passionfruit	27	25	0.22	Yelgun	Market stable.
Custard Apples	16	19	0.48	Deep soils on plateau	-
Pawpaws	11	18	0.27	-	-
Kiwifruit	10	18	0.28	Cooler gully areas of the upper valleys	Potentially high returns in Autumn.
Peaches/ Nectarines	13	16	0.39	Well drained alluvial flats	Potential for growth.
Pineapples	1	3	0.04	-	Low level of production. Market problems.
Mangoes	1	4	0.02	-	-
Vegetables	33	N/A	0.28	Eureka, Goonengerry, Ewingsdale	Mostly part time.

Source: "Byron Shire Agricultural Land Suitability Study".
Department of Agriculture, North Coast Region. Draft Report, May 1983.



- LEGEND**
- P PIGGERY
 - D DAIRY
 - BANANAS
 - x MACADAMIA
 - ▲ AVOCADO
 - △ PEACH
 - ∇ PASSIONFRUIT
 - ∩ LYCHEE
 - ∪ KIWIFRUIT
 - GUAVA
 - ∞ MISCELLANEOUS
 - ▨ CANE ASSIGNMENTS

SOURCE: NEW SOUTH WALES DEPARTMENT OF AGRICULTURE MAY 1982

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AGRICULTURAL LAND USE 9

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The emergence of the tropical horticultural industry in the Shire has highlighted the high quality of agricultural land on the plateau.

6.2.2 Dairying

At present there are 88 dairies in the Shire with an average holding size of 90 hectares. The industry was once predominant in the Shire but declining export markets heralded its demise. The recent growth in the local market has seen strengthening of the market of benefit to those with a quota in the area.

6.2.3 Beef

Currently beef production is the major industry in the Shire and generally occupies land not used for other purposes. Most beef is raised in conjunction with some other farm or non-farm enterprise. Beef grazing is an important and efficient use of land in the Shire unsuitable for other forms of production. It contributes to the maintenance of land in a clean pasture condition and thus, to the rural character of the Shire.

6.2.4 Pigs and Poultry

There are over 100 commercial piggeries in Byron Shire, mostly intensively run. Such a use requires careful planning considerations because of the odour, noise and pollution from large commercial piggeries. Because land is not an important component of commercial piggeries, the industry is footloose. Care should be taken in assessing applications for piggeries to ensure that any adverse environmental effects are mitigated. Similarly, planning for the future growth of the Shire should take into consideration the existence of commercial piggeries and suitable buffers identified.

6.3 Agricultural Suitability

Land use management policies for rural land needs to be based, among other things, on an assessment of the quality of agricultural land in specific areas. A system for classifying rural land based on its suitability for agriculture, has been developed by the Departments of Agriculture and Environment and Planning. The classification system describes the potential for agriculture in an area based on the physical and economic limitations to agricultural activity.

The method makes use of the Agricultural Capability Assessment of the Soil Conservation Service described above.

The Agricultural Suitability Assessment is based on a 5 level classification system. Land within each class is similar with respect to the degree of limitations on agricultural activity. Inputs into the process of defining agricultural suitability include:

- * Aerial photography.
- * Agricultural Capability mapping from the Soil Conservation Service.

- * The experience of well managed farms in the Shire.
- * Local knowledge of field officers of the Department of Agriculture and the Soil Conservation Service.
- * Input from soil scientists from the Biological and Chemical Research Institute.

The survey work and resulting agricultural suitability map were prepared at a 1:100,000 scale, based on a generalised Shire-wide reconnaissance survey.

Limitations taken into consideration in determining the classification of land include:

- ** Erosion - present and potential, kind and degree.
- * Fertility status.
- * Topography including steepness, length and shape of slope, dissection.
- * Soil structure, including low permeability, surface cloddiness or crusting, water holding capacity, etc.
- * Soil characteristics including salinity, alkalinity, acidity, etc.
- * Stoniness and rock outcrops.
- * Climatic factors, such as frost, exposure to winds, aspect, etc."

(Department of Agriculture (1983) pp.11-12)

The five land classes can be broadly defined as follows:

"Class 1:

Land suitable for regular cultivation for cropping or intensive horticulture; has high agricultural suitability with only minor or no constraints to sustained high levels of production. This class is confined to level to very gently sloping soils which are deep, friable and porous. These areas comprise only 3 per cent of the total and many areas were too small to be mapped separately at 1:100,000, the scale used in the survey. Such areas are confined to the level of volcanic areas.

The proneness of the volcanic krasnozems soils to flooding and therefore susceptibility to erosion would preclude broad areas of Class 1 land being identified. Class 1 land is excellent for vegetable and other crop production.

Class 2:

Land suitable for cultivation for cropping, but not suited to continuous cropping. Has good capability for agriculture but constraints limit the cropping phase to a rotation with improved pasture and does reduce the overall level of production. This class is again confined to the krasnozems. Many of the areas are too small to map at a scale of 1:100,000, but there are limited areas to be found on the flood plains and more extensive areas on the plateau. Suitable for vegetable and other crop production.

Class 3:

Land suitable for grazing. Well suited to pasture improvement and can be cultivated for an occasional cash crop or forage crop in conjunction with pasture management. Overall level of production is moderate as a result of high environmental costs which limit the frequency of ground disturbance. In the Byron Shire, Class 3 land occurs in three distinct categories:

1. Moderately sloping krasnozem areas of the plateau areas.
2. Moderately to gently sloping land derived from sedimentary rocks on which good pastures can be established.
3. Most of the better drained coastal plain which could be used for the production of sugar cane.

In general, the major limitations on production in the Class 3 lands are slope, shallowness and erosion hazard on the more steeply sloping soils, poor internal drainage, flooding, and weakly structured surface soils on the alluvials.

Classes 1, 2 and 3 are generally considered "good" agricultural land, worthy of protection for agriculture.

Class 4:

Land suitable for grazing but not suitable for cultivation.

Class 5:

Land suitable for only rough grazing or land not suited to agriculture.

Class 4 and 5 land is generally of low productivity, and retention for agriculture would be largely as a means of protecting the environment rather than protecting a limited resource as such.

In many locations, the productivity of Class 4 and 5 land is very dependent on small pockets of Class 1, 2 and 3 land scattered through the area.

The five land classes are not discrete, but rather reflect the predominant class. For example, an area mapped as Class 4 may contain up to 40 per cent Class 3 in small pockets unable to be mapped at a scale of 1:100,000 (i.e. less than 40 hectares in area).

An additional classification "unique" agricultural land can be applied to areas with special soils, climate or productive potential. Some steeper Class 4 areas of the plateau are regarded as unique agricultural land, worthy of protection but have not been identified in this initial reconnaissance survey."

(Department of Agriculture (1983) pp.12-13)

A summary of the land classes, their location, area and current potential use in the Byron Shire is included in Table 6.2. The location of the various land classes is shown in Figure 10.

6.4 Planning Implications

6.4.1 Statutory Requirements

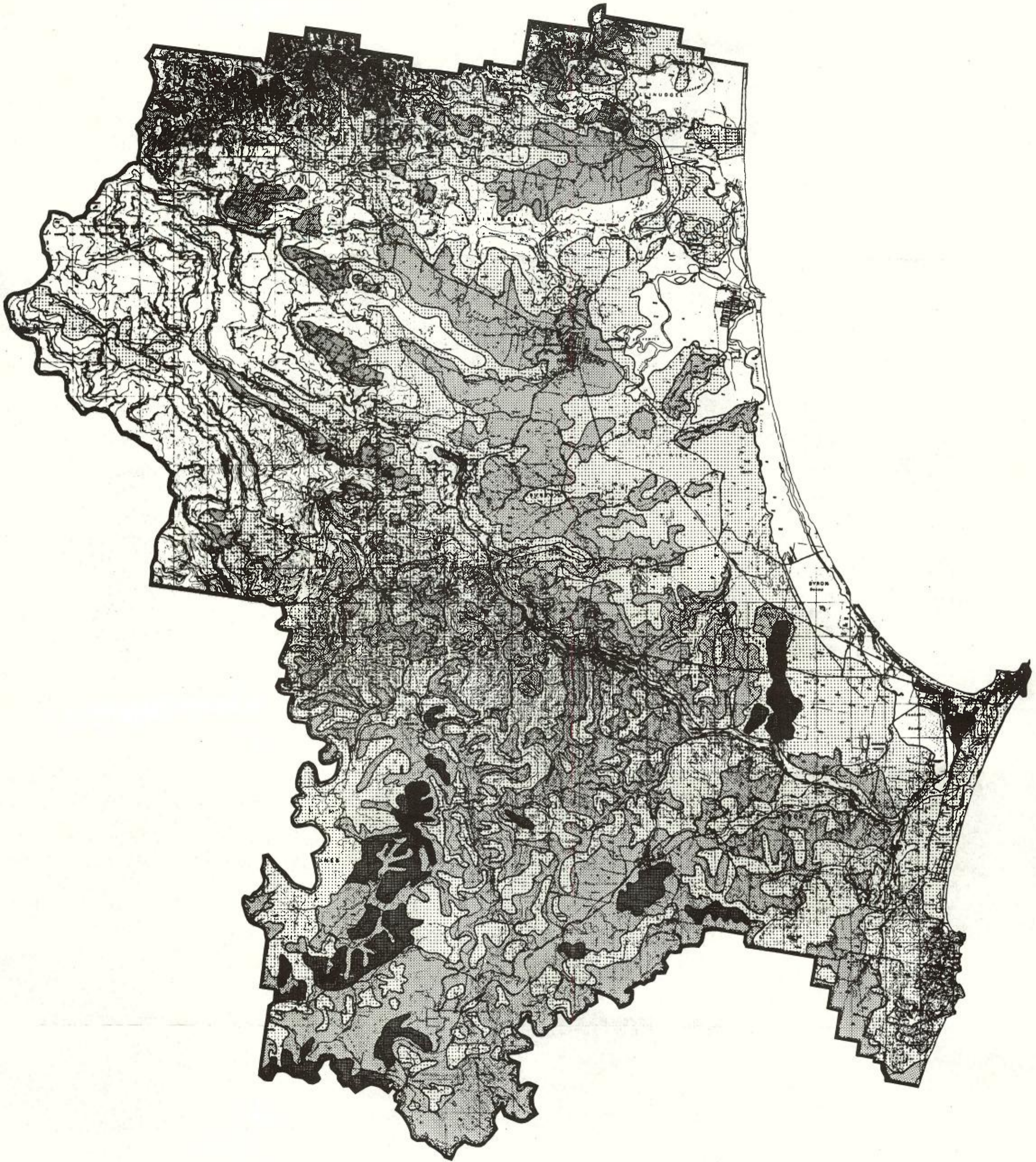
The Environmental Planning and Assessment Act, 1979, requires that draft Local Environmental Plans be consistent with a number of policy statements issued by the State Planning Authority, the Department of Environment and Planning or its predecessors, the Planning and Environment Commission and the State Planning Authority. Policies on the management of non-urban lands are incorporated in the following circulars issued to Councils in New South Wales:

- * Circulars 67 and 74 issued by the State Planning Authority.
- * Circular 13 issued by the Planning and Environment Commission.

These policies have been discussed at length in Working Paper No. 5.

Directions issued under Section 117(2) of the Act on the 27th August, 1980 further influence the contents of Local Environmental Plans with respect to rural land in the following respects:

- * Existing provisions enabling a dwelling house to be erected on an existing parcel of land shall be retained.
- * Existing provisions relating to the erection of workers' dwelling houses shall be retained.
- * Existing provisions relating to the control of development and access on major road frontages shall be maintained.
- * Draft Local Environmental Plans shall not rezone rural land for urban purposes unless justified in an Environmental Study.



Banana Plantation

Land can be placed into one of five agricultural suitability classes. The essential characteristics of the classes are set out below.

Class 1: Land suitable for regular cultivation for cropping (cereals, oilseeds, fodder etc.) or intensive horticulture (vegetables, orchards). Has a very good suitability for agriculture, where there are only minor or no constraints to sustained high levels of production. Will include irrigated areas with high production.

Class 2: Land suitable for cultivation for cropping but not suited to continuous cropping or intensive horticulture. Has good suitability for agriculture, but constraints limit the cropping phase to a rotation with improved pastures, thus reducing the overall level of production.

Class 3: Land suitable for grazing. Well suited to pasture improvement and can be cultivated for an occasional cash crop or forage crop in conjunction with pasture management. Overall level of production is moderate as a result of high environmental costs which limit the frequency of ground disturbance. Has a moderate suitability for agriculture. Pasture lands are capable of sustained high levels of production, although conservation measures may be required.

Class 4: Land suitable for grazing and not suitable for cultivation. Agriculture is based on native pastures or improved pastures relying on minimum tillage techniques. Overall level of production is low. Environmental constraints make arable agriculture uneconomic.

Class 5: Land suited for only rough grazing or land not suited to agriculture. Agricultural production is very low or zero. Severe or absolute constraints to production imposed by environmental factors.

INFORMATION SUPPLIED BY DEPARTMENT OF AGRICULTURE NORTH COAST REGION

BYRON SHIRE ENVIRONMENTAL STUDY
AGRICULTURAL LAND 10
SUITABILITY

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Table 6.2: Summary of the Agricultural Land Suitability Classes

Class	Description*	Major Locations	Current and Potential Use
1 (0%)	Land suitable for regular cultivation. Excellent for intensive horticulture. Minor or no constraints to agriculture.	Very limited areas, on the plateaux and highest alluvial levies (too small to map at scale used).	Horticulture, cane, diaring, beef, regular cash crops including fruit, vegetables and cereals.
2 (3%)	Land suitable for cultivation for cropping but not suited to continuous cropping. Good capability for intensive agriculture, but constraints limit cropping phase to a rotation with improved pasture.	Many small areas on the plateaux and on the higher, well drained alluvials.	Horticulture, cane, beef, forage crops and rotational cash crops as above.
3 (26%)	Land suited mostly to grazing but can be cultivated for an occasional cash crop. Overall level of production is moderate. Conservation measures required.	Most extensive on plateau areas, lower flood plain and hill country with gentler slopes.	Horticulture, dairying, cane and occasional forage cash crops and extensive pasture improvement.
4 (38%)	Land suitable for grazing and not suitable for cultivation.	Extensive areas of moderate to steep hill country.	Sugar drained lands, beef grazing at low stocking rates, limited pasture improvement; potential for re-forestation on slopes.
5 (33%) ⁺	Land suitable for only rough grazing or land not suited to agriculture.	Confined to steep mountainous country, largely timbered.	Sparce seasonal grazing with most potential for timber production.

* Rural Land Evaluation Manual.
 + Includes all State Forests and National Parks etc.

6.4.2 Good Agricultural Land

Essential to the process of implementing State Government rural land policies is the availability of information on the location of good agricultural land. This technical information has been provided by the Department of Agriculture and has been outlined above. The Department has also provided advice on policies to encourage the proper use and management of good agricultural land including controls on subdivision. For the purposes of this Environmental Study, the locations of good agricultural land will be taken into consideration in two ways:

- * In determining the location of future urban and rural residential development.
- * In developing appropriate land use and subdivision policies for rural lands of the Shire. The Department of Agriculture's recommendations for land use controls will be assessed in relation to the development of these policies.

7. HYDROLOGY

7.1 Catchments and Major Drainage Patterns

Byron Shire may be divided into a number of broad water catchments. These fall into two groups - the coastal catchments, drained by creeks and streams in the Shire flowing into the Pacific Ocean; and the inland catchments flowing generally south forming part of the Richmond River Catchment.

The major catchment areas in the Shire are shown on Figure 11 and consist of:

Coastal Catchments

- * Mooball Creek Catchment Area, draining the very north of the Shire.
- * Brunswick River Catchment incorporating the Simpsons Creek and Marshall Creek sub-catchments.
- * Belongil Creek Catchment.
- * Tallow Creek Catchment.

Inland Catchments

- * Richmond River Catchment incorporating the Coopers Creek and Wilsons Creek sub-catchments.
- * Lower Richmond Catchment - Emmigrant Creek and Newrybar Swamp.

Major drainage patterns in the Shire are also shown on Figure 11.

7.1.1 Mooball Creek Catchment

The extreme northern part of the Shire drains into the Mooball Creek and Tweed River basins. Thus in both the far northern and south western parts of the Shire the headwaters of the two major coastal rivers - the Tweed and the Richmond - are located. The southern arm of the Buringban range separates the Mooball and Tweed catchments from the Brunswick.

7.1.2 Brunswick River Catchment

The Brunswick River drains most of Byron Shire to the north of the escarpment including the upper valleys and northern valley areas. It covers an area of approximately 222 square kilometres, and can be divided into three sub-catchments - Marshalls Creek, Simpsons Creek and the main Brunswick River catchment.

Marshalls Creek drains the area to the north of the Mt. Chincogan Range extending eastwards to Ocean Shores. Simpsons Creek drains an area bounded by Macauleys Ridge (the Saddle) to the north, the escarpment to

the west and south and a ridge following the alignment of McGettigans Lane to the east. The Brunswick River itself and its smaller tributaries drain the upper valley areas of the Shire.

7.1.3 Tallow Creek and Belongil Creek Catchments

These minor coastal catchments drain areas in the vicinity of Byron Bay and have been discussed in detail in the Byron Bay Suffolk Park Local Environmental Study. The Belongil Creek drains an area bounded to the south by the escarpment, the west by McGettigans Lane/Quarry Lane ridge and to the east by another smaller ridge extending into Byron Bay. The Cumbebin swamp and the town to the west of the railway line is drained by the Belongil. A large part of this catchment area is low-lying swamp land which acts as retention basins. Substantial amounts of rainwater permeate the sandy soils into extensive groundwater resources.

Tallow Creek drains a substantial part of the area between Byron Bay and Broken Head east of the escarpment. The Tallow Creek basin also includes a smaller area of about 2 square kilometres draining into Taylor Lake.

7.1.4 Richmond River Catchment

The entire plateau area of the Shire drains into the Richmond River. Major sub-catchments located within the Shire include the Coopers Creek catchment, Wilsons River catchment and the Lower Richmond catchment draining into Newrybar Swamp and Emmigrant Creek.

The Wilsons River and its tributaries (Skinners Creek, Byron Creek, Opossum Creek, Coorabell Creek) drain most of this plateau area.

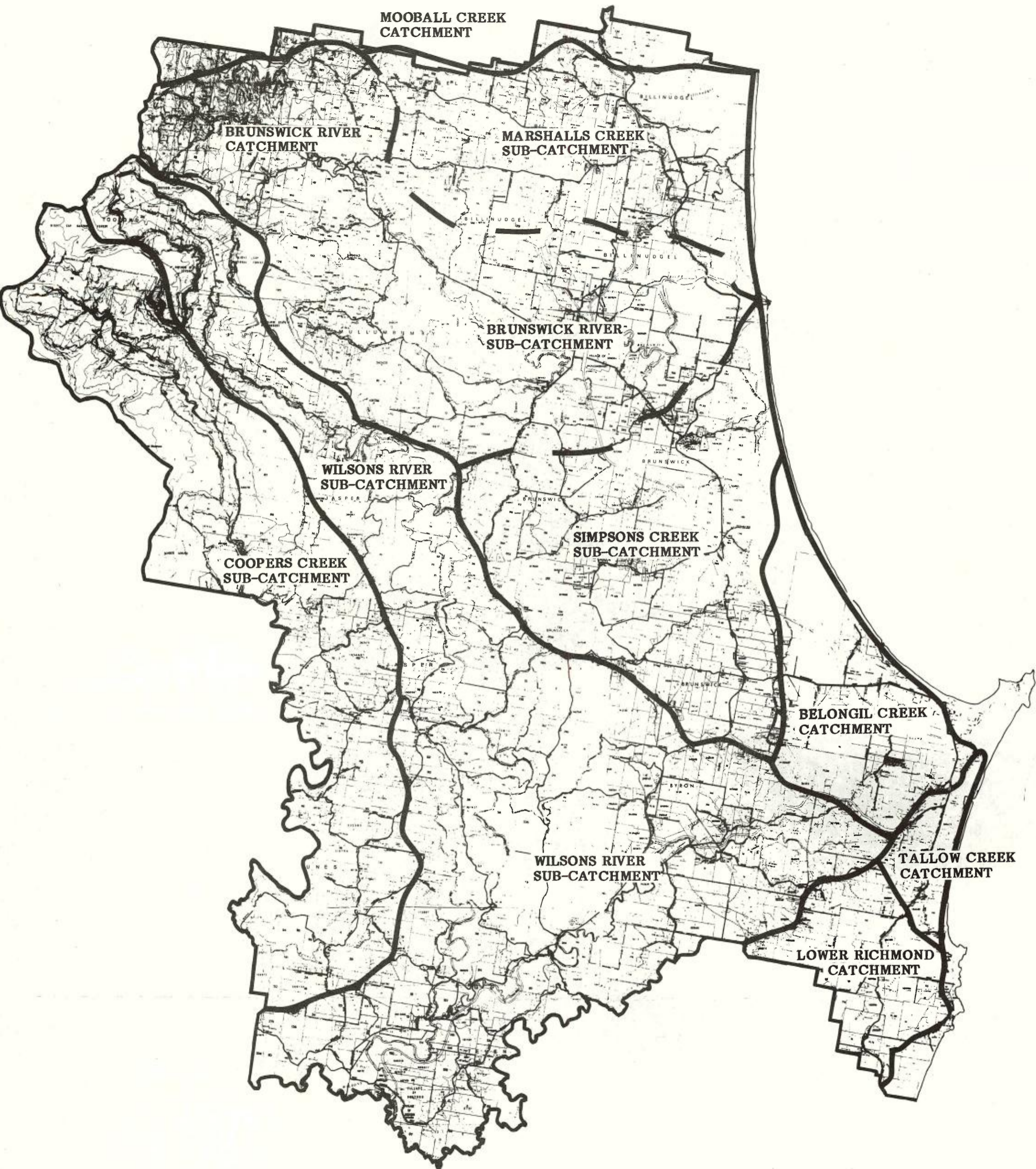
7.2 Groundwater Reserves

7.2.1 Introduction

Groundwater occurrence¹ within the Shire is described in accordance with a broad subdivision of geological formations into fractured rocks (which contain water in joints and fractures) and unconsolidated deposits (in which water is stored in sands or gravels associated with river deposited alluvium, or in accumulations of beach and dune sands near the coastline).

Because of the high rainfall normally prevailing in the Shire and the relative reliability of many of the streams (a number of which are spring-fed from groundwater stored in the volcanic rock), there is less reliance on groundwater than in most other parts of the State. Registered bores, wells and spearpoints in the Shire number less than about 50, but it is known that there are many shallow wells (and excavations) on soakages in the higher country and on river flats, and spearpoints in coastal sands which provide stock and domestic supplies.

1. Information on groundwater reserves was provided by the Water Resources Commission of NSW.



7.2.2 Fractured Rocks

Tertiary basalt deposits which have been generally little exploited for groundwater occur in the central-western and south-western parts of the Shire. Bores sunk in these deposits can usually be relied on to yield supplies of 0.5 to 1.0 litres per second of fresh, but hard, water from depths ranging to 50 metres. Wells and excavations sometimes have proved successful but a tendency for such shallow supplies to fail in dry spells makes such sources much less reliable than bores.

Palaeozoic slate, quartzite, phyllite and greywacke underlie the north-western parts of the Shire. Much of the country underlain by these rocks has a high relief and the more elevated parts are occupied by State Forests, only the areas of more subdued relief being farmed.

Bores on topographically good sites (i.e. low-lying) which encounter the harder strata can be expected to yield useful stock supplies in the order of half a litre per second from depths to about 50 metres. With the prevailing high rainfall, the salinity of groundwater should be relatively low, but it could still be too saline for garden use and for some domestic purposes.

7.2.3 Unconsolidated Deposits

Shallow alluvial deposits of limited extent occur along the course of the Brunswick River and its tributaries. The main area of alluvial flats is in the vicinity of Mullumbimby and wells in that area could be expected to yield supplies suitable for stock, domestic and limited irrigation purposes. The river is tidal throughout the length of the flats and it is likely that the alluvium is at least partly of estuarine origin. There is only one registered irrigation well on the Brunswick River alluvium. The well (Bore No. 48707) is located 1 kilometre south-east of Mullumbimby and it was sunk to a depth of 4 metres and yielded 3 litres per second.

Along the coastline behind the beaches there are areas of sand deposits which are predominantly of aeolian (wind blown) origin. These sand beds occur over quite a large area and they may contain significant quantities of low salinity water. However, some parts are low lying and swampy and where such conditions prevail the groundwater may be rather acidic and dissolved hydrogen sulphide and iron are commonly present. Within these areas there are a number of registered spearpoints which provide useful supplies up to about 1 litre per second, for domestic, garden and stock use. However higher yields could probably be obtained from ravelpacked screened bores which fully penetrate the aquifer zone or from batteries of spearpoints.

Leachate or liquid waste from activities such as sewerage works, sanitary landfill, agriculture, animal husbandry and industry could all be a potential hazard if not managed correctly. A further possible cause of pollution of groundwater reserves is the sand and gravel extraction industry. If there is considerable demand on the alluvial deposits by this industry, and gravel pits intersect the water table, stringent control measures are necessary.

Council may give consideration to the protection of groundwater resources by controlling activities that could affect recharge areas, cause pollution problems, sterilise resources and lead to inefficient usage of or over demand on the resources.

7.3 Surface Water - Stream Flows and Quality¹

The Commission operates or has operated seven stream gauging stations within the Shire. The periods of operation and catchment areas of these stations are given in Table 7.1. Annual peak flows and heights recorded for these stations could be useful as a measure of potential flooding in neighbouring reaches of the streams. Streamflow records over the recorded period can be obtained on computer print-out sheets available on application to the Water Resources Commission.

Table 7.1: Stream Gauging Stations Located within the Byron Shire

Station Name/Number	Stream	Catchment (km ²)	Period of Operation		Computed Record
			From	To	
Durrumbul 202001	Brunswick River	34	21.10.56	Present	1954-78
Billinudgel* 202400	Marshalls Creek	31	31.8.71	Present	No Records
Goonengerry 203001	Wilsons River	29	4.2.20	31.10.29	1920-29
Repentance 203002	Coopers Creek	62	11.2.20	Present	1920-1977
Binna Burra 203012	Byron Creek	39	28.8.51	Present	1951-1977
Federal 203013	Wilsons River	54	8.2.52	Present	1952-1981
Near Booyong 203038	Pearces Creek	13	26.7.72	Present	1972-1976

* This station was established on behalf of the Public Works Department. As it is located in the tidal reach it is of very limited value for water resources assessment purposes and has been operated to obtain records of stage only. Its operation is in the process of being taken over by that Department.

Source : Water Resources Commission

1. Information supplied by Water Resources Commission.

The Commission holds water quality data for 6 gauging sites in or adjacent to the Shire. Table 7.2 is a summary of water quality data for each site.

Table 7.2: Water Quality Gauging Sites Located Within or Adjacent to the Byron Shire

Station Name/Number	Stream	Salinity Range	S/cm Median	pH Range	Medium
Durrumbul 202001	Brunswick River	52-175	134	6.6.-7.8	6.8
Repentance 203002	Coopers Creek	30-108	72	6.6-8.6	7.1
Binna Burra 203012	Byron Creek	53-345*	106	6.7-7.5	7.0
Federal 203013	Wilson's River	57-117	90	6.6-8.1	7.1
Eltham 203014	Wilson's River	60-150	97	6.3-7.4	6.9
Booyong 203038	Pearces Creek	62-135	97	6.0-7.3	7.0

* The highest salinity of 345 US/cm recorded is an anomaly that cannot be explained, the 90 percentile salinity for this station is only 130 US/cm.

All of the gauging sites in Byron Shire have waters of similar and good quality. The salinity and turbidity values are all low and pH values show the waters to be essentially neutral.

There are no state-sponsored irrigation schemes proposed in the Shire.

7.4 Future Storage Resources

Working Paper No. 4, 'Man-made Environment' made reference to investigations by the Department of Public Works into future water storage requirements for the Richmond/Brunswick catchment. Three of the alternative dam sites are located in the Shire on Wilson's River - a major tributary of the Richmond River (see Figure 12).

Investigations into the need for and feasibility of additional storage facilities in the area have not yet been finalised. No decision has been made on which, if any, of the three dam sites is preferred. Thus whilst it would be premature at this stage to recommend land use controls

facilitating protection of the dam sites and their catchments, it is necessary to be aware of the proposals in the area and to implement policies that would not unnecessarily increase the public cost of future storage construction nor preclude such options from consideration.

7.5 Flooding

7.5.1 Introduction

Detailed flood studies of the major catchments in the Shire have not yet been undertaken. High rainfall and large catchment areas can result in the build-up of large amounts of water. In the upper reaches of the Shire's rivers and streams the movement of water at times of flood tends to be rapid. Floodwaters are often deep but confined by the generally steep to undulating terrain. On the coastal plain, the nature of flooding changes. Velocities and depth of floods are generally low. The identification of flood-prone land and the nature of flooding is particularly important and in the coastal reaches of rivers and streams flooding in these areas is complicated by tidal influences. Where terrain is flat the careful delineation of the one in 100 years flood line is important as is the nature of floodwaters (velocity, depth, whether it is backwater). Also further complicating matters is the influence that impeded local drainage may have on floodlevels - such impedence varying from time to time.

Flooding in the major catchments is discussed below.

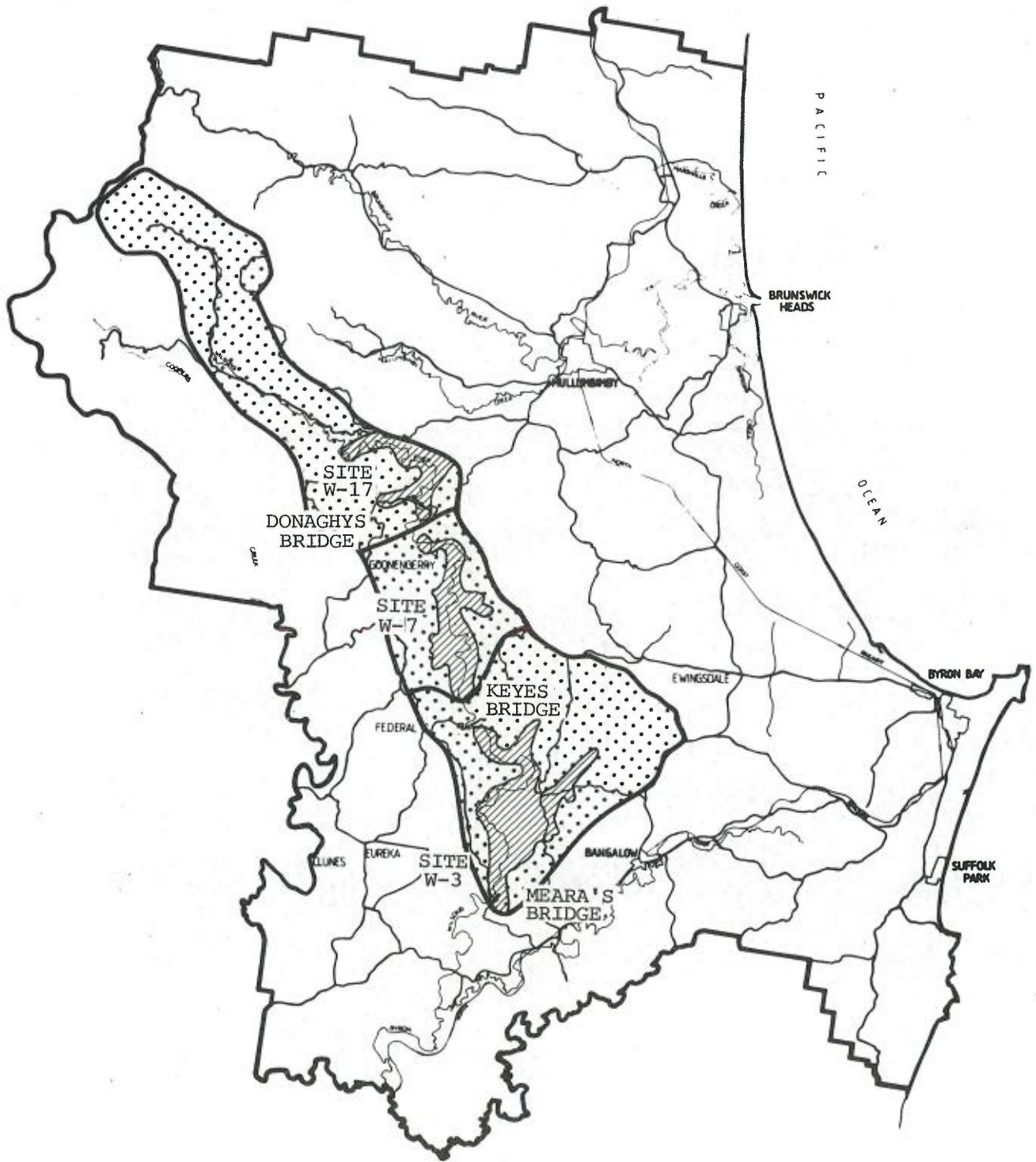
7.5.2 Flooding in the Shire¹

Brunswick River Catchment



A comprehensive flood study of the Brunswick River Catchment is presently being undertaken by Council in conjunction with the Public Works Department. The findings of this study are anticipated to be completed in October, 1983. Previous studying data on this catchment is sketchy. However, the Public Works Department has previously undertaken work in the vicinity of Mullumbimby and New Brighton, and Council has estimates of other flood heights for other sections of the catchment.

In the upper reaches of this catchment, flooding is limited to drainage courses and principal creeks. As valleys are invariably steep sided, flood flows are restricted to areas immediately adjacent to watercourses. Stream velocities during storms and periods of heavy rainfall can be high. Motor vehicles have been known to be washed off causeways whilst crossing them. The depth of water in these upper reaches during periods of heavy rain can rise many metres in a few hours, and then return to normal flow conditions within 24 hours. As most access routes follow, and sometimes cross these water courses, some rural areas may be trapped by flood waters on occasions (eg. Main Arm and The Pocket areas).

1. Figure 8 indicates flood inundation in the Shire.



SOURCE: RICHMOND-BRUNSWICK-REGIONAL WATER SUPPLY INVESTIGATION, PUBLIC WORKS DEPARTMENT

STORAGE AREAS OF EACH SITE	
CATCHMENT AREAS	
<u>CATCHMENT AREAS</u>	
W17 = 39sq kms	
W7 = 39+21 = 60sq kms	
W3 = 39+21+30 = 90sq kms	

BYRON SHIRE ENVIRONMENTAL STUDY	12 ↑
WATER SUPPLY INVESTIGATION SITES	
WILSONS RIVER	
10km	

Prepared by PLANNING WORKSHOP PTY. LTD. 346 KENT ST., SYDNEY For BYRON SHIRE COUNCIL

In the lower reaches of this catchment, the nature of flooding changes from that of the upper reaches. Flooding on the lowland plains is more extensive than in the steeper, upper reaches of the catchment. Flood water velocities and, on the other hand, depth, tend to be lower in this part of the catchment compared with the upper reaches. Swamps and wetlands on the coastal plains tend to act as flood storage areas and they also play a major role in reducing flood flow velocities, depth and routing flood flow direction. These vegetated areas tend to provide a fairly adequate protection of downstream areas from serious flood damage.

Minor Coastal Catchment

These minor coastal catchments consist of the following:

- * **Belongil Catchment:** Comprises those land generally draining into the Belongil Creek area, approximately 21 square kilometres.
- * **East Byron Catchment:** Comprises land draining into coastal dune and beach areas, east of Byron Bay town centre. Area approximately 2 square kilometres.
- * **Tallow Creek Catchment:** Comprises those lands generally draining into Tallow Creek. Area approximately 5.5 square kilometres.
- * **Taylor Lake Catchment:** Comprises those lands generally draining into Taylor Lake. Area approximately 2 square kilometres.
- * **Newrybar Swamp Catchment:** Comprises those lands generally draining into Newrybar Swamp area. Area approximately 7.5 square kilometers.

Investigations are currently underway to determine the nature of flooding and to identify flood-prone lands in the vicinity of Byron Bay. This would involve an analysis of flooding in the Belongil, East Byron and Tallow Creek catchments.

Richmond River Catchment:

This catchment includes smaller sub-catchments of Coopers and Wilsons Creeks. Flooding is generally restricted to the drainage courses and the principal streams in the catchment, with some more wide scale flooding occurring in some wider valley situations. Stream velocities are higher on Wilsons Creek and Coopers Creek, compared with Possum Creek and Byron Creek. Development should be prohibited from these areas of rapid flow. Some areas in Upper Coopers Creek and Wilsons Creek have been cut off by floodwaters during major wet periods for periods up to a week.

Council has prepared detailed inundation maps for Bangalow.

7.6 Planning Implications

7.6.1 Introduction

Consideration of future development with regard to watercourses should address the following:

- * the effect development will have on flood levels on any other land;
- * the effect development will have on the velocity of the flow of flood water;
- * the effect development will have on erosion, siltation or unnecessary destruction of river bank vegetation in the area thus affecting flooding behaviour downstream; and
- * the effect development will have on the water table of any adjoining land.

7.6.2 Government Policy

State Government policy on development in flood-prone land is set out in two circulars issued in 1977 and 1978 by the New South Wales Planning and Environment Commission (Circulars Nos. 15 and 22). Circular 13 issued by the Department of Environment and Planning in 1982 extends the earlier two circulars by discussing the zoning which is appropriate for land subject to various degrees of flood.

The basis tenet of the Government's flood-prone land policy is that:

"urban development is generally undesirable on any flood-prone land if there are alternative flood-free sites available. Urban development in the context of this policy includes all buildings, structures, filling and excavation, whether temporary or permanent, which could affect the flow of floodwaters and be imperilled or cause damage elsewhere in times of flood."

Also development in floodways should be restricted as such development would inevitably be imperilled or would divert floodwaters onto other property.

Flood-prone land for the purpose of government policy is defined as:

"Those areas covered by a 1 in 100 years flood unless otherwise determined by the Department of Public Works in the tidal reaches of rivers, and the Water Resources Commission elsewhere."

Floodways are:

"Those areas covered by the 1 in 100 years flood unless otherwise determined as above. (Floodways are the main flow paths for floodwaters once the river channel has overflowed)."

Councils were advised in a non-mandatory fashion to implement State Government policy. Circulars 15 and 22 were among those included in the Minister's direction of the 27th August, 1980 under Section 117(2) of the Environmental Planning and Assessment Act, 1979, and thus must be followed by Council in the preparation of local environmental plans.

The flood-prone land policy can be best implemented through land use zoning.

There are two criteria therefore for assessing whether land is suitable for rezoning to permit certain developments or in assessing development applications on flood-prone land:

- * Is the development likely to be imperilled by the threat of water entering the development and causing damage?
- * Will the development affect the nature of flooding in the area thus causing properties elsewhere to be affected?

7.6.3 Constraints to Development

In order to implement government policy on control and development on flood-prone land, it is necessary to identify to the satisfaction of the Department of Public Works, flood-prone land and floodways. At the present time such information is not available, although as mentioned above, studies are being undertaken to determine the extent of flooding in the Brunswick River and Belongil Creek catchments.

Flooding information available at present includes inundation maps for the villages and rural parts of the Shire. This information will be used for the purposes of this Environmental Study to identify growth areas and to develop appropriate land use management policies for flood-prone lands within the village areas.

The current studies to identify flood-prone lands in the Brunswick River and Belongil Catchments will be incorporated into the plan when the information becomes available.

7.7 Availability of Flood Information

To effectively implement the State Government's policy on flood-prone land and incorporate such a policy into future local environmental plans, information is required on the location of flood-prone lands and floodways. This is because land use management policies as reflected in local environmental plans may be different for floodways and flood-prone land.

Generally, flood-prone land is land susceptible to inundation with a probability of at least once each 100 years. Floodways are lands likely to flood once every 20 years. These are only general criteria. Government policy suggests that these criteria be accepted unless otherwise determined by the Department of Public Works or the Water Resources Commission. In the absence of advice from either of these

two organisations on the location of flood-prone land and floodways (as defined above) then the 100 years and 20 years flood limits should be used (if determined using a procedure acceptable to the Public Works Department or Water Resources Commission).

At the present time, no information is available for Byron Shire to enable the statistically valid determination of floodways, flood-prone land or 20 years or 100 years flood frequency limits.

Studies are currently underway to determine flood-prone lands and floodways in the vicinity of Byron Bay and in the Brunswick River catchment in the vicinity of Brunswick Heads. It is also believed that private studies are being undertaken to determine flood limits of Marshalls Creek - the north arm of the Brunswick River) in the vicinity of Ocean Shores.

Current flood information available for the purposes of this environmental study include:

- * Flood inundation mapping of the township of Mullumbimby prepared by the Department of Public Works.
- * Flood inundation mapping for the townships of Brunswick Heads, Byron Bay, Bangalow and the rural areas of the Shire prepared from historical records and local knowledge by Council's Engineering Department together with available information from the Richmond River flood plain mapping exercise.

This information has been augmented at specific locations with specific statements on the 100 years flood frequency limits (e.g. Manton land).

8. NATURAL ECOSYSTEMS

8.1 Coastal Wetlands and Associated Communities in Byron Shire - A Preliminary Survey¹

8.1.1 Introduction

A survey of coastal wetlands and associated communities in Byron Shire was undertaken by R.L. Pressey in January 1983. This report was prepared on the basis of field work and a subsequent review of published and unpublished information on the area specifically and on the types of communities found there.

This survey had four main aims:

- * to identify and describe wetlands and other communities on the coastal strip of Byron Shire;
- * to outline the past and future impacts of development on these areas;
- * to indicate priorities for preservation;
- * to indicate ways of protecting and managing all remaining natural areas.

In no way is this study a substitute for detailed investigations and environmental assessment of natural areas prior to development. Indeed, before environmental planning is adequate in Byron Shire there is a need for more comprehensive surveys to identify all the factors influencing the long-term viability of coastal communities and to assess these communities in a broad context.

The major constraint on this study was time. Field work was limited to fairly brief inspections of each of the areas identified on aerial photographs and to meetings with local naturalists. Highest priority was given to compiling information on each area from a variety of sources and to outlining the necessary approaches for planning.

8.1.2 Acknowledgements

Thanks are due to the following for assistance during this work:

- * The staff of Planning Workshop for patience and for information on natural areas in Byron Shire.
- * Members of BEACON, particularly Liz Smith, for discussions, field inspections and valuable information.

1. This section was researched and written by R.L. Pressey (a wetlands specialist) practising as a private consultant in NSW.

- * Sandy Gilmore for his willingness to share his extensive knowledge of the north coast.
- * Alex Floyd for reviewing an early draft of part of the report.
- * Rob Doolan for information and discussions.
- * Bob Hayworth for information on the Tyagarah dunes area.
- * Russ Maslen for information on local plants.
- * Greg Clancy for information on Little Terns.
- * Pat Hutchings for helpful discussions.
- * Harry Recher for helpful discussion.

While these people made valuable contributions to the report the author takes full responsibility for any errors in the interpretation of information and for omissions of relevant material.

8.1.3 Types of Coastal Communities in Byron Shire

Wetlands

Byron Shire contains many of the broad types of coastal wetlands found in NSW. Some types occupy very large areas of the Shire while some are represented by only one or a few small areas. All the wetlands have conservation value in their own right, although this varies according to habitat and species diversity, long-term viability and other factors. Some wetlands may have additional values, for example as a basis for estuarine food chains or as particular faunal habitats. Despite many years of observations by naturalists in coastal areas of the state the faunal values of most wetland types are not completely understood and so neither are the implications of their loss.

Paperbark and Sheoak Swamps

Paperbarks (Melaleuca quinquenervia) and Sheoaks (Casuarina glauca) are generally discussed together in this report since they usually occur in mixed stands on the coastal lowlands of the Shire. The "swamp-forest" of the Shire is dominated by M. quinquenervia with C. glauca subdominant.

No overview is available on the status of C. glauca in coastal New South Wales. Although it is widely distributed and would originally have been one of the most widespread trees on the flood plains and sandy flats, significant stands are now becoming scarce. For example, on the Hunter flood plain C. glauca occurs in or around 20 per cent of wetlands but comprises only 2.5 per cent of the total wetland area (Pressey 1981).

As for paperbarks, Goodrick (1970) estimated that about 9,400 hectares of M. quinquenervia swamps remained on the coast at that time, about 80 per cent of the original area. These were mainly in the far north (26 per cent) and mid north (70 per cent) coast districts. The extent of

paperbark swamps remaining today would be significantly less than the 1970 figures because of widespread clearing, such as that occurring in Byron Shire. Briggs (1977) has commented that, of all coastal wetlands, paperbark and sheoak swamps in particular have been reduced in area since Goodrick's survey.

Most of the sandy alluvial lowlands of Byron Shire would once have been covered with paperbark and sheoak swamp and much of this has now been cleared for grazing or other uses. One of the most spectacular efforts at clearing paperbarks was just south of Byron Shire when the extensive Newrybar Swamp was altered to grow sugar cane. Paperbarks also grow as one of the higher zones around brackish lakes in coastal New South Wales (Eadie 1981), including Byron Shire, and occur in swampy dune areas.

Paperbark swamps support a very diverse fauna (see BEACON 1981) and are of particular value because they provide a seasonal food source for many birds which move down to the coast in the cooler months. Studies by CSIRO have found the low-lying parts of the far north coast to be "primary overwintering areas" for birds because the moist, warm conditions provide abundant food. Paperbark forests may be of particular value, even in this context, because of their extent and winter flowering. Scarlet and White-throated Honeyeaters are among the species which concentrate in paperbarks during the cooler months (S. Gilmore pers. comm.).

Another important feature of paperbarks is the apparent dependence of the Blossum Bat (only a few records in the State) on Melaleuca quinquenervia and Callistemon salignus (which often grows in association). The National Parks and Wildlife Service (1982) has identified three flying fox camps in the paperbark areas of Byron Shire. BEACON (1981) has reported an additional one in Cumbebin Swamp. Since only about 12 are known for the north coast (S. Gilmore pers. comm.) these must be considered very significant.

A notable feature of paperbark swamps on the sandy flats of the Shire is the very high plant species diversity compared to paperbarks on river flood plains. The distinct understorey species on sandy flats indicate that the swamp forest in these areas should be regarded as a distinct type from that on the flood plains. Conservation decisions on this wetland type are, however, difficult to make because:

- * there is no estimate of the extent of swamp forest on sandy soils in coastal NSW; and
- * the distribution and status of the understorey species is apparently not known.

There is therefore little evidence on which to base an assessment of the uniqueness or commonness of swamp forest in Byron Shire.

Swamp Sclerophyll

This is a loose term referring to communities dominated by eucalypts in poorly drained coastal areas. Beadle (1981) has discussed the occurrence of two main species which occur in Byron Shire:

- * Eucalyptus tereticornis which is dominant on coastal alluvial flats, adjacent to stream lines and in valleys. It often adjoins rainforest, mangroves and sheoak swamps and, on the north coast of NSW, is associated with a variety of other species including those typical of rainforest and other wetland types.
- * Eucalyptus robusta is found in very waterlogged conditions, may adjoin littoral communities of paperbarks and sheoaks and may have both as an understorey.

No figures on the coastal distribution and status of these species is available although both have a limited distribution in Byron Shire.

Lepironia Swamps

Lepironia articulata occurs in a variety of situations in the north and central coast districts of NSW. On the river flood plains it tends to occur in wetlands with reliable water supply and it is scattered through swampy dune areas. Only in certain situations, however, does it occur as a distinct formation in coastal dune country, typically in a monospecific stand.

Goodrick (1970) estimated that only 440 hectares of Lepironia swamps existed on the coast and that their loss had been negligible until then. The bulk of this wetland type (73 per cent) was on the far north coast. The impacts of more recent developments on the extent of Lepironia swamps are unknown, although clearly they have always been very restricted. Only one small example occurs in Byron Shire.

Fresh Marshes and Fresh Open Water

Due to the intensive development of the coastal flood plains, the once extensive areas of shallow freshwater wetlands have been seriously depleted and some originally deep wetlands made shallower and less persistent. The bulk of the decline in fresh wetlands has been in the north coast districts and, on the far north coast, the loss of shallow fresh wetlands represented 85 per cent of the total wetland loss for 1970 (Goodrick 1970).

In Byron Shire fresh marshes and open fresh water have never been extensive and are now represented only by a handful of very small wetlands.

Dune Lakes

These are areas of open water in the depressions of dune systems and may be "perched" above the water table on an impervious layer or may be a surface expression of the local water table. They may also be connected with or separate from the sea.

The survey of Goodrick (1970) lumped these areas with the open fresh waters of the flood plains but good perspectives on dune lakes in NSW are provided by Timms (1977^a, 1982) and Bell and Edwards (1980). Timms (1977a) comments that there are few sizeable dune lakes on the north coast and lists 20 between Byron Bay and Lake Macquarie,

including Taylor Lake, the only dune lake in Byron Shire. The past impacts on these wetlands included drainage, introduced fauna, recreational use, nutrient enrichment from urban areas and sand mining. He found that only 4 of the 20 were generally pristine and without development proposals. When the condition of catchments is considered, the statistics are more dramatic. On the whole NSW coast only two dune lakes or coastal lagoons have undisturbed catchments (Bell and Edwards 1980). All the remainder including Taylors Lake are subject to the effects of catchment development such as sedimentation, altered hydrology and nutrient enrichment.

Estuaries

The main estuary in Byron Shire is the lower Brunswick River which also includes Simpsons Creek (south arm) and Marshalls Creek (north arm). Belongil and Tallow Creeks are smaller examples. Habitats included in this category are mangroves, saltmarsh, mudflats, seagrass beds, shallow estuarine water and fringing emergents such as Phragmites australis.

Relatively little loss of mangroves and saltmarsh was estimated by Goodrick (1970) for coastal NSW although the elimination of estuarine habitats has been extensive since then. Developments affecting the estuaries include the floodgating of tidal inlets, filling estuarine wetlands or isolating them behind levees and replacing them with marinas and canal estates.

The very high natural and economic values of estuaries have been established for some time. Estuarine vegetation is specifically adapted to salinity and tidal variation. The fauna includes a diverse and distinctive assemblage of invertebrates, fish and birds (e.g. Hutchings and Recher 1974, Hutchings 1983, Robinson *et al.* 1983) including many migratory wading birds, most of which are heavily dependent on estuarine habitats for food and shelter.

Some important aquatic food chains are based on the organic detritus produced by estuarine vegetation, including those on which the coastal fisheries are based. Pollard (1976) found that about 60 per cent of the important commercial fish species in south-eastern Australia are estuarine-dependent at some stage of the life cycle, including several which are caught mainly offshore. Other estuarine-dependent species include crabs, prawns and oysters. Mangroves and seagrasses are nursery areas for juvenile fish, prawns and crabs and feeding areas for adults. Saltmarshes contribute to the production of detritus and serve to buffer mangroves from the impacts of surrounding developments and have important direct values for fauna, particularly birds. In 1976 the annual value of New South Wales estuaries for commercial fisheries production, with retail mark-ups, was estimated at \$25 million and the total income generated by estuarine-dependent fisheries was about \$36 million (Pollard 1976). The State's oyster industry has recently been valued at about \$23 million. These figures do not include enjoyment and income generated by healthy estuaries through amateur fishing, boating, recreation and tourism.

8.1.4 Other Coastal Communities

The wetlands of the Shire's coastal strip cannot be assessed and conserved in isolation from other natural areas. Five other broad community types have been identified in this study.

Heath

Specht (1981) gives a basic classification of lowland heaths into wet and dry which has been followed in this study:

- * Wet heathlands occur on seasonally waterlogged soils where tree seedlings usually fail to survive during the long period of poor aeration.
- * Dry heathlands occur on well drained but seasonally droughted infertile soils where fungal mycorrhizae usually fail to inoculate tree seedlings.

Specht emphasises that the distribution of heath is dependent upon extremely low levels of plant nutrients in the soil and comments that, wherever soil fertility is improved, the heathland is replaced by a grassy - herbaceous vegetation.

Coastal heath in NSW is concentrated in the central and far north coast districts (Groves 1981). In the Myall Lakes area, Grover describes three typical spatial patterns in coastal heath:

- * a continuum of heath types from wet to dry;
- * variation in floristic composition over small distances;
- * patterns of heath interspersed with other structural types of vegetation such as woodland and open forest over larger distances.

These patterns are also evident in the heathland of Byron Shire. Within the Shire, as on the rest of the coast, large areas of heath have been destroyed by development or damaged by sand mining.

A quote from Specht (1981) indicates the sensitivity of heathland to disturbance:

"The heathland habitat is balanced on a knife edge. A small change in the water balance (hydrology), soil nutrient level (due to frequent fires or the waste products of tourists), soil fungi (either beneficial mycorrhizal species or root-pathogens like Phytophthora cinnamoni) can change the whole nature of the vegetation within a decade."

Coastal heath has some significant faunal values. It is important for the conservation of at least 11 bird species, four of which are most abundant there and two of which are among the rarest birds in eastern Australia (Recher 1981). Heaths and coastal scrub (see below) are important areas

seasonally for the feeding and breeding of honeyeaters, mainly in autumn and winter (S. Gilmore, pers. comm.). Two native mammals are also characteristic of coastal heaths (Catling and Newsome 1981).

Coastal Scrub

This is another loose term referring to tall shrubs and small trees, usually with a heath understorey, which occupies sand dunes in Byron Shire and on much of the NSW coast. Hannah (1968) has listed the following species as dominants in coastal scrub on the north coast: Banksia serrata, B. integrifolia, Pandanus pedunculatus, Acacia longifolia, Melaleuca leucodendron, Leptospermum laevigatum and Eucalyptus gummifera. The term as used here also includes the pioneer foredune vegetation which Hannah describes as the littoral strand.

The decline and alteration of coastal scrub in Byron Shire and elsewhere in the State are probably due mainly to development for recreation, tourism or residential areas and to sand mining. Clark (1979) has noted that regeneration after sand mining may take a very long time and it is still uncertain whether the original community will return in some places. In particular, the dominant shrubs and trees which give the community its distinctive character may be slow to return. According to local naturalists, areas which have been sandmined in Byron Shire are distinctive because of the plants used to re-stabilise the dunes. These include horsetail oaks, Casuarina equisetifolia (an Australian native but not native to the area) and bitou bush which is a serious weed in many coastal areas.

The faunal values of coastal scrub are probably similar to those outlined for heath.

Littoral Rainforest

This term refers to disjunct and usually very small patches of rainforest vegetation which forms a distinct type by virtue of its special habitat adjacent to the coastline. Much of the original littoral rainforest in NSW has now been destroyed by coastal development and sand mining and the National Parks and Wildlife Service (1979) has a policy to protect all significant stands and to encourage the retention of smaller remnants for education and faunal habitat.

Littoral rainforest is sensitive to disturbance and relies on a protective layer of other vegetation to buffer it from salt spray. Clearing of dunes or altering their shape by sand mining may therefore damage or eliminate it. Analyses of soil supporting littoral rainforest show extremely low levels of all nutrients although the vegetation contains high levels of nutrients, comparable to those in other rainforest types (Beadle 1981). This indicates that, once cleared, littoral rainforest may re-establish only very slowly.

Of the common plants of rainforest in eastern NSW and south-eastern Queensland, two occur only in littoral rainforest (Beadle 1981). In addition, there are a number of rare and endangered species in the littoral rainforest of Byron Shire.

Riverine Rainforest

Due to widespread clearing of the coastal flood plains, riverine rainforest is now very restricted in occurrence and may occupy only about 100 hectares of the State. The policy of the National Parks and Wildlife Service (1979) is to protect all stands which are viable in the medium to long-term. An appropriate aim of Byron Shire Council would be to identify and retain all remaining stands (generally small and fragmented) pending their evaluation. Even small remnants will have educational and scientific value in the short-term. The occurrence of rare species would indicate the need for special management to maximise the chances of survival in the long-term.

Alluvial Eucalypt Forest

Clearing of the coastal flood plains has also eliminated nearly all of the once extensive eucalypt forests which grew on alluvium and sandy alluvium. A few large stands remain in Byron Shire, dominated by trees such as Eucalyptus tereticorius and E. pilularis and sometimes associated with riverine rainforest.

A Note on "Naturalness"

In the assessment of natural areas for protection the degree of alteration or, inversely, of "naturalness" is often used as a criterion. In many cases this is a valid approach. For example, undisturbed paperbark forest in Byron Shire is very uncommon and is important as a baseline for comparison with other areas. It may also support species which are highly sensitive to disturbance.

However, there are limitations to the uncritical use of this criterion:

- * Disturbed areas may still have high value for flora and fauna. Previously cleared paperbarks in Byron Shire are important as a seasonal food source for birds and bats (see 8.1.5). At least one area of disturbed littoral rainforest in the Shire (see Section 8.1.5) includes endangered tree species. Many other examples within Byron Shire could be given.
- * Downgrading areas because of past disturbance ignores the potential for regeneration of the original community, with or without management.

The future of remaining natural areas on the coastal strip should not therefore rest solely on past disturbance but should be based on detailed surveys and assessment in a broad context (see Section 8.1.6).

8.1.5 Specific Areas on the Coastal Lowlands

This section provides descriptions of parts of the coastal strip, outlines what is known of their significance and discusses activities or developments which have affected or will affect their natural values.

Area numbers refer to those on Map 13. Map 14 shows areas identified by the National Parks and Wildlife Service as having ecological significance. Numbers on this map relate to information in Table 8.2.



WETLANDS	AREA 19
PROTECTION ESSENTIAL	[Vertical line pattern]
PROTECTION IMPORTANT	[Horizontal line pattern]
PROTECTION DESIRABLE	[Diagonal line pattern]

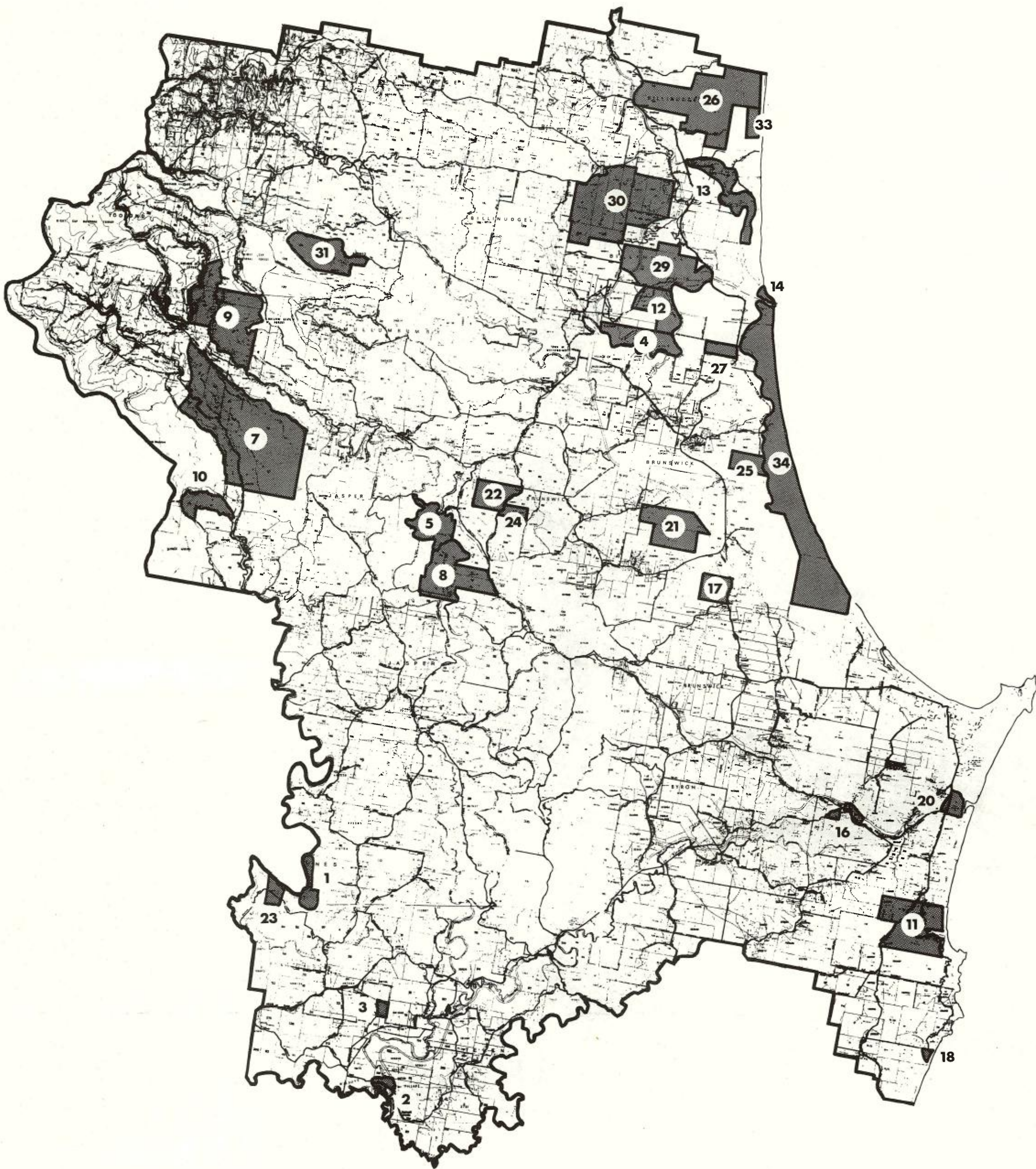
BYRON SHIRE ENVIRONMENTAL STUDY

WETLANDS **13**

0 5km

↑

Prepared by PLANNING WORKSHOP PTY. LTD. 346 KENT ST., SYDNEY
For BYRON SHIRE COUNCIL



BYRON SHIRE ENVIRONMENTAL STUDY
AREAS OF CONSERVATION
VALUE - N.P.W.S. 14
 0 5km ↑

Prepared by PLANNING WORKSHOP PTY. LTD. 346 KENT ST., SYDNEY
 For BYRON SHIRE COUNCIL

AREA 1: North of the existing Ocean Shores development, occupying low-lying country between the Pacific Highway, the northern Shire boundary and the beach.

Description

Poor access and limited time prevented a detailed field inspection and the following brief description is based on views from tracks in and around the area and from high ground above.

The western part of the area is mainly paperbark (Melaleuca quinquenervia) forest in varying stages of regeneration and condition. The eastern part contains a diverse range of coastal dune vegetation including paperbarks in swampy areas, Banksia scrub, heath, eucalypt woodland and littoral rainforest. Some points of particular interest here (see map) are:

- * a grove of Callitris columellaris (a cypress pine) (Part A);
- * an area of large scribbly gums on an old dune with a dense dry heath understorey containing Acacia and Banksia species (Part B);
- * an area of undisturbed and very old paperbarks (Part C).

Paperbarks in similar condition may occur further east along the blocked drain although this could not be confirmed during field work.

Significance

Significant features of the area include a flying fox camp (possibly only about 12 on the north coast) and the presence of many epiphytic orchids including Cymbidium maddidum in large clumps on mature paperbarks (National Parks and Wildlife Service 1982, BEACON 1983).

The area of Callitris columellaris is very important as it is probably the most extensive stand on the north coast and much of Area 1 is significant because of several very uncommon faunal records (S. Gilmore pers. comm.).

BEACON (1983) has also pointed out that mature undisturbed paperbark forest is rare in the Shire and its presence here is one of the most important aspects of the area.

Other paperbark areas in the Shire, with the possible exception of part of Area 9, have been altered in some way, for example by past clearing, grazing or drainage. While these effects do not eliminate ecological values they may exclude some species. Undisturbed stands are therefore valuable because:

- * They may contain species with specific habitat requirements and which are sensitive to disturbance (e.g. orchids) which have been eliminated elsewhere. Certain orchids and other species may be indicators of the lack of disturbance because of their sensitivity.
- * They provide a baseline for comparison with disturbed areas.

- * They are of scientific interest in their own right.

The north-eastern part of Portion 358, Parish of Billinudgel, has also been identified as significant. It contains littoral rainforest and Banksia woodland which is regenerating after fire (National Parks and Wildlife Service 1982). The littoral rainforest is significant in itself and the Service considers the area to be a good sample of a rare association of species. At least two endangered plant species occur here (S. Gilmore pers. comm.).

Past impacts

Parts of the area have been disturbed in a number of ways:

- * the lowland communities have been contracted or altered by development to the south;
- * there has been a previous attempt to drain the area eastwards to the beach although the outlet has now been blocked;
- * there are signs of extractive industry and clearing along the track leading south from the Wooyung Road (western parts of Portion 286, Parish of Billinudgel);
- * aerial photographs show the marks of past clearing in the middle of Portion 286 and sparser growth of paperbarks further west, for example the eastern parts of Portion 290, which may also indicate clearing;
- * fire has affected vegetation in Portion 358 as mentioned above.

Threats

Major threats to the natural values of Area 1 seem to be the expansion of development from the south and its indirect impacts on adjacent areas.

Any expansion of residential and recreational areas will obviously remove natural parts of Area 1. Any drainage associated with development could affect communities over a wide area. Although some wetland plants, including the paperbarks, could survive drainage their reproductive potential might be reduced and the important undisturbed stand of paperbarks would be degraded by the loss of sensitive species. Changed water tables in the dune areas could also affect vegetation and fauna.

Linking the canal system to the ocean at some stage could have extensive impacts by raising the salinity of the groundwater. There are a number of other threats:

- * Vehicle and pedestrian traffic could degrade dune areas, particularly those on the eastern side of Portion 358 unless carefully managed.

- * Canal developments can have a number of adverse effects if not carefully designed. Any expansion of canals in the area should be in line with guidelines for canal estates being prepared by State Fisheries (1983). The draft of these guidelines strongly recommends that such developments should be restricted to non-sensitive areas. It also lists some of the impacts of canal estates and refers to some useful literature.
- * Along with other coastal areas, communities near the beach could be affected in the long-term by natural coastal erosion.

AREA 2: Low-lying areas associated with Marshalls Creek (Brunswick River North Arm) downstream of the Pacific Highway to the Brunswick main channel.

Description

The area contains several communities:

- * Between the Pacific Highway and New Brighton to the north of the New Brighton Road the trees are mainly Eucalyptus robusta, Melaleuca quinquenervia and Eucalyptus tereticornis. A very swampy section abutting the highway is mainly E. robusta and M. quinquenervia regenerating after clearing.
- * South of the New Brighton Road Eucalyptus tereticornis features prominently in the flood plain forest.
- * Along the Golden Beach Road is a dense stand of Casuarina glauca with eucalypts (Part A).
- * Downstream of New Brighton the river is estuarine and is lined with mangroves (four species). To the east of the river the dunes support coastal scrub and littoral rainforest (BEACON 1983). Extensive sand and mudflats occur on the lower reaches.

Significance

The diverse E. tereticornis dominated community with associated rainforest species is of considerable importance in the local context (National Parks and Wildlife Service 1982). Although E. tereticornis has a wide distribution there are few (possibly only 3) significant stands in the Shire. This species is an important food source for koalas and according to BEACON (1983) the area is a feeding and breeding area for Glossy Black Cockatoos, a species described by Pizzey (1980) as "generally local and very uncommon".

The estuarine and coastal section of Area 2 also rates highly for protection for a number of reasons:

- * The general value of estuarine communities described in Section 8.1.4.

- * The diverse mangrove community including Excoecaria agallocha and a significant population of Bruguiera gymnorrhiza, which has its southern limit on the Clarence River (S. Gilmore pers. comm.).
- * The importance of the tidal flats for migratory waders (National Parks and Wildlife Service 1982).
- * The littoral rainforest (BEACON 1983), any remnants of which are valuable (National Parks and Wildlife Service 1979).

Past Impacts

Large scale clearing and general disturbance is evident north of the New Brighton Road as is limited clearing to the south of the road. Tracks and clearing have also affected an area just north of Harrys Head on the eastern side of the estuary.

Threats

An extension of development northward from Ocean Shores or southward from the South Golden Beach area would remove or fragment valuable flood plain forest, reducing faunal values and increasing the risk of weed invasions and fire damage. New development could also result in associated impacts from recreational use and predation by domestic animals on the remaining forest.

The estuarine reaches are vulnerable to enlargements of urban areas, uncontrolled access on foot or by vehicle and sedimentation from adjacent slopes. There is now very little buffer between the Ocean Shores development and the mangroves. A dense vegetative buffer around the top of the estuarine zone would help to ensure the long-term survival of the intertidal communities in a natural state. Restricted vehicle access to disturbed sandy areas north of the creek mouth would assist regeneration there.

In the long-term, coastal erosion could affect parts of Area 2 adjacent to the beach.

AREA 3: Parcel of land (lot 1043, Parish Billinudgel) above the Brunswick Nature Reserve

Description

An area of about 5 hectares, partly cleared.

Significance

The land supports two individuals, including the type specimen, of a very rare rainforest tree, Acronychia littoralis (m.s.), still formally undescribed. Another eight specimens grew on the block before clearing and the extant world population may be only 20, all on the far north coast (R. Maslen, pers. comm.). The significance of the site for this species has been recognised by the Heritage Council of New South Wales who placed an interim conservation order on the land in July, 1982.

As the original population of the species in this area was a large proportion of the known total number, the site may have some peculiarities which are important for its long-term survival, a possibility which needs to be carefully investigated before any further development is allowed.

Another reason for excluding development from this land and allowing or encouraging regeneration of native vegetation is that it functions as a buffer between the Nature Reserve and the developed areas to the north. Some disturbance of the Nature Reserve has already occurred and could intensify as the population at Ocean Shores grows.

Past Impacts

Clearing of the block has removed a major part of the world population of A. littoralis and may have caused some erosion down into the Nature Reserve. Although affecting a small area it is one of the most dramatic examples of the adverse effects of unplanned coastal development.

Threats

Problems of disturbance from adjacent areas can be expected and careful management will be required to re-establish the natural values of the area. For example, if damage results from people walking through the area a 'forest walk' with interpretative signs and even a platform for viewing the river mouth could be established.

AREA 4: North Head of the Brunswick River mouth (Harrys Hill)

Description

Rock outcrop and sand supporting littoral and sub-tropical rainforest.

Significance

According to the National Trust of Australia (1983) the headland is outstanding because of the occurrence of both upland sub-tropical rainforest on slate and littoral rainforest on sand. This document also lists characteristic species of each type and mentions the important scenic value of the area.

One species, Stinking Cryptocarya, Cryptocarya foetida, in the sub-tropical rainforest is exceedingly rare, the known world population occurring in only a few other areas on the far north coast in very small numbers (A. Floyd pers. comm.).

Past impacts

Salt spray has caused chloride poisoning of the eastern edge of the littoral rainforest (National Trust of Australia, 1983), presumably after clearing of protective vegetation. The growth of lantana and pioneer rainforest species are now providing some protection.

Threats

No specific problems were identified. Further clearing or damage to foredune vegetation should be prevented.

AREA 5: The Brunswick River downstream of Kings Creek to the Pacific Highway bridge (including a patch of flood plain forest upstream of the bridge) and Kings Creek to 500 metres above the Mullumbimby Road.

Description

A largely undisturbed, estuarine stretch of water with mangroves and some shallow inlets, backed by eucalypt forest, rainforest and casuarinas.

Significance

The significant feature of this stretch of river is its naturalness. The traditional widespread clearing of the coastal flood plains in NSW has given most rivers a rural backdrop. Very few are lined with natural or near-natural vegetation in their lower reaches and still fewer are close to tourist centres.

A natural buffer strip should be maintained along the river and Kings Creek for a number of reasons:

- * To retain the largely natural character of the waterway for conservation and recreation.
- * To ensure the retention of estuarine vegetation and its protection from fringing development. Four species of mangroves occur here including a significant population of Bruguiera gymnorhiza. BEACON (1983) refers to a fifth species of "mangrove", although it is not generally regarded as such, which is Hibiscus filiaceus. This species occurs on the upper fringes of the tidal zone and is relatively widespread in the region.
- * To maximise stability of the banks in the long-term. There is some erosion of outside bends at present which is typical of senile streams and may be aggravated by clearing of the catchment and resultant alterations in hydrology.
- * Importantly to protect an uncommon tree which occurs along the banks. Acacia bakeri is found along the river, mainly on the western bank, from the Mullumbimby showground downstream to the Brunswick Nature Reserve (R. Masten pers. comm.). This may be the main occurrence of the species in NSW and the only other specimens known for this State are also on the far north coast.
- * To retain faunal values. Although no specific studies on the fauna of the area are available, Australian and overseas literature indicates that riparian vegetation often supports distinctive faunal assemblages and may have special functions, for example, as movement corridors and drought or fire refuge.

- * The flood plain forest is significant because of its limited distribution regionally.

Without an objectively derived figure for the width of a streamside buffer strip, the following is suggested:

- * Preserve a 100 metre natural margin or existing narrower margins along both sides of the river and Kings Creek.
- * Encourage revegetation of disturbed areas within this margin.

Past Impacts

Clearing of the flood plain, particularly on the eastern side of the river, has detracted from its scenic and natural values although substantial lengths of the shore are unaltered. A number of fallen trees in the water probably represent natural (and perhaps accelerated) changes in stream course. They should not be seen as detracting from conservation value as they are important as roosting spots for birds and for a wide range of aquatic fauna.

Sewage from Ocean Shores and Mullumbimby is discharged into the Brunswick River. Together, these sources make up more than 30 per cent of the treatment capacity of the Shire's system. Increased nutrient loads in the river could be having an effect on the estuarine system.

Threats

Further clearing of the Brunswick River catchment could result in progressive sedimentation of the lower reaches and more changes in runoff patterns. Even with the present extent of clearance there may be potential to reduce erosion and sedimentation with appropriate land use controls.

Increased clearing of the river banks in Area 5 would detract from natural values and, in particular, reduce the population of Acacia bakeri. Clearing could also eliminate the valuable flood plain forest on the river.

Increasing populations, particularly at Ocean Shores where the projected growth rate is 7 per cent per annum giving a three-fold increase by 2001 (Byron Shire Council 1982), will test the capacity of the estuary to absorb sewage effluent. The ocean outfall mooted for the Ocean Shores area would be environmentally desirable because of the possibly serious water quality problems in the river.

AREA 6: Flood plain on the western side of the Brunswick River, including Vallances Lagoon.

Description

The area can be described as two units:

i. Wetlands

Vallances Lagoon and another wetland to the east are oxbow lakes or prior stream courses, the easternmost one almost completely infilled and very shallow. Vallances Lagoon is mainly deep open water with emergent vegetation mostly at the downstream end. This includes Juncus, Polygonum, Typha and Myriophyllum. The infilled oxbow is mainly covered with paperbarks, Melaleuca quinquenervia, but with a variety of herbs and rushes on the mud or in shallow water.

ii. Flood plain areas

Area 6 includes a large patch of diverse flood plain forest. This has been described by the National Parks and Wildlife Service (1982) as "sclerophyll forest with rain forest and swamp forest species" with a "rich collection of mammals and birds". BEACON (1983) have noted paperbarks, bloodwood, blackbutt and ironbark in the area. R. Maslen (pers. comm.) also knows of cabbage tree palms, hoop pines and riverine rainforest in the area and has recorded koalas and swamp wallabies there.

Significance

The wetlands are significant for a number of reasons:

- * They are examples of a geomorphic feature (oxbow lake) which occurs nowhere else in the Shire and is generally uncommon on the New South Wales coast, making up a small proportion of the total alluvial wetland area.
- * The National Parks and Wildlife Service (1982) has identified both lagoons as important breeding areas for Cattle Egrets, Black Swans, Little Pied Cormorants and, most importantly, the Osprey. Many Pied Cormorants were roosting at Vallances Lagoon in January, 1983.
- * Open fresh swamps are very limited in the Shire. There are only a few other very small ones on the coastal strip. For this reason Vallances Lagoon is significant. The lagoon has been artificially separated from the river by a rockfill barrier but this simulates a natural barrier and does not lessen its value.

The importance of the flood plain forest rests on two aspects:

- * The area contains riverine rainforest, recognised by the National Parks and Wildlife Service (1979) as greatly depleted on the coast. Very small areas now remain in NSW.

- * The forest may provide a link for fauna moving between the coastal vegetation and remnants of vegetation on the uplands.

Past impacts

Area 6 has been adversely affected in a number of ways:

- * Clearing has isolated Vallances Lagoon from flood plain forest, possibly excluding some species which need to move between both habitats.
- * The edges of the wetlands are grazed which reduces their value for species dependent on marginal vegetation and eliminates the protective value of a vegetative buffer strip.
- * Vallances Lagoon may be used as a source of irrigation water. Although water level manipulation is an important aspect of wetland management, the timing, direction and amplitude of changes need to be carefully controlled for optimal results. Pumping from the river would be more desirable.
- * The lagoons are silting up. R. Maslen (pers. comm.) has noted an increase in sediment in Vallances Lagoon over the years. This is a natural process which has been greatly accelerated by clearance of catchments and flood plains.
- * Clearing has fragmented the existing block of flood plain forest and allowed the establishment of weeds.

Threats

The continuation of two processes mentioned above pose the major threats to the natural values in Area 6:

- * Like other alluvial wetlands on the coast, the wetlands will fill up with sediment at a relatively rapid rate due to clearing and grazing. An important measure to prolong their lives is the establishment of vegetative filter or buffer strips on their banks.
- * Further clearing will reduce the values of the flood plain forest, encourage weeds and may affect movements of fauna.

AREA 7: Fresh and estuarine wetlands on the south bank of the river just downstream of the Pacific Highway bridge.

Description

North of the highway between the marina and the bridge is an area of dense mangroves (Part A). The small size and dense growth of most trees suggest recent colonisation or regeneration.

To the south of this area is a patch of degraded estuarine wetland (Part B).

Further west (Part C) is a large stand of Typha with Phragmites australis and Casuarina glauca around the southern fringe.

Significance

The mangroves, regardless of past alteration, are an important part of the estuary for reasons outlined in Section 8.1.3.

The fresh and brackish wetland (Part C) has considerable value in its own right, despite disturbance, and has great potential for management. Although all three major plants here are widespread in coastal wetlands, this area may contain the only significant pure stands of Typha and Phragmites australis in the Shire. The emergent vegetation and swamp oaks could be managed to diversify the wetland fauna (Typha and Phragmites have a distinctive avifauna) and to encourage visitors, for example by installing boardwalks for nature tours.

Past impacts

The estuarine wetland south of the highway (Part B) has been highly altered by grazing and by the exclusion of tidal flow with the floodgate on the road culvert. Saltmarsh and mangroves here are dead or dying.

Drainage has reduced the depth and permanence of the fresh/brackish wetlands (Part C) and has encouraged the establishment of weeds south of the highway.

Threats

The chances of further impacts could be greatest for wetlands in Part C since both drainage and filling could be used to develop this section. The further decline of Part B is inevitable as long as the floodgate remains. Foreshore development might exclude the mangroves to the north but should be prevented because of the natural and economic values of estuarine communities.

AREA 8: Heathland and flood plain forest south-west of Brunswick Heads.

Description

Area 8 has an extensive core of dry heathland surrounded by a mixed flood plain forest. Portion 58, Parish of Brunswick has been described as supporting "diverse vegetation including swamp forest with some heathland and rainforest interspersed" (National Parks and Wildlife Service 1982). BEACON (1983) have recorded Eucalyptus tereticornis and E. resinifera in this portion.

Significance

With the exception of Area 9, this area contains one of the largest samples of dry heath in the Shire. Its significance depends on its botanical affinities with Area 9 and on the wider significance of sandy heath on the far north coast, both of which should be investigated before any development occurs.

As for Area 6, the flood plain forest is uncommon regionally and the extent of E. tereticornis needs to be established because of its importance as discussed for Area 2. The area may also contain some riverine rainforest species of significance.

Past impacts

Some clearing has contracted the flood plain forest. There is minor development of tracks and an electricity easement. The adjacent urban area could increase the risk of fire, introduce weeds and affect fauna through predation by domestic animals.

Threats

Further clearing would contract the area and perhaps affect important plant species. Clearing could also isolate the vegetation from neighbouring areas with adverse effects on fauna, including those which move seasonally.

AREA 9: Belongil Swamp - Tyagarah dunes - Simpsons Creek.

Description

A very extensive, largely undisturbed area containing a complex mosaic of vegetation in response to alternating dunes and swales and the general gradation from the beach to the basalt slopes, basaltic colluvium and sandy alluvium on the western fringes.

The area was not thoroughly inspected on the ground but some brief descriptions serve to illustrate the diversity of habitats:

- * A large patch of paperbarks south-east of Brunswick Heads and north-east of the sewage treatment works has been sandmined to some extent but contains regenerating littoral rainforest in the understorey (S. Gilmore pers. comm.). BEACON (1983) have reported mature, undisturbed paperbarks there in deep water. Some interesting orchid records have also been made there (R. Maslen pers. comm.). Taeniophyllum wikeanum was found growing there on Monotoca elliptica (not known previously to host an orchid). This is also the only known occurrence of this species in the district. The Christmas Orchid, Calanthe triplicata occurs there and is not known to occur on sand elsewhere.
- * The main body of Area 9 to the east of Simpsons Creek consists of long parallel dunes supporting mainly dry heath with wet heath, marsh and open water in the swales. Paperbarks and eucalypts occur in patches, particularly along the creek
- * A heathy area south of the sewage treatment works has been cleared recently, possibly for construction. Some tall remnant paperbarks and other trees (to about 8 metres) suggest the area was originally a mixutre of swamp forest and coastal scrub
- * Just to the west of here where the boundary of Area 9 crosses the highway are some lowland rainforest and scherophyll species including Eucalyptus tereticornis and E. robusta.
- * About 1.6 kilometres upstream from the treatment works is a large patch of scribbly gums on the banks of the creek.

- * Just to the north of the airfield and to the east of Simpsons Creek the lowland forest contains a significant stand of Eucalyptus tereticornis.
- * A small wetland (Brunswick Heads 547 458) near the western boundary is fringed with Melaleuca quinquenervia and has extensive stands of Cyperus exaltatus. Also present are Nymphoides indica, Phylidrum lanuginosum, Schoenoplectus mucronatus and Typha.
- * Another wetland to the south (550 347) is also fringed with paperbarks and contains some Cyperus exaltatus, Schoenoplectus sp. and Nymphaea capensis (introduced).
- * Vegetation along the track from Tyagarah across to the beach is extremely diverse. Wetland vegetation in the swales includes small patches of Lepironia articulata, Phragmites australis and Typha.
- * Simpsons Creek downstream of the airfield is a picturesque and undisturbed estuarine waterway with at least three types of mangroves, saltmarsh and tidal flats.

Significance

The significance of the area rests on a number of attributes:

- * The diversity of the area was mentioned by the National Parks and Wildlife Service (1982) as a justification for its nature conservation value. The fact that the diverse vegetation occurs in an uninterrupted sequence across a range of environments is also significant.
- * The area of paperbarks near the northern end must be given high value because of the associated littoral rainforest and other plants.
- * Area 9 contains the bulk of the Shire's wet and dry heath and may be significant for these broad vegetation types in a wider context. The botanical importance of the heathland is suggested by the fact that the Tyagarah area is renowned for the number of Callistemon species occurring there (Byron Shire Council 1981).
- * Simpsons Creek is a valuable estuarine waterway because of the role of estuaries in fisheries production (Section 8.1.4).
- * The two small wetlands south of the airfield are examples of a very restricted habitat type in Byron Shire.
- * Several rare bird species have been recorded in the area (BEACON 1981, Byron Shire Council 1981).

Past impacts

Disturbance to the area includes:

- * Sandmining of the foredune which has altered the vegetation, allowing weeds to become established, and changed the local topography.
- * Clearing to the west of Simpsons Creek has reduced the extent of Area 9 and narrowed the buffer strip for Simpsons Creek. On the eastern edge of Portion 152, Parish of Brunswick, extraction of material has occurred on the edge of the creek.
- * Sand extraction has proceeded to the edge of one of the small wetlands (Brunswick Heads 550 347) although the original banks are still generally intact.
- * Sewage effluent may be having an adverse effect on the ecology of the creek.
- * The extent of clearing on the coastal lowlands and in the upper catchment of Simpsons Creek indicates that some sedimentation must be occurring. About 10 per cent of the catchment has been classed as steep and 70 per cent undulating (Byron Shire Council 1981). Only 20 per cent of the catchment provides little erosion threat unless disturbance occurs close to the waterways.

Threats

- * Proposals to dedicate much of Area 9 as State Recreation Area or Reserve for public recreation could involve serious impacts on its natural values unless inappropriate uses are excluded and all uses carefully controlled. A detailed management plan will be necessary as a basis for any recreation area.
- * Any expansion of clearing in the catchment of Simpsons Creek will exacerbate sedimentation. Even a continuation of the current condition of the catchment will sustain levels of sediment movement well above those which occurred before clearing. Stream management measures such as vegetative buffer strips and sediment traps may be necessary for protection of Simpsons Creek in the long-term.

In particular, any urbanisation of the catchment or increase in small holdings will pose a major threat to the condition of the creek because of sediment movement and altered hydrology and water quality.

- * If development of the cleared area to the south of the sewage treatment works does proceed, adverse impacts might occur well beyond the construction area through changes in hydrology, water quality, sediment movement and general condition of Simpsons Creek unless strict control measures are taken.

- * While all the coastal strip will be affected by long-term coastal erosion to some extent, parts of Area 9 could be seriously affected if groynes are placed to protect the Belongil area. The groynes will reduce the sediment supply to the beach immediately to the north causing additional westward erosion (Department of Public Works 1978).
- * The expected increase in sewage effluent by over 30 per cent to 2001 could cause problems for the estuarine community.
- * Extension of sand extraction should be limited to protect the small wetland (Brunswick Heads 550 347) near Tyagarah.

AREA 10:

Description

Remnant area of paperbarks, Melaleuca quinquenervia.

Significance

No specific importance known but significant for reasons outlined in Section 8.1.3.

Past impacts

Clearing (before aerial photos taken 27.7.81) has separated Area 10 from the main expanse of coastal vegetation to the east. Recent clearing and draining (post aerial photos) has further contracted the area from the south and lowered the water table, perhaps excluding some native species and allowing weeds to establish. Isolation by clearing may also render the area inaccessible and unsuitable for some fauna.

Threats

Future clearing will eliminate the area or further reduce its size. More drainage will affect the long-term viability of the stand and change its species composition.

AREA 11:

Description

Remnant area of paperbarks and rainforest separated from coastal vegetation by clearing and a quarry.

Significance

General significance as for Area 10. In addition, the National Parks and Wildlife Service (1982) has identified Portion 162, Parish of Brunswick, as having conservation value, describing it as a remnant of lowland subtropical and littoral rainforest. Most of this portion is now cleared but further work is needed to establish the value of the remainder.

Past impacts

Clearing and drainage.

Threats

Further clearing and drainage.

AREA 12:

Description

Two remnants of paperbark forest.

Significance

As for Area 10.

Past impacts

Clearing and drainage.

Threats

Further clearing and drainage.

AREA 13:

Description

Two remnants of lowland forest, mainly paperbarks.

Significance

General significance as for Area 10. The National Parks and Wildlife Service (1982) have recorded a flying fox camp there, the significance of which has already been outlined. In addition, this area contains an extensive stand of Eucalyptus tereticornis dominated forest (S. Gilmore pers. comm.), examples of which are now uncommon in the Shire.

Past impacts

Clearing and drainage.

Threats

Further clearing and drainage.

AREA 14:

Description

A remnant of lowland forest, mainly paperbarks with some eucalypts.

Significance

General significance as for Area 10.

Past impacts

Clearing and grazing.

Threats

Further clearing and grazing.

AREA 15: Coastal vegetation west of Belongil Creek and north of the Ewingsdale Road.

Description

The area can be divided into three sections:

- * North of the railway line (Part A). This is the area adjoining the Globetrotters tourist development. It supports mainly coastal Banksia scrub and heath, littoral rainforest and paperbarks on the margins of the Belongil estuary.
- * South of the railway line and adjoining the industrial area (Part B). This was originally coastal scrub (Banksia and eucalypts) and heath but was cleared shortly before field work in January 1983. Vegetation remains only along drainage lines and roads. Young paperbarks still form a dense strip on the eastern end adjoining Part C.
- * The area south of the railway line adjoining Belongil Creek (Part C). There is some regrowth of Banksia and paperbarks after clearing many years ago.

Significance

The most significant part of Area 15, now that Part B has been cleared, is Part A, north of the railway line. This section contains littoral rainforest which is of high conservation value (see Section 8.1.4) and is a valuable physical and visual buffer for the Belongil estuary. Management of this area would aid regeneration of native species and remove exotics.

The margins of Part C are important as physical and visual buffers for Belongil Creek and should be managed as such. This will require some restoration of vegetation and ideally some earthmoving:

- * Mangroves, Juncus kraussii and Casuarina glauca should be planted or encouraged to grow (for example by providing a gently sloping shoreline) along the creek and the drain beside the railway line.
- * Banksia and other species from coastal dunes behind this lower zone, preferably on low sandy mounds.

Past impacts

Part A has been partly cleared and grazed and contains some exotic species including lantana, crepe myrtle and remnants of pasture. Part B has recently been cleared and supports no significant stands of vegetation. Part C has been highly altered for agriculture and subsequently crossed with a network of tracks.

Threats

It would be hard to envisage development in Part B which would further degrade natural values. However, during and after construction here care should be taken to minimise the erosion from this block and subsequent siltation in nearby streams or wetlands.

Development of Part C does not pose an environmental problem for the land itself but could have serious impacts on Belongil Creek unless management provides buffer zones (see above).

A proposal for low intensity development of Part A has been suggested and could even enhance the value of the area providing:

- * exotic species such as privet, crepe myrtle and lantana are removed;
- * no littoral rainforest is damaged;
- * areas of littoral rainforest are managed to allow regeneration and ensure survival in the long-term;
- * visitor use is managed to prevent damage to dune and estuarine vegetation.

A high intensity development would seriously detract from the high value (despite past alteration) of Part A and would impinge physically and visually on the tidal flats and saltmarsh of the Belongil estuary.

AREA 16: Swampy flats and heath between Skinners Shoot Road and the Ewingsdale Road.

Description

Five fragments of swamp forest, mainly paperbarks but with some Casuarina glauca, eucalypts and rainforest species. Just below the Ewingsdale Road is an area of dry heath, also fragmented by clearing.

Significance

The swamp forest areas dominated by Melaleuca quinquenervia have general values as outlined in Section 8.1.3. Some are significant for more specific reasons:

- * BEACON (1983) regard the swamp forest remnant on Portion 210, Parish of Byron, as important because of the dense understorey of rainforest species, mainly Bangalow palms.

- * The part of swamp forest adjoining forest on high ground beside the Skinners Shoot Road could be important because of the gradient of conditions there. For example, some plants may occur only within such a gradient and some fauna such as reptiles or frogs may need both habitats to be contiguous. The transition from swamp forest to high forest is now unusual in the Shire because of clearing.
- * The largest remnant of swamp forest is directly connected to Belongil Creek and could have important functions in regulating hydrology and water quality and providing organic detritus to drive the estuary's food chains. (These functions are discussed in more detail for Cumbebin Swamp, in Area 17.)
- * The areas of dry heath should not be allowed to degrade simply because they are small and fragmented. A botanical survey is necessary (as for Area 8) to determine their affinities with other heath in the Shire and their significance in a wider context.
- * BEACON (1983) has also pointed out that the golden mangrove fern occurs on the upper reaches of Belongil Creek. This plant is near its southern limit in Byron Shire which could contain a significant portion of the NSW population.

Past Impacts

The swamp forest has been fragmented, thinned, grazed and drained but the viability of at least the large area is undoubted. Because of the resilience of the dominant species even the small patches could survive and even expand in the long-term.

The dry heath area has also been fragmented, and some clearing occurred just before the field survey. The remaining heath has been disturbed by drainage works and tracks.

Clearing has been extended very close to the banks of the upper reaches of Belongil Creek and could have caused bank instability and sedimentation downstream. Vegetative buffer zones should be re-established.

Drainage may have led to an accelerated delivery of storm flows to the creek which could have worsened bank instability (see Area 17).

Threats

Further clearing and drainage of heath and swamp forest with possible repercussions on the Belongil Estuary.

AREA 17: Cumbebin Swamp - Belongil Creek and estuary.

Description

The report of BEACON (1981) on the Cumbebin Swamp system leaves little to add in the way of description for a brief study such as this although, as pointed out by BEACON, further detailed research is necessary as a basis for the protection and management of the area.

Significance

Only the major significant attributes of Area 17 are outlined here. More detail is provided by BEACON (1981):

- * The water quality of Belongil Creek is controlled largely because most of the catchment discharges through Cumbebin Swamp, swampy areas to the west and the Belongil Swamp area (Byron Shire Council 1981). Substantial areas of cleared country above the coastal plain and some urban development are in the Cumbebin catchment and could cause serious sedimentation, water pollution and hydrological impacts but for the presence of the Cumbebin Swamp. The swamp acts as a detention basin to attenuate storm flows and to filter the water which passes through.

Although further studies are needed, it is believed that urban run-off which by-passes the swamp and flows directly into Belongil Creek is of lower quality than that 'treated' in the swamp forest (BEACON 1981). According to Byron Shire Council (1981) there has been a marked increase in siltation and bank erosion in Belongil Creek, mainly due to increasing urbanisation, clearing and drainage. Such developments have altered the rate and quality of water entering the creek by reducing the role of swampland and other vegetation for detention and filtration of run-off.

- * The Belongil estuary, like all others on the coast, has significant natural and economic values.
- * Cumbebin Swamp and the Belongil estuary are a functional unit. Together they support an uninterrupted gradation of wetland communities. As well as regulating water flow and quality, Cumbebin Swamp provides organic detritus which drives some of the estuarine food chains.
- * Area 17 is significant for its avifauna. Several rare or uncommon species have been recorded, herons and royal spoonbills are known to nest in Cumbebin Swamp and the estuary is recognised for the diversity of wading birds which occur there.
- * Of particular significance is the Little Tern colony at the mouth of the Belongil. Although in late 1980 there were only 4 breeding pairs at this site, this was about 10 per cent of the total breeding population on the north coast at that time (Clancy undated a.). The same survey found only one nest at the Belongil but only 26 on the whole north coast. This information indicates that the colony, although small, is significant in a regional context.

Other information suggests a wider significance. Of the 59 colonies in NSW for which details are available, about half had four pairs or less (i.e. the size of the Belongil colony or smaller) (Morris 1979). The importance of the existing colonies is due both to their rarity and to the declining status of the Little Tern in

this State. Many previous breeding sites are no longer suitable due to coastal development and the breeding population has contracted sharply since the 1950's (Morris 1979).

- * Several interesting records of mammals have been made for the area. Of special note are the existence of a flying fox camp and the occurrence of the Blossom Bat in Cumbebin Swamp.

Past impacts

Adverse alterations to Area 17 include:

- * Deterioration of water quality in the Belongil with increasing agricultural, urban and industrial development in the catchments
- * Increased instability of the banks of Belongil Creek by clearing and development near the creek and by altered hydrology following clearing and construction in the catchment. This indicates the need for buffer strips along the whole length of the creek
- * Many factors have reduced the success of the Little Tern colony at the mouth of the Belongil. Artificial opening of the creek to the south-east of the colony has washed it away (Clancy, undated b) and other impacts include egg collection, recreation use of the beach, disturbance by dogs, sand mining and rough seas (Morris 1979, G. Clancy, pers. comm.).
- * Parts of Area 17 are probably not viable in the long-term because of drainage, grazing and other changes. For example, small areas east of Belongil Creek and south of the Ewingsdale Road (within dashed line) and remnant saltmarsh west of Skinners Shoot Road are probably declining.
- * Much of Cumbebin Swamp has been cleared for various purposes, including the supply of firewood for local industry. However, this historical alteration does not detract from its present values (see Section 8.1.1)
- * Collection of orchids in Cumbebin Swamp has reduced their populations there (Byron Shire Council 1981).
- * The garbage tip on the north-eastern side of Cumbebin Swamp contributes leachate and wind-blown rubbish to the area.
- * Clearing and urbanisation of the catchment has altered the hydrology of the system, probably reducing sustained run-off and seepage with possible effects on the wetland biota.
- * Clearing and filling of the swamp has reduced its values for flora and fauna and its functions in attenuating storm flows, filtering polluted water and providing organic detritus to the estuary.

- * Recent drainage of the swamp may have had significant effects on the ecology of the area by lowering the water table, reducing the duration of standing water and increasing the flood peak in Belongil Creek.

Threats

As well as a continuation and intensification of the impacts outlined above, there is at least one new development which threatens the integrity of the Cumbebin-Belongil system. Threats include:

- * Continuing impacts on the Little Tern colony. The persistence of the birds there may say something for the suitability of the site for breeding. The site has the two main attributes of a suitable breeding area (G. Clancy pers. comm.):
 - . proximity to a lagoon or creek;
 - . a sand base with shingle, wood, shells, etc. for camouflage (thick vegetation is unsuitable).

Measures necessary to maximise protection of the colony are sturdy fencing, signs and law enforcement to discourage egg collection. The nature of the problem is such that no amount of protection will ensure breeding success. For example, one loose dog could ruin the year's breeding in a few minutes. Nevertheless, breeding has been successful there in the past and can be again if the site is managed carefully. There may even be potential to expand the colony with appropriate management.

Protection of the colony should also involve a new approach to the management of the creek mouth since northward movement of the constructed channel has created problems in the past. For example, suitable stabilisation of the dunes to the west of the colony could eliminate the threat of erosion from the upper, natural channel, making the constructed channel unnecessary. Maintenance of the natural channel might also provide some protection for the colony from tourist development beyond the dunes.

- * Further clearing, filling and urbanisation of the catchment will increase the effects of sedimentation and altered hydrology and water quality on Cumbebin Swamp and Belongil Creek.
- * Further reductions in the size of Cumbebin Swamp could reduce its natural values proportionately. On the other hand, beyond a certain undefined limit, further reductions in the swamp area could cause a disproportionate acceleration of its degradation. For example, the long-term viability of less mobile fauna may reach a critical level when the swamp has been reduced by a further given amount. Also, beyond a certain ratio of cleared and urbanised area to swamp area, the protection provided by the swamp for Belongil Creek may decline rapidly. Clearly, there are many unsolved problems in the development of wetlands.

Further clearing of the swamp may also affect areas which have special faunal values such as the flying fox camp. BEACON (1981) has mentioned the importance of southern parts of the swamp and fringing eucalypts for koalas and this feature needs to be investigated further.

- * The recently constructed drain may have long-term adverse effects unless blocked or carefully managed. There is an urgent need to investigate the possible impacts of the drain and its potential for management of the swamp.
- * A road by-pass through the swamp has been suggested and could have a number of impacts besides eliminating habitat. These include:
 - . sedimentation from fill;
 - . altered hydrology unless culverts allow freedom of water movement;
 - . effects on fauna such as mortality on the road and isolation on either side;
 - . increased risk of fire during dry conditions;
 - . encouragement of commercial and other developments which would extend these impacts;
 - . degradation of isolated parts of the swamp which might be seen as justification for developing them.

AREA 18: Remnant wetland in Byron Bay.

Description

Dominated by paperbarks and Phragmites australis which extends eastwards from the road in a dense stand.

Significance

The area's small size, disturbance and nearness to development indicate that it has little long-term conservation value.

Past impacts

The wetland has been drained and supports a wide variety of weed species. There is an infestation of bitou bush on dune remnants on the northern side.

Threats

Continuation and extension of current problems.

AREA 19**Dune swamps and heath south of Byron Head.**Description

The area contains a diverse collection of swamps:

- A. Wet heath with paperbarks and Gahnia sp.
- B. Wet heath.
- C. Now wet heath with some Lepironia articulata.
- D. The Cibum Margil Swamp: Described in Byron Shire Council (1981) as a perched dunal swamp, probably perched on clay derived from the surrounding hills and on organic material. The vegetation is almost entirely Lepironia articulata.
- E. A pond (probably man made) covered by floating Nymphaea capensis and lined with Phragmites australis and Eleocharis sphacelata.

Small paperbarks are scattered around swamps and wet heath and in other low points through the dunes.

The area also contains dry heath, the floristics of which are unknown and should be investigated.

Significance

Both wet and dry heath areas need botanical assessment before their significance can be determined.

The Cibum Margil Swamp is highly significant in a local context and possibly more widely as the only Lepironia swamp on the Shire's coastal strip. Although Lepironia occurs sparsely through the dune areas of the Shire this is the only example of the monospecific stand in a specialised habitat and warranting inclusion in Goodrick's (1970) category.

The small pond (E) is also an unusual habitat type in the Shire, regardless of its origins.

The whole area includes a diverse range of intergrading habitats which is desirable to preserve.

Past impacts

Sand mining has altered the topography of the area and possibly the distribution of wetlands. The area, in common with most of the coast in this Shire, has a highly disturbed foredune following sand mining which is infested with lantana and other exotics.

Some sedimentation of the Cibum Margil Swamp has no doubt resulted from clearing of the adjacent steep slopes.

Threats

The likelihood of further sedimentation of the Cibum Margil Swamp indicates that all disturbed areas in its catchment should be stabilised and a buffer of dense vegetation established around its perimeter.

Further disturbance of heathland should be prevented by blocking the remaining vehicle tracks through the area and stabilising them.

AREA 20: Tallow Creek and surrounds.

Description

Tallow Creek is an estuarine inlet open to limited tidal flushing. It is fringed with dense stands of Phragmites australis and, on the eastern side, Juncus kraussii. To the south and south-west paperbarks and wet heath grow between the creek and the surrounding dry dune vegetation.

The creek's catchment is small - only 2.7 square kilometres according to Bell and Edwards (1980). The catchment consists mainly of the relatively flat coastal plain but includes part of the steep escarpment and foothills (Byron Shire Council 1981).

To the west and north of the creek entrance is an area of heathland.

Significance

The creek is a fisheries resource and the surrounding vegetation provides detritus for the estuarine food chain. The report by Byron Shire Council (1981) comments on the diversity of migratory waders observed on the tidal flats.

The most significant feature of the area is the heathland, on Portion 71, Parish of Byron, described by the National Parks and Wildlife Service (1972) as "dry heath with the only population of Strangea linearis in New South Wales".

Past impacts

Sewage effluent from the largest treatment works in the Shire discharges directly into the inlet and although the Department of Public Works found no pollution problems from this input (Byron Shire Council 1981) an examination of the estuarine biota might indicate to the contrary.

The potential for run-off from the steep country of the upper catchment to cause sedimentation of the creek has been recognised (Byron Shire Council 1981) and only land use controls and possibly sediment traps on drainage lines will prevent this. Council's report has also recognised the need for a stabilised waterway to carry storm flows. A particular problem could be posed by a quarry on the creek draining steep land to the west.

The area of heathland has been heavily disturbed by extraction and many tracks, most of which are superfluous. This does not, however, diminish its value for the protection of Strangea linearis, but highlights the urgency for adequate management of the site.

Sand mining has affected the dune areas of Area 20 and has altered the shape of Tallow Creek.

Threats

The population growth in the catchment of the sewage treatment works on the creek is 4.7 per cent per annum to 2001 when output will have increased 2.5 times. The likely replacement of the treatment works here by one further west (Byron Shire Council 1982) will avoid the serious pollution of the creek at that time (although the problem may be transferred elsewhere depending on the future strategy for disposal of effluent).

Further clearing in the catchment will exacerbate storm surge effects and sedimentation in the creek. Development in the catchment should be minimised and drainage lines should be protected.

Development of Portion 71 will have serious consequences for the rare heath plant in that area. Areas not destroyed by construction will suffer from increased vehicle and pedestrian traffic, fire and other indirect effects. Given the importance of the area, the proposed school should be relocated to one of many sites with little remaining natural values. A botanical survey will be necessary to determine the extent and requirements of Strangea linearis.

AREA 21: Taylor Lake and surrounds.

Description

Taylor Lake is botanically a very diverse wetland. It is lined with dense Phragmites australis on the eastern side and Cladium procerum on the western side. A number of other species were also common during the field survey: Juncus kraussii, Bacopa manniera, Schoenoplectus validus, Isolepis nodosa, Melaleuca quinquenervia, Baumea juncea, Zoysia macrantha, Triglochin striata, Typha and Azolia. In addition, Timms (1977b) has recorded Cyperus laevigatus, Sporobolus sp. and the mangrove fern, Acrostichum speciosum.

Average salinity of the lake is about 5 parts per thousand (Timms 1977b) and its catchment is small, only about 2 square kilometres, of which 30 per cent is steep land (Byron Shire Council 1981). The level of the lake entrance indicates infrequent flushing by seawater.

Surrounding the lake is a mixture of coastal vegetation including paperbarks, eucalypts, heath, Banksia scrub and littoral rainforest just north of the Broken Head Road.

Significance

According to Timms (1977b) the lake in its present condition is not an unusual type although in its original condition (see below) it would have been. Nevertheless, it is the only dune lake in Byron Shire and so has considerable local importance. Due to its largely unaltered catchment it is also in very good condition.

Area 21 as a whole contains a rich variety of vegetation types which intergrade with changes in elevation and other factors.

Littoral rainforest in this area occurs on both sides of the Broken Head Road. It is outside the Broken Head Nature Reserve, and therefore in need of protection, and contains two very uncommon species: Euodia littoralis which is only known from Broken Head and Brunswick Heads in NSW and Exocarpus latifolius which occurs only from Ballina northwards (A. Floyd pers. comm.).

An area of Eucalyptus signata with heath understorey near the lake has been identified by Byron Shire Council (1981) as having high conservation value. The same report and that of BEACON (1983) point out that the rare mosaic-tailed rat has been recorded from wet heath in the area.

Past impacts

Sand mining has had a significant effect on the area. The frontal dune separating the lake from the ocean was mined for mineral sands in 1960, 1963 and 1965-66 (Timms 1977b). Timms notes that the dune was stabilised and revegetated but has since eroded, particularly around the lake entrance, changing the salinity regime from either of two previous situations, both of which are uncommon on the east coast.

Threats

High intensity development for the northern part of Area 21, immediately above Taylor Lake, is a possibility. Previous environmental assessments for such development have not considered the ecology of the lake area in detail nor have they looked at all the possible impacts of all its aspects.

Concern should not be given only to the presence or absence of rare species on the immediate development site.

Significant impacts of the proposal on the area as a whole would include:

- * Elimination of the vegetative buffer zone between the lake and nearby development which is the main reason for the lake's good condition. Taylor Lake is in fact the only expanse of enclosed or flowing water in the Shire without clearing or development on its margins.
- * Sedimentation of the northern section of the lake from construction areas and other soil disturbance, during and after construction.

- * Human disturbance of natural vegetation in the lake's catchment, including increased fire risk.
- * Human disturbance of the lake itself. It would be naive to expect the lake to retain its natural values for long with a large adjacent population seeking water-based recreation, regardless of the facilities provided with the development.

A low intensity development has been proposed for the southern part of Area 21, just to the north of the Broken Head Road. The main constraints on this development should be:

- * most importantly, that it does not damage littoral rainforest in the area either directly during construction or indirectly through visitor and resident use of the site;
- * that there are no significant direct or indirect impacts on Taylor Lake.

AREA 22: Small area south-west of Broken Head.

Description

Information on this area is based solely on submissions by the National Parks and Wildlife Service (1982) and BEACON (1983).

Small area of swamp forest with rainforest elements and a flying fox camp.

Significance

The flying fox camp must be regarded as significant in the context of the north coast.

Past impacts

Unknown.

Threats

Unknown.

AREA 23: Low-lying areas south of Jews Point.

Description

Area 23 refers to a pocket of littoral rainforest and other coastal species at the eastern end of Portion 70, Parish of Newrybar, and an area of dry heath and paperbarks to the south.

Significance

The patch of littoral rainforest is of great importance. On the triangular portion across the track from Portion 70 the rainforest includes three specimens of *Acronychia littoralis* (m.s.) (R. Maslen, A. Floyd pers. comm.), the significance and rareness of which have already been outlined (Area 3). Two other specimens are within Portion 70.

The National Parks and Wildlife Service (1982) has also recorded regenerating Coastal Cypress Pine in this area.

The importance of the heathland here, as in other areas, needs to be established with a thorough botanical survey.

Past impacts

The littoral rainforest has been damaged by campers so that management of the site is urgently needed.

Threats

Further deterioration of the littoral rainforest.

8.1.6 Conservation Priorities

One of the tasks of this survey was to place conservation priorities on natural communities along the coastal strip. These have been outlined below but need to be prefaced with the following comments:

- * This study has done little to widen our knowledge of the ways in which these communities function and of how significant they are in the local, regional or State contexts. This information will only come from further work in the Shire and elsewhere.

We are therefore attempting to manage and plan for systems which we know little about. This should lead to a very cautious approach to future coastal development in Byron Shire and elsewhere. An example of the serious effects of unplanned development is the inadvertent destruction of much of the known population of a rare rainforest tree at Brunswick Heads (Section 8.1.4, Area 3).

- * Many extensive parts of the Shire have had their natural values removed, including some close to the coast. It is obviously environmentally more sound to develop these rather than the remaining natural areas, all of which have some conservation value.

- * Much of the degradation of coastal areas has happened incrementally. Decision-makers often feel that isolated or small natural areas are insignificant. However, the degradation of coastal communities will never stop while this philosophy prevails. The time to stop the destruction of coastal communities is obviously now.

With those points in mind areas have been allocated to one of four categories for protection. As the systematic recording of relevant attributes for evaluation was beyond the scope of this study, the allocation is highly subjective. Further work is needed to confirm some allocations.

The four categories are:

1. **Protection essential:** This category is reserved for areas with very rare or endangered species or areas which are important in a State context. No further development should occur and protective management should be undertaken.
2. **Protection important:** These are areas which are significant in a local or regional context because of uncommon features, high diversity, high productivity etc. This category includes all of the Shire's estuaries.
3. **Protection desirable:** Areas without special significance but with natural values which should ideally be retained.
4. **Protection unwarranted:** Highly altered areas with little or no prospects of rehabilitation.

Protection Essential

Area 1: area of littoral rainforest on Portion 358 with endangered species.

Area 3: remaining specimens of Acronychia littoralis and all efforts should be made to reserve or protect the whole block for regeneration of this species.

Area 4

Area 5: western bank of Brunswick River and a buffer zone to protect Acacia bakeri.

Area 20: heathland with Strangea linearis (survey needed to confirm extent and requirements of this species).

Area 21: littoral rainforest on either side of the Broken Head Road with rare species.

Area 23: littoral rainforest containing Acronychia littoralis.

Protection Important

Area 1:

- * area of undisturbed paperbarks (Area C on Figure 13);
- * flying fox camp and appropriate buffer;
- * patch of Callitris columellaris (Area A on Figure 13);

(Further work needed to define more precise boundaries for these areas)

Area 2: all areas south of the New Brighton Road

Area 5: whole of area apart from western bank and buffer zone.

Area 6

Area 7: parts A and C.

Area 8

Area 9

Area 11: (pending survey to establish value of remainder after clearing)

Area 13

Area 15: part A.

Area 16:

* remnant with Bangalow Palms on Portion 210 (pending botanical survey to confirm significance);

* upper reaches of Belongil Creek and buffers.

Area 17: except for part within dashed line.

Area 19

Area 20: Tallow Creek and wetland and wet heath in the immediate vicinity.

Area 21: except for littoral rainforest near Broken Head.

Area 22

Area 23: except for littoral rainforest with Acronychia littoralis.

Protection Desirable

Area 1: remainder after allocation of parts to high priorities.

Area 2: parts north of the New Brighton Road.

Area 10

Area 12

Area 14

Area 17: part within dashed line (pending further work to establish long-term viability).

Area 20: except for Strangea linearis heathland and the immediate surrounds of Tallow Creek.

Protection Unwarranted

Area 7: part B.

Area 15: parts B and C (but note that an estuarine buffer is needed on the eastern side of C).

Area 18

8.1.7 Future Planning for Coastal Communities

Mitigation of the impacts of development

There are a variety of ways in which the impacts of existing and future developments can be minimised. Some general comments are made in Table 8.1 below, but the appropriate protection measures for specific areas will need to be discussed with various experts such as those in the Soil Conservation Service, State Fisheries, National Parks and Wildlife Service, State Pollution Control Commission, Department of Environment and Planning and with environmental consultants and local naturalists.

8.1.8 Wetland Management

There is great potential for management of wetlands in Byron Shire to enhance habitat values and to encourage tourist and general recreational use. The walkway proposals for Cumbebin Swamp by BEACON are a good example of the latter use. Other possibilities include:

- * management of water levels to benefit flora and fauna (for example, via the drain through Cumbebin Swamp);
- * diversification of habitat by clearing, excavation, filling, etc. to provide interspersions of many vegetation types and open water;
- * replanting of edges of wetlands to benefit fauna.

The shortage of fresh marshes in Byron Shire has already been mentioned. New fresh wetlands could be created in the Shire as a by-product of activities such as sand extraction if appropriate extractive sites are used (ideally areas whose natural values have been eliminated) and if the borrow pits are managed to maximise biological values.

Wetlands could also be created to function as sites for sewage treatment. The concept has received much attention in Australia and has met with success overseas. Australian researchers include Peter Cullen at the Canberra College of Advanced Education and Ian Lawrence at the National Capital Development Commission. There is a great deal of overseas literature. One recent review paper is Sloey *et al.* (1978) (copy sent to Council) which lists many other references on nutrient assimilation in wetlands.

Table 8.1: Mitigation of the Impacts of Development

Impacts	Mitigation
<u>Clearing of Vegetation</u>	
Elimination of communities (especially serious when uncommon species or pristine areas are involved).	Minimise or avoid by developing areas already disturbed or without natural values. Re-establish impacted communities.
Reduction of areas below those needed for viable faunal populations.	Minimise. Maintain links of natural vegetation between natural areas.
Interruption of movement corridors.	As above. Re-establish corridors.
Exposure of littoral rainforest to salt spray (in some cases even clearing of lantana and other weeds can damage littoral rainforest if salt spray enters below the canopy).	Retain or replace vegetative buffers. Replace lantana and other weeds with saline fencing or encourage native buffers.
Loss of wetland buffer zones* - sedimentation, loss of marginal flora and fauna, visual impacts, increased disturbance to fauna	Retain or re-establish.*
Reduction of wetland functions in attenuating peak flows and filtering pollutants - additional pollution and erosion in estuarine areas.	Minimise or avoid. If possible replace with new detention/filter basis as recommended by BEACON.
Reduction of detritus supply to estuaries with possible reductions in productivity.	Minimise or avoid.
Isolation of wetlands from high ground communities - elimination of some fauna.	Minimise or avoid. Re-establish links.
Exposure of erodible surfaces - loss of soil and sedimentation.	Stabilise quickly and take measures to prevent movement of sediment from site.
Facilitation of weed growth.	Re-establish native plants on exposed soil and on edges.

* The importance of buffer zones for aquatic habitats is widely recognised but the width of zones are difficult to quantify because the degree of protection needed depends on factors such as topography, type of vegetation, adjacent land uses etc. An arbitrary (but probably necessary) figure of 100 metres has been suggested for the Brunswick River (Section 8.1.5, Area 5). For estuarine areas 50 metres might be adequate and 20 metres could suffice for fresh wetlands on flat country. Obviously, the effectiveness of the buffer needs to be monitored and changes made accordingly.

Buffers should be dense fringes of native vegetation. In the case of estuaries the buffer should extend above the Juncus and Casuarina zones. Around estuarine areas such as Belongil Creek there would be value in constructing sandy mounds behind the estuarine vegetation and establishing coastal scrub species on these. The mounds would enhance the visual and physical buffering of the vegetation. Care would be necessary to prevent sediment from the mounds moving onto estuarine vegetation.

Table 8.1: Mitigation of the Impacts of Development (cont'd)

Impacts	Mitigation
<u>Recreation Use of Natural Areas</u>	
Off-road vehicles, trampling, firewood collection, boating, etc. - damage to plant communities, erosion, introduction of weeds, increased fire risk, littering.	Careful management to control access, extent, levels and types of uses. Foster understanding of natural areas and their fragility.
<u>Urbanisation</u>	
Increased run-off leading to higher peak flows and subsequent erosion and sedimentation	Water detention structures, careful planning of drainage system.
Septic seepage, leaks and overflows from sewerage network.	Phase out septics, upgrade systems to cope with peak volumes.
Sewage outfalls (difficult to generalise on impacts but effects include algal blooms, eutrophication, reduced species diversity. Possibly positive effects in some cases at certain levels of outflow).	Ocean outfalls, natural processing in wetlands (see Section 8.6.2).
Erosion and sedimentation* - impacts on aquatic and terrestrial communities.	Employ and enforce control measures detailed by the Soil Conservation Service.
Use of fill to develop flood-prone areas - elimination of wetlands, sedimentation from fill batters, damage due to extraction of fill material.	Minimise or avoid. Stabilise fill batters. Manage extraction areas as wetland or other habitat.
Other off-site impacts, eg. visitor and resident pressure on adjacent areas.	Careful management of adjacent uses. Separate dense populations widely from sensitive communities.
<u>Agriculture</u>	
Erosion and sedimentation.	Control level and types of uses. Protect stream banks.
Clearing of catchments - altered flood patterns, reduced sustained flow.	Whole catchment management.
<u>Dredging</u>	
Elimination of aquatic flora and fauna and prevention of recolonisation due to depth and turbidity, downstream effects from disturbed sediment.	Minimise, avoid.
<u>Canal Estates</u>	
Variety of impacts on water quality, flora and fauna.	See guidelines by State Fisheries.

* Sedimentation due to urbanisation, including road construction, is a widespread environmental problem. Although control measures have been known for decades these are seldom rigorously employed or enforced.

8.1.9 Further Work Needed

As mentioned previously, this study provides only a compilation of existing information on coastal communities and there are still many gaps in the information needed as a basis for sound environmental planning in Byron Shire. Much of this information can only be obtained by research in a broad context but there are a number of studies needed within the Shire before the coastal areas can be effectively protected and managed. (In constructing the list below it was assumed that all future developments will be based on comprehensive surveys of the areas involved.)

Further work of a specific nature includes:

- Area 1:** Definition of boundaries of areas rated as important for protection.
- Area 3:** Possibility of re-establishing other individuals of Acronychia littoralis and the possible importance of the site for this species.
- Area 5:** Delineation of the distribution of Acacia bakeri and identification of management requirements.
- Area 11:** Importance of the patch of vegetation remaining after recent clearing.
- Area 16:** Significance of the swamp forest remnant with Bangalow Palms.
- Area 17:** Plans for wetland management; research into impacts of recent drainage; potential to protect and manage the Little Tern colony; importance of southern areas for koalas; viability of altered areas (within dashed line)
- Area 20:** Delineation of the extent of Strangea linearis and identification of management needs.
- Area 21:** Delineation of littoral rainforest on the Broken Head road and identification of management needs.
- Area 23:** Requirements for management and, if possible, further establishment of Acronychia littoralis.

Some of the more general studies needed in the Shire are:

- * Botanical surveys of heathland to identify types present and their regional and State significance.
- * Studies of estuarine communities including the effects of sewage, the needs for protection and management and the significance of the estuarine biota.
- * A survey of littoral rainforest in the Shire, species present and needs for protection and management.

8.2 Other Areas of Environmental Importance

The National Parks and Wildlife Service has provided Council with information on areas within the Shire which have nature conservation value. These areas are shown on Figure 14. Areas of conservation value falling within the coastal wetlands and associated communities have been appraised above in Section 8.1.

Inland areas of conservation values are described in Table 8.2. This table was compiled by the National Parks and Wildlife Service based on published and unpublished information and are examples of the major vegetation structural types found in the Shire (see Table 8.3).

According to the National Parks and Wildlife Service, each of the above vegetation structural types or habitats has a particular group of plants and animals restricted to it. Others are widespread in more than one type and some are dependent on different types for various resources, e.g. treed areas are used for nesting by egrets and lorikeets which may obtain food in wetlands and heathlands respectively.

The value of these habitats is seen by the Service to lie largely in the fact that a very high proportion of Byron Shire's native vegetation has been destroyed means that locally the remaining remnants are very important. Also, its location within the State of NSW, nearness to the sea and climate means that plants and animals with a more typically tropical distribution approach the edge of their range here, e.g. the Bush Hen, White-eared Flycatcher, Little Bronze Cuckoo.

Many lowland subtropical rainforest plants reach their southernmost occurrence in the lower Richmond Valley (Floyd 1961 to 1982) (Williams 1979), and some are restricted to the northern rivers. Thus Byron Shire contains a significant number of their remaining population, e.g. Syzygium moorei, Coolamon; Floydia praelta, Ball Nut; Endiandra globosa, Black Walnut; Endiandra compressa, Whitebark; Cryptocarya foetida, Stinking Cryptocarya; Davidsonia sp. and Acronychia littoralis.

According to the Service, any remnants of lowland subtropical rainforest are of State-wide significance (National Parks and Wildlife Service 1981).

The significance of these habitats to wildlife is also noted by the National Parks and Wildlife Service, given that over 200 bird species have been recorded within Byron Shire and 45 of these have been assessed by Morris et al. 1981 as being Rare, Uncommon or Scarce (see Table 8.4).

Table 8.2: Inland Areas of Environmental Significance

Reference Number	Area and Location	Cadastral Information	Significance
1.	20 ha. Eureka	Jonston's Scrub Park Portion 15, Parish of Clunes.	Largest sample of the big Scrub remaining with 85 tree species.
2.	13 ha. Booyong.	Booyong Scrub Reserves R62153, R62154.	Subtropical rainforest on alluvial soil.
3.	4.25 ha. Nashua.	Emery's Scrub.	Subtropical rainforest with rare species.
5.	50 ha. Goonengerry.	Part Portion 18, Parish of Jasper Part Portion 39, Parish of Mullumbimby	Wet and dry sclerophyll forest with a few rainforest species and a wedge-tailed eagle's nest.
6.	400 ha. Goonengerry	BGF Forest and surrounding Portion including 8, 9, 29, 30, 56, 75, 87, 88, 90, 91 Parish of Jasper.	Dry and Wet sclerophyll forest. Rich mammal fauna including koalas, greater gliders and pademelon wallabies.
7.	200 ha. Upper Coopers Creek	Wanganui Gorge Parts Portion 8, 30, 29, Parish of Tooland, Parts Portion 91, 90, 75, 87, 65 Parish Jasper.	Remnant subtropical rainforest along Coopers Creek and isolated patches surrounded by <u>Lantana</u> shrubland. Many Albert's Lyrebirds.
8.	40 ha. Coorabell	Banks of Wilson's River including parts of Portion 21, 25, 28, 29, 27, 63, 70 and the 20 metre riverbank reserve for catchment protection.	Subtropical rainforest and regrowth. Platypus are frequently seen in the river and the vegetated banks provide a corridor for the movement of fauna between the hills and the lower flood plain.
9.	300 ha. Upper Wilson's Creek	Parts Portion 1, 3, 24, 62, Parish of Tooland.	Rich assemblage of remnant and regrowth rainforest.
10.	50 ha. Upper Cooper's Creek.	Snow's Gully Parts Portion 81, 91, Parish of Jasper.	Rainforest and wet sclerophyll forest. White-eared fly-catcher, marbled frogmouth.
15.	3 ha. Bangalow/Byron Bay area.	Eastock Wildlife Refuge Lots 4/5 DP577728.	Subtropical rainforest remnant.
16.	4.5 ha. Bangalow/Byron Road.	Hayters Hill East Wildlife Refuge Lot 1, DP5034.	Rare easterly remnant of dry rainforest.
22.	Montecollum	Part Portion 98, Parish of Mullumbimby	Subtropical rainforest with some dry rainforest species.
23.	4 ha. Clunes	Morton's Scrub Lot 1, DP517776.	Remnant of lowland subtropical rainforest.
24.	Montecollum	Part Portion 99, Parish of Brunswick.	Remnant of lowland subtropical rainforest.
28.	Broken Head 3 ha.	Part Portion 2, Parish of Byron	Swamp forest and rainforest elements and a flying fox camp.
30.	Hilan's Corner 100 ha.	Parts Portion 216, 6, 102 and 98 Parish of Billinudgel.	Mixed Brushbox forest and subtropical rainforest.
31.	Durrumbul 80 ha.	Parts Portion 1212, 1232, 125 and 91, Parish of Mullumbimby.	Dry and wet sclerophyll with warm temperate and subtropical rainforest species, including large Red Cedar.
32.	Goonengerry 20 ha.	Berangery Grass travelling Stock Reserve.	Unique grassy dry sclerophyll and wet sclerophyll forest growing on perlite. This geological substratum and vegetation is not common in the Shire. Has koalas, red-necked wallabies, and is the only locality in the Shire from which the insectivorous marsupial <u>Antechinus swainsonii</u> is known.

Table 8.3: Vegetation Structural Types or Habitats in Byron Shire

Structural Type	Sub-Type	Dominant Species
Closed Forest or Rainforest	Dry subtropical littoral regrowth	Hoop pine, white booyong, lilly pilly, red kamala.
Tall open forest or wet sclerophyll		Brushbox, flooded gum, Tallowwood, turpentine
Open forest	Dry sclerophyll	Pink bloodwood, ironbark blackbutt
	Swamp forest	Broad-leaved paperbark swamp oak, swamp turpentine swamp mahogany
Low open forest	Mangroves	Grey mangrove
	Frontal dune	Coastal banksia
Woodland		Coast cypress pine, forest red gum, scribbly gum, horsetail oak.
Shrubland	Dry heath	Wallum banksia
	Wet heath	Heath-leaved banksia
	Mangrove	River mangrove
	Weed thickets	<u>Lantana</u> and Bitou bush
Grassland	Headlands	Kangaroo grass

Source: National Parks and Wildlife Service

Table 8.4: Birds in Byron Shire, Recorded as Scarce, Uncommon or Rare by Morris et al., 1981

Eastern Reef Egret	Scarce
Mangrove Heron	Uncommon
Little Bittern	Uncommon
Black Bittern	Uncommon
Black-necked Stork (Jabiru)	Rare
Magpie Goose	Irregular visitor
Osprey	Rare
Crested Hawk	Scarce?
Brahminy Kite	Scarce
Grey Goshawk	Uncommon
White-bellied Sea Eagle	Uncommon
Bush-hen	Scarce?
Brolga	Scarce
Comb-crested Jacana	Uncommon
Beach Stone-Curlew	Rare
Pied Oystercatcher	Scarce
Sooty Oystercatcher	Scarce
Ruddy Turnstone	Uncommon
Eastern Curlew	Uncommon
Whimbrel	Uncommon
Little Curlew	Rare
Grey-tailed Tattler	Uncommon
Common Sandpiper	Scarce
Bar-tailed Godwit	Uncommon
Buff-breasted Sandpiper	Very rare
Peregrine Falcon	Uncommon
Red-backed Button Quail	Uncommon
Kelp Gull	Rare
Gull-billed Tern	Uncommon
Caspian Tern	Uncommon
Little Tern (breeding population declining)	Moderately common
White Tern	Very rare vagrant
Superb Fruit Dove	Scarce
Swift Parrot	Moderately common/scarce
Little Bronze-Cuckoo	Scarce
Channel-billed Cuckoo	Uncommon
Eastern Grass Owl	Scarce
Forest Kingfisher	Uncommon
Noisy Pitta	Uncommon
Albert's Lyrebird	Uncommon
Barred Cuckoo-shrike	Scarce
White-eared Monarch	Scarce?
Mangrove Warbler	Uncommon
Mangrove Honeyeater	Rare
Nutmeg Mannikin	Uncommon

Source: National Parks and Wildlife Service

"Many migratory birds from higher elevations on the adjacent ranges and tablelands and higher latitudes move to the area over winter and thus a reduction in the area of various habitat types within Byron Shire may well have consequence for a much larger area of the country. Many species from the higher elevation rainforest largely National Park and State Forest move down to low elevation remnants and regrowth during winter including the Noisy Pitta, Rose Robin, Spangled Drongo, Varied Triller, Eastern Spinebill, Topknot Pigeon, White's Thrush, Golden Whistler, Satin Bowerbird, Pied Currawong and Rufous Fantail. Rufous Whistlers move down from higher elevation open forests, as do the Yellow-faced Honeyeater, Red Wattlebird and Silvereye. Other species that typically depart from south-eastern Australia over winter remain including Rainbow Bee-eaters, Sacred Kingfisher, White-throated Warbler, Grey Fantail, Fantail Cuckoo, Shining Bronze Cuckoo.

Other intercontinental migrants arrive during summer. They are principally wading birds dependent on tidal flats in the estuaries for feeding grounds. They include Stints, Sandpipers, Tattlers, Plovers, Curlew, Knots etc.

There is a general influx of ducks and ibis over winter and spring as water further inland dries up.

Some species move around locally in response to the varying flowering and fruiting seasons of different plants, with honeyeaters and lorikeets being prominent in this regard." (See Table 8.5)

Thus in the opinion of the Service, to cater for the food requirements of these species throughout the year and to help in the pollination of the plants it is necessary to reserve samples of all vegetation types.

8.3 Planning Implications

It is clear that there are significant areas of the Shire which warrant environmental protection of various degrees.

There are several methods of achieving this protection, and several governmental or semi-governmental authorities have powers under various Acts to initiate preservation or conservation controls.

The Heritage Council of NSW is responsible for the protection of buildings, works, relics or places of scientific, cultural, social, archaeological, architectural, historical and natural significance.

On July 23rd, 1982, Interim Conservation Order No. 260 was placed by the Minister for Environment and Planning on land adjoining Rajah Road, Ocean Shores, near Brunswick Heads. It was considered that this area warranted protection under the Heritage Act, 1977, because it has on it a specimen of a very rare species of rainforest tree. The seven metre high tree is the largest known specimen of a total known population of more than 20 trees.

Table 8.5: Flowering Seasons of Major Nectar Bearing Plants within Byron Shire

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Pink Bloodwood	O	O	O									O
Beach Acronychia		O	O									
Blackbutt		O	O	O								
Red Bloodwood		O	O									
Flooded Gum		O	O	O	O							
Broad-leaved Paperbark	O	O	O	O	O	O						
Wallum Banksia		O	O	O	O	O	O	O				
Swamp Banksia			O	O	O	O						
Blue Fig			O	O	O	O						
Coastal Banksia			O	O	O	O	O	O	O			
Heath-leaved Banksia			O	O	O	O	O					
Tallowwood						O	O	O	O	O	O	
Scribbly Gum							O	O	O			
Ironbark								O	O	O		
Swamp Mahogany								O				
Red Mahogany								O				
Forest Red Gum								O	O	O		
Turpentine										O		
Willow Bottlebrush									O	O		
Silky Oak										O		
Grass Trees												O
Black Bean												O
Swamp Bottlebrush	O	O	O	O	O	O	O	O	O	O	O	O
Grey Mangrove				O	O	O	O	O	O			
River Mangrove									O	O		

Source: National Parks and Wildlife Service

Consistent with the objects of the National Trust of Australia (NSW) Act, 1960, the Trust has a special interest in the conservation of landscapes which it recognises as having heritage value for future generations as well as for the present community.

Landscapes are classified in the Trust Register as Landscape Conservation Areas if, in the Trust's view, they satisfy the criteria for classification.

The landscapes investigated by the Trust may be grouped into two broad categories - 'Natural' and 'Man-Modified'. The former are, as the name implies, predominantly natural in character; the latter modified by pastoral, agricultural or other development.

Natural areas identified as being worthy of classification are usually recommended for acquisition (if required) and management and protection by an appropriate authority.

Man-modified landscapes identified as being worthy of classification are usually recommended for protection by appropriate zonings under local environmental plans.

To date, the Trust has not classified any landscapes within Byron Shire. The Trust's landscape surveys have so far been completed for the Illawarra, Sydney and Hunter Regions. It is intended to extend the scope of such landscape surveys to include the North Coast Region.

However, several natural areas of interest to the Trust were revealed as a result of the recently completed Coastal Headlands Study which was undertaken by the Trust with the assistance of a grant from the Coastal Council of NSW. These included Brunswick Heads to North Head, Broken Head and Cape Byron Headland. The Belongil/Cumbebin wetlands were also noted to be of interest. As a result of these investigations, the Trust recommended:

- * Protection of the Brunswick Heads and North Head by appropriate Environmental Protection Zones pending dedication as a Nature Reserve under the National Parks and Wildlife Act, 1974.
- * Planting of salt tolerant shrubs on both the eastern and western sides of the road leading to the Broken Head caravan park.
- * Instigation of appropriate management procedures to ensure the protection of the distinctive vegetation of the Cape Byron area, and in particular, the cycad.
- * Protection of the Belongil/Cumbebin Wetland System by appropriate local environmental zonings.

The National Parks and Wildlife Service has also made various recommendations in relation to the protection of the areas of significance which it has identified. These are all contained within the Rural Environmental Protection 7 Zone as outlined in Department of Environment and Planning Circular No. 13, comprised of the following elements:

- 7(a) Wetlands
- 7(b) Estuarine Wetlands
- 7(c) Water Catchment Areas
- 7(d) Scenic
- 7(e) Escarpment
- 7(f) Foreshore Protection
- 7(g) Archaeological Sites
- 7(h) Historic Site
- 7(i) Scientific
- 7(j) Wildlife Refuge

The appropriate recommendations of the Coastal Communities Study, where not contained within the recommendations of the National Parks and Wildlife Service in this regard, will be integrated with the proposed local environmental zonings of these authorities, and contained within the Local Environmental Plan.

9. ARCHAEOLOGY

9.1 Introduction

Prior to the arrival of the European, the far north coast of New South Wales supported one of the largest, and most concentrated, Aboriginal populations in the State.

The main tribe in the region was the Bundjalung Tribe. It is told that during the winter months of the year members of the Tribe living in higher tableland areas would visit the warmer coastal areas to fish, hunt and engage in various activities important in maintaining tribal unity. Great feasts were often held, usually near coastal areas. Ceremonies were held at sacred sites in protected locations.

9.2 Responsibility

The National Parks and Wildlife Service is responsible for the protection and preservation of all Aboriginal Relics in New South Wales, under the National Parks and Wildlife Act, 1974.

A relic is defined as "Any deposit, object or material evidence (not being a handicraft for sale), relating to indigenous and non European of the area that comprises New South Wales, being habitation as prior to and concurrent with the occupation of the area of persons of European extraction" (National Parks and Wildlife Service, 1979).

In addition to relics, the Act protects Aboriginal places. These are areas gazetted as having, in the opinion of the Minister, special significance to Aboriginal culture. Gazettal of Aboriginal places protects sites which may be important to Aborigines, but which are not technically relics. Natural features of the landscape with mythological significance are one type of site which can be declared an Aboriginal place.

Areas of unoccupied Crown Land which contain important relics, may be dedicated as Aboriginal areas. These are managed entirely by the Service, in the same way as National Parks and Historic Sites.

Anyone who discovers a relic, whether it is the property of the Crown or not must report the discovery to the Director, National Parks and Wildlife Service, within a reasonable time of the discovery, unless he/she believes that the Director already knows of the existence and locations.

It is illegal to disturb, damage, deface or destroy a relic or Aboriginal place, without the Director's prior consent. If this consent is refused the applicant may appeal to the Minister.

9.3 Indicators of Aboriginal Habitation

A partial inventory of Aboriginal relics in the Shire has been carried out by the National Parks and Wildlife Service. They may be summarised as comprising:

- * Burial sites, often occurring in sand dunes or middens.

- * Painting and rock engravings, usually being of human figures, animals and tracks, and abstract designs of unknown significance.
- * Stone artifacts, axes, slate tools, grinding dishes, etc.
- * Ceremonial sites - raised earth rings ("Bora" rings) or arrangements of stone.
- * Natural sacred sites - features of the landscape such as mountains, rocks or trees which are sacred or significant to living Aboriginals, because of associations with Aboriginal mythology.

These Aboriginal relics identified to date are shown on the accompanying Map 15.

As can be seen from the map, most of the known relics are found in the coastal region of the Shire. Many such relics have disappeared due to sand mining and urbanisation.

9.4 Implications for Development

As most of the remaining relics are relatively undisturbed, their preservation value is great. Archaeological sites are a non renewable cultural resource, the importance of which must be evaluated in the context of possibility of loss of some such resources should development occur in such areas.

Any substantial development of previously undeveloped land surfaces likely to disturb Aboriginal relics or sites should be preceded by a survey by a suitably qualified person to locate and protect any relics or sites. In all future development in areas known to contain such relics or sites, Council shall require that the National Parks and Wildlife Service be consulted prior to works being carried out. In future, the Service may establish protection zones around some of the more important sites.



- CAMP SITE
- ART SITE
- ★ CEREMONIAL SITE - ONLY COMPLETE KNOWN SITE IN DISTRICT
- ◆ CEREMONIAL SITE - STONE ARRANGEMENT
- MYTHOLOGICAL SITE
- ◎ MIDDENS
- MULTI-TRAIT SITE - MYTHOLOGICAL, BURIAL, OPEN CAMP SITE

BYRON SHIRE ENVIRONMENTAL STUDY
ABORIGINAL SITES 15

0 5km ↑

Prepared by PLANNING WORKSHOP PTY. LTD. 346 KENT ST., SYDNEY
 For BYRON SHIRE COUNCIL

10. BUSH FIRE HAZARD

10.1 Fire History

Little documentation of fires previous to 1945 exists. Scattered reports and the use of drought graphs and rainfall statistics suggest that serious fires coincided with prolonged droughts within the Shire. Locally, prolonged droughts are regarded as dry spells lasting several months. Despite the relative short duration, the effects of drought can be quite severe, depending on weather, soil and vegetation.

The worst fire recorded occurred in late spring, 1945. A fire started on the northerly aspect of the Main Arm Valley, approximately half-way between the Nullum State Forest and Palmwoods. The fire spread rapidly, burning out banana plantations and associated buildings. The village of Palmwoods was narrowly saved by the united effort of fire fighters from the newly formed Mullumbimby/Brunswick Heads Police Patrol Bush Fire Brigade and locals. The fire continued in a westerly direction until it was brought under control at a narrow ridge near the Nullum State Forest. About 100 fire fighters had worked non stop for several days (F. Mills, 1981).

In 1951, a fire which started at the top end of Huonbrook, jumped 4 firebreaks by burning through the tops of trees and burnt for 4 days until brought under control by more than 200 fire fighters with some assistance from a typical November thunderstorm. The fire burnt down the saw mill at the end of Mill Road at Goonengerry. apart from damage to buildings and near tragedy, involving a sawmiller who survived by lying in a creek, the fire set the mill operation back 10 to 15 years, as the intense heat killed many hectares of forest.

In 1957 bad fire weather prevailed for a number of months and several fires raged in the Shire during the fire season which lasted almost uninterrupted from March to January the following year. The area around Palmwoods proved again to be the most prone, when spotting caused considerable damage to banana plantations and threatened life and property in the Palmwoods settlement.

Another bad year was 1968. However Byron Shire escaped major damage because the community heeded advice from fire fighting authorities which included total fire bans. Unfortunately, Tweed Shire was badly affected in that year when more than 1,000 hectares including many banana plantations were burnt.

On 29 September, 1971 a controlled burn by the Forestry Commission got out of control on the Koonyum Range between Laverty's Gap, Palmwoods and Mullumbimby Creek and extensively burnt the plateau. The fire was believed to be under control by October, 1971 but on the following day re-ignited and took another week to control. It burnt a 10 hectare banana plantation, one bulldozer and a large area of State Forest, causing damage to a total of 1,000 hectares.

In 1977, a hazard reduction burn to the south of Byron Bay got out of control, burning heath country and moving northwards threatening houses from the outskirts of town.

10.2 Factors Contributing to Fire Hazard

10.2.1 Fire Path

The topography of the forested valleys in the western part of the Shire are aligned north-west to south-east, thus forming an open fire path for the dry north-westerly winds which may occur during late spring. Consequently, slopes and ridges which are exposed to the north-west dry winds figure prominently within the high fire hazard areas (Map 16). Most of these ridges are also very difficult to access with fire fighting equipment because of the rugged terrain. In fact, some are regarded as totally inaccessible.

This orientation of valleys into natural fire paths makes Byron Shire more prone to fires than the neighbouring Tweed Shire where valleys generally run in a north-south direction.

10.2.2 Population Change

Since the last serious fire in 1971, the population of the Shire has increased dramatically. Consequently, a large proportion of the population have not experienced a serious fire and would find it difficult to imagine the threat, not having had the personal experience of a severe fire.

This aspect will be further compounded as the Shire experiences a dramatic increase in population, in the form of tourists, during the highest hazard period of the year. These visitors to the Shire would be even less aware of the inherent fire threat. This period of the year is also the time for most outdoor activities such as camping and barbecues.

10.2.3 Changes in Land Use

The changes in levels of bush fire risk are pronounced in rural areas of the Shire where land use changes and increased accessibility have resulted in a more diverse spatial pattern of settlement.

In past years, when the rural sector of the Shire was characterised by settlement patterns supporting the dairy, banana and timber industries, most rural dwellings were located in villages and along roadsides. Most of these areas were fairly well removed from bush fire hazard lands. After the introduction of the bulldozer and the four-wheel-drive vehicle, the potential for rural dwellings to be situated in hitherto inaccessible locations was improved drastically. Some rural dwellers have now chosen secluded wooded areas in which to locate their dwellings. Some of these wooded areas comprise areas of potential bush fire hazard.

In recent years there has been a change in rural land use and management, mainly from banana growing, grazing and dairying to orchards and hobby farms. Both types of operations are largely ungrazed, apart from a few house cows and horses. Consequently fuel accumulation is significantly increased. Banana plantations on high hill slopes, when well managed, in effect create a buffer zone to hinder the path fires. In recent years the quantity of banana plantations has

decreased and management techniques have altered from racking and removal of ground litter to the use of herbicides who do not entail the removal of ground litter. As a consequence of this, banana plantations do not play the role of a fire-retarding buffer strip to the extent they used to.

10.2.4 Changes in Vegetation Types

Grasses and Fire Hazard

The fire hazard potential of areas of grassland, and areas of forest containing areas of grasses, is related to the type of grass and the combination of various grasses and trees. The degree of inflammability of grasses varies according to the moisture content of the grass and its ability to completely dry out, i.e. cure. Wind velocity over such grassed areas is also a contributing factor. Molasses and bladey grass can reach a 100 per cent curing level.

Banna grass, known for its rapid growth (reaching a height of four metres in a matter of months), cures quickly and produces a heavy tonnage per hectare of ground fuel.

The spread of grasses is dependent upon soil types. Grasses such as paspalum and giant paspalum require a fertile soil which limits their spread into dry and wet sclerophyll forest.

Molasses grass will grow in all types of soil, fully utilising the late summer rains resulting in prolific growth during this period. This then dries out creating a fire hazard as stock will only feed on molasses grass during autumn when the grass is moist. Once lit, molasses grass is extremely difficult to extinguish, since it is extremely dense and gives off acrid smoke when burning. The spread of molasses grass is increasing throughout the Shire.

Camphorlaurel and Fire Hazard

Camphorlaurel trees contain a readily combustible oil and are spreading in plague proportions across many parts of the Shire, especially in the red soil areas. Trees growing on grazed land do not pose any serious threat, but removal of stock from the same area and the accumulation of dry grass causes a dramatic increase in fire hazard potential. The combination of camphorlaurel trees and molasses grass, as is the case at Montecollum increases the potential of fire threat to the extreme level.

10.3 High Fire Hazard Areas

10.3.1 Methodology

Areas of fire risk in Byron Shire have been identified in a two-stage process. Council's planning staff implemented the procedure for identifying fire hazard as recommended by the Department of environment in the Rural Lands Evaluation Manual. This involved the following steps:

- * Dividing the Shire into homogenous environmental units or landforms, based broadly on vegetation type and topography.

- * Assessing the susceptibility of these units to fire, taking into account factors such as fuel (combustible material, particularly undergrowth); fire season frequency; and terrain. These factors relate mainly to vegetation type, climate and slope. Each factor is scored to give a basic unadjusted value of fire risk or hazard.
- * Adjusting these basic fire risk values in each unit by a qualitative assessment of factors such as fire history, level of existing development, access to existing development (and the existence of alternative access) and the availability of fire fighting services.

Largely independently of this procedure, Council's Fire Control Officer identified fire hazard areas based on past experience and local knowledge of the terrain and its degree of fire risk.

The results of the two processes largely coincided, resulting in the ability to effectively map high and medium bush fire risk areas in Byron Shire (Map 16).

10.3.2 Fire Hazard Areas

Koonyum Range

The Koonyum Range area is the high plateau area stretching from Laverty's Gap in the south to Mount Boogarom in the north. Koonyum Range forms the picturesque backdrop to the west of Mullumbimby.

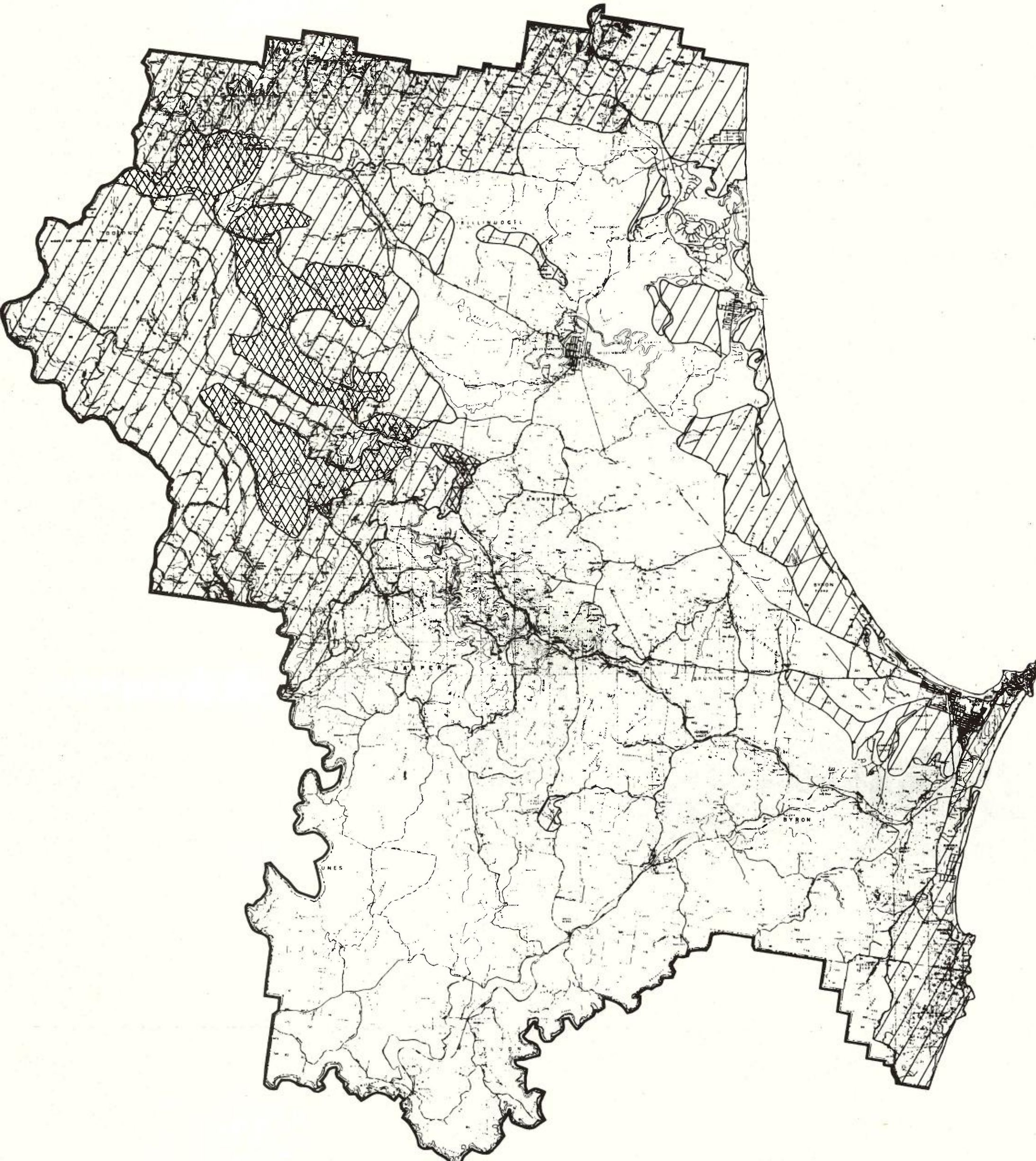
The last serious fire on Koonyum Range was in the early 1970's which destroyed hundreds of hectares of forest and forestry earth-moving equipment. The Forestry Commission has commented on the fire history in this area:

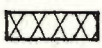
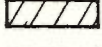

"Koonyum Range has a bad fire history. Over the years fires have often swept through the forest by the cliff to the north-east and from our experience about six years ago, i.e. 1973, when a Commission controlled burn spotted over the fire breaks, fires on this mountain are difficult to bring under control. They also burn with great intensity, probably because of the prevalence of unpredictable air currents.

Although the fire history has improved in recent years because of a combination of regular hazard reduction and good seasons, I would always regard Koonyum Range as a danger area and, in my opinion, more vulnerable than any other forest in the Murwillumbah sub-district."

(Forestry Commission, Murwillumbah,
correspondence to Council on 18th April, 1979)

The vegetation on Koonyum Range consists of approximately 75 per cent wet sclerophyll forest and 25 per cent dry sclerophyll forest including such species as scribbly gum, blackbutt, bloodwood, mountain oak, acacias and melaleucas. Byron Shire's Fire Control Officer has estimated the fuel accumulation in this area to be approximately 37 tonnes per hectare.



HIGH FIRE RISK AREAS	
MEDIUM FIRE RISK AREAS	
LOW FIRE RISK AREAS	

BYRON SHIRE ENVIRONMENTAL STUDY
FIRE PRONE AREAS 16

0  5km 

Prepared by PLANNING WORKSHOP PTY. LTD. 346 KENT ST., SYDNEY
For BYRON SHIRE COUNCIL

Being a plateau, the Koonyum Range area has insufficient water for fire suppression purposes, the only supply being two small streams. Access into this area is limited to only one entrance which is from the north of Wilson's Creek Road.

Palmwoods Fire Path

This area is generally described as the northern slopes west of Palmwoods which is situated at the foot of the northern extremity of the Koonyum Range Plateau.

The Palmwood area is divided into two portions, the western portion and the eastern portion (see Map 16).

The eastern portion, which is approximately one-third of the Palmwood high fire hazard area, last undertook hazard-reduction fires in 1978. The amount of fuel in this area is estimated at 21 tonnes per hectare while the main vegetation type is wet sclerophyll forest with the dominant species being ironbark, greygum, blackbutt, bloodwood and mahogany. No water is available for fire suppression purposes.

The western portion of the Palmwood high fire hazard area also has a bad fire history. It is exposed to the north-west and has no access for fire fighting equipment. The last serious fire was approximately 25 years ago and the fuel build-up has been estimated at approximately 37 tonnes per hectare. The forest type is classed wet sclerophyll with blackbutt, bloodwood, tallow wood, greygum and forest oak being the dominant species. Whereas the only grass in the eastern portion of this area is forest grass, the western portion includes bladey grass and molasses grass, further adding to the fire hazard of this area.

Montecollum

This area experiences fires regularly, mainly resulting from two sources - controlled burns getting out of control and passing motorists. While public access through the area is good, it is difficult for fire fighting equipment attempting to fight the fire to access the fire front. This is mainly because of the steep slopes and difficult terrain. The vegetation consists of wet sclerophyll forest over a small portion of the area with the remainder consisting of molasses grass and camphourlaurel trees. The number of camphourlaurel trees is increasing rapidly in this area. The fuel accumulation is estimated at 15 tonnes per hectare, which is not heavy. The area is classed as dangerous due to the extensive distribution of molasses grass.

Cooper's Lane - Mullumbimby Creek

This area can also be described as a fire path. Northerly and north-westerly winds can spread fire over the entire area. Further to this problem is the danger of falling rocks loosened by fire on the cliffs above endangering fire fighters and, in some cases, property.

Goonengerry - B.G.C. Forest and Areas Adjoining to the North to North-East

This area last experienced a serious fire in 1951. Vegetation type is classed as wet sclerophyll forest, with blackbutt and some flooded gum being the dominant species.

The fuel accumulation within this area is estimated at 45 tonnes per hectare and is classed in the "extreme" category. Once again, insufficient water exists in the area for fire fighting purposes, although slopes are such that conventional drive vehicles can traverse most of the area.

10.3.3 Infrastructure at Risk

Within the Shire there is considerable public infrastructure likely to be endangered by bush fire.

The highway from south of Brunswick Heads to the Shire boundary in the north can be cut by smoke, increasing motoring hazards for motorists. Many of the roads within the rural area of the Shire could be closed during fire within such areas. Roads along ridges are more likely to be affected by fire and smoke while roads along the floor of the valleys are not likely to be affected to the same degree. Many property access roads within the rural areas would also be closed by fire. The time periods that roads would be closed would be governed by the amount of fuel within that area and other factors at the time.

The railway line within the Shire, especially that part to the north of Byron Bay has suffered from fire on many occasions. Bridges, which are constructed of timber have been particularly vulnerable. There are forty-one such wooden railway bridges between Mullumbimby and Murwillumbah. In 1982, one railway bridge and 1 kilometre of railway sleepers were burnt at Myocum.

The Fire Control Officer has also identified the Shire's only airport, at Tyagarah as being susceptible to fire hazard.

10.3.4 Urban Areas at Risk

All urban areas within Byron Shire could be classified as being exposed to serious fire threats except Mullumbimby and Bangalow.

All coastal urban centres possess key contributing factors to the potential for fire hazard. Well-drained heathland, where dry litter builds up and creates highly volatile bush fire potential every 3-5 years. This natural condition is compounded by the fact that coastal areas possess the highest incidence of the major contributing factor to fires - people. This factor is exacerbated by the fact that many of these people (particularly tourists) are not familiar with fire risks. Ocean Shores fire threat could be expected to progressively increase. Vacant lots and park land require regular hazard reduction.

Other closely settled rural settlements within the Shire can be classified as being susceptible to fire hazard. Such settlements with a single access only and those within fire paths face the highest fire hazard. The mountain village of Palmwoods rates highly in this assessment. The Shire's Fire Control Officer also identifies such areas as Cooper's Lane, Frazers Road, Lighthouse Road, Mill Road, Jones Road and Seven Mile Beach Road as having potential fire threats.

The Shire's Fire Control Officer also considers many of the Shire's caravan parks as having potential fire threats. The following caravan parks are considered the most susceptible - Suffolk Park, Clarkes Beach, Globetrotters and Ferry Reserve Caravan Park.

10.4 Bush Fire Prevention

Bush fire risk is a natural hazard that can be reduced effectively at very little cost to individuals.

10.4.1 Fire Fighting Services Within the Shire

Byron Shire has an effective bush fire service with approximately 250 active volunteers in the six New South Wales Bush Fire Brigades covering the entire Shire - Bush Fire district.

Headquarters and Mullumbimby Brigade Centre

The Bush Fire Control Centre (Headquarters) is a modern brick building located at the Mullumbimby Brigade Centre. A large amount of miscellaneous fire fighting items are stored at the Control Centre sufficient to equip volunteers during any fire emergency. Fire Brigade vehicles stationed at this centre are the MFR Fire Tanker and Mullumbimby's Light Toyota Tanker, both being four-wheel-drive vehicles.

Brigade communications at the Control Centre are radio and telephone. All fire fighting vehicles are equipped with radio. A centralised brigade communication system is operated from this centre.

The Fire Control Officer's station sedan has both a multi channel radio for communications with neighbouring Shires and the Forestry Commission as well as a radio for direct contact with 000 Base Lismore on the N.S.W. Fire Brigade frequency.

Byron Bay Brigade

This brigade has its headquarters at Suffolk Park which is equipped with a Bedford Fire Tanker, Tanker trailer and other fire fighting items.

Main Arm Brigade

Main Arm Brigade is centered at the Main Arm Village and is equipped with a four-wheel-drive light tanker.

Ocean Shores/Billinudgel Brigade

The Ocean Shores/Billinudgel Brigade Station is in the process of being constructed to house the fire tanker stationed at Billinudgel. The brigade area includes Ocean Shores, Golden Beach and New Brighton Village areas.

Goonengerry/Nashua Brigade

The brigade is centered at Goonengerry and has a four-wheel drive light tanker at hand.

10.5 Planning Implications

In planning the future development of the Shire, particularly the location of urban development and the question of closer settlement in rural areas, the threat of bushfire needs to be properly addressed.

The Department of Environment and Planning has recently issued a draft circular to Councils entitled "Planning for Fire-Prone Areas". The principles of the planning implications of bushfires embodied in that draft circular have been incorporated into this study. Planning measures to take account of bush fire risk can take two related forms.

Firstly, if areas are available for development on land not prone to fire hazard then, where possible, these should be developed first - all other things being equal. There are problems with this relatively inflexible approach however. Fire risk is something that can be significantly reduced by proper management practices. Development in fire risk areas can incorporate bush fire prevention procedures and concepts. Also such development can bring with it greater access to fire-prone areas, a significant reduction in fuel and more frequent preventative measures such as clearing of undergrowth, controlled burns, more readily available fire fighters.

The second option therefore involves the implementation of management procedures which would include:

- * The design of development to incorporate fire prevention measures. Should the incorporation of such measures not be desirable for other reasons such as visual impact, difficulty of access, etc., then the development should not proceed in the form contemplated.
- * Controls on the location and design of buildings and policies on materials to be used in buildings.
- * Expansion of fire fighting capacity in the areas and the possibility of developer contribution to such expansion.
- * The dissemination of information on bush fire hazards and prevention including information for developers on appropriate layouts and for landholders on appropriate management of holdings (recommended tree species, layout of buildings and openspaces, etc., fire fighting equipment suggestions, fire fighting procedures, etc.).

With respect to bushfire control therefore, the following recommendations are made:

- * Where possible future urban and rural residential developments should be located away from areas of fire risk.
- * Where development occurs in bush fire-prone areas, development control policies should be adopted requiring development to have regard to the bush fire risk and be designed so as to minimise fire risk. Such policies would include:
 - . the requirement for perimeter roads or providing alternative access and fire fighting access;
 - . the requirement for a fire radiation zone surrounding the development where appropriate;
 - . controls on the width of lots adjacent to fire hazard zones;
 - . control on building setbacks from boundaries adjacent to fire hazard zones;
 - . controls on building materials and building design in bush fire risk areas to minimise the risk of fire;
 - . where possible all access of rural residential development should be provided with a through road where it is likely that fire could restrict access along a no-through road.
- * To facilitate fire fighting protection, development should as far as possible be restricted to a number of localities rather than dispersed throughout the rural areas of the Shire.
- * Council should prepare and disseminate information on bush fire risks and preventative action that can be taken by residents on the fringe of hazard risk areas or residents in rural areas.

11. CLIMATE

11.1 General Characteristics of the North Coast Region

The following extract from the North Coast Region Resources Inventory and Land Use Planning Guidelines to the year 2001 (Munro et al., 1976) provides a concise description of the climatic regime of the North Coast Region:

"The North Coast of New South Wales is regarded as having one of the most pleasant climates for human habitation in the continent. The summers are generally warm to hot in the north, while winters are mild. Rainfall is regular, though extremes of droughts and storms associated with tropical cyclonic depressions occur. Climatically much of the area may be classified as humid sub-tropical. The presence of the relatively warm Pacific Ocean along the Eastern boundary causes an east to west variation in climatic parameters. The changing pattern of topography along the coastal fringe however modifies this variation to give each location its own particular climate".

The climate within the region is mainly controlled by the seasonal migration of trade winds to the north and the anti-cyclone belt to the south:

"At the beginning of the year, the anti-cyclone belt is well south of the Region. Consequently, warm, humid conditions associated with the easterly trades are experienced. The anti-cyclone belt begins to move northward during April and generally lies over the Region by July. Rainfall averages and the water vapour content of the air (the humidity) decrease during this period. From July to September, the anti-cyclone belt is over, or slightly northward, of the Region. This period is the relatively dry season of the year and the light winds and clear skies associated with anti-cyclone centres are conducive to the formation of frost at places in the Region away from the immediate coast, even though there is a relatively warm ocean to the east of the Region. Humid conditions return and rainfall averages increase as the anti-cyclone belt moves well south of the area in November."

Munro et al. (1976)

11.2 Characteristics of Byron Shire

Byron Shire is situated within the sub-tropical climatic zone. On a broad scale, the climate of the Shire can be described as humid sub-tropical. It is characterised by hot, humid summers and mild winters. Rainfall is seasonally distributed, being concentrated mainly during the summer months. On a more localised scale the climatic regimes within the Shire vary according to factors such as topography, altitude, aspect, exposure and position in relation to the ocean. In general, diurnal temperature ranges, frosts and fogs increase with increasing altitude and/or distance from the ocean, while rainfall decreases.

Within the Shire, the Australian Bureau of Meteorology currently operates one climatic station located at Cape Byron Lookout, and has records for four rainfall stations at Newrybar, Federal, Bangalow and Mullumbimby. The climatic station at Cape Byron Lookout is not considered representative for much of the central and western parts of the Shire. Since climatic records are not available for his part of the Shire, climatic data for the Alstonville Tropical Fruit Research Station, situated to the south west of Byron Shire, was used to approximate the climatic regime of the central and western part of the Shire. Information provided by the rainfall station at Dunoon, near the western boundary of the Shire, is also included in this section.

11.2.1 Precipitation

The distribution of rainfall within Byron Shire is controlled to a large extent by the topography and closeness to the sea. In general, the annual average rainfall tends to decrease from east to west across the Shire from 1,868 millimetres at Cape Byron, 1,856 millimetres at Newrybar, 188 millimetres at Bangalow, 1,773 millimetres at Mullumbimby, 1,763 millimetres at Federal and 1,429 millimetres at Dunoon. Higher rainfall is recorded at more elevated locations along the Nightcap and Koonyum Ranges in the north western and western parts of the Shire. These higher rainfalls result from the orographic effect of moist maritime air being forced to converge and rise over these ranges. The annual average rainfall at the summit of the Nightcap Ranges is 2,031 millimetres.¹

Rainfall within the Shire is seasonally distributed with a later summer/early autumn maximum and late winter/early spring minimum. March, followed by February, are the wettest months at all rainfall stations, while August and September are the driest months. The mean monthly rainfall is given in Table 11.1.

Heavy rain may occur over the Shire during any month of the year, however it is more prevalent in the late summer/early autumn period, and is generally associated with cyclonic activity. The highest recorded daily rainfalls were 350 millimetres at Cape Byron in March 1974, and 449 millimetres at Alstonville in February 1976.

The cyclone season along the eastern coast of Australia extends from December to mid-April. The Bureau of Meteorology estimates that an average of one cyclone in every two cyclone seasons is likely to affect the study area. During such cyclones the Shire is battered by gale force winds and torrential rain.

1. Shire of Byron Strategic Plan, 1979.

Table 11.1: Mean Monthly Rainfall

Month	Cape Byron	Newrybar	Bangalow	Mullumbimby	Federal	Dunoon
January	162.5	229	219	211	184	151
February	180.4	211	250	236	242	197
March	233.0	240	255	250	250	207
April	193.6	183	177	173	172	124
May	185.8	208	179	168	161	124
June	141.3	134	167	127	112	111
July	95.8	129	111	103	86	84
August	110.4	78	98	78	84	53
September	73.4	82	62	65	58	64
October	129.3	92	113	106	119	83
November	119.9	132	112	115	114	106
December	150.8	138	138	141	154	125
Year	1,868	1,856	1,881	1,773	1,736	1,429

Since 1909 only three cyclones have actually passed across the coastline in the area extending from Mooball in the north to Evans Head in the south (Ballina Council 1982 p.18).

In addition to cyclones, severe local thunderstorms can also affect the Shire. These storms, which are generally accompanied by strong winds, hail and intense rain, may occur during any month of the year, however tend to be more frequent in the period September to January, with November and December being the most likely months. Water sports and willy-willys may also be generated by these storms.

Within the Shire, months receiving no rain are extremely rare. Of the 284 months of rainfall data for Cape Byron, no rainfall was recorded for only one month. At other rainfall stations the occurrence of no monthly rainfall was as follows:

- * Bangalow - rain experienced during all months on record (136 months).
- * Mullumbimby - 6 months without rain since 1898 (1,069 months of records).
- * Newrybar - rain experienced during all months on record (158 months).
- * Federal - only 1 month without rain during 179 months of record.
- * Dunoon - only 1 month without rainfall during 147 months of recording.

On average, Cape Byron records 15 rain days per year with February having the highest number and July, August and September the lowest number. The average annual number of raindays experienced at other stations is as follows:

<u>Average No. of Raindays per Year</u>	
Newrybar	130
Federal	146
Dunoon	119
Bangalow	117
Mullumbimby	127

The mean number of raindays per month at these stations is given in Table 11.2.

Table 11.2: Mean Number of Raindays

Month	Cape Byron	Newrybar	Bangalow	Mullumbimby	Federal	Dunoon
January	15	13	12	13	15	12
February	18	12	13	14	18	13
March	17	16	14	16	16	15
April	15	14	11	12	13	11
May	15	13	11	11	14	10
June	13	10	8	9	10	9
July	9	9	7	8	8	8
August	9	8	7	7	8	7
September	9	8	7	7	8	7
October	11	8	9	9	11	8
November	13	9	9	10	13	9
December	11	10	9	11	12	10
Total:	155	130	117	127	146	119

Other forms of precipitation occurring within the Shire are hail, fog and frost. Hail is a highly localised, infrequent phenomena which can be expected to occur during any month of the year. Hailstorms are most likely from October through to January at Cape Byron and in November and December at Alstonville.

Fog is also a highly localised phenomena, with its occurrence largely dependent on the local topography, altitude, aspect and proximity to the ocean. At Cape Byron, fogs have been experienced in the period extending from July to April, however, fogs are most likely to occur from October through to March. The frequency of occurrence at Astonville is considerably lower than at Cape Byron, with fogs having been recorded in February, March, June and November.

11.2.2 Temperature

Temperatures experienced in the region will vary in accordance with local relief factors such as elevation, exposure, position in relation to areas of cold air drainage, and local radiation effects.

In general, temperatures are hot in summer and mild in winter with January and February being the hottest months and July the coldest at both Cape Byron and Alstonville. The mean monthly maximum and minimum temperatures for Cape Byron and Alstonville are given in Table 11.3.

Table 11.3: Mean Monthly Maximum and Minimum Temperatures - Cape Byron and Alstonville

	Alstonville		Cape Byron	
	Mean Max.	Mean Min.	Mean Max.	Mean Min.
January	27.4	19.3	27.5	20.8
February	26.7	19.3	27.5	20.6
March	26.1	18.2	26.4	19.6
April	24.3	15.6	24.5	17.1
May	21.3	12.9	22.1	14.8
June	18.9	10.2	19.6	12.5
July	18.5	9.2	19.3	11.5
August	19.9	10.0	20.1	12.3
September	21.7	12.0	21.5	13.9
October	23.9	14.2	22.7	15.9
November	25.8	16.3	24.6	17.9
December	27.3	18.3	26.4	19.7

Temperatures in excess of 30 degrees have been recorded for the months September through to April, at Cape Byron and at Alstonville, however, these temperatures are more frequent between December and March. The highest recorded temperature experienced at Cape Byron was 33.2 degrees celsius, while at Alstonville the corresponding temperature was 40.7 degrees. Heatwave conditions (temperatures in excess of 37 degrees), can be expected to occur in the central and western parts of the Shire about once every 5 to 6 years. Temperatures along the coastal strip of the Shire do not reach such extremes due to the moderating effect of the cooling south easterly and north easterly sea breezes.

Temperatures during the winter months are generally mild, with the lowest recorded temperature for Alstonville being 7.3 degrees and for Cape Byron, 5.2 degrees. Minimum temperatures would be lower in the higher elevated areas in the western part of the Shire.

In terms of living conditions, the temperatures in Byron shire are favourable throughout the year. Due to mild winter temperatures, the Shire is a popular place to visit during winter periods.

Temperatures experienced in the Shire are generally not a limiting factor in determining the length of the growing season of sub-tropical and temperature crops. Low temperatures in winter could however damage sub-tropical crops. Microclimatic variations in temperature as a result of aspect and terrain, affect the suitability of an area for tropical crops and banana plantations. North easterly facing slopes, because of their higher isolation budgets, are more favoured for tropical crop/banana production, while valley bottoms and lower slopes are generally avoided because of the effects of cold air drainage or stagnation.

11.2.3 Frost

The occurrence of frost in the Shire is governed by local conditions, with slope, elevation and aspect being the main limiting factors. The immediate coastal region is frost free with no frosts having been recorded at Cape Byron. A few frosts have been observed at Alstonville for the period July to September. It is expected that the lower parts of the sheltered valleys and depressions in the west of the Shire would have a higher frequency of frost.

Areas subject to frost are not suitable for many tropical crops and banana plantations.

11.2.4 Winds

Wind analyses have been undertaken by the Australian Bureau of Meteorology for 9 am and 3 pm at Cape Byron and for 9 am at Alstonville. Wind frequency and strength is usually greatest on the coast, tending to decrease inland. Cape Byron, due to its prominent position, can be expected to experience more frequent and stronger winds than the remainder of the Shire.

At 9 am at Cape Byron, south easterly sea breezes are the dominant winds from October through to March, while from April to September south westerly winds are dominant. At Alstonville, south easterly winds are dominant in January, north westerly winds in December and south westerly winds during the remainder of the year. At Cape Byron strong winds (winds in excess of 40 kilometres per hour) could be expected to average 1 to 2 days per month during summer, June and November, and about 1 day per month during the remainder of the year. These winds are generally from the south east. At Alstonville, strong winds can be expected on average, 1 to 2 days per month in January and August, and less than 1 day per month for the remainder of the year. Strong winds experienced at Alstonville are more variable in direction than at Cape Byron, with north westerly and south westerly winds predominating.

At 3 pm south easterly winds are dominant at Cape Byron from January to July. In August, south westerly winds dominate, while for the remainder of the year, northerly winds are more dominant. Strong winds

can be expected, on average, 4 to 6 days per month from October to March and 1 to 3 days per month for the remainder of the year. December and January tend to experience the highest frequency of strong winds.

The strong winds are generally from the south east, and north. Strong north westerly winds, which are generally associated with high/ extreme fire danger weather, are relatively infrequent during the summer months. On average these winds could be expected about 1 day per month during summer. South easterly winds also present a strong fire danger. A number of the main fire paths are aligned in a north-west/south-east direction, resulting in the tunnelling of south-easterly winds along the path. This is especially the case in the Main Arm Valley which is open to both south easterly and north westerly winds.

Gale force winds, generally associated with cyclonic activity, can be expected in any month. These winds are generally from the south east. At Cape Byron, gale force winds are more frequent in February and March, and less frequent in August. The frequency and intensity of these winds decreases rapidly inland. At Alstonville, the occurrence of these winds is significantly less than at Cape Byron, and there appears to be no seasonal distribution.

11.2.5 Relative Humidity

Being located within the sub-tropical climatic zone, the relative humidity experienced in Byron Shire can become very oppressive during the summer months. The relative humidity generally exceeds 70 percent at 9 a.m. and 3 p.m. during the summer months and 55 percent during the winter months. Relative humidities greater than 90 percent are very common throughout the summer months. In general, relative humidity is higher in the inland areas where the moderating effects of the sea breezes are not experienced.

12. VISUAL ASSESSMENT

12.1 Introduction

An important component of the Shire's natural resource base is its visual attributes and character. It is of importance to visitors and residents alike. The identification of areas of visual significance assist in the following ways:

- * In maintaining the rural character of the Shire.
- * In promoting and protecting tourist activity in the Shire.
- * In identifying important landscape units that may require protection in association with urban or semi-rural development.

This paper therefore provides a description of the visual characteristics of the landscape of the Shire and outlines planning policies to protect and enhance the visual quality of the Shire.

The analysis has been undertaken on a Shire-wide basis and is therefore broad-brushed. It is not intended that areas of visual significance always be taken as a hard constraint to development. Rather, in most cases, particularly areas of medium visual significance, it is more important to ensure that the items of visual significance (e.g. ridgeline, vegetation stand) are given careful consideration in development design.

12.2 Methodology

Any assessment of visual quality of an area is subjective, as individual perceptions of beauty or scenic quality are likely to vary. The methodology used here is that recommended by the Department of Environment and Planning in its 'Rural Land Evaluation Manual' published in November 1981.

The approach is a two stage process to assess and grade the Shire in terms of visual quality. The two stages include:

- * Assessing the relative scenic quality of the area.
- * Identifying visually prominent places.

These two aspects combine to provide a visual quality ranking of the Shire.

The Shire was firstly divided into broad topographic units. Each unit is then assessed in terms of the variety of natural features. The three main topographic units in Byron Shire are:

- * the plateau area covering the south-west part of the Shire;
- * the mountain area to the north and north-west of the Shire;

- * the coastal plain.

Visual quality within each unit is assessed in terms of the diversity and range of land forms and the extent of visual prominence. Scenic quality is assumed to increase as:

- * topographic ruggedness increases, i.e. mountainous or steep country;
- * vegetation patterns become more diverse;
- * the number of natural landscapes increase;
- * presence of views, prominent places or panoramic vistas increase.

A three tier classification system is used - high, medium and low.

- * **High visual quality** includes areas with features that are outstanding, unusual, distinctive, diverse or prominent.
- * **Moderate scenic quality** includes areas that are more common but nonetheless form an important component of the scenic quality of the Shire and one that could be degraded or spoilt by development.
- * **Low scenic quality** includes the remaining areas of the Shire.

12.3 Visual Quality

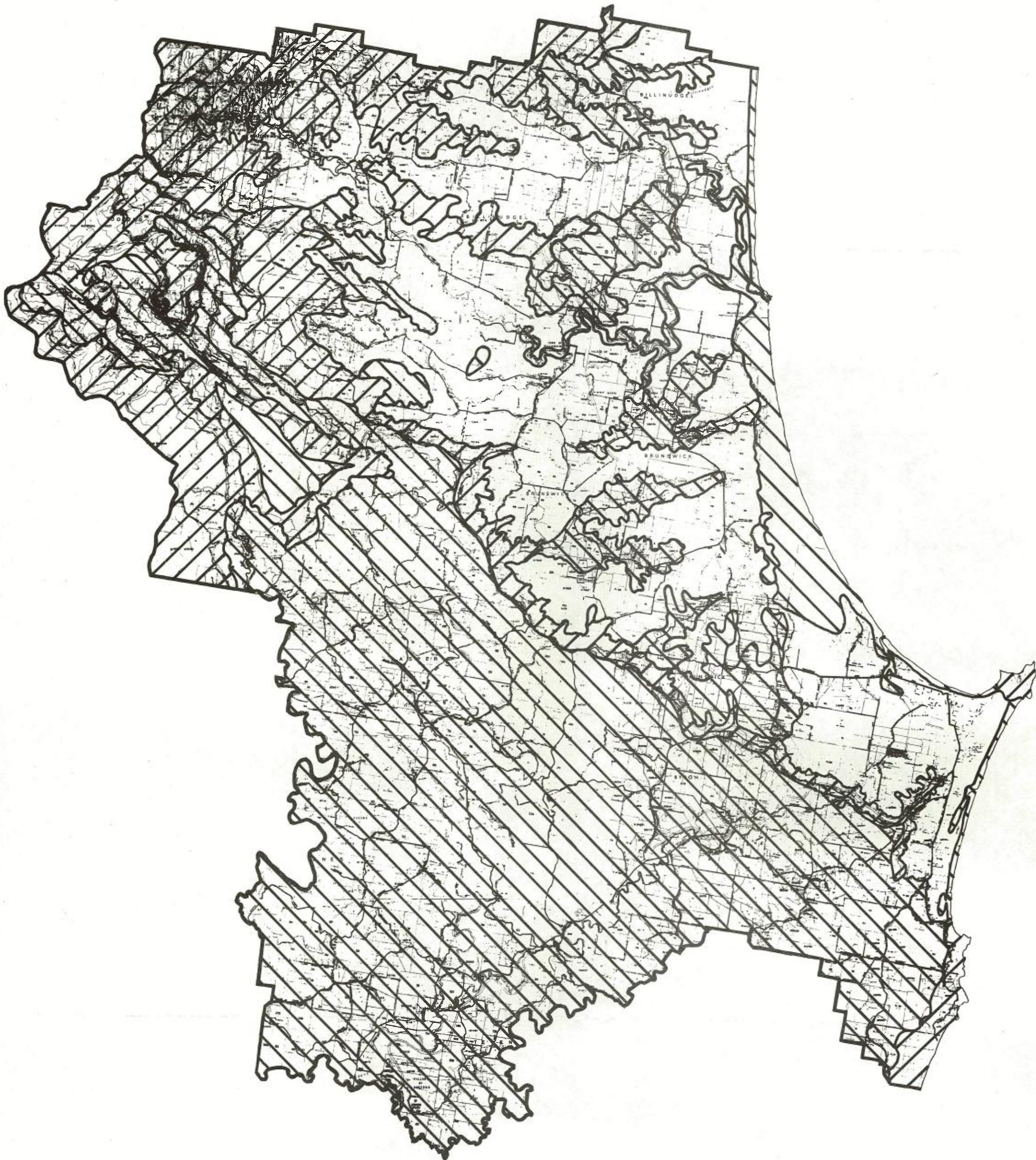
A brief description of the visual assessment of the Shire is given below. Map 17 shows the visual quality ranking of the Shire.




12.4 Plateau Country

The plateau area is bounded to the north and north-east by a long and visually prominent escarpment. The escarpment forms a middle distance backdrop to the coastal settlements from Byron Bay to Brunswick Heads and inland to Mullumbimby. As such, it is important to ensure that the quality of this backdrop is maintained and that the natural line of the escarpment is not broken by incompatible building forms or structures. Because of its prominence and because it provides a distinct separation between the coastal plain and the plateau area, the escarpment is considered of high visual significance.

The remaining plateau area contains a rich diversity of land and water forms. The road pattern follows mainly prominent ridgelines providing a multitude of views of a variety of rural landscapes and naturally vegetated areas. The roads also wind round steep valleys and slopes and through heavily vegetated areas, all contributing to the diversity of the scenery. The character of this area is distinctly rural and it is important that such a character be maintained.

The whole plateau area is considered of medium scenic quality.



HIGH VISUAL SIGNIFICANCE	
MEDIUM VISUAL SIGNIFICANCE	
LOW VISUAL SIGNIFICANCE	

BYRON SHIRE ENVIRONMENTAL STUDY	
VISUAL QUALITY	17
	
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Care should be taken when assessing development applications in this area to ensure that buildings are designed and located so as to be as visually unobtrusive as possible. Consideration should be given to the following factors:

- * buildings should not be located on prominent ridgelines when viewed from roadways or other public places;
- * access paths to houses on rural parcels should follow contours where possible;
- * use of vegetation species to screen buildings and soften edges and provide a continuous silhouette should occur;
- * roof lines should reflect the overall land profile.

12.5 Mountain Areas

The mountain areas to the north-west of the Shire provide a distant backdrop to the Shire and are visually prominent from most locations in the Shire. The areas are rugged, consisting of steep heavily vegetated and rarely explored terrain. Prominent or unusual features include Mt. Boogarem and its rocky escarpment, Wilsons River gorge and the more isolated Wanganui Gorge. Because of its prominence, a large part of this area is considered of high visual quality.

12.6 Coastal Plain

The coastal strip of the Shire is generally flat to undulating. The southern extremity has a more varied topography in the vicinity of Broken Head; this being part of the plateau area and the eastern extreme of the escarpment. Consequently visually prominent places are rare and consist mainly of:

- * The Broken Head area extending south from the Broken Head headland to the southern Shire border. This area is characterised by a number of headlands, rocky cliffs and small secluded beaches. As such, it is considered of high visual significance.
- * The Byron Bay headland, which is the most famous and prominent land mark in the Shire.
- * Harry's Hill - a smaller headland forming the north head of the mouth of the Brunswick River.

The remainder of the coastline consists of flat coastal heathland and dunes with little visual prominence and minimal variety in land form. There is however some significant variety in land cover and in waterforms within the long sweeping beach north and immediately south of Byron Bay. Areas of visual significance include the long expanses of open beaches which dominate the coastal fringe. Behind the coastal fringe, the lowland coastal plain is broken by a series of ridges from the escarpment and the mountains to the north. A large part of these lowlands have been cleared for agricultural purposes - and in some areas

the frontal dunes have been mined for mineral sands. There are areas of coastal heathland that have not been cleared and, together with estuary systems, these areas are considered to have visual significance.

Areas of medium visual significance on the coastal plain include:

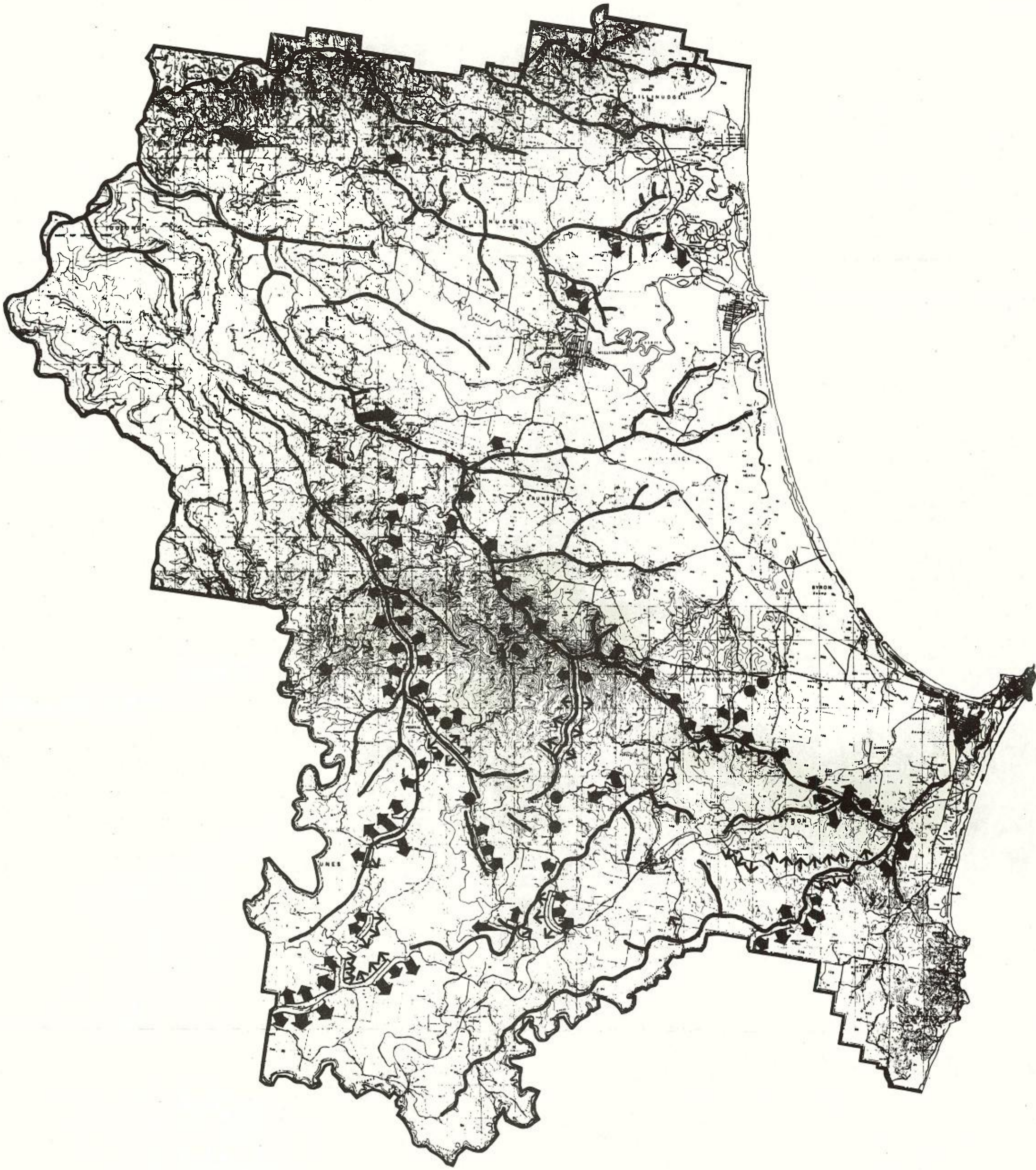
- * The dunal heathland system extending from the northern periphery of Byron Bay to the southern periphery of Brunswick Heads incorporating the Simpson's Creek estuarine system. This area consists of heavily vegetated hind dunal fields characterised by a series of strongly aligned dunes displaying deep long swales. Most of this area has remained undisturbed.
- * The Brunswick River. This is the most important inland water system in the Shire and is navigable by small craft upstream as far as Mullumbimby. It is important that the visual quality of this system be maintained by the control of development adjacent to the river and the maintenance of a vegetation buffer along the banks of the river.
- * The estuarine area of Marshalls Creek to the north of Brunswick Heads. It is considered important that the visual assets of the creek be maintained and that a vegetation buffer along the creek be maintained to visually separate the creek system from any form of development.
- * The estuarine systems of the Belongil and Tallow Creeks. Because of the variety that these forms introduce into the coastal system, it is important that the waterbodies be maintained as a visual unit. This implies that a vegetation buffer along these creeks be maintained where possible to visually separate the systems from surrounding development.
- * Taylor Lakes. Relative to the remainder of the coastal plain, these lakes constitute an unusual land form that from a visual viewpoint should be separated from other forms of development by a vegetation buffer.

12.7 View Potential

A further important aspect of the visual quality or attractiveness of the Shire is the view potential of the Shire. Because many of the roads in the Shire follow prominent ridgelines, there is ample opportunity for panoramic views and vistas, either covering long distances such as to the mountains or coastline or of more restricted rural landscapes or farm settings.

View potential in the Shire is shown on Map 18. Views from major roads in the Shire are shown under two categories:

- * Distant views to the coast or mountains or over rural landscapes.
- * More localised internal but nevertheless significant and interesting views.



DISTANT VIEWS
 LOCAL VIEWS
 RIDGES
 IMPORTANT TREE STANDS

BYRON SHIRE ENVIRONMENTAL STUDY
VIEW POTENTIAL 18

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As can be expected, views are predominant from the roads following the major ridgelines in the Shire such as Coolamon Scenic Drive and the Goonengerry/Federal/Eureka Road.

The view potential map is useful for the following reasons:

- * It will assist in the identification of tourist routes.
- * It provides information that Council can use as a basis for ensuring that views are protected.

12.8 Planning Implications

The most important element in identifying the visual quality of the Shire is to determine an appropriate planning response. This involves recommending an objective to be adopted and a number of planning policies that could be implemented to achieve that objective.

Objective

Identify, protect and enhance the scenic resources of the Shire.

Policies

- * Include provisions in the draft Local Environmental Plan to ensure that areas of high visual quality, as identified on Map 17 are protected from development that is incompatible with the visual quality of these areas. This could be done by including such areas within a scenic protection zone and ensuring that there are adequate controls over tree-felling, site and height of buildings and colour and texture of buildings if necessary.
- * Include provisions in the draft Local Environmental Plan to give Council definite power to consider the impact of development on the visual quality of the area when determining development applications in areas of high and medium visual quality. Consideration should also be given to extending tree preservation orders over these lands.
- * More intensive forms of development such as urban, rural residential or tourist development should not be located on areas of high visual significance.
- * Development Control Plans should be prepared for rural residential development or urban development in areas of medium visual significance that specifically incorporate guidelines on subdivision design and the location of dwellings to maintain the visual quality of the area.
- * Design guidelines should be prepared to assist rural home builders to properly locate and design their dwellings and to assist Council in determining applications.

- * Tourist routes should be defined and promoted to take advantage of the spectacular views available from the Shire's rural roads.
- * Council should enhance these views and the diversity of the rural scenic drives by taking the following steps:
 - . ensuring road reserves are maintained to enable views to be appreciated;
 - . developing lookouts at strategic locations on defined tourist routes such as on the Federal Road just south of the Kings Road intersection (other possible locations are discussed under tourism);
 - . preserving important vegetation stands along roadsides that add diversity to the rural landscape, play a significant role for the birdlife of the Shire by including such areas within a tree preservation order.
- * Maintain vegetation buffers along the Marshalls, Simpsons Creek (western side), Brunswick River, Belongil Creek, Tallow Creek and Taylor Lakes in order to maintain the visual integrity of these units.

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