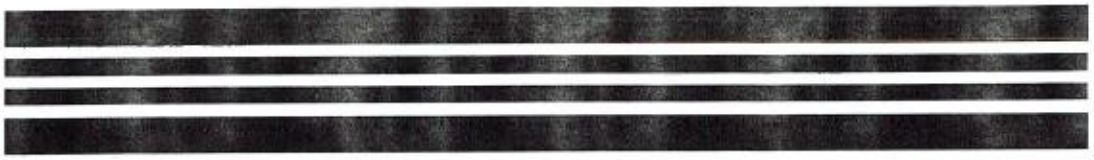

EIS 975

AB019631

Local environment study : land in the vicinity of Blue Angle Creek, Gerroa : summary report

Quality Environmental Management Pty Limited

KIAMA MUNICIPAL COUNCIL

May 1992

LOCAL ENVIRONMENT STUDY

LAND IN THE VICINITY OF BLUE ANGLE CREEK, GERROA

SUMMARY REPORT

QEM

Quality Environmental Management Pty Limited
PO Box 113 FAIRY MEADOW 2519

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Botanical Analysis - Proposed Rezoning of Land in the Vicinity of Blue Angle Creek and Crooked River, Gerroa by Dr R M Muston, Quality Environmental Management Pty Limited.

Fauna Report

Fauna & Habitat Assessment - Blue Angle Creek, Gerroa by Assoc Prof R J Whelan, Australian Flora & Fauna Research Program, University of Wollongong.

Avifauna Report

Review & Survey of Avifauna - Land in the Vicinity of Blue Angle Creek and Crooked River, Gerroa by Mr Richard Jordan for Quality Environmental Management Pty Limited.

Archaeological Report

Archaeological Assessment of Land Proposed for Rezoning at Blue Angle Creek Gerroa by Ms Kerry Navin, Navin Officer Archaeological Resource Management.

Visual Analysis Report

Visual Analysis - Proposed Rezoning of Land at Blue Angle Creek, Gerroa by Ms Vanessa Ebbutt, Gutteridge Haskins & Davey Pty Limited.

Coastal Hazards & Sand Resource Report

Coastal Hazards Analysis and Sand Resource Assessment for Gerroa Draft Local Environmental Plan by Mr Graeme Hurrell, Webb McKeown & Associates Pty Limited.

Section 1

BACKGROUND

In February 1990 Kiama Municipal Council resolved to prepare a Draft Local Environmental Plan to rezone land in the vicinity of Blue Angle Creek and Baileys Island from Rural 1(a) to Rural Environmental Protection - General 7(l).

At that time the study area was the subject of an EIS for sand extraction and a subsequent appeal by Cleary Bros (Bombo) Pty Limited in the Land and Environment Court. In May 1990 the Department of Planning declined to issue a certificate pursuant of Section 65 of the Environmental Planning & Assessment Act 1979, but agreed to review that decision pending the outcome of the Appeal. At the same time the Department of Planning advised Council that a Local Environmental Study would be required should Council wish to pursue finalisation of the Local Environmental Plan. In December 1990 the Cleary Bros' Appeal was dismissed and development consent refused for sand extraction within the study area.

The proposed rezoning did not proceed until December 1991 when Quality Environmental Management Pty Limited was invited to prepare a Local Environmental Study for the land proposed by Kiama Municipal Council for rezoning.

Section 2

THE STUDY BRIEF

The Department of Planning specified that the Local Environmental Study should have regard to:

a) The Illawarra Regional Environmental Plan No. 1

b) State Environmental Planning Policy No. 14 - Coastal Lands

b) State Environmental Planning Policy No. 26 - Littoral Rainforests, and

d) the relevant findings and recommendations of the following studies:

   i) Illawarra Region Sand Mining Study, and

   ii) Illawarra Region Wetlands Study.

In addition, the study had to identify and assess features of environmental, heritage, cultural or visual importance, with a view to protecting them from undesirable development, especially:

a) significant stands of vegetation and wildlife habitats and corridors

b) areas of particular visual amenity, or land which is an important component of the Municipality's rural environment, and

c) wetland areas.

Section 3

THE STUDY AREA

The area proposed for rezoning is located south of Gerroa township. It extends along the northern and southern side of Blue Angle Creek and is bounded on the east by Crooked River (Figure 1). In one section of the study area the native forest has been cleared and partially replaced with a softwood plantation and improved pasture. In other sections the native understorey has been cleared, pasture improved and the tree cover thinned. The remainder of the area has a native tree/understorey cover (Figure 2).

The majority of the study area is owned by Bridon Pty Limited. Smaller properties, located on the periphery of the main site are owned by:

P J & G C Cooke
Processed Sand Pty Limited
Breen Holdings Pty Limited
Kiama Municipal Council.

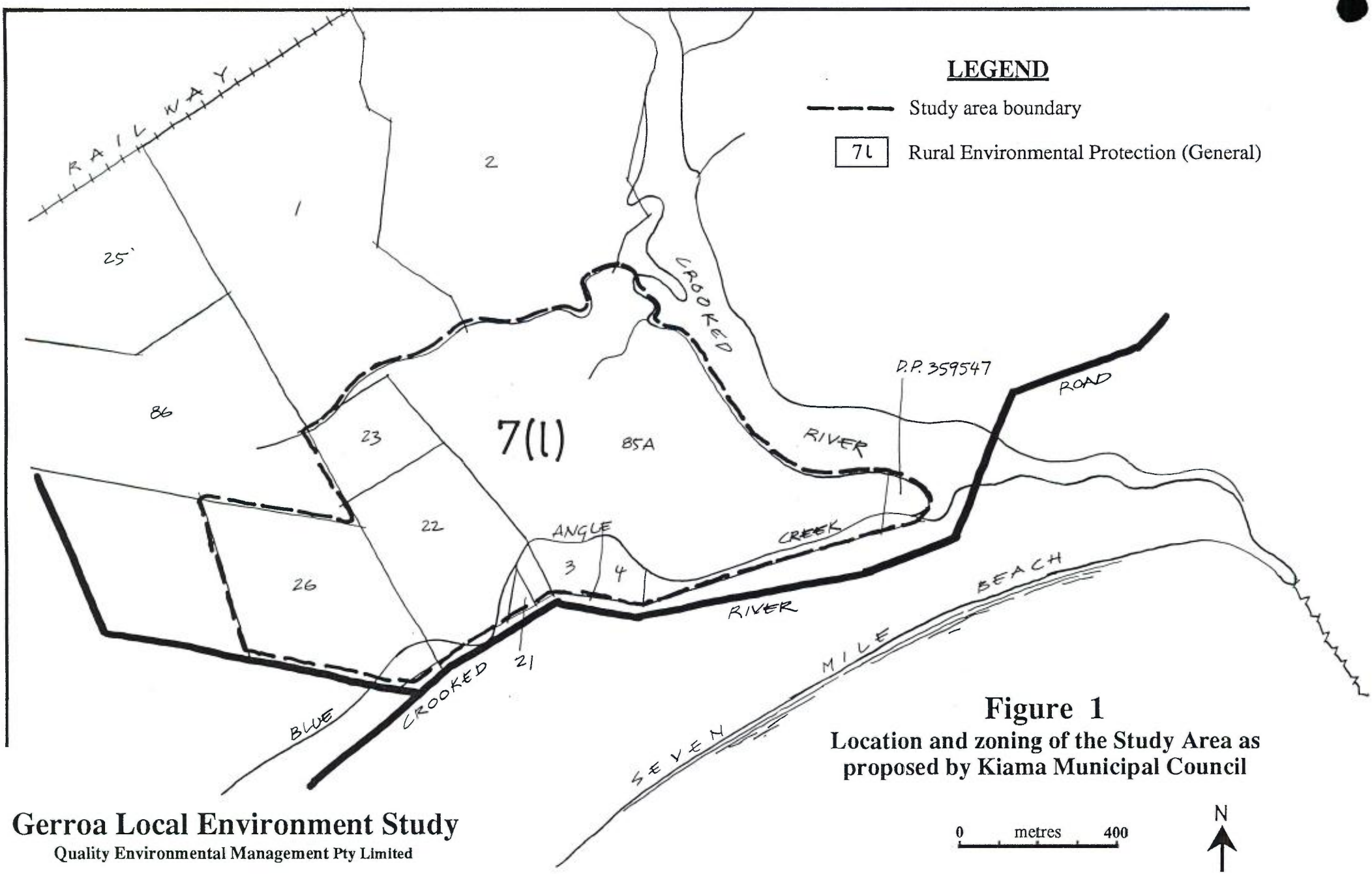

Figure 1
Location and zoning of the Study Area as proposed by Kiama Municipal Council

Gerroa Local Environment Study
Quality Environmental Management Pty Limited

Figure 2

Vegetation cover in the Study Area 1989

Gerroa Local Environment Study

Quality Environmental Management Pty Limited

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Section 4

LOCAL ENVIRONMENTAL STUDY

The Local Environmental Study consists of this Summary Report and six specialist reports each of which focuses on a particular resource within the land proposed for rezoning. The Summary Report presents a brief overview of Council's proposal in the light of information contained in the six specialist studies. These studies review available information and include new data in their assessment of the current status and conservation significance of the natural and cultural resources of the study area. As data in the specialist studies is not repeated, the Summary Report is intended to be read in conjunction with the specialist reports which are attached to this summary report.

These specialist studies are:

- *Botanical Analysis - Proposed Rezoning of Land in the Vicinity of Blue Angle Creek and Crooked River, Gerroa* by Dr R M Muston, Quality Environmental Management Pty Limited.
- *Fauna & Habitat Assessment - Blue Angle Creek, Gerroa* by Assoc Prof R J Whelan, Australian Flora & Fauna Research Program, University of Wollongong.
- *Review & Survey of Avifauna - Land in the Vicinity of Blue Angle Creek and Crooked River, Gerroa* by Mr Richard Jordan for Quality Environmental Management Pty Limited.
- *Archaeological Assessment of Land Proposed for Rezoning at Blue Angle Creek Gerroa* by Ms Kerry Navin, Navin Officer Archaeological Resource Management.
- *Visual Analysis - Proposed Rezoning of Land at Blue Angle Creek, Gerroa* by Ms Vanessa Ebbutt, Gutteridge Haskins & Davey Pty Limited.
- *Coastal Hazards Analysis and Sand Resource Assessment for Gerroa Draft Local Environmental Plan* by Mr Graeme Hurrell, Webb McKeown & Associates Pty Limited.

Section 5

LIAISON WITH STATE GOVERNMENT AGENCIES

During preparation of this study discussion and correspondence occurred between members of the study team and the following:

Mr G MacRae	Department of Mineral Resources
Mr I Paterson	Department of Mineral Resources
Ms S Feary, Regional Archaeologist	National Parks & Wildlife Service, South East Region
Mr G Sales, Senior Ranger	National Parks & Wildlife Service, Nowra Office
Mr G Spencer, Superintendent	National Parks & Wildlife Service, Nowra Office
Mr P Dalmazzo, Biologist	NSW Fisheries, Nowra Office.

Information collected during these discussions was used in the preparation of the specialist study reports.

Section 6

RELEVANT PLANNING INSTRUMENTS, REGIONAL STUDIES AND GOVERNMENT POLICY STATEMENTS

6.1 KIAMA LOCAL ENVIRONMENTAL PLAN NO. 5 1981 AND PROPOSED AMENDMENTS

The study area is presently zoned Rural 1(a) under Kiama Environmental Plan No. 5 as follows:

Column I	Column II	Column III	Column IV	Column V
Zone and colour or indication on the map	Purposes for which development may be carried out without consent	Purposes for which development may be carried out subject to such conditions as may be imposed by the consent authority under section 91 of the Act	Purposes for which development may not be carried out except with consent	Purposes for which development is prohibited
1. Rural: (a) Rural "A" Light Brown	Agriculture other than buildings, dog breeding or boarding, lot feeding of livestock, pig-keeping, poultry farming or goat farming: REP No.2 Amendment Gazetted 11th September 1987	Dwelling-houses	Any purpose other than those included in Column II, III or V	Advertising structures; boarding-houses; bulk stores; car repair stations; commercial premises other than caravan parks; gas holders; industries other than home industries, rural industries or extractive industries for the winning of sand, clay, soil or turf; junk yards; liquid fuel depots; motor showrooms; residential flat buildings; refreshment rooms; roadside stalls; service stations; shops; timber yards; transport terminals; warehouses.

A General Tree Preservation Order applies to all land within the Municipality of Kiama. Much of the study area is currently being developed for agricultural purposes and two

attempts have been made to seek approval for sand extraction activities. The first attempt, which included Lot 26 (DP4498) and part of Pt 85A (DP4467), was refused after an appeal in the Land & Environment Court in 1990. The second, which is limited to Lot 26, was submitted to Kiama Municipal Council in January 1992 and at the time of preparation of this Local Environmental Study was awaiting a decision by Council.

South of the study area is an area of forest which extends west along Seven Mile Beach. While most of this land has been gazetted as Seven Mile Beach National Park, that part on the eastern end of Seven Mile Beach adjoining the study area is Crown Land. This area of forest is zoned Open Space (a) - Existing Recreation as shown below. Under the present zoning, many of the purposes for which development may be carried out subject to conditions imposed by the consent authority are detrimental to the native forest cover and are likely to be prejudicial to the present presumed high habitat value of the area.

Column I	Column II	Column III	Column IV	Column V
6. Open Space: (a) Existing Recreation Dark Green		Any purpose authorized by Division 2 or 3 or Part XIII of the Local Government Act, 1919; race-courses; recreation areas; show-grounds; sports-grounds; any development carried out by or on behalf of the National Parks and Wildlife Service under the National Parks & Wildlife Act, 1974.	Agriculture; caravan parks; drainage; forestry; roads; utility installations other than generating works or gas holders.	Any purpose other than those included in Column III or IV.

Council proposes to amend Kiama Local Environmental Plan No. 5 as follows:

Kiama Local Environmental Plan No. 5 is amended -

a) by inserting at the end of the definition of "the map" in clause 6(1) the following words:
Kiama Local Environmental Plan No. ;

b) by inserting at the end of the Table to clause 11 the following matters:

Column I	Column II	Column III	Column IV	Column V
7(1) Rural Environmental Protection (General) Orange with red edging and lettered 7(1)			Bushfire hazard reduction; environmental protection works drainage; removal or destruction of trees and other vegetation; roads; subdivision	Any purpose other than a purpose specified in Column IV

Council proposes to prohibit sandmining and other forms of extraction in the proposed Rural Environmental Protection 7(l) - General zone.

Council proposes that the study area be rezoned from Rural 1(a) to Rural Environmental Protection (General) 7(l). At this stage there has been no proposal to alter the zoning of the land presently zoned Open Space (a) - Existing Recreation.

6.2 ILLAWARRA REGIONAL ENVIRONMENTAL PLAN NO. 1 1986

The Illawarra Regional Plan - Landscape and Environment Study (Department of Environment & Planning 1981) identifies part of the study area as lying within "Unit 6: Shoalhaven Delta", and as being a "Botanically Significant Area". This delineation appears to encompass Lots 21, 22, 23 (DP511283), Lot 26 (DP4498), Lots 3 and 4 (DP420533) and part of Pt 85A (DP4467). No details are given of the significance of the area. The presence of extractive sand deposits are however noted as potential pressures affecting the environmental attributes of the area.

It is significant to note that the study area is a beach dune system much of which retains a natural vegetation cover. Furthermore, the study area lies within the immediate catchment of an extensive estuarine wetland. Therefore the Council's proposed rezoning would appear to meet the objectives of the Illawarra Regional Plan (REP) No. 1 1986 in relation to:

105 "(a) to protect beach systems and conserve their scenic, recreational and natural values;"

> "(c) to protect the productive ecosystems and natural habitats of the region's estuaries, wetlands, lakes and lagoons and their scenic attributes."

Two SEPP No. 26 - Littoral Rainforest areas are located within the study area. Significant additional stands of littoral rainforest which are not protected by the SEPP No. 26 - Littoral Rainforest gazettal have now been identified within the area proposed for rezoning (QEM 1992 Botanical Analysis Report). Regional Environmental Plan No. 1 provides specific controls for the protection for land supporting rainforest vegetation species. Although the additional littoral rainforests and the two SEPP No. 26 areas were not mapped in the Regional Environmental Plan No. 1, that Plan acknowledged that other small areas would be likely to be identified in the future and need to be assessed. Of the 38 plant species specifically mentioned in *Background to Illawarra Regional Plan No. 1* (Department of Planning 1986) as being rainforest vegetation species, 20 are located in the study area. The remaining 18 species are not generally considered typical of littoral rainforest. The Background Report to the Regional Plan states:

> "The remaining (rainforest) areas are important because of their relative rarity, for their educational value and, because, being in many cases very close to urban areas, they are particularly significant to the local community."

Kiama Municipal Council's proposal to include stands of littoral rainforest in the area to be rezoned therefore appears to meet the aims and objectives of Regional Environmental Plan No. 1 in relation to protection of land supporting rainforest vegetation.

6.3 SEPP NO. 26 LITTORAL RAINFOREST

Two SEPP No. 26 littoral rainforest areas (175J and 175K) are located between Crooked River Road and Blue Angle Creek within the study area . The restrictions on activities in areas listed under this State Environmental Planning Policy also cover a 100 metre buffer zone around the gazetted SEPP No. 26 boundaries.

Department of Planning Circular B18 states that:

> "...littoral rainforest is a distinct type of rainforest which is well suited to living in the harsh conditions of exposure to salt-laden and drying winds on the coast. It is estimated that more than three-quarters of the littoral rainforest which was in New South Wales 200 years ago has been destroyed or severely degraded. Because it is confined to the coast it

has suffered greatly in the past from clearing, development and sandmining. Therefore, it is in need of protection."

Kiama Municipal Council's proposal to increase the level of planning protection and exclude sandmining in an area containing significant stands of littoral rainforest (including two SEPP No. 26 areas) is consistent with the intent of SEPP No. 26. This Local Environmental Study goes further by recommending that the present SEPP No. 26 areas be reviewed with the aim of including those additional stands of littoral rainforest identified by Mills (1990) and further described in the Botanical Analysis Report which supports this Summary Report.

6.4 COASTAL WETLANDS

No part of the study area is gazetted under SEPP No 14 - Coastal Wetlands.

The Illawarra Region Wetland Study (Department Environment & Planning 1983) recognised as 'wetland' a part of the western shoreline of the Crooked River. No other part of the study area is particularly noted in that study.

The Department of Agriculture and Fisheries' *Estuarine Habitat Management Guidelines* (1991) requires that during the preparation of Local Environment Plans, all wetlands (including seagrasses, mangroves and saltmarshes) must be mapped for the purpose of protective zoning. The Guidelines refer to a foreshore buffer zone at least 30 metres wide which must be created to protect foreshores and separate developments from sensitive habitats. At present a 30 metre reservation exists along the western foreshores of the Crooked River. Correspondence received from NSW Fisheries (included in the QEM 1992 Botanical Analysis Report) recommends that in this area the buffer zone should be 100 metres wide. Mills (1989) and McNeill (1990) also recommend at least a 100 metre buffer adjacent to Crooked River.

6.5 THE NEW SOUTH WALES COAST - GOVERNMENT POLICY

The New South Wales Coast - Government Policy (1990) is directly relevant to the area proposed for rezoning. The Policy states that "the protection of representative coastal species and ecosystems is important for aesthetic, environmental, scientific and economic

reasons" and furthermore that "....the responsibility for species protection must also be shared by private landholders."

The following sections quoted from this policy statement are considered to be directly relevant to the study area.

i) "The Government's policy is to ensure that environmental planning and land management strategies (i) acknowledge the sensitivities associated with the presence of unique species of flora and fauna and particular ecosystems outside of the National Park and Nature Reserve network; and (ii) appropriate measures to protect them.

This will still be achieved through the land zoning provisions of the Environmental Planning and Assessment Act, 1979. The first major zoning to be used under this Act has been the Environmental Protection Zone. This special zoning was a measure originally introduced under the 1973 Coastal Lands Protection Scheme to generally prohibit uses not related to agricultural or recreational purposes on environmentally significant sites. Local councils have subsequently incorporated other environmental protection zones over coastal land in Local Environmental Plans. These include environmental zones for purposes such as escarpment protection, wetlands, foreshore protection and habitat protection.

There has been increasing pressure to permit development within these zones and theoretically this could be achieved by rezoning. The Government policy will be to require Local Environmental Studies to be undertaken to support any proposal to rezone land currently zoned for environmental protection purposes."

"Local councils will retain the option of identifying land to be subject to environmental protection zonings where this is necessary. It should also be noted that the question of flora and fauna protection is a matter which must be considered by local councils when making decisions on development proposals."

Through the proposed rezoning Kiama Municipal Council appears to be attempting to implement the aims and strategies of the NSW Coast Policy as quoted above.

ii) "Coastal Wetlands and littoral rainforests are special cases where the Government has already introduced protective provisions."

"The number of Littoral Rainforests has been greatly reduced by land development, clearing and sand mining along the coast. The small remaining pockets are still under considerable threat of disturbance or destruction. Littoral rainforests are a unique type of

> rainforest that have specifically adapted to the salt bearing winds and sandy soils of coastal areas.
>
> SEPP 26 was introduced in 1988 to provide for conservation of specially identified littoral rainforests. It has similar provisions to the Coastal Wetlands SEPP but also requires development approval from the local council for proposals in 100 metre buffer zones around the rainforest core to assist in protecting these sensitive ecosystems from disturbance."
>
> "The Government will continue to implement Coastal Wetlands and Littoral Rainforest State Environmental Planning Policies. Ongoing monitoring and review will be carried out by the Department of Planning to ensure that boundaries are precisely mapped and that the most significant areas are protected."

In addition, the Policy outlines a number of "new initiatives which have been developed to strengthen the range of coastal management measures available to local and State administrations and to give all users of the coastal resource clear signals about how coastal land in NSW is to be used". These include development controls whereby:

> "Heavy mineral sands mining in National Parks, Nature Reserves and littoral rainforests on the coast will be prohibited."
>
> "These prohibitions reflect the fragility of these environments and the high priority that is placed on their preservation."

Thus Kiama Municipal Council's proposal to increase planning protection for an area which contains significant stands of littoral rainforest and estuarine wetland appears to be consistent with *The NSW Coast - Government Policy*. The Council seeks to reduce identified threats to the littoral rainforest and estuarine wetland by prohibiting sand extraction.

6.6 ILLAWARRA REGION SAND MINING STUDY

The Illawarra Region Sand Mining Study (Young & Reffel 1981) refers to the "Seven Mile Beach Sediment Compartment" of the Lower Shoalhaven River which includes the study area. However, the sand mining study does not assess the value of the sand resource within the study area.

6.7 NPWS REFERENCED ADDITION TO SEVEN MILE BEACH NATIONAL PARK

On 17 February 1989 the NSW National Parks & Wildlife Service referenced an addition to the Seven Mile Beach National Park. This proposal includes Lots 21, 22, 23 (DP511283), Lots 3 and 4 (DP420533) and the forested area adjacent to the study area south of Crooked River Road. The proposal was based primarily on the conservation value of the vegetation in the area. Important features identified include floristic diversity, the presence of littoral rainforest and the strip of vegetation from Lot 23 to the sea which was considered to be possibly the only intact representation of the vegetation succession across a coastal barrier dune system in the region and as such to have scientific and educational value.

Section 7

VALUE OF THE EXISTING ENVIRONMENT

This section is limited to a summary of the conclusions of the specialist studies which are attached to this Summary Report. Data, literature reviews and illustrations supporting the statements made in this section can be found in the studies themselves.

7.1 VEGETATION

Two core areas of native vegetation located within the study area have been identified in previous studies, and confirmed by further investigation in this review study, as having inherent high conservation significance. These are:

Core Area a)

An area either side of Blue Angle Creek including Lots 3, 4, 21 and part of Pt 85A and extending through Lots 22 and 23 which contains:

- a plant community of regional conservation significance - swamp forest (*Eucalyptus robusta)*
- stands of a plant community of regional and national conservation significance - littoral rainforest including SEPP No. 26 areas
- an undisturbed and continuous sample of coastal vegetation zonation which extends from the fore dune vegetation south of Crooked River Road, through riparian, dune and swale, and swamp forest
- an area containing a variety of mature rainforest trees identified as an important seed source for replenishment of the littoral rainforest.

Core Area b)

An intact wetland area considered to be of regional significance because of its contribution to the marine productivity of the Crooked River and consisting of:

- a delta formation on the western shore of the Crooked River estuary between the junctions of two un-named tributaries and the Crooked River (Department of Environment and Planning 1983)
- all of the remaining creek bank vegetation along the banks of these two un-named tributaries.

The SEPP No. 26 littoral rainforest areas within the study area are enclosed by a 100 metre wide protective buffer zone. Mills (1989) proposed an additional 150 metre buffer area on the northern shore of Blue Angle Creek to protect the littoral rainforest species on the northern shore from the sand extraction development proposed in 1989. The vegetation survey conducted for this Local Environmental Study recommends that the 100 metre buffer be extended to encompass all of core area (a).

It is also suggested that consistency is needed between the zoning of the study area and that area between Crooked River Road, Seven Mile Beach and the Seven Mile Beach National Park presently zoned Open Space 6 (a). Under the existing zonings of Rural 1(a) and Open Space 6(a) native plant communities of conservation value in both areas are at risk of being progressively destroyed.

The National Parks & Wildlife Service have previously recognised the conservation value of the native vegetation within core area (a) by referencing the area as a proposed extension of Seven Mile Beach National Park.

Mills (1989), McNeill (1990) and NSW Fisheries in 1992 (correspondence included in Appendix A) consider that a buffer zone at least 100 metres wide on the western shore of Crooked River is needed to protect the estuarine wetland area (core area b). The vegetation survey conducted for this Local Environmental Study confirms the need for the proposed 100 metre wide estuarine wetland buffer zone.

7.2 FAUNA AND WILDLIFE HABITAT CORRIDORS

Appendix B shows that no detailed fauna surveys have been carried out in the study area. Previous reports have contained:

i) lists of species casually observed, or

ii) species expected to occur in habitats identified by botanical assessment (Mills 1988, 1990a, b).

The limited site surveys conducted for this review study (see Fauna Report and Avifauna Report attached to this Summary Report) identified four habitat types within the study area. A rich native avifauna and a high density of greater gliders was also identified, particularly in Lot 22.

Although Blue Angle Creek represents a barrier to the movement of some ground-dwelling animal species, the importance of the study area for fauna is related to its connection with Seven Mile Beach National Park. The study area contains faunal habitats that are apparently not abundant in the National Park (swamp forest, littoral rainforest) but which provide important food resources and shelter, particularly for arboreal mammals. Therefore it is expected that for many animal species the forest and woodland communities within the study area form a functional extension of Seven Mile Beach National Park.

The forest types represented in Seven Mile Beach National Park are poorly conserved in the Illawarra region and the park is long and narrow in shape and already well isolated from other coastal forest remnant. Therefore the forests in the study area are likely to contribute to the ability of the National Park to conserve the animal species of the area in the long term.

Rezoning of the entire study area in its present condition could not be justified on the basis of the fauna species found or the faunal habitat present in the site. However, certain sections within the study area (viz Habitats A and B) do have high faunal habitat value, which should be protected, especially in the context of the proximity to Seven Mile Beach National Park.

Habitat A contains a diverse range of habitat types. The extensive herb layer is important for many terrestrial mammals such as *Antechinus* species, long-nosed bandicoot and bush rat. There is also a dense shrub layer which provides cover and also food for species such as the feathertail glider, eastern pygmy-possum and ringtail possum. Many mature trees in this area contain hollows suitable for arboreal species.

This area is probably used by arboreal and larger terrestrial mammals (eg swamp wallaby and bandicoot) as an extension of the habitat present in the Seven Mile Beach National Park.

Habitat B contains littoral rainforest and swamp forest (dominated by *Eucalyptus robusta).* This area has value for a variety of fauna, providing: (i) tree hollows for arboreal mammals, bats, and some reptiles and (ii) creek bank habitat and moist terrestrial habitat for many amphibian species. A variety of feed tree species are provided within and around the littoral rainforest, in particular *Acacia* species which provide a food source for sugar gliders and other arboreal mammals.

Species listed in the revised (interim) Schedule 12 of the National Parks and Wildlife Act are known or expected to occur in these areas.

This habitat type is poorly represented in the Seven Mile Beach National Park and is therefore an important source of the resources mentioned above for fauna within the area.

It is recommended that the areas shown as Habitats A and B (Figure 1, Fauna Report) be protected by a rezoning to Rural Environmental Protection 7(1).

Habitat C has been cleared extensively and its potential as habitat has therefore been considerably reduced. Some use by greater gliders was observed and swamp wallabies were also seen using the area.

Habitat D was quite heavily infested with *Lantana camara* and was further disturbed due to its close proximity to the caravan park. Only one native mammal species, the common ringtail possum, was observed here. This species uses dense shrub for nesting and is known for its resilience to disturbance.

Due to the amount of past and recent disturbance in Habitats C and D, faunal habitat value has been considerably reduced. It is concluded therefore that protection of these areas by rezoning would be of little immediate benefit.

7.3 ARCHAEOLOGY

Based on the available database, it is shown in the Archaeological Report attached to this Summary Report that the study area originally contained a relatively high density of sites of various types which indicated a variety of subsistence strategies and site location preferences.

Site inspections conducted for this study by Ms Kerry Navin and NPWS Regional Archaeologist Ms Sue Feary indicated that many of the recorded sites and relics have recently been destroyed by agricultural or sand extraction activities.

Despite the potential for sub-surface archaeological material in estuarine fringing areas, the disturbed nature of the majority of the study area and the probable surface character of most of the archaeological material means that the majority of the known archaeological resource has limited or low significance.

Based on this assessment, a proposal to rezone the total study area based on the significance of the archaeological resource would be difficult, if not impossible, to support.

The available database indicates that no archaeological survey or recording has occurred in Lots 22, 23 (DP511283) and Lots 3 and 4 (DP420533). The absence of direct information

makes it impossible to make specific assessments about these land portions with regard to the rezoning proposal.

However, based on the limited amount of land disturbance which has occurred in these areas (as evidenced by the surviving vegetation) and the distribution of archaeological sites on comparable adjacent topographic features, the potential for archaeological sites to occur is considered to be moderate. Sites are most likely to be found where locally elevated and well drained ground occurs adjacent to wetland or swale areas.

It could be anticipated that any sites occurring in these areas are likely to be less disturbed than the known sites in the adjacent areas. As the only surviving sites located within a now substantially disturbed site complex, their archaeological significance is potentially high. Without information from area specific archaeological investigations, it cannot be determined whether these areas include archaeological resources which would warrant protection under a Rural Environmental Protection 7(l) zoning.

7.4 VISUAL

Previous visual analyses of the study area appear to have adequately assessed the areas scenic attributes (Visual Analysis Report attached to this Summary Report). Previous studies generally agree that the site is part of an area of significant scenic quality with a wide visual variety but differ on the potential visual impact of proposed sand extraction in the area.

The study area and its surroundings are of significant scenic quality and are visible from a number of vantage points. Within the study area three different landscape character types were identified during a site inspection on 17 December 1991. These are:

- blackbutt forest
- swamp forest
- scattered trees (result of recent land clearance).

The blackbutt and swamp forest areas can be considered to have low scenic quality due to lack of visual variety, whereas the cleared area can be considered to have a medium to high scenic quality because of increased visual variety. The landscape character within the site would be permanently changed by sand mining, the forest being replaced by large areas of open water.

The high visual significance of a continuous tree cover on the coastal plain unit which includes the study area, means that further large scale clearing is undesirable. Further clearing of the already partially cleared portion of the study area would be visible from the Kingsford Smith Memorial at Gerroa, but screening with tall growing tree species would be effective in reducing this impact. A change of landscape character within the study area would occur if sand extraction occurred, but this would only be visible from within the area and not of regional significance.

It is difficult to support rezoning the study area to environmental protection on visual grounds as properly planned and maintained buffer planting and site rehabilitation should be able to minimize any short- or long-term visual impacts.

7.5 THE SAND RESOURCE

The Coastal Hazards Analysis and Sand Resource Assessment Report attached to this Summary Report confirms that the value of the sand resource to the Illawarra Region is substantial. However, as with all non-proven resources, there is a tendency to overstate its quality, quantity and value. This would appear to be the case at Gerroa. Until the extent and quality of the resource are more clearly defined, future demand is identified, and alternative sources developed or rejected, it is possible to develop a number of scenarios from the available information which give the resource a greater or lesser degree of importance.

There are however a number of factors which currently mitigate the importance of the Gerroa resource:

- a high proportion of sand may not be suitable for concrete and would be used as fill material (this opinion is supported by statements made in the 1992 EIS for sand extraction from Lot 26 (Corkery & Co Pty Limited 1992))
- the existing approved resource at Gerroa is capable of supplying the projected local demand for around 20 years
- the site is currently the most remote from the major markets in the northern region
- the currently approved Illawarra Region resource is of the order of 10 to 12 years supply (high when compared to the Sydney market)

- there are a number of other potential sources (such as Lake Illawarra) which may be developed over the next few years.

The main problems with the existing zoning, which permits sand extraction with consent, relate to increased erosion, particularly along Blue Angle Creek during major flood events, and increased turbidity in the Crooked River estuary as a result of the clearing operations. There would also be some lowering of ground water levels as a result of the recent formalisation of drainage channels through the area.

If sand extraction activities were to proceed, eg as proposed by Cleary Bros (Bombo) Pty Limited (Hardcastle & Richards 1988 & 1992 and Corkery & Co Pty Limited 1992), there would be further changes in groundwater levels and flow patterns. It is not possible to quantify the impact of these changes given the available information, and further investigation would be required, particularly near important vegetation and habitat areas. Flooding of the excavation pits or erosion along Blue Angle Creek could also occur. This may result in a breakthrough into the excavation pits which would exacerbate changes to the creek alignment and mobilise large quantities of washery fines.

Following any substantial mobilisation of fines, turbidity in the Crooked River estuary would increase with a consequent adverse impact on the biota. Any pyrites in the fines deposited above water level would oxidise and contribute to increased groundwater acidity.

The rezoning proposed by Council would sterilise the sand resource in the study area. The modified rezoning recommended in this Local Environmental Study would effectively sterilise the sand resource in Lot 22 and within the proposed buffer area in Lot 26 and Pt 85A (DP4467). The sand resource in Lots 21 (DP511283), 3 and 4 (DP420533) and part of Pt 85A (DP4467) and part of Lot 22 have already been sterilized through gazettal of the littoral rainforests and buffers in these areas under SEPP No. 26.

Section 8

RECOMMENDATIONS

The following recommendations are based on evidence collected through review of available information, liaison with government agencies and new data collected for this Local Environmental Study. Rezoning is recommended only where the flora and fauna resource is considered to be of high conservation value and presently vulnerable to degradation or destruction under the existing zoning.

1. The rezoning of the total study area as proposed by Kiama Municipal Council in February 1990 is not supported by the findings of this Local Environmental Study.

2. Information collected for this study and presented or referenced in the supporting documents does however indicate a modification of the proposed rezoning to cover portions of the study area with high conservation value. It is considered that the recommended modified rezoning proposal meets the aims and objectives of Illawarra Regional Environmental Plan No. 1, the National Parks & Wildlife Service, the NSW Fisheries guidelines and NSW Government's Coastal Policy Statement.

3. Based on both the flora and fauna resource, this Local Environmental Study identifies a core area (Figure 3) of high conservation value. The core area includes Lots 3 and 4 (DP420533), Lots 21, 22, 23 (DP511283), part of Lot 26 (DP4498), part of Pt 85A (DP4467) and part of DP359547. This area contains:
   - stands of littoral rainforest which are not protected by existing zoning or SEPP No. 26 - Littoral Rainforest
   - two SEPP No. 26 - Littoral Rainforest areas and their buffer zones
   - several stands of *Eucalyptus robusta* swamp forest
   - a coastal vegetation zonation.

   In their own right, the vegetation communities within the core area are considered to be of regional conservation significance. Under the present Rural 1(a) zoning these vegetation communities are unprotected and vulnerable to damage or destruction as a result of permitted activities within and adjacent to the core area (including sand extraction).

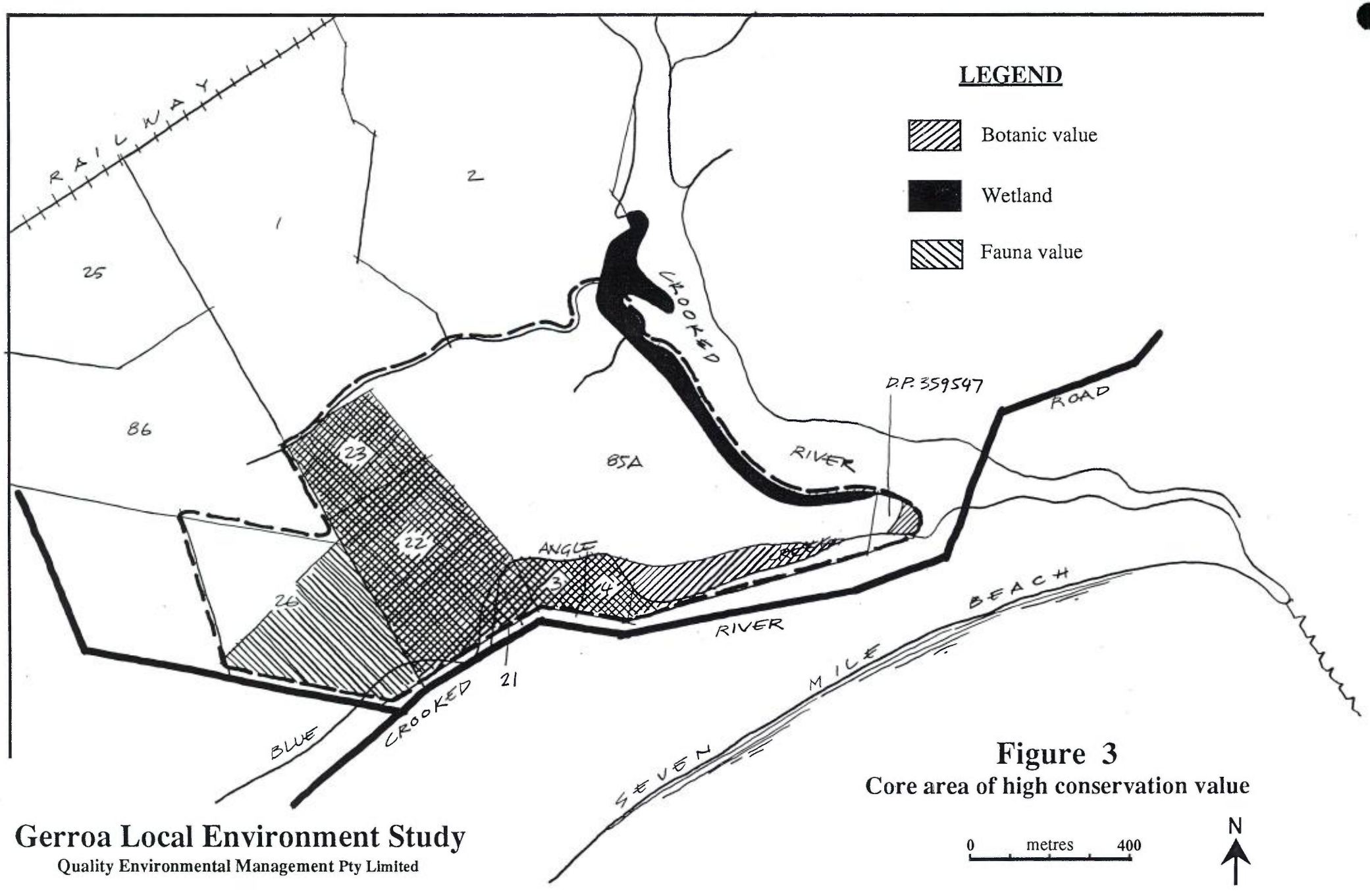

Figure 3
Core area of high conservation value

Gerroa Local Environment Study
Quality Environmental Management Pty Limited

The vegetation communities in the core area represent a faunal habitat which, when considered as a functional unit of Seven Mile Beach National Park, is of high conservation significance. Part of Lot 26 has been proposed for rezoning on faunal habitat value alone. This area is considered to be currently part of an important functional habitat extension of Seven Mile Beach National Park.

The prehistory archaeological resource in the core area is unknown but is likely to be of similar value to that which was known to occur in adjacent areas. It is **not** recommended that any part of the flora and fauna of the core area be destroyed to ascertain the nature of any archaeological deposits.

4. A second core area containing estuarine wetland was identified, although its conservation significance is unconfirmed (Figure 3). It is recommended that the conservation value of the Crooked River estuary wetland be further assessed so that appropriate controls may be imposed to protect this natural, commercial (in terms of fish breeding) and recreational resource.

5. This study indicated that the flora, fauna and archaeological resources on those parts of the study area outside of the core area, have been degraded by agricultural and sand extraction activities. As a result they no longer possess attributes which make them suitable, in their own right, for the proposed rezoning to Rural Environmental Protection - General 7(l). However, a rezoning of parts of this disturbed area is strongly recommended to provide a buffer for long-term protection of the core areas. Furthermore, a visual buffer area containing both *Casuarina glauca* and taller eucalypts is recommended to be protected and enhanced on the shoreline of Crooked River and Blue Angle Creek.

6. It is recommended that the conservation value of the Crown Land on the southern side of Crooked River Road be assessed and that, where appropriate, consistency in management aims and objectives be achieved between the zoning of this land and that of the study area. This area is a critical section of the fauna habitat linkage between the core area and Seven Mile Beach National Park.

7. The following suggestions are made in relation to the proposed Rural Environmental Protection Zone 7(l) as it applies to the core area. Purposes for which development may not be carried out except with consent should include:
   - bushfire hazard reduction (to be defined to prohibit burning)
   - environmental protection work (to be defined)

- removal or destruction of proclaimed noxious weeds
- subdivision pursuant of consolidation of the conservation area
- works by NPWS.

Purposes proposed by Kiama Municipal Council to be allowed as 'development permitted with consent' in the zone, which should be deleted include:

- drainage
- removal or destruction of trees and other vegetation
- roads
- subdivision.

8. The sand resource in the Illawarra Region is currently under multiple ownership. A continuation of the piecemeal approach to consent for successive extensions of extraction of this sand is likely to result in a cumulative reduction and ultimate loss of coastal areas of high conservation significance within the Region. It is therefore recommended that a Regional Plan of Management for Sand Extraction should be prepared to ensure that a regional balance is established between conservation of the coastal environment and utilisation of the sand resource. If such a plan was available it is considered that it would indicate that the sand resource on the study area is of insufficient relative value to warrant further destruction or indirect impact upon vegetation of significant conservation value.

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BOTANICAL ANALYSIS REPORT

KIAMA MUNICIPAL COUNCIL

JANUARY 1992

BOTANICAL ANALYSIS

PROPOSED REZONING OF LAND IN THE VICINITY OF BLUE ANGLE CREEK, GERROA

Quality Environmental Management Pty Limited
PO Box 113 FAIRY MEADOW 2519

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1. INTRODUCTION

In February 1990 Kiama Municipal Council resolved to prepare a Draft Local Environmental Plan to rezone land in the vicinity of Blue Angle Creek and Baileys Island from Rural 1(a) to Rural Environmental Protection - General 7(l).

In May 1990 the Department of Planning advised Council that a Local Environment Study was required for finalisation of the Local Environment Plan.

The matter did not proceed until December 1991 when Quality Environmental Management Pty Limited was invited to prepare a Local Environmental Study for the land proposed for rezoning (Figure 1).

This report considers the botanical resources contained within the study area and reviews information and opinion contained in previous reports. For the purposes of the preparation of this report, site inspections were undertaken on 17 December 1991 and 14, 15, 22 and 25 January 1992 to assess the current status of the botanical resource within the study area in relation to the content of previous studies.

Botanical reports undertaken previously represent a comprehensive analysis of the significance of the botanical resources in the study area. All of the previous reports indicate that it contains areas in which the botanical resource is of high conservation significance. In addition, they imply that this botanical resource is sensitive to modification of the adjacent environment and that specific management strategies need to be adopted to protect the resource for future generations. Two sites within the study area have been gazetted under State Environmental Planning Policy No 26 - (Littoral Rainforests) as Littoral Rainforests 175K and 175J.

Recommendations are made about protection of those botanical resources identified as having conservation significance.

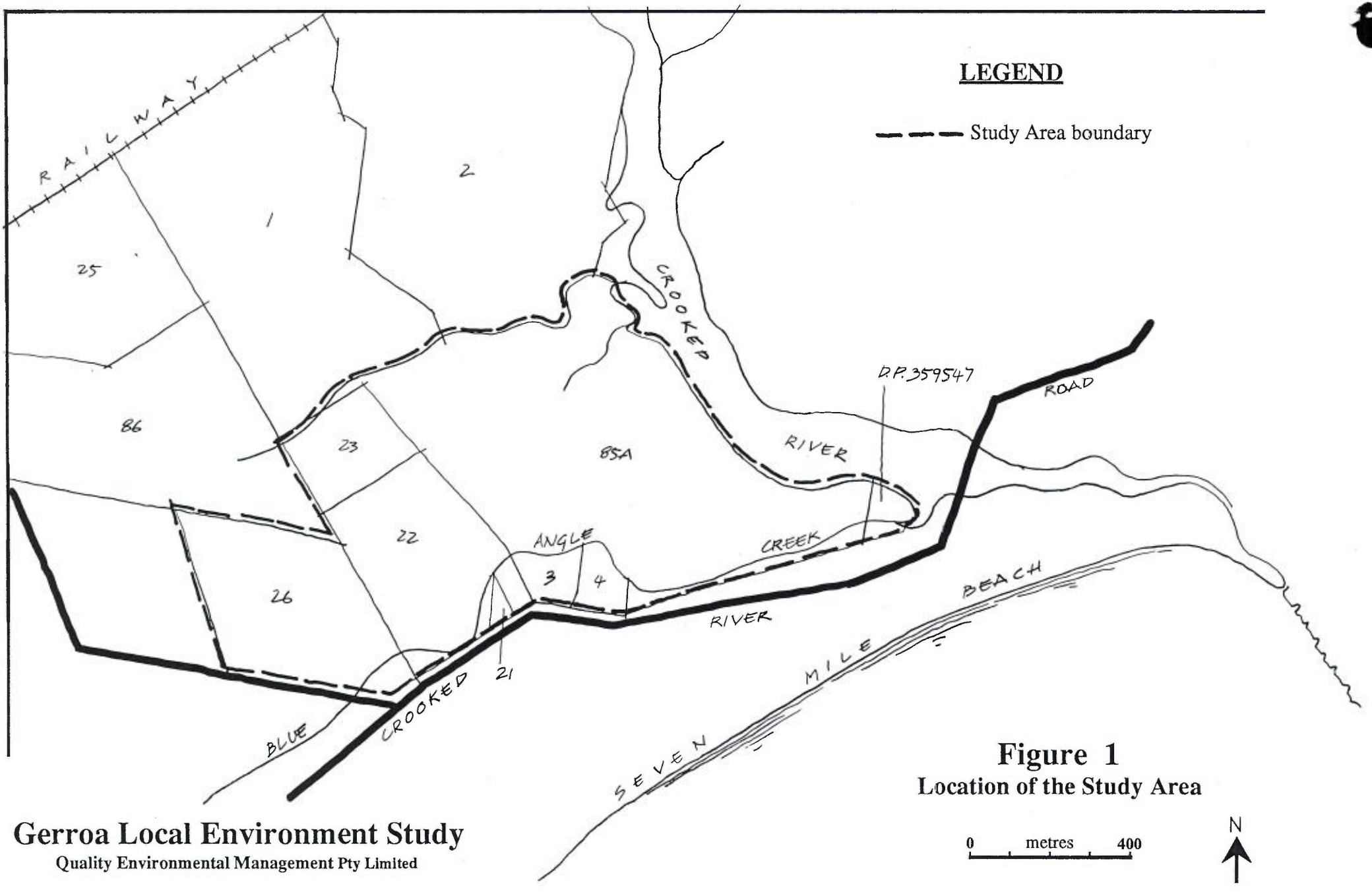

Figure 1
Location of the Study Area

Gerroa Local Environment Study
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2. THE STUDY BRIEF

The Department of Planning has specified that the Local Environment Study should have regard to:

a) The Illawarra Regional Environmental Plan No. 1

b) State Environmental Planning Policy No. 14 - Coastal Wetlands

b) State Environmental Planning Policy No. 26 - Littoral Rainforests, and

d) the relevant findings and recommendations of the following studies:

  i) Illawarra Region Sand Mining Study, and

  ii) Illawarra Region Wetlands Study.

In addition, the study should identify and assess features of environmental, heritage, cultural or visual importance, with a view to protecting them from undesirable development, especially:

a) significant stands of vegetation and wildlife habitats and corridors

b) areas of particular visual amenity, or land which is an important component of the Municipality's rural environment, and

c) wetland areas.

3. PLANNING INSTRUMENTS, REGULATIONS, NSW GOVERNMENT POLICY STATEMENTS AND REGIONAL STUDIES

The study area has a vegetation cover which varies between open pasture, scattered eucalypt trees in cleared land and dense native forest. The future of this vegetation is likely to be influenced directly by nomination and regulation in various planning instruments and state government documents, and indirectly by the interpretation of various government policy statements. This section of the report reviews the status of the vegetation cover within the study area in relation to these documents.

Under Kiama Local Environmental Plan No 5 1981, the study area is zoned Rural 1(a). Agricultural activities may be carried out on the land without consent. This includes modification of drainage, application of fertilizers and grazing. The Rural 1(a) zoning affords no part of the vegetation cover any special recognition or protection apart from control by Council under its Tree Preservation Order. Two SEPP No. 26 - Littoral

Rainforest areas and a 30 metre wide reservation bordering the Crooked River are located within the study area.

Council currently proposes to rezone the study area to Rural Environment Protection - General 7(l). Under this zoning, sandmining and other forms of extractive industry are proposed to be prohibited. It is further proposed that other works such as bushfire hazard reduction, environmental protection works, drainage, removal or destruction of trees and other vegetation, roads and subdivision will require development consent from Council. The proposed rezoning would strengthen Council's position in relation to protection of any significant environmental sites or features on the study area.

The Illawarra Regional Plan - Landscape and Environment Study (Department of Environment & Planning 1981) identifies part of the study area as lying within "Unit 6: Shoalhaven Delta", and as being a "Botanically Significant Area". This delineation appears to encompass Lots 21, 22, 23 (DP511283), Lot 26 (DP4498), Lots 3 and 4 (DP420533) and part of Pt 85A (DP4467) (Figure 2). The presence of extractable sand deposits are noted in that report as potential pressures affecting the environmental attributes of the area.

No part of the study area is gazetted under SEPP No 14 - Coastal Wetlands. *The Illawarra Region Wetland Study* (Department Environment & Planning 1983) however, recognises as 'wetland' a part of the western shoreline of the Crooked River (Figure 3). No other part of the study area is specifically noted in that study.

The Department of Agriculture and Fisheries' *Estuarine Habitat Management Guidelines* (1991) requires that, during the preparation of Local Environment Plans, all wetlands (including seagrasses, mangroves and saltmarshes) must be mapped for the purpose of protective zoning. In addition, foreshore buffer zones at least 30 metres wide must be created to protect foreshores and separate developments from sensitive habitats. At present a 30 metre reservation exists along the western foreshores of the Crooked River.

Within the study area, two areas located between Blue Angle Creek and Crooked River Road have been gazetted as Littoral Rainforests 175K and 175J under SEPP No. 26. Vegetation within a 100 metre wide strip around the outer edge of each of these designated areas is protected under SEPP No. 26 as a buffer zone.

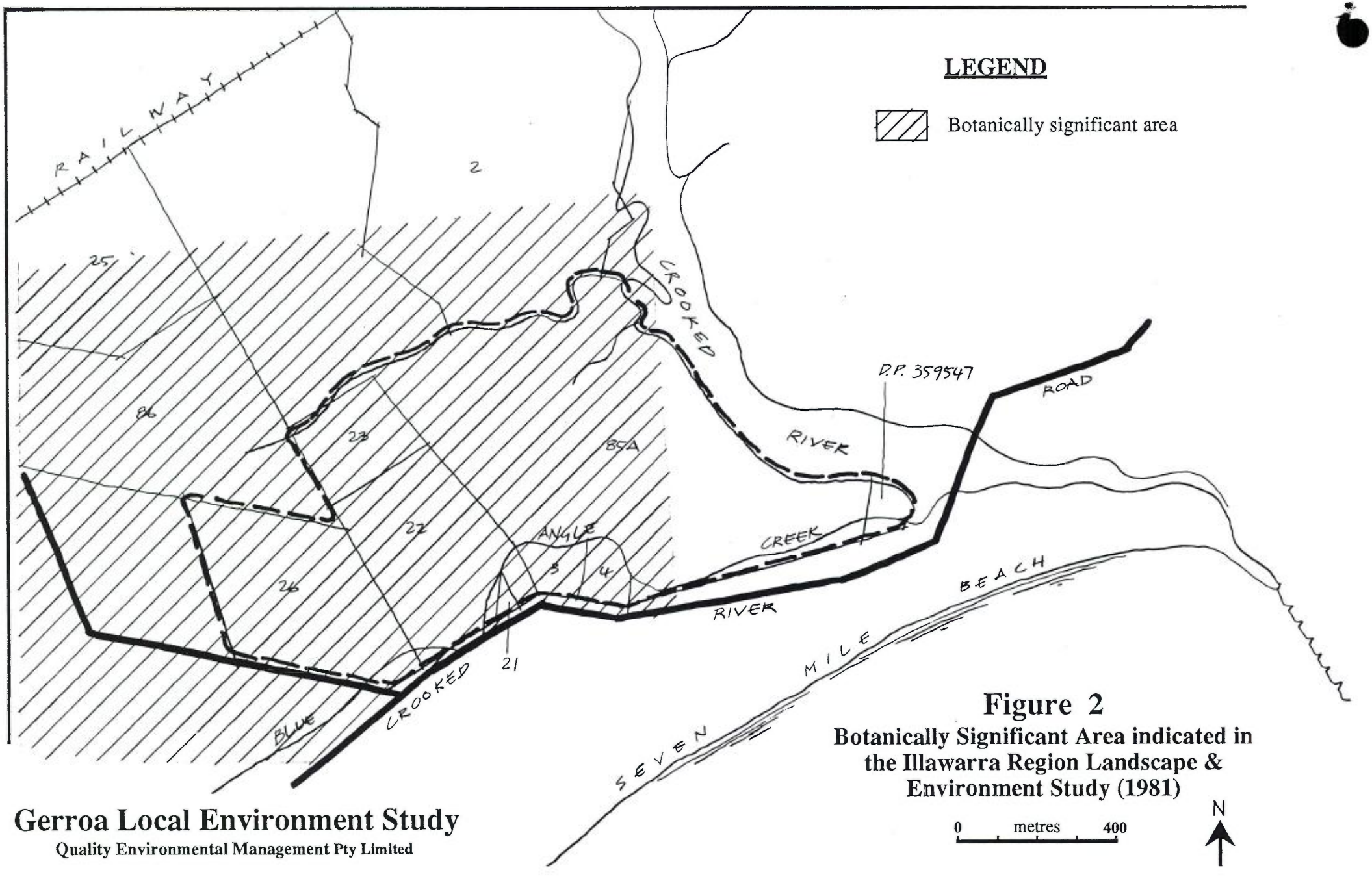

Figure 2

Botanically Significant Area indicated in the Illawarra Region Landscape & Environment Study (1981)

Gerroa Local Environment Study

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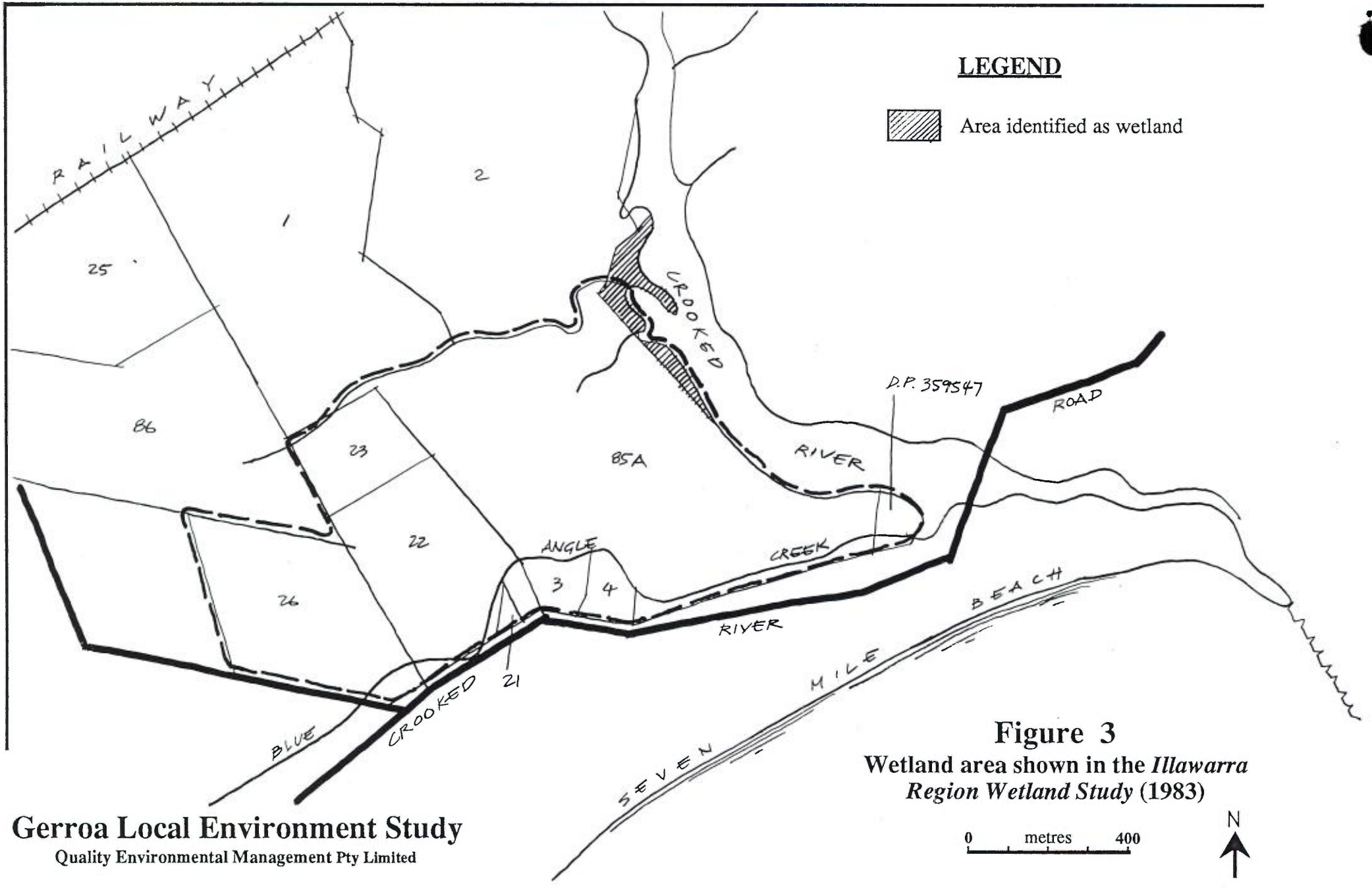

Gerroa Local Environment Study

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Figure 3

Wetland area shown in the *Illawarra Region Wetland Study* (1983)

In 1990 the NSW State Government published its Coastal Policy (Department of Planning 1990). This Policy states that "the protection of representative coastal species and ecosystems is important for aesthetic, environmental, scientific and economic reasons". The Policy aims to ensure that particular ecosystems outside of the National Park and Nature Reserve network are protected through the land zoning provisions of the Environmental Planning & Assessment Act 1979. Furthermore, it is government policy to undertake on-going monitoring and review of coastal wetlands and littoral rainforest to ensure that the boundaries of areas protected by State environmental planning policies are precisely mapped and the most significant areas are protected.

The Illawarra Region Sand Mining Study (Young & Reffel 1981) does not make specific reference to the study area although it does make general reference to the vegetation communities located on the Seven Mile Beach dune system. Its authors state that in 1979 the vegetation was considered by them to be still essentially in its natural state.

On 17 February 1989 the NSW National Parks & Wildlife Service (NPWS) referenced an addition to the Seven Mile Beach National Park (Figure 4). This proposal includes Lots 21, 22, 23 (DP511283) and Lots 3 and 4 (DP420533). The proposal was based primarily on the conservation value of the vegetation in the area. Important features mentioned included floristic diversity, the presence of littoral rainforest and the strip of vegetation from Lot 23 to the sea which is possibly the only intact representation of the vegetation succession across a coastal barrier dune system in the region and as such has scientific and educational value.

Recent correspondence with the NPWS indicates that the proposed addition is still viable (Appendix A).

4. HISTORY OF VEGETATION DISTURBANCE

The degree of change undergone by the vegetation within the study area since European settlement has a bearing on its scientific and historic value. It was therefore considered important to assess how much the vegetation in the study area has been disturbed.

Aerial photographs of the site were used to assess changes between 1949 and the present. As no written records were found for the period prior to 1949, changes which may have occurred before 1949 can only be inferred from evidence collected at the site, such as the

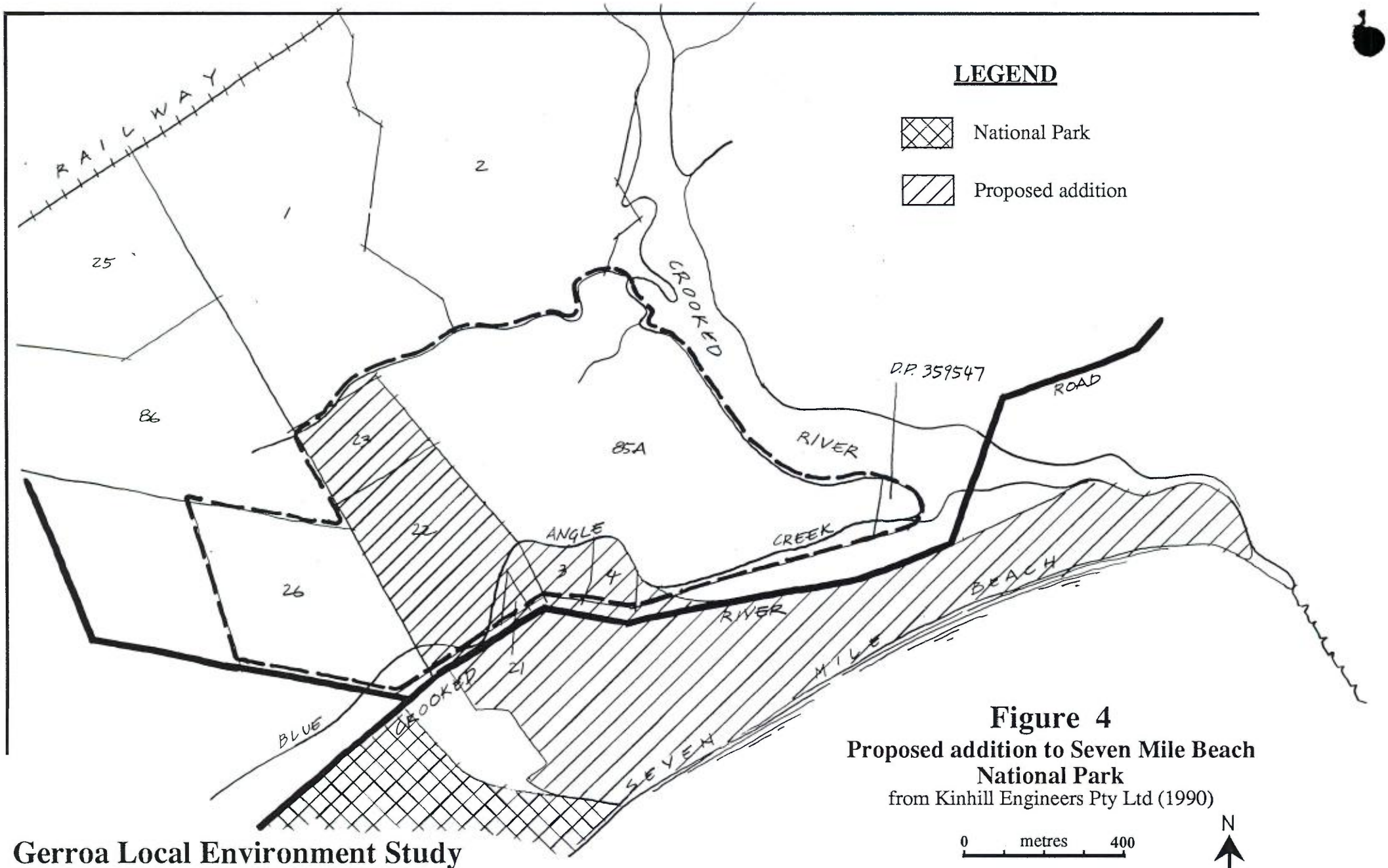

Figure 4

Proposed addition to Seven Mile Beach National Park

from Kinhill Engineers Pty Ltd (1990)

general age of the plant community as reflected in structural characteristics, cut stumps or archaeological relics.

In the following section this evidence is used to determine whether any part of the study area contains vegetation which may be considered representative of that which predated European settlement.

Examination of aerial photographs taken in 1949, 1961, 1963, 1974, 1979, 1980, 1984, 1986 and 1988 indicated that statements about a lack of vegetation disturbance in the *Illawarra Region Sand Mining Study* (Young & Reffel 1981) are somewhat misleading in relation to the study area. Figures 5 to 8 indicate the chronology and extent of disturbance, but give no indication of the degree of disturbance.

The 1949 photograph (Figure 5) showed some slight activity probably involving minor clearing of undergrowth and some trees immediately adjacent to the land owned by Kiama Municipal Council at the confluence of Crooked River and Blue Angle Creek. A cleared area was located in the middle of the northern section of Lot 26. The 1961 photograph showed an intensification of tree clearing in the same area and a cleared patch on the southern edge of the area now designated Littoral Rainforest 175K (SEPP No. 26). The 1963 photograph showed the same extent of disturbance plus an additional scar on the south western side of Littoral Rainforest 175J (SEPP No. 26). In addition there were incursions of tree clearing into the northern boundaries of Lot 26. The 1974 photograph (Figure 6) showed further areas of clearing including definite evidence of tree thinning and understorey clearance along Blue Angle Creek and over the area now locally known as Baileys Island. Destruction of the forest cover between Littoral Rainforests 175K and 175J (SEPP No. 26) had been extended and a small break in the canopy towards the north of Lot 23 was obvious. In the 1979 aerial photograph, the open tree canopy pattern was much less obvious, most probably due to a discontinuation of disturbance and regrowth of a shrub or tree sapling cover over previously cleared areas. In the 1979 photograph, however, there was a thinning of the forest cover over the area known as Lot 26 indicating the first major disturbance in the southern part of this area.

In the 1984 photograph, with the exception of a gap in the canopy between littoral rainforests 175K and 175J (SEPP No. 26) all other parts of the study area appeared under undisturbed forest cover or in a state of forest recovery sufficient to conceal earlier periods of disturbance. This indicates an extension of the regrowth phase noted on the 1979 photograph.

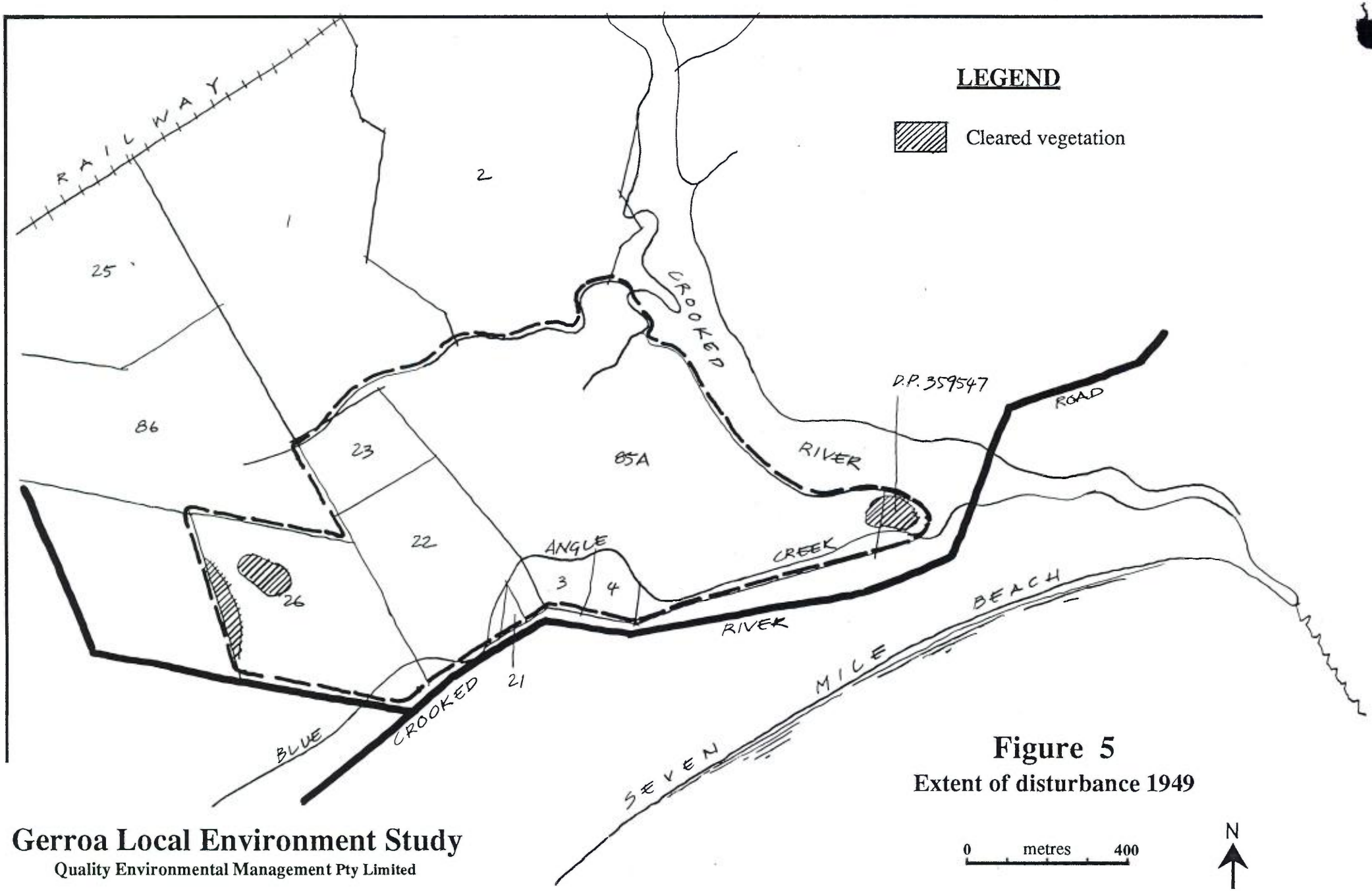

Figure 5
Extent of disturbance 1949

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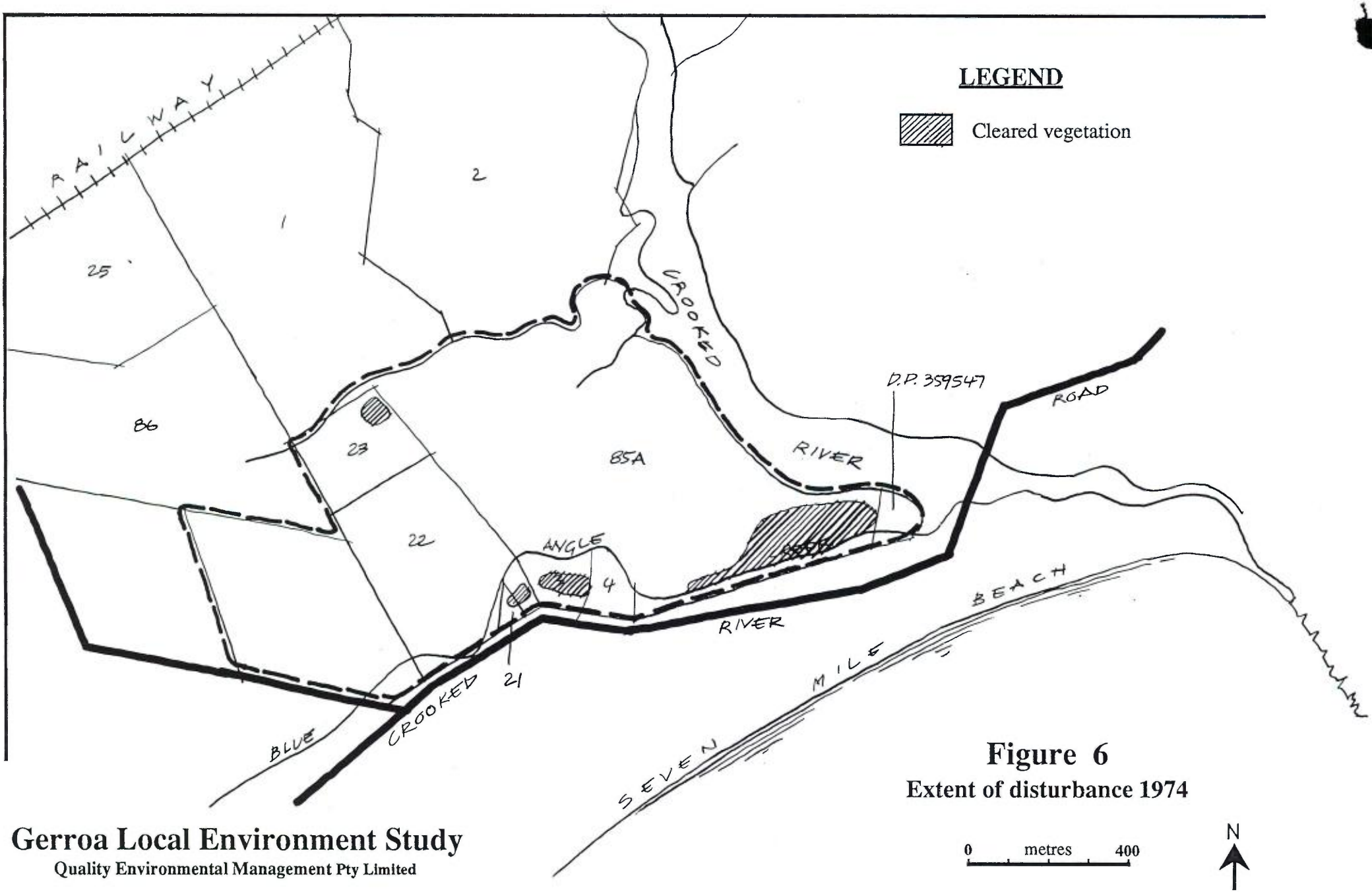

Figure 6
Extent of disturbance 1974

Gerroa Local Environment Study
Quality Environmental Management Pty Limited

In the 1986 photograph (Figure 7) the forest cover appeared to have recovered over Lot 26, the area adjacent to the SEPP No. 26 areas and part of the area east of Lots 22 and 23. There was an obvious area of extensive tree removal in the middle of Pt 85A (DP4467). By 1986 the entire northern triangle of Lot 26 had been cleared.

In the 1988 photograph (Figure 8) removal of the tree canopy was extensive across Pt 85A (DP4467) with evidence of windrowing of cleared tree and undergrowth. In addition an excavation pit had been created on Lot 26. The early stages of clearing of tree cover on Pt 85A (DP4467) was noted by Dr Muston in an inspection of Baileys Island in 1985. Site inspections in 1991 and 1992 pursuant of preparation of this report indicated that most of the windrowed material evident on Baileys Island (Pt 85A DP4467) in the 1988 photograph had been removed, the ground surface raked and/or ploughed and much of the remnant vegetation on the verges of the drainage lines through the area had been burnt. In addition, understorey shrubs, lantana and ground cover plants had been cleared by machinery in and around the remnant forest cover on the western side of Blue Angle Creek, adjacent to and inside the 100 metre buffer zone of Littoral Rainforest 175J (SEPP No. 26).

It is evident from examination of the sequence of aerial photographs from 1949 to 1988 and site inspections in 1985, 1991 and 1992, that there are areas of native forest cover within the study area which have not been disturbed since 1949. However, even within Littoral Rainforests 175K and 175J (SEPP No. 26) and Lot 22 the field evidence indicates an early episode of selective logging and fire scars indicate that periodic bushfires have occurred.

4.1 UNDISTURBED SITES

Based on available evidence, it is concluded that the presently 'undisturbed areas' of vegetation have maintained an indigenous species diversity and have resisted gross invasions of exotic species throughout the period of European settlement of the area. These areas are:

- all of Lot 23, except an excavated drainage line across the Lot, a small excavated pit and an area at the north-eastern edge of the Lot where a drain has recently been constructed and regrowth cleared
- all of Lot 22, except for an access road beside Blue Angle Creek

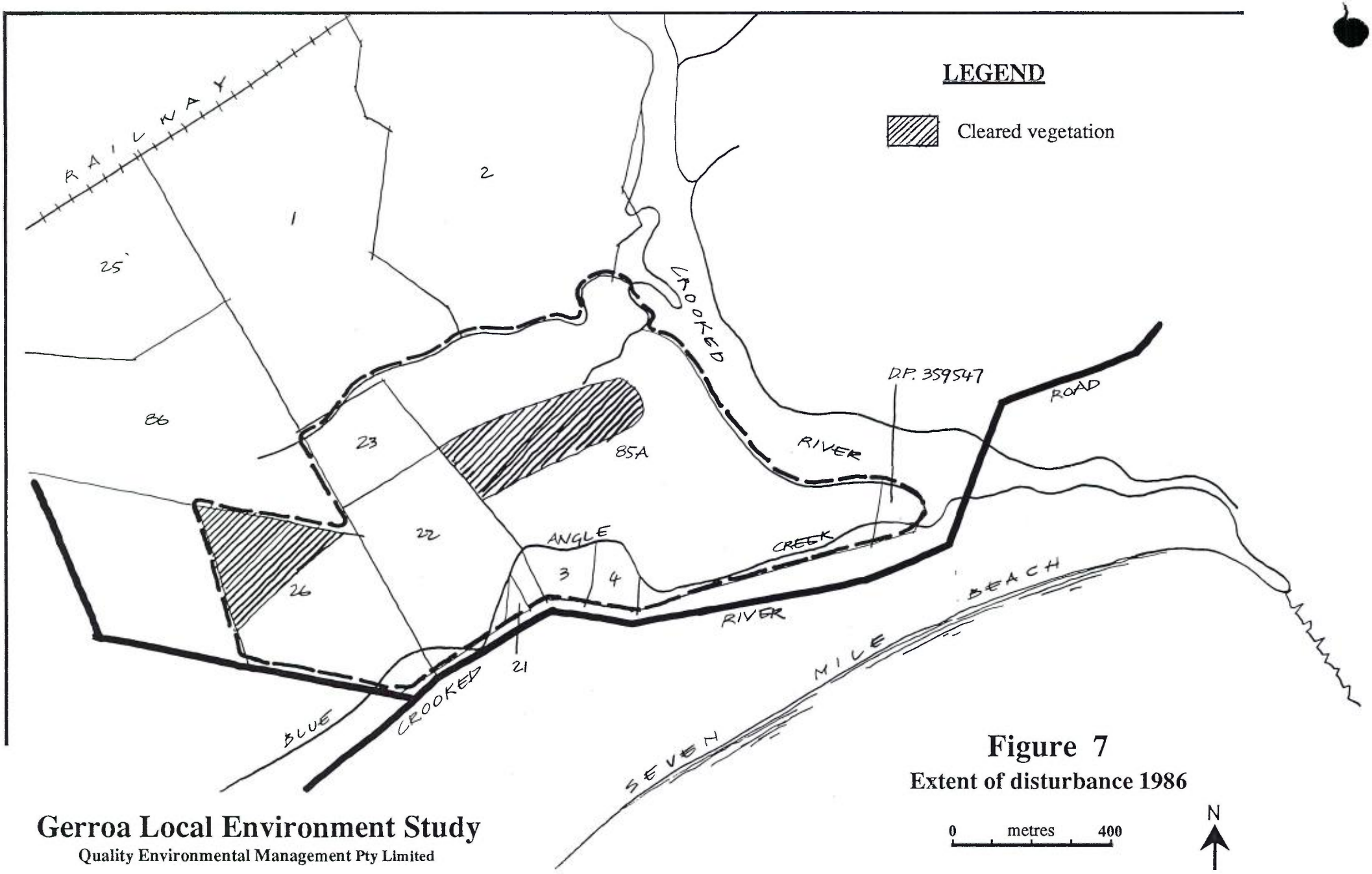

Figure 7
Extent of disturbance 1986

Gerroa Local Environment Study
Quality Environmental Management Pty Limited

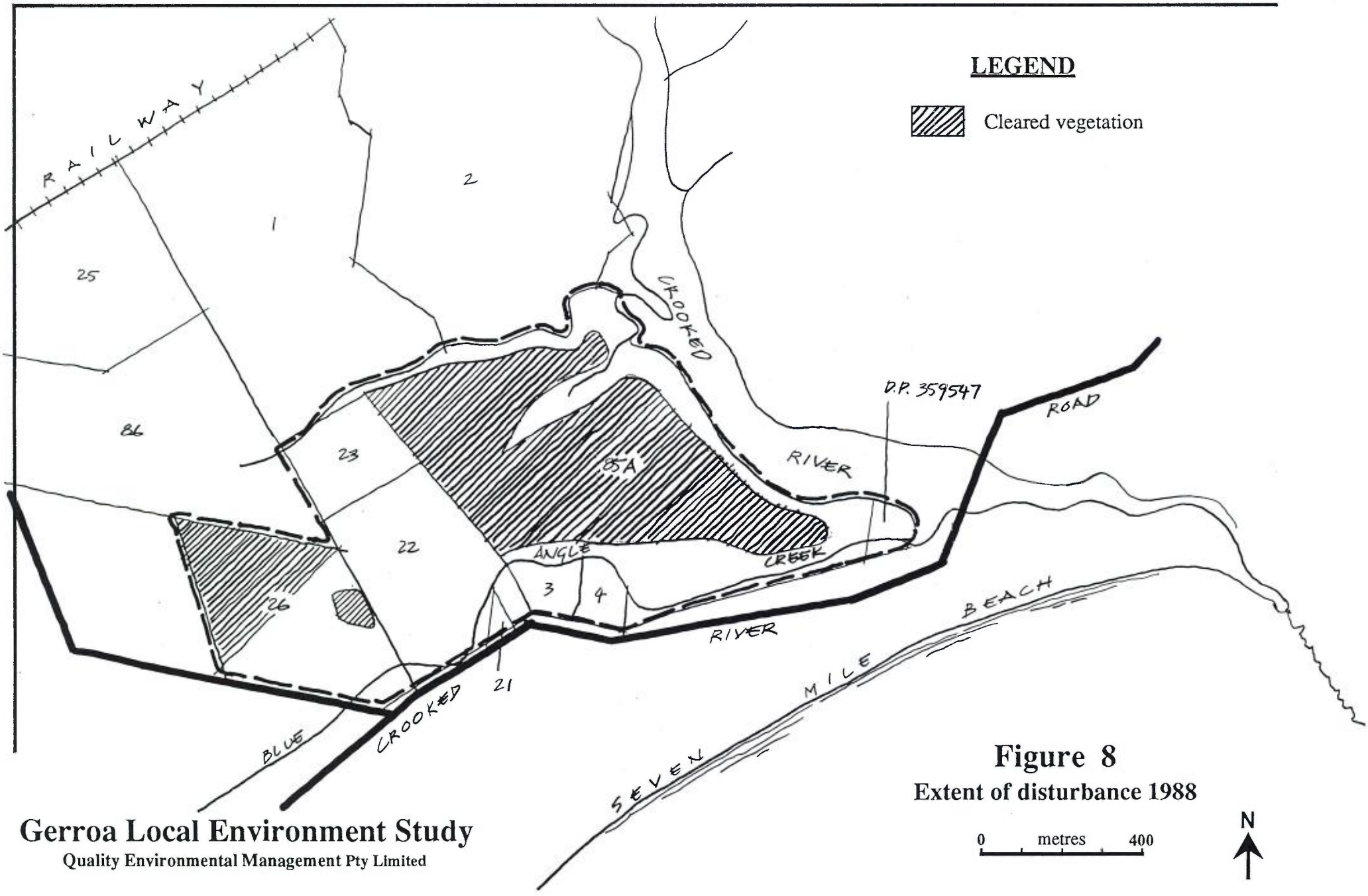

Figure 8

Extent of disturbance 1988

Gerroa Local Environment Study

Quality Environmental Management Pty Limited

- most of Lots 3, 4 and 21 (except for an area between Littoral Rainforests 175K and 175J (SEPP No. 26) where native dry forest species have colonised old sand extraction pits)
- the eastern edge of Lot 26 on the southern side of Blue Angle Creek.

Three additional areas were found to be rich in rainforest species despite the presence of a lantana understorey. These are:

- most of the land between the caravan park and Lot 4 on the southern side of Blue Angle Creek
- a small area at the tip of Baileys Island at the confluence of Crooked River and Blue Angle Creek
- small areas on the northern side of Blue Angle Creek east of Lot 4.

4.2 DISTURBED SITES

The remaining forest within the study area has undergone phases of disturbance from which there is evidence of a capacity for forest recovery in all instances except:

- the northern triangle of Lot 26, where in the first phase of disturbance the forest was replaced with improved pasture and grazed
- the pit on Lot 26, where excavation of sand resulted in removal of surface and subsurface materials and in which there is no evidence of colonisation by indigenous species
- the bulk of Pt 85A (DP4467) after the 1991 episode of clearing and surface disturbance where there has been insufficient time for overall colonisation by indigenous species.

4.3 RECOVERY POTENTIAL

Some indigenous species are already germinating and establishing in Pt 85A (DP4467) despite recent removal of the windrows left after the 1986 - 1988 episode of clearing on the northern section of this area. These windrows represented scattered patches of recovering native plant cover in which the growth and maturing of seed bearing trees would have created a focus for dispersal of seed and thus waves of regrowth across the broader cleared areas. Some of these regrowth areas remain but on the northern part of this area potential seed bearing trees have been significantly thinned.

Across the more elevated sections in the middle and southern sections of Pt 85A (DP4467) there is a diversity of mature seed bearing eucalypts sufficient to initiate recovery of the forest cover. In the absence of grazing or clearing it is common for 'halos' of germinating eucalypt seedlings to emerge under trees like these. The density of mature trees in this area would result in an overlapping of these 'halos'. Establishing specimens of other indigenous species (including the mesic understorey species) are presently scattered over this area.

Exotic species, in particular lantana and blackberry, are also likely to colonise the cleared areas in the absence of grazing or further clearing. The quality of any native forest cover in this area will depend on the relative growth of exotic and native species. Any recovering forest which established on this extensively disturbed area is now likely to have a significant component of introduced species for many decades to come. It is likely however that indigenous species will continue to germinate, establish, and emerge from under any lantana canopy.

The apparent ability of disturbed areas of the forests in the study area to recover so successfully, prior to the 1970s, would probably have been due to a general lack of disturbance in adjoining areas and a lack of any extensive adjacent weed seed source.

By the 1980s the episodes of disturbance were more frequent, the extent of clearing was broader and the availability of weed seed had increased greatly. These factors now inhibit return of a native plant community in anywhere near its original form.

Thus, although recent disturbance within parts of the study area has been extreme, the area is likely to still have the capacity to undergo a natural process of forest recovery. Despite the presence of invasive introduced species, the resulting forests of mixed indigenous and exotic species would have a higher wildlife habitat value when they occur on the edges of broader undisturbed forests. These areas of regrowth functionally extend available habitat (food,

shelter) for native fauna than when they occur as small isolated fragments. The native plant species richness of these forests usually continues to increase as seed from adjacent forests is introduced via animal agents.

Regrowth forests of mixed mature and exotic species are most important in situations where adjacent remnant forest is of such a small size that removal of the regrowth forest is likely to leave the remnant forest as an 'island' in an otherwise cleared or developed landscape and therefore vulnerable to disturbance.

In summary, there appear to be areas of 'undisturbed' vegetation within the study area. The remaining disturbed areas appear to retain sufficient of their natural attributes to still possess the capacity to recover in the form of mixed native and exotic forest. Some of the more disturbed areas, such as the sand pit and treeless paddocks, would be likely to take much longer to achieve a forest cover than those areas in which the presence of indigenous trees provides a ready seed source.

5. PLANT COMMUNITIES WITHIN THE SUBJECT LAND

The plant communities within the study area have already been comprehensively described and assessed in various previous studies (Muston 1984 and Mills 1988, 1988(a), 1989 & 1990).

It is not the intention of this report to repeat the detailed descriptions given in those previous reports. This section of the report will consider the botanical significance of the vegetation.

Plant communities of regional and statewide conservation significance have previously been identified within the study area. These include:

a) littoral rainforest patches and associated buffer areas, and mature rainforest specimen trees *(National Significance)* covering:
   - much of Lot 22 (identified in Mills 1990)
   - part of Baileys Island (Pt 85A DP4467) adjacent to the western shore of Blue Angle Creek (Mills 1989 & 1990)
   - Lots 21, 3 and 4, and the land between the caravan park and Lot 4 (Mills 1990)
   - a small area at the confluence of Crooked River and Blue Angle Creek (DP35947) (Muston 1984).

b) *Eucalyptus robusta* open forest/woodland *(Local Significance)* found in Lots 21 and 22 (Mills 1990).

c) Wetland *(Regional Significance)* on the shores of Crooked River (Dept of Environment & Planning 1983).

During the site inspections a floristic comparison was made of three rainforest sites within the study area (Figure 9). Comparative species lists in Tables 1 - 4 are not comprehensive and are only intended as indicative of the similarity between the areas. These lists indicate that Lot 22 and the SEPP No. 26 Littoral Rainforests are essentially similar in rainforest species composition. However, red cedar *(Toona ciliata)* and celerywood *(Polyscias elegans)* were observed in Lot 22 but not in the SEPP No. 26 areas.

Pt 85A (DP4467) adjacent to Blue Angle Creek contains not only many of the species in Lot 22 and the SEPP No. 26 Littoral Rainforest areas but also ten additional rainforest tree species. Mills (1990) indicated the presence of species of conservation significance due to their being at or close to their southern limit of distribution in Lot 22, SEPP No. 26 areas and their buffer zones and Pt 85A (DP4467). The 1992 surveys conducted for the Local Environmental Study confirmed that these species are distributed across these areas as well as the small area owned by Kiama Municipal Council on the eastern tip of Baileys Island (DP359547).

5.1 LITTORAL RAINFOREST

5.1.1 Intact Littoral Rainforest

Site inspection revealed that the littoral rainforest within Lot 22 appears relatively 'undisturbed' and in excellent condition. Mills (1990) states that "Lot 22 contains vegetation types that are uncommon to rare in the Illawarra Region and in Southern New South Wales generally."

Table 1 (Appendix C) provides a comparison of the rainforest tree/shrub species composition of Lot 22, the SEPP No. 26 areas and associated buffer areas, and the land on the northern shore of Blue Angle Creek. Table 1 shows that the rainforest species composition on Lot 22 is essentially the same as that in the SEPP No. 26 areas. Pt 85A (DP4467) was observed to contain four rainforest tree species which were not found in the other areas. Lot 22 contains less exotic weed species possibly because it is further removed from potential sources of disturbance along the main road than the SEPP No. 26 area,

however, the forest structure in Lot 22 is different from the other areas containing rainforest communities. Emergent eucalypts occur in all the littoral rainforest stands including the SEPP No. 26 areas. There are extremely old eucalypts in all areas although those on Lot 22 have been damaged and these trees now occur as smaller stems re-sprouted from massive bases. Generally, the eucalypts in Lot 22 and Pt 85A (DP4467) are smaller in stem diameter and appear more frequent in distribution than in the SEPP No. 26 areas. Similarly, the rainforest trees in Lot 22 tend to be multi-stemmed, less tall and with smaller stem diameters than those in the SEPP No. 26 areas. Mills (1990) implies that this difference may be due to a moisture regime difference between the two sites with Lot 22 being 'drier'. Alternatively, selective logging and fire in the distant past may have caused the initiation of a phase of rainforest recovery or colonisation which has produced the present low closed rainforest canopy. Regardless of the history of development of each area, floristically the three areas are similar and all occur in a similar topographic location on the same sand deposit which qualifies all three to be identified as 'Littoral Rainforest'.

5.1.2 Disturbed Littoral Rainforest

During the 1991 - 1992 site inspections it was noted that the littoral rainforest at the confluence of Crooked River and Blue Angle Creek appears to retain the mature rainforest component that was described in the Muston (1984) study, however considerable lantana invasion occurs in the understorey.

Part of the strip of mature rainforest trees which extend along the northern shore of Blue Angle Creek in Pt 85A (DP4467) has been disturbed by clearing of the understorey and a lantana understorey is present through the remainder. However, the rainforest trees which remain in this area have a high conservation value both in their own right and as a seed source for replenishment and enhancement of adjacent intact littoral rainforest areas.

5.1.3 The Viability of the Littoral Rainforest

Long-term survival of any part of the littoral rainforest is dependant on a continuing seed source for replenishment, maintenance of a faunal community (in particular, bats, insects and birds which act as agents of seed dispersal and pollination), protection of the existing moisture and nutrient regime, and shelter from wind and salt damage.

The probability of long-term survival of the present SEPP No. 26 areas is therefore not only dependant on maintenance of an appropriate buffer area, but also on the continued existence of the adjacent intact and disturbed littoral rainforest patches which presently have no statutory protection.

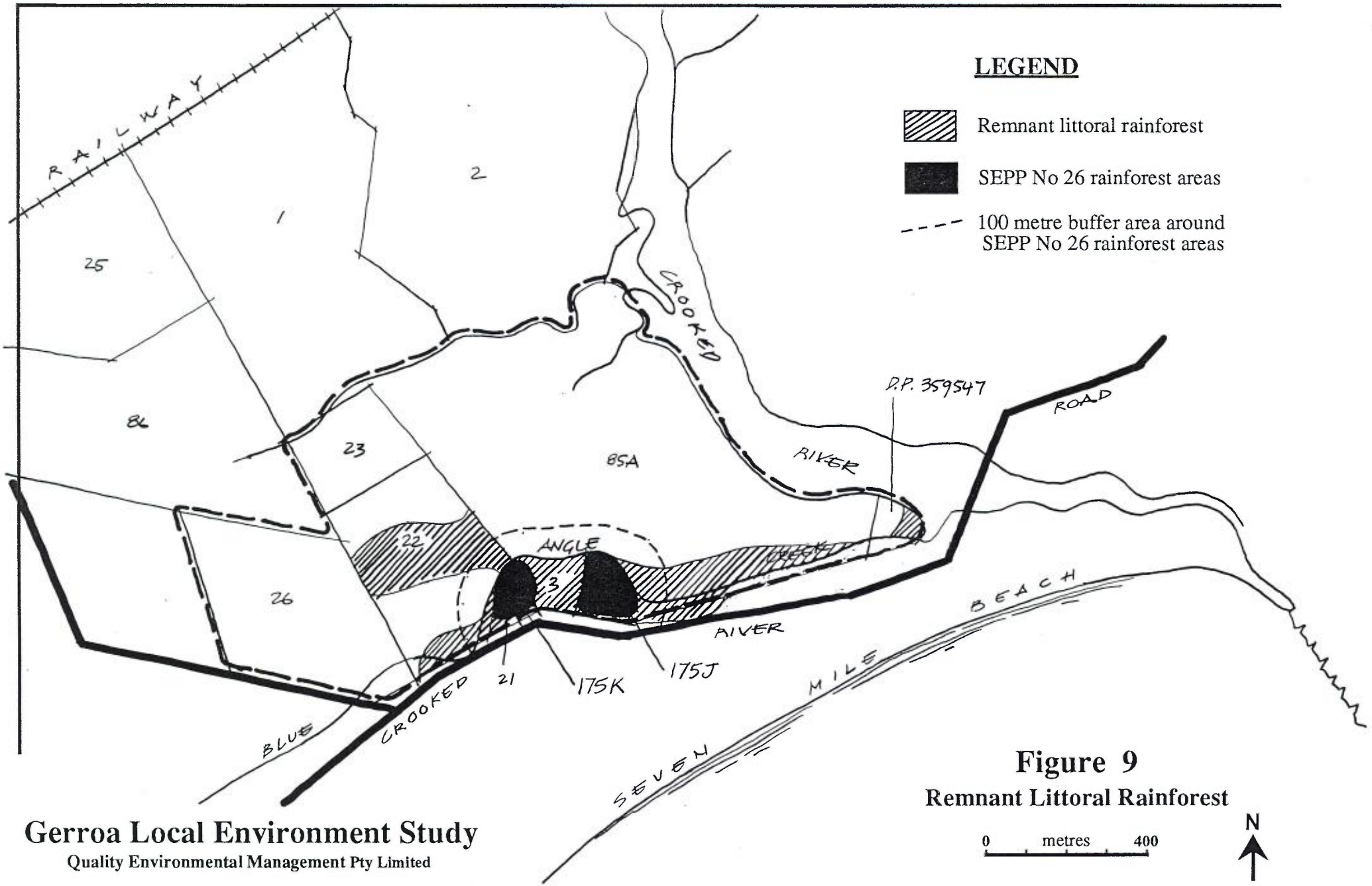

Figure 9
Remnant Littoral Rainforest

Gerroa Local Environment Study
Quality Environmental Management Pty Limited

When considered as a single, continuous botanic unit the littoral rainforest remaining on either side of Blue Angle Creek (Figure 9) in both disturbed and intact stands is a relatively large and mostly unprotected, but valuable, representation of this now rare and poorly protected plant community type. The SEPP No. 26 areas were gazetted in 1988 whereas no investigation or reporting was undertaken for Lot 22 until 1990 and no separate lists have previously been prepared for each area. A prompt review of the adequacy of the boundaries of the SEPP No. 26 areas at Gerroa would appear to be urgently needed in order to incorporate information that has become available since the 1988 gazettal and to ensure that all littoral rainforest areas are afforded adequate long term protection.

5.2 *Eucalyptus robusta* SWAMP FOREST

Swamp forest *(Eucalyptus robusta* community*)* had previously been mapped in Lots 22 and 26 (Mills 1990).

Site inspection revealed that most of the Swamp Forest mapped by Mills (1990) within Lot 22 remains 'undisturbed' except for the presence of a dirt access road, however further clearing of this community has occurred in Lot 26. During preparation of the Local Environmental Study *Eucalyptus robusta* was also observed on drainage lines elsewhere in Lots 22 and 23, in a patch of intact swamp forest behind the rainforest strip on Pt 85A (DP4467) and as isolated trees on the north-eastern edge of Lot 26 (Figure 10). *Eucalyptus robusta* is at its southern limit in this area and not protected in conservation reserves south of Sydney. The *Eucalyptus robusta* community does not cover large areas anywhere in the Illawarra Region (Mills 1990).

5.3 WETLANDS

Detailed specialist assessment of the estuarine habitat of Crooked River is lacking although the anticipated high conservation value of the fishery resource in the Crooked River and Blue Angle Creek is supported by the local fishing club's (Black Matukas) records of catches, by O'Neill (1990) and by statements of the NSW Fisheries (Appendix B).

The area of wetland identified in the Department of Environment & Planning (1983) study still appears to be in excellent condition. This area lies at the confluence of two un-named

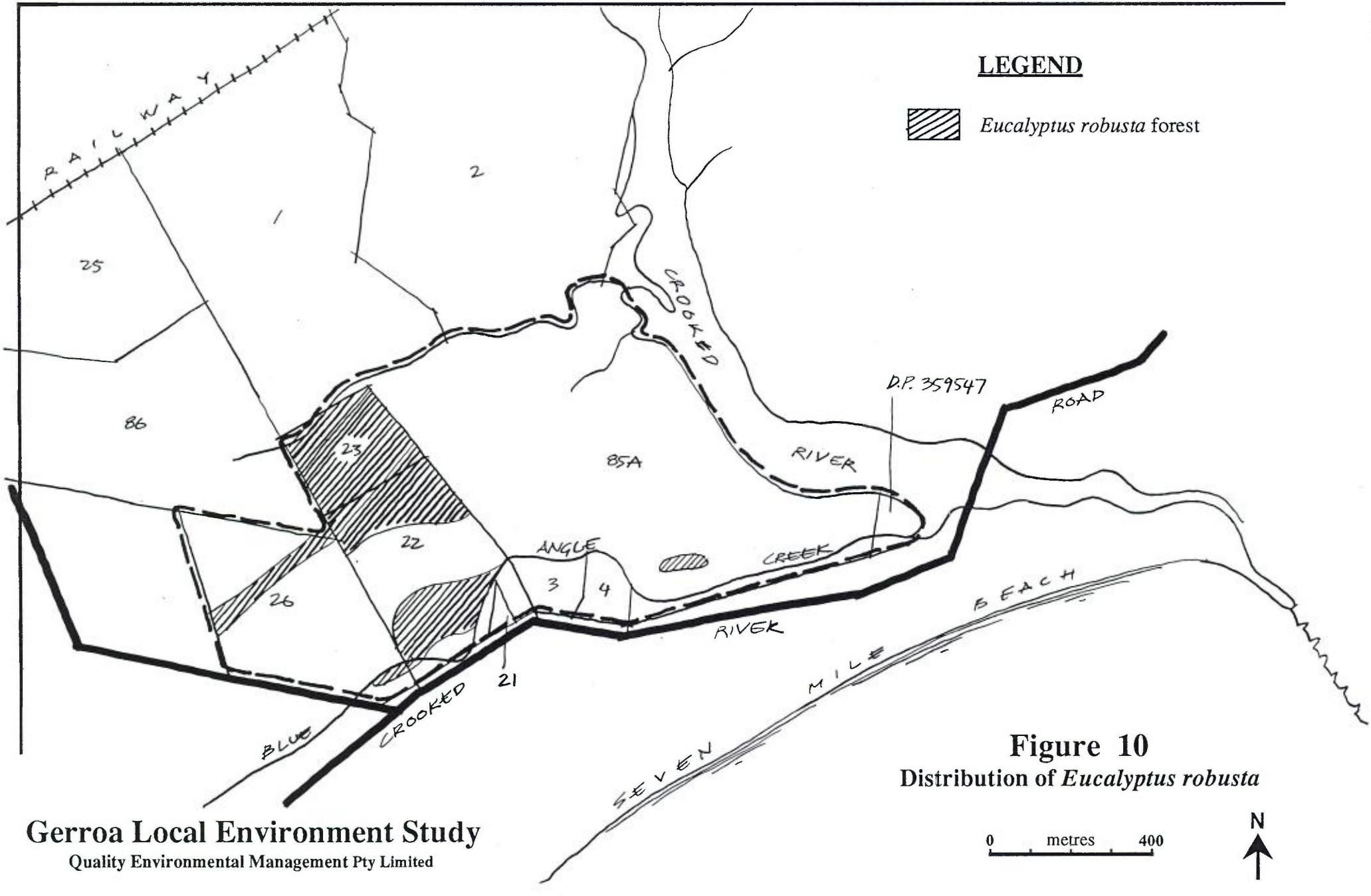

Figure 10
Distribution of *Eucalyptus robusta*

Gerroa Local Environment Study
Quality Environmental Management Pty Limited

tributaries and the Crooked River, and in this location is situated on a deltaic deposit from the larger of the two tributaries. Site inspection undertaken for this study revealed that the wetland area extends in an unbroken band along the southern shore of Crooked River as far as Blue Angle Creek.

It consists of several monospecific zones:

- an intertidal zone of grey mangrove (*Avecinnea marina).* Sand couch and samphire *(Sarcocornia quinqueflora)* occur on the edge of this zone. Isolated mature mangroves to 2.5 metres tall are scattered along this zone. They are connected by a continuous band of immature mangroves of two sizes - one metre tall and prolific recently germinated seedlings.
- a zone of sea rush *(Juncus krausii)*
- an intermediate zone of sand couch
- a zone of *Casuarina glauca* with monkey-rope vine (*Parsonsia straminea)* and swamp lily (*Crinum pedunculatum)*
- a narrow zone of dominated by *Gahnia sieberana* with New Zealand spinach *(Tetragonia tetragonioides),* coastal saltbush *(Einadia hastata)* and other succulent species. The eucalypt forest which would have abutted this zone has in some parts been totally cleared, but isolated *Eucalyptus pilularis* and *Eucalyptus botryoides* occur along much of this zone and in places a native understorey of shrubs, herbs and ferns remains.

The Crooked River was observed to contain broad seagrass beds which cover approximately 60 - 70 per cent of the permanently inundated channel upstream of the road bridge.

The continued protection of this estuarine wetland area will depend on the management of the catchments of its tributaries and protection of creek bank vegetation. It is likely this wetland area would be degraded by erosion, chemical contamination or mechanical disturbance.

5.4 ADDITIONAL CONSERVATION SIGNIFICANCE

Lots 21, 22 and 23 have additional conservation significance as an intact representative sample of the zonation of plant communities across the hind-dunes of coastal barrier systems. Evidence of this zonation was also found in Lot 26 and Pt 85A (DP4467). These hind-dune forests have been largely destroyed on the south coast of NSW. During a recent site inspection a transect was made from the northern boundary of Lot 23 through Lot 22 to Crooked River Road. Reconnaissance of topographic and botanic variation along this transect indicated the following sequence from Lot 23 to Crooked River Road:

- a broad band of swamp in Lot 23
- a sequence of swale and dune sets (two dune ridges) in Lot 22 including areas of littoral rainforest and *Eucalyptus robusta* swamp forest
- Blue Angle Creek and its associated riparian vegetation
- a broad swale containing riparian vegetation and littoral rainforest.

There is no other vegetation zonation of this type conserved between Jervis Bay and Sydney.

The particular significance of this site as an example of coastal vegetation and geomorphological zonation is further enhanced by the inclusion of intact examples of littoral rainforest and *Eucalyptus robusta* communities.

5.5 DISTURBED SITES (OTHER THAN LITTORAL RAINFOREST)

Site inspection confirmed that the indigenous vegetation within most of Pt 85A (DP4467) has been grossly disturbed. It does not represent a plant community of high conservation significance or contain significant species. It does retain some capacity to recover. The exceptions to this are the rainforest patch and the *Eucalyptus robusta* forest on the northern shore of Blue Angle Creek.

The forested portion of Lot 26 was found to have a largely intact indigenous tree canopy and to include isolated mature rainforest specimens. However the understorey in most of this area has been disturbed in the past and is now heavily infested with lantana. Immature common mesic species are establishing amongst the lantana and sclerophytic native shrub understorey indicating that in the future, a low closed rainforest canopy may develop in this area. Although it is clearly in a phase of recovery and has a high wildlife habitat value, this

vegetation community does not, at present, represent a botanic resource of high conservation significance.

6. RECOMMENDATIONS

Review of previous studies together with recent site inspections indicates that within the study area there is a core of vegetation communities which have a sufficiently high conservation value as littoral rainforest, *Eucalyptus robusta* swamp forest or intact coastal zonation to warrant increased protection through rezoning and gazettal under SEPP No. 26 (Littoral Rainforest). The core area proposed for rezoning is shown on Figure 11 and that for gazettal under SEPP No. 26 on Figure 9.

The botanic resource in the core area is vulnerable to activities and changes in the adjacent environment. Of particular concern are:

- changes in the moisture regime of littoral rainforest and swamp forest including alteration of watertable levels and ground water quality
- any severance of the canopy edge which results in exposure of the understorey and a subsequent lowered humidity and/or increased light levels in the littoral rainforest
- destruction of mycorrhizal associations through pollution, lowering of groundwater, or application or wind-drift of fungicides and other toxic substances
- application or wind-drift of herbicides, insecticides or fertilisers
- grazing by domestic livestock
- trampling or disturbance of soil surfaces
- erosion
- fire.

Rezoning of the core area alone will not ensure protection of its botanic resource. It will be necessary to control and restrict activities in the adjacent environment. It is recommended that this would best be achieved by rezoning a buffer area at least 100 metres wide surrounding the core area. Activities specifically prohibited in the buffer zone would include grazing by domestic livestock, drainage works, fuel reduction by burning and removal of vegetation other than proclaimed noxious weeds, except as part of bush regeneration works.

Activities which would require consent would include environment protection works, mechanical fuel reduction, removal of proclaimed noxious weeds, subdivision which consolidates the conservation reserve and works by NPWS.

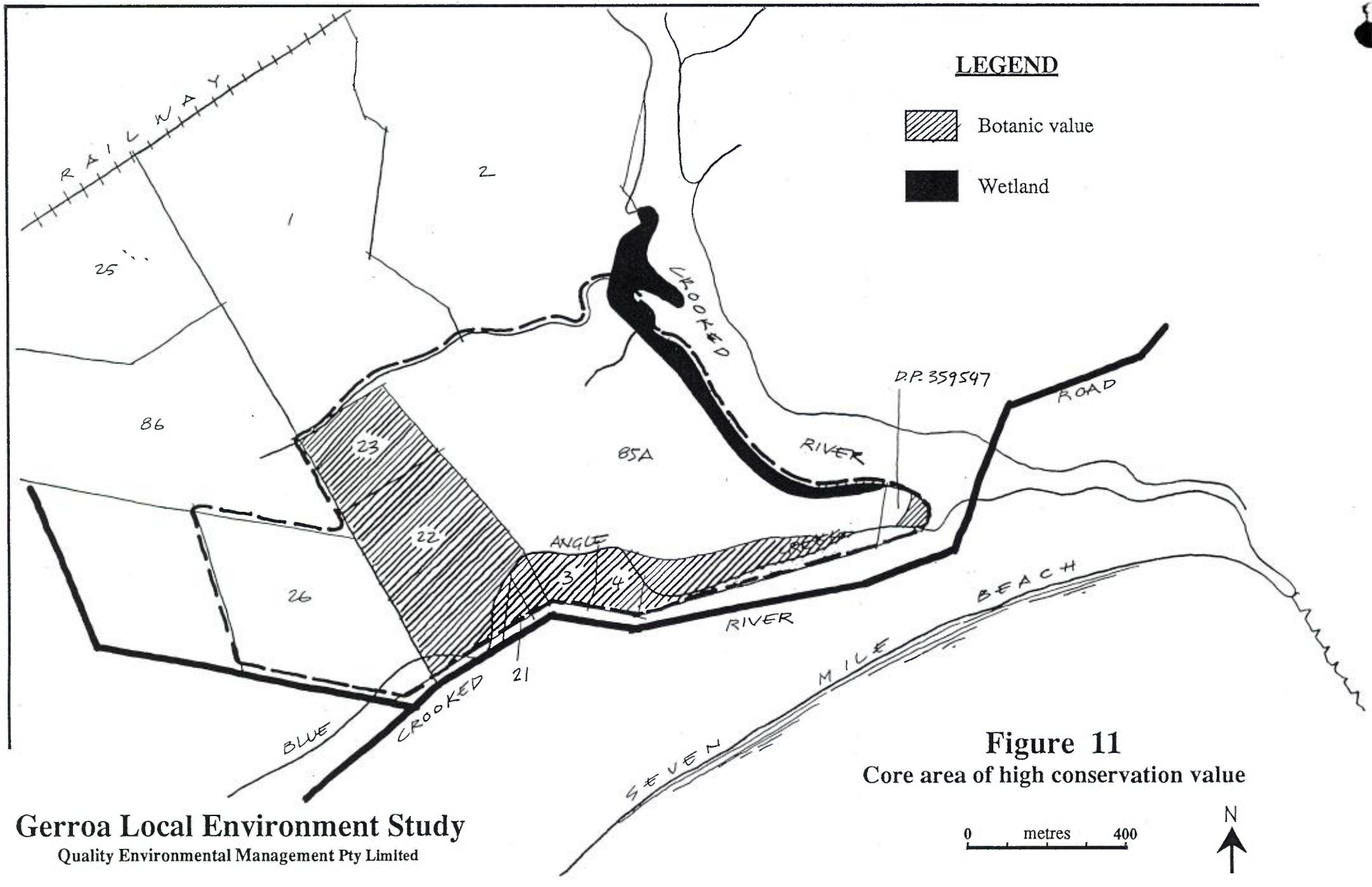

Figure 11
Core area of high conservation value

Gerroa Local Environment Study
Quality Environmental Management Pty Limited

In addition to the core area, the estuarine wetland section of the Crooked River upstream of the road bridge is considered to be of conservation value. It is recommended that further specialist investigation of this area is needed to gauge the level of its conservation value. This area currently has no formal protection under any planning instrument. Activities on the adjacent shorelines and within tributary catchments are likely to have an effect on the estuarine wetland. It is recommended that a buffer area at least 100 metres wide is needed:

- along the inland edge of the wetland on the Crooked River north of Blue Angle Creek
- along the water course on the western boundary of the study area.

Rezoning of the 100 metre buffer area is recommended to control and restrict activities and thus increase the level of protection of the estuarine wetland. Suggested prohibited activities within the buffer zone include vegetation removal, fire, grazing of domestic livestock, roads, use of fertilizers, fungicides and herbicides, and dredging.

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APPENDIX A

Quality Environmental Management Pty Limited
ACN 003 723 288

131 Balgownie Road, Balgownie NSW 2519
PO Box 113, Fairy Meadow NSW 2519
Telephone: (042) **85 2552** Facsimile: (042) 85 2551

29 January 1992

Mr G Spencer
Superintendent
National Parks & Wildlife Service
24 Berry Street
NOWRA 2541

ENVIRONMENTAL SURVEY - LAND IN THE VICINITY OF BLUE ANGLE CREEK, GERROA

Our company has been requested by Kiama Municipal Council to prepare a Local Environmental Study of the land shown on the accompanying map (Figure 1).

I understand from my discussions with Senior Ranger Sales and your fax of 21 January 1992 that the NPWS position is as follows:

1. Area shown on figure 2 has been referenced as proposed additions to Seven Mile Beach National Park. The proposal is currently viable. Acquisition and dedication of the land is subject to state wide priorities.

2. The plant and animal community which occupy the area are considered to have significant conservation value. The Service is concerned that the erosion of these values, particularly littoral rainforest and archaeological values may continue. Forested areas and watercourse vegetation which remain hold considerable value as wildlife corridor and refuge areas.

3. The NPWS would like to see adequate planning and development controls in place over adjacent land uses and activities. These controls should reflect the sensitive nature of remaining stands of vegetation.

4. The NPWS is concerned that the buffer areas around the SEPP 26 land are not disturbed. Any disturbance eg fire, underscrubbing or grazing detracts from the value of the buffer zones. It should be made clear to the landowner that buffer zones are in place to protect SEPP environmental values.

The extent of Archaeological deposits in the area indicates the high likelihood of *in situ* relics within the referenced area.

Thank you in anticipation for your prompt confirmation of the contents of this letter. I apologise for the brief time frame within which I seek your advice.

Yours sincerely

Roslyn Muston

New South Wales Government

National Parks and Wildlife Service

NOWRA DISTRICT

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~~Telephone (044) 21 8969~~
~~Fax (044) 21 9974~~
Telephone (044) 239800
Fax (044) 233122

5th February, 1992

Dear Ms. Muston,

Re: Environmental Study - land in the vicinity of Blue Angle Creek, Gerroa

I refer to your letter of 29th January, 1992 concerning to subject matter.

The points raised in your letter are quotes from my fax of 21st January, 1992. The fax also suggested that the environmental/natural values of the area are strong enough to argue against the proposal to extend sand quarrying operations.

The proposed addition to Seven Mile Beach National Park is secondary or subservient to the existing natural values.

Yours faithfully,

GEOFF SPENCER,
District Officer-in-Charge
for the Director

APPENDIX B

N · S · W FISHERIES

P.O. Box 456 NOWRA NSW 2541
Phone: (044) 219958 Fax: (044) 210588

Dr Roslyn Muston
Quality Environmental Management P/L
PO Box 118
Fairy Meadow 2519

Our ref: HS 92/003

23 January, 1992

Dear Dr Muston

RE: ENVIRONMENTAL STUDY - LAND IN THE VICINITY OF BLUE ANGLE CREEK, GERROA

I refer to you letter of January 20th, 1992 requesting comments to assist you in the preparation of the above study.

VALUE OF CROOKED RIVER, BLUE ANGLE CREEK ETC.

The subject waterways are important to fisheries for recreational fishing in the waterways themselves, contribution to inshore and offshore fish catches (commercial and recreational) and scientific and educational values. The location of a number of caravan parks that are utilised heavily by holiday makers in the area makes the waterways a locally valuable resource. Whilst I am unaware of any studies that quantify these values for the subject waterways, the following information applies to estuaries in general in New South Wales: approximately two thirds by value of the NSW commercial fish catch consists of species that are dependent during all or part of their life cycles on estuaries; approximately one third of NSW residents go fishing at least once per year; expenditure on recreational fishing (excluding items such as accommodation and meals) in NSW in 1980 was estimated to be $280 million (equivalent to $590 million in 1991).

The subject waterways provide the diversity of habitats that are essential for the maintenance of fish populations. These include seagrass, mangrove, shallow sand and mud, and deeper channels. These habitats are used variously by different species of fish, and different habitats are utilised at different life history stages by many species. In addition to finfish the waterways support invertebrates and plant species, which apart from their intrinsic conservation values, are either collected for food (crabs and prawns) or bait (worms and nippers) and form part of the estuarine ecosystem on which the fisheries depend. For these reasons there is a need to protect habitat diversity within the waterways. The smaller creeks and shallow areas are particularly important for juvenile fish.

Apart from their importance for production of estuarine and offshore fish, the subject waterways may be valuable habitats for species which are predominantly freshwater in their habits. Two species of particular interest are Australian Grayling and Australian Bass.

The Australian Grayling, *Prototroctes maraena*, is a potentially threatened fish which is the sole surviving species of a unique Southern Hemisphere family. The New Zealand Grayling is now extinct. Juvenile Australian Grayling are thought to migrate from estuarine or oceanic waters to the freshwater habitats where they spend their adult lives. The species has recently been recorded from Broughton Creek and the Minnamurra River and so could reasonably be expected to inhabit the Crooked River System. Grayling is a protected fish under the NSW Fisheries and Oyster Farms Act. The species and its habitats require special consideration and protection. Australian Bass is a most valuable angling species in NSW coastal streams. Bass generally inhabit freshwater habitats, but they must migrate from fresh to salt water to spawn. After spawning, adult fish return to freshwater over several months. After the young have developed for some time in the estuaries they migrate upstream.

EFFECTS OF CATCHMENT ACTIVITIES

Undoubtedly the most valuable type of catchment for the protection of estuarine values is one with natural vegetation cover and NSW Fisheries supports any land zoning that would protect such a feature. Catchment activities that have involved or may involve tree-clearing, exposure of soils to erosive forces, changed flow conditions, increased nutrient loads, changed channel morphology, creation of barriers to fish movement would all be detrimental to the subject waterways. The types of activities liable to affect aquatic habitats and a general account of the effects of such activities are outlined in NSW Fisheries Freshwater and Estuarine Habitat Management Guidelines. I am unaware of any studies that directly address the measurement of effects of catchment activities on the subject waterways.

From the point of view of protecting aquatic values a completely undeveloped catchment is the most valuable, as stated above. Where this is not feasible, NSW Fisheries recommends that buffer zones be used to separate potentially damaging activities from aquatic habitats. In general these buffers should be at least: 50 metres from seagrasses, 30 metres from mangrove and saltmarsh, and 30 metres from the edge of any waterway. However, the actual size of a buffer zone at any particular site must be calculated based on its effectiveness in slowing surface runoff, absorbing sediment, nutrient and other pollutant loads, stabilising stream banks etc. This calculation must consider the potential flows and loads generated by the local climatic, geological and hydrological conditions, as well as the nature of the activity itself. A setback of 100 metres has been suggested by NSW Fisheries officers for this site.

I hope these comments are helpful.

Yours sincerely

P. Dalmazzo
Biologist (Habitat Management)
for R. Claxton
Director of Fisheries

APPENDIX C

TABLE 1

RAINFOREST TREES/SHRUBS	Lot 22	Pt 85A (DP4467)	SEPP No. 26 175J	SEPP No. 26 175K	DP359547 (Muston 1984)
Acmena smithii	√	√	√	√	√
Acronychia oblongifolia	√	√	√	√	√
Alectryon subcinereus	√				
Alphitonia excelsa	√	√	√	√	√
Canthium coprosmoides	√		√	√	
Cassine australis	√	√	√	√	√
Cinnamomum oliveri		√	√		
Claoxylon australe		√	√		√
Clerodenron tomentosum	√	√		√	√
Commersonia fraseri		√			
Cryptocarya glaucescens	√	√	√	√	
Cryptocarya microneura	√	√		√	√
Diospyros australia		√	√		√
Duboisia myoporoides	√			√	√
Elaeocarpus kirtonii		√			
Elaeocarpus reticulatus	√	√		√	
Endiandra sieberi	√	√	√	√	√
Eupomatia laurina	√	√	√	√	√
Euroschinus falcata	√	√			
Ficus coronata		√			
Ficus macrophylla		√	√	√	
Ficus obliqua		√			
Ficus? rubiginosa	√				
Glochidion ferdinandi	√	√	√	√	√
Glochidion ferdinandi var *pubens*				√	
Guioa semiglauca	√		√	√	√
Litsea reticulata	√?	√			
Livistona australis	√	√	√	√	
Melicope micrococca		√	√	√	√
Notelaea longifolia	√	√			√
Notelaea venosa	√	√	√	√	
Pararchidendron pruinosum			√		√
Pittosporum undulatum	√	√		√	√
Podocarpus elatus	√	√	√	√	√
Polyscias elegans	√				
Rapanea howittiana	√	√		√	
Rapanea variabilis	√	√	√	√	√
Scolopia braunii		√			√
Synoum glandulosum	√	√	√	√	√
Toona ciliata	√				
Trema aspera	√				
Wikiea huegeliana	√	√	√	√	

TABLE 2

OTHER TREES/SHRUBS COMMON ON SAND DUNES	Lot 22	Pt 85A (DP4467)	SEPP No. 26 175J	SEPP No. 26 175K	DP359547 (Muston 1984)
Acacia binervata					√
Acacia floribunda	√				
Acacia maidenii	√	√	√	√	√
Acacia mearnsii		√			
Acacia ulicifolia	√				
Allocasuarina littoralis	√				
Banksia integrifolia	√	√	√	√	√
Banksia serrata	√			√	
Breynia oblongifolia	√	√	√		√
Calistemon salignus	√				
Casuarina glauca	√			√	√
Citriobatus pauciflorus	√	√		√	
Eucalyptus botryoides	√		√	√	√
Eucalyptus pilularis			√	√	
Eucalyptus robusta	√	√			
Goodenia ovata	√				
Leptospermum laevigatum		√	√		√
Melaleuca linariifolia	√				
Monotoca scoparia	√	√	√	√	
Persoonia linearis	√				
Pittosporum revolutum	√	√		√	√
Zieria arborescens	√	√	√		
EXOTIC SPECIES TREES/SHRUBS					
Chrysanthemoides moniliferum		√			
Erythrina x sykesii			√	√	
Lantana camara	√	√	√	√	

TABLE 3

NATIVE VINES	Lot 22	Pt 85A (DP4467)	SEPP No. 26 175J	SEPP No. 26 175K	DP359547 (Muston 1984)
Billardiera scandens	√	√			
Cassytha sp.		√			
Cayratia clematidea	√	√	√		
Cissus antartica	√	√	√	√	
Cissus hypoglauca	√	√	√	√	√
Clematis sp.			√		
Eustrephus latifolius	√	√	√	√	√
Geitenoplesium cymosum	√		√	√	√
Glycine clandestina	√	√		√	√
Hibbertia scandens	√	√	√		√
Kennedia rubicunda	√			√	√
Maclura cochinchinensis		√	√		√
Malaisia scandens		√			
Marsdenia rostrata	√			√	
Morinda jasminoides	√	√	√	√	
Pandorea pandorana	√	√	√	√	√
Parsonsia straminea	√	√	√	√	√
Rubus parvifolius	√	√	√		
Sarcopetalum harveyanum	√			√	√
Senecia sp.				√	
Smilax australis	√		√		
Smilax glyciphylla	√	√	√	√	√
Stephania japonica	√	√	√	√	
Tylophora barbarta	√	√	√	√	

TABLE 4

NATIVE HERBS/FERNS	Lot 22	Pt 85A (DP4467)	SEPP No. 26 175J	SEPP No. 26 175K	DP359547 (Muston 1984)
Baumea juncea	√				
Blechnum indica		√			
Blechnum sp.	√				
Commelina cynea	√	√	√	√	
Cyperus spp.		√			
Desmodium varians	√			√	
Dianella caerulea				√	
Doodia aspera		√			
Einadia hastata		√			
Entolasia marginata?	√	√	√		
Gahnia sieberana	√	√		√	
Geranium sp.	√				
Gymnostachys anceps	√	√	√		
Helichrysum elata	√				
Hypolepis sp.	√	√			
Imperata cylindrica	√	√			√
Juncus krausii	√				
Lomandra longifolia	√	√	√	√	√
Oplismus aemulus	√	√	√	√	
Pellea falcata var falcata	√	√	√		
Pellea falcata var nana		√			
Phagmites australis	√				
Plectranthus parviflorus	√				
Pratia purpurascens	√	√			
Pseudanthus gasstroemii	√	√			
Pteridium esculentum	√	√	√	√	√
Pyrrosia rupestris		√	√	√	
Schelhammera undulata	√			√	
Scirpus nodosus	√				
Tetragonia tetragonioides		√			
Themeda australis	√				
Viola hederacea	√	√		√	
EXOTIC HERBS					
Asparagus sp.				√	
Eupatorium riparium	√				
Hypochoeris radicata	√				
Senecio mikaniodes				√	
Stellaria flaccida	√	√			√
Stellaria media	√	√	√		√

FAUNA REPORT

FAUNA AND HABITAT ASSESSMENT

Blue-Angle Creek, Gerroa

Mammals and Reptiles

Prepared for:

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by

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1. INTRODUCTION

This report has been prepared for Quality Environmental Management Pty Ltd in response to a commission from Kiama Council. The study relates to proposed changes to the zoning of land adjacent to Blue Angle Creek at Gerroa from Rural 1(a) to Rural Environmental Protection 7(1). The proposed changes would be included in a draft Local Environmental Plan (LEP) for the area.

The purpose of the study was to address various issues, including the identification and assessment of wildlife habitats and their associated fauna. Available information, capable of being assessed within the timeframe allowed for the study, has been reviewed; references have been listed at the end of this report. Additional field studies have also been conducted.

The impacts of current zonings, proposed zonings, and sand extraction on native fauna and fauna habitats have been assessed.

Documentation of the qualifications and experience of the scientists involved in the faunal survey appear in Appendix 2.

2. METHODS

A literature review was undertaken using a variety of sources including:
(i) previous faunal studies (Robinson, 1988; Mills, 1989, 1990a)
(ii) National Parks and Wildlife reports (NPWS, 1989; Dovey, 1990) and
(iii) other submissions (Mills, 1988, 1990b; Young & Reffel, 1981; Dept. of Planning, 1981).

The main aims of the field survey were to assess the different types of habitat present and to confirm the presence of species in the area. It was not within the brief to produce a definitive study of the fauna of the area. Field work was carried out over two days, the 17th and 23rd December 1991.

Evidence for mammal presence was obtained using various methods. Predator scats and mammal hairs were collected during a day search on the 17th December, 1991 (sent to Barbara Triggs for analysis). Also, identifications were made of other scats, diggings, scratchings and nest sites.

Spotlighting for arboreal mammals was carried out over one night, the 23rd December, 1991, using 50 watt, 12v spotlights.

Incidental observations of other fauna, such as reptiles, were recorded. Descriptions, habits, diets, ranges and conservation status of the mammal species referred to in this report are found in Strahan (1983).

3. LITERATURE REVIEW

Both species diversity and population abundances of many animal species in the Illawarra region were generally higher than they are now. The formerly expansive areas of native forest on the coastal plain have largely disappeared, leaving remnant "islands" or isolates.

Three main features of an isolate determine the richness of the native mammal fauna and the presence of introduced fauna. These are: its size, the severity of disturbance, and the degree of isolation. A typical feature of small isolated patches in the Illawarra region is a low diversity of native mammal species, and a high diversity of introduced species (Robinson, 1988). Larger areas therefore contain a more diverse range of native species.

In addition to the mammal species actually recorded during the survey (see below, Table 1), there are a number of native species which appear in anecdotal reports (e.g. the echidna) or are likely to occur in the study area (e.g. brown antechinus, common brushtail possum, eastern pygmy-possum, feathertail glider, and bush rat.

All these species were recorded by Robinson (1988), during survey work concentrated in the Seven Mile Beach National Park. A study by Mills (1989) added two more species, the grey-headed flying-fox and eastern water-rat, but no faunal field survey was referred to in the Mills survey.

Of particular importance is a record from 1987 of a Spotted-tailed Quoll (Robinson, 1988). This individual, killed on the "road bordering the National Park", is the only record of this marsupial carnivore in the area within the last 20 years.

A high density of arboreal marsupials, particularly the greater glider, was noted by Robinson (1988) in Seven Mile Beach National Park. Although the status each of the following species, greater glider, sugar glider, feathertail glider and eastern pygmy-possum, is considered to be common, suitable habitat on the Illawarra coastal plain has been largely cleared (Robinson, 1988). As a result, this habitat type is poorly represented on the coastal plain north of Berry. Only fragments, such as Seven Mile Beach National Park , and smaller portions, such as this study area, remain. Both the feathertail glider and eastern pygmy-possum are listed under 'Fauna of Special Concern' on Schedule 12 of the National Parks and Wildlife Service Act.

There are some habitat types, which occur within the study area, that are absent or poorly represented in the adjacent Seven Mile Beach National Park. These are the areas of swamp forest and littoral rainforest. A report from the National Parks and Wildlife Service (1989) suggested that these rainforests provide feed trees and shelter for many arboreal mammals such as sugar gliders, greater gliders, ringtail possums, brushtail possums and grey-headed flying-fox. The maintenance of a 100 m buffer zone around the littoral rainforest is stressed by Mills (1989). Also suggested is a 100 metre wide buffer zone along Crooked River and a 150 metre buffer zone along Blue Angle Creek (Mills, 1989). These buffers would include areas of swamp forest, littoral rainforest, and She-oak woodland and subsequently protect the habitat contained within them.

Mills (1990) and Dovey (1990) considered that the *Eucalyptus robusta* swamp forest is an important faunal habitat.

Species listed on Schedule 12 of the National Parks and Wildlife Act which may occur in the area are listed by Mills (1990). Mills considered that species such as the Diamond Python, is unlikely to be affected as long as littoral rainforest is not cleared or disturbed.

4. FIELD SURVEY

4.1 Native mammals

Four distinct habitats were identified during the field survey. These habitats were identified as:

Habitat A Open forest dominated by *Eucalyptus pilularis* (blackbutt) and *E. botryoides* (bangalay). Also included is swamp forest dominated by *Eucalyptus robusta*. This habitat occurs in Lot 26, and parts of Lot 22 and 23. It contains dense understorey (suitable for many native terrestrial mammals), and many mature trees suitable for arboreal mammals.

Habitat B Closed forest, essentially littoral rainforest, with some areas of mixed littoral rainforest/blackbutt forest. This habitat occurs in Lots 3, 4, 21 and part of 22. It contains many nest-site and feed trees both within the littoral rainforest and within the forest's margins.

Habitat C Scattered trees resulting from clearing. This habitat occurs in 'Bailey's Island'. It still contains useful resources for arboreal mammals, such as nest-sites and food sources, especially bordering Habitats A and B.

Habitat D Area of forest on the foreshores of the Crooked River and Blue Angle Creek on Portion 85a. Parts of this Habitat have been invaded by *Lantana camara*, though this still provides habitat for terrestrial and arboreal mammal species such as the common ringtail possum.

In all, four native mammal species were positively identified, one bat species was identified by its call, other unidentified bat species were seen, and the presence of one terrestrial mammal species was inferred from identification of remains in a predator scat (see Table 1). These findings are discussed in more detail in the following paragraphs.

Spotlighting revealed the presence of a variety of native arboreal mammal species. Ten greater gliders were recorded, in various locations throughout the study area. This is a high density compared to some other forest areas in the Illawarra. Other arboreal animals observed included the common ringtail possum and the sugar glider.

The greater gliders were seen in the areas dominated by tall eucalypts. Many of these trees were mature and contained hollows suitable for nesting. Both dark and light colour morphs of greater glider were seen.

Sugar gliders were seen in one of the littoral rainforest areas, classified as SEPP 26. *Acacia* gum and *Eucalyptus* sap are important food sources for this species, as are insects (Henry & Suckling, 1984). Several *Acacia* species occur within and around the littoral rainforest. One of the species present, *Acacia mearnsii*, is a preferred food source of sugar gliders during Autumn and Winter (Suckling, 1980, 1984). Other *Acacia* species occur within the drier blackbutt/bangalay forest.

Mature *Eucalyptus* trees contain hollows necessary for shelter and breeding by arboreal species, such as those mentioned above. Tree hollows occur in many parts of the study area, particularly Habitats A, B, and C.

The common ringtail possum uses dense thickets of shrub for nesting and many were seen in areas with dense stands of the introduced shrub *Lantana camara* (Habitat D). The native *Leptospermum* shrub is also a favoured habitat and this occurs throughout Habitat A. This possum species is known for its resilience to disturbance.

The only native terrestrial mammal species seen was the swamp wallaby. A relatively high number was seen both along tracks and in cleared areas. Macropod species (again, most probably swamp wallaby) were also heard moving through the vegetation. Areas suitable for this species exist due to the dense vegetation of the open forests (essential for shelter) and the amount of cleared grassland (used for feeding).

A number of bats were seen during the survey. It was not possible to identify the species without a more detailed survey, including trapping. However, they were likely to be moving through the area, not using it exclusively. 'Flyways' occurred along the tracks through the site. One species noted, due to its audible call, was probably the white-striped mastiff-bat. Due to the location of the study area and the type of call heard, this has been confirmed as likely to be one of the species present (Dr Roger Coles pers. comm.).

Predator scats and hair samples analysed by Barbara Triggs revealed two native species: swamp wallaby and long-nosed bandicoot. The swamp wallaby was seen on several occasions during the survey (see above) and the long-nosed bandicoot is a common species which was expected to occur in the area. It should be noted that species identified in scats cannot be considered positive indications of occurence in an area, because predators may have fed outside an area (e.g. in Seven Mile Beach National Park, in this case), but left scats within it. However, due to the isolated nature of this site and the habitats present, it is very likely that the long-nosed bandicoot does occur in the site.

Species recorded	No. found	Technique	Habitat species found in
Greater glider	10	spotlighting	A, B, C
Common ringtail possum	4	spotlighting	A, D
Sugar glider	2	spotlighting	B
Swamp wallaby	4	spotlighting and heard	A, B, C, D
Bats (unknown species)	~4	spotlighting	A, B, C
White-striped mastiff-bat	?	heard	creekside
Long-nosed bandicoot	?	scat analysis	A (scats only)

Table 1: Summary of mammal species recorded during field survey of the study area.

4.2 Reptiles

Incidental observations of reptiles were made and are listed in Table 2. Both of the snake species were discovered near tracks which have been cleared through the site. The Diamond Python was found dead in the Bailey's Island area, near the Crooked River.

Species recorded	No. found	Technique
Red-bellied Black Snake	1	seen
Diamond Python	1	seen (dead)
Eastern Water Skink	1	seen
She-oak Skink	1	seen

Table 2: Summary of reptile species recorded during field survey of the study area.

4.3 Introduced species

Rabbits (*Oryctolagus cuninculus*) were seen during spotlighting and a number of diggings were seen in the cleared areas. A hare (*Lepus capensis*) was also seen.

Some cow pats were observed in areas where grazing had occurred from domestic stock.

Introduced species identified from material in scats collected from within the study area included: cow (*Bos taurus*), dog (*Canis familiaris*) and black rat (*Rattus rattus*).

5. DISCUSSION

5.1 Significance of fauna at the site

A total of 6 native mammal species were recorded during the survey, with a further 8 species previously recorded or expected to occur there. All mammal species found to be at the site are considered to be common and widespread in southeastern Australia (Strahan, 1983), and so their occurrence is not of national or regional conservation significance.

Two species which occur in the adjacent National Park, have previously been reported in the Gerroa area (Robinson 1988) and would be expected to occur in the study site (feathertail glider and eastern pygmy-possum), are listed on Schedule 12 of the National Parks and Wildlife Act as 'Fauna of Special Concern'.

One reptile recorded at the study site, the diamond python, is listed under 'Fauna of Special Concern' on Schedule 12 of the National Parks and Wildlife Act. This species is likely to occur in the wetter forests at the site.

5.2 Significance of area as faunal habitat

The clearing and grazing, which have already taken place in Habitat C, have undoubtedly reduced the habitat value of the study area. Removal of the herb and shrub layers destroys the habitat for many terrestrial mammals which are known to occur in the region, for example, the long-nosed bandicoot, echidna, brown antechinus and bush rat. Continued clearing will reduce the amount of available habitat for arboreal mammals, reduce food resources and will cause loss of local populations of those species which still occupy the area.

The scattered trees that have been left after the past clearing still contain some suitable resources for arboreal mammals. This is particularly the case where Habitat C borders Habitats A and B. For example, many greater gliders were observed in trees of Habitat C within close proximity of Habitats A and B.

The areas of littoral rainforest and swamp forest in Habitat B contain trees suitable for habitat and food sources for arboreal mammals. Also, a variety of resources for a diversity of fauna are provided in these habitats. For example, reptiles such as the diamond python are usually found inhabiting rainforest. The littoral rainforest and creekbank areas also provide habitat and resources (such as insects for food) for many amphibious species.

5.3 Other factors contributing to significance of area

The relatively high abundance and diversity of arboreal mammals present in the site is of regional significance. The coastal plain of the Illawarra has been cleared extensively over time and therefore suitable mammal habitat is limited to a few, isolated forests, such as Seven Mile Beach National Park. As mentioned above, size

and degree of isolation of a remnant forest patch contribute to its ability to conserve viable populations of animal species. Other factors include its shape and the degree of disturbance.

As one of the few remaining, protected areas of coastal forest in the Illawarra region, Seven Mile Beach National Park has considerable conservation significance. It contains several faunal species of special concern, and some species, especially some arboreal mammals, appear to occur in particularly high densities.

Robinson (1988), for example, noted that one of the highest densities of greater glider's in the region in Seven Mile Beach National Park. Both light and dark colour morphs of the Greater Glider were seen in the study area. Seven Mile Beach National Park is believed to have high incidence of light morphs. However, both colour morphs are often found in other populations.

The study area therefore has conservation significance for the fauna in the ways in which it interacts with Seven Mile Beach National Park:

(i) it adds to the effective area of forest used by the fauna, thereby increasing the likelihood that certain species will be conserved in the long term, particularly because...

(ii) it adds diversity to the forest already protected by the National Park, because of the littoral rainforest and swamp forest included in it. These forest types are apparently not well represented in the Park, and they provide important resources for some faunal species, as outlined above.

The study area and Seven Mile Beach National Park are separated by a two-lane road and a creek. Tree lines are currently close to the road on both sides and it would be possible for gliding mammals to cross between the National Park and the study area. Terrestrial animals, especially larger ones, would also be able to cross the road barrier, but their journey would be more hazardous. The long-term value of the study area for faunal conservation within Seven Mile Beach National Park will depend on the maintenance of an effective connection between the two areas.

The study area is not thought to have value as a corridor. A viable corridor is considered to link larger areas of habitat, therefore enabling movement of animals and consequent maintenance of genetic diversity. Although the study area is in close proximity to the Seven Mile Beach National Park, it does not link the Park to any other substantial area of habitat.

5.4 Impacts of zoning decisions

Under the existing zoning, continued clearing would be expected. This would cause the loss of local populations of both arboreal and terrestrial mammals due to a loss of habitat. Species listed on Schedule 12 of the National Parks and Wildlife Act, the diamond python, feathertail glider, and eastern pygmy-possum, would all be affected

by the loss of habitat. Some loss of all habitat types would be expected if clearing and grazing were to continue.

If sand mining were to be permitted, similar impacts would occur to those mentioned above. The loss of 22% of the swamp forest (Mills, 1990) and the littoral rainforest which occurs in Lot 22 , would reduce the amount of these habitat types, both of which are poorly represented in the adjacent Seven Mile Beach National Park. Moreover, these habitat types, in particular, provide important resources for soame animal species.

If the study area were to be rezoned Rural Environmental Protection 7(1), present faunal populations would remain. It is unlikely that species diversity would decline as the close proximity to the Seven Mile Beach National Park should ensure the area maintains its faunal integrity, as long as the site is protected from further disturbance.

6. RECOMMENDATIONS

In its present condition, the rezoning of the entire study area could not be justified on the basis of the species of fauna found or the faunal habitat present in the site. However, certain sections within the study area (viz. Habitats A and B) do have high faunal habitat value, which should be protected, especially in the context of the proximity to Seven Mile Beach National Park.

Habitat A contains a diverse range of habitat types. The extensive herb layer is important for many terrestrial mammals such as *Antechinus* species, long-nosed bandicoot and bush rat. There is also a dense shrub layer which provide cover and also food for species such as the feathertail glider, eastern pygmy-possum and ringtail possum. Many mature trees in this area contain hollows suitable for arboreal species.

This area is probably used by arboreal and larger terrestrial mammals (e.g. swamp wallaby and bandicoot) as an extension of the habitat present in the Seven Mile Beach National Park.

Habitat B contains littoral rainforest and swamp forest (dominated by *E. robusta*). This area has value for a variety of fauna, providing: (i) tree hollows for arboreal mammals, bats, and some reptiles and (ii) creek bank habitat and moist terrestrial habitat for many amphibian species. A variety of feed tree species are provided within and around the littoral rainforest, in particular *Acacia* species which provide a food source for sugar gliders and other arboreal mammals.

Species listed on Schedule 12 of the National Parks and Wildlife Act are known or expected to occur in these areas.

This habitat type is poorly represented in the Seven Mile Beach National Park and is therefore an important source for the resources mentioned above for fauna within the area.

It is recommended that the areas shown as Habitats A and B be protected by a rezoning to Rural Environmental Protection 7(1).

Habitat C has been cleared extensively and its potential as habitat has therefore been considerably reduced. Some use by greater gliders was observed and swamp wallabies were also seen using the area.

Habitat D was quite heavily infested with *Lantana camara* and was further disturbed due to its close proximity to the caravan park. Only one native mammal species, the common ringtail possum, was observed here. This species uses dense shrub for nesting and is known for its resilience to disturbance.

Due to the amount of past and recent disturbance in Habitats C and D, faunal habitat value has been considerably reduced. It is concluded therefore that protection of these areas by rezoning would be of little immediate benefit.

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Appendix 1: Mammal species recorded or expected to occur in the Gerroa study area.

Species	Recorded	Expected	On Schedule 12
Tachyglossus aculeatus			
Short-beaked Echidnat		X	
Antechinus stuartii			
Brown Antechinus		X	
Perameles nasuta			
Long-nosed Bandicoot	X		
Pseudocheirus peregrinus			
Common Ringtail Possum	X		
Petauroides volans			
Greater Glider	X		
Petaurus breviceps			
Sugar Glider	X		
Trichosurus vulpecula			
Common Brushtail Possum		X	
Cercartetus nanus			
Eastern Pygmy-possum		X	X
Acrobates pygmaeus			
Feathertail Glider		X	X
Wallabia bicolor			
Swamp Wallaby	X		
Pteropus poliocephalus			
Grey-headed Flying-fox		X	
Tadarida australis			
White-striped Mastiff-bat	X		
Hydromys chrysogaster			
Water Rat		X	
Rattus fuscipes			
Bush Rat		X	
Rattus rattus			
Black Rat	X		
Mus musculus			
House Mouse		X	
Oryctolagus cuniculus			
Rabbit	X		
Lepus capensis			
Hare	X		
Vulpes vulpes			
Fox		X	
Canis familiaris			
Dog	X		
Bos taurus			
Cow	X		

† Anecdotal observation in the site (reported by K. Sekulic, pers. comm.).

Appendix 2

Curricula Vitae of the scientists in the faunal survey team
(excluding bird survey)

Assoc. Prof. R.J. Whelan
Mr M. Ooi
Mr D. Engel.

Curriculum Vitae

Personal

Name	**Dr Robert John WHELAN**		
Date of birth	29th July 1952	**Citizenship**	Australian
Home address	13 Cornock Avenue, Thirroul, NSW, 2515 Australia	**Home phone** **Fax**	(042) 671 037 (042) 674 739
Work address	Biology Department, University of Wollongong, Wollongong, NSW, 2500 Australia	**Work phone** **Fax**	(042) 213 442 (042) 213 477

Post-secondary Education

Tertiary	1974	BSc (Hons) Flinders University of South Australia **Thesis:** *The effects of herbivore grazing and physical stability on the plant diversity of an annual grassland.*
	1978	PhD, University of Western Australia. **Thesis:** *The influence of insect grazers on the establishment of post-fire plant populations.*
Post-doctoral	1978-79	School of Plant Biology, University College of North Wales, UK.
	1980-81	Department of Zoology, University of Florida, Gainesville, USA.

Scholarships and Awards

1971-73	Commonwealth Tertiary Award
1974, 77	University of Western Australia Postgraduate Studentship
1989	Fulbright Senior Award for research on fire ecology in the USA

Summary of Employment

1974	Research Officer, Elder Smith-Goldsbrough Mort Pty. Ltd., Perth, W.A.
1975-76	Graduate Teaching Assistant, Zoology Department, University of W.A.
1978-79	Part-time lecturer, MSc course, School of Plant Biology, University College of North Wales.
1980-82	Research Fellow, University of Florida, USA
1982-86	Lecturer, Biology Department, University of Wollongong
1986-present	Senior Lecturer, Biology Department, University of Wollongong
1990-present	Associate Professor, Biology Dept. University of Wollongong

Professional Qualifications

1984-1989	Council Member, Ecological Society of Australia Editor, Australian Journal of Ecology
1989-present	Editorial Board, Australian Journal of Ecology

1990-present Editorial Advisory Board Member, *Ecological Abstracts*, Elsevier.

Memberships

Ecological Society of Australia
Ecological Society of America
American Society of Naturalists
Linnean Society of New South Wales
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Australian Institute of Biologists
Australian Pollination Ecologists' Society

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Contracts

1973-74	Elder Smith Goldsbrough Mort Ltd. *Overgrazing in the Gascoyne region of Western Australia*
1974	Pastoralists and Graziers Assoc. of W.A. *Conservation (Ch. 10 in submission to the Federal Govt. Green Paper on Agriculture)*
1977	Dept. of Fisheries & Wildlife of W.A. *Bushfire as a management technique in W.A. coastal plain reserves. In: P.A. Clay (ed.) Management Report on Thompson Lake Reserve*
1980-82	National Geographic Society, Publications Consultant - *Mammals Encyclopaedia; Strange Australian Mammals; Deserts*
1981	Expert Witness, Federal Court of Australia. *Ecological effects of fire on flora and fauna of S-W Australian forests*
1983	Department of Main Roads (NSW). *Faunal Survey: Berrima - Mittagong By-Pass*

1983	BHP Steel-division Collieries. *Ecological survey, proposed ventilation shaft*
1983-89	Department of Main Roads (NSW). *Platypus population surveys, Wingecarribee River, New South Wales*
1984	BHP Steel-division Collieries. *Ecological survey, proposed ventilation shaft*
1984	Edgell Pty. Ltd. *Identification of mammalian hair*
1984	NP&WS (New South Wales). *Barren Grounds Nature Reserve: Proposal for a fire-protection plan*
1987	Cleary Brothers Concrete. *Flora and fauna survey; proposed quarry extension*
1988	Expert Witness, NSW Land and Environment Court. *Fire and forestry in S-E New South Wales*
1990	State Rail Authority of NSW. *Advice on revegetation program, Helensburgh slip, South Coast Line*
1990	Roads & Traffic Authority (NSW). *Faunal survey of proposed routes for the Tomerong by-pass*
1990	Electricity Commission (NSW). *Management plan for the endangered Yallah Orchid*
1990	Expert Witness, Land & Environment Court of NSW - evidence on fire behaviour in the proximity of residential development.
1991	Roads & Traffic Authority (NSW) / Muston & Associates *Faunal survey of potential road routes: Gerringong to Berry, NSW.*
1991	Argyle Consultants, Canberra. *Review of bushfire risk report.*
1991	BHP Slab and Plate Products. *Faunal study of revegetation site in Cringila; Pt. Kembla Steelworks*
1991	BHP Slab and Plate Products. *Evaluation of potential of soil substitutes as plant growth media.*

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Date of Birth :- 24th March 1966

Education :- Secondary

Caringbah High School	Higher School Certificate	1983
Port Hacking High	Higher School Certificate	1984

English	Chemistry	Mathematics
Modern History	Physics	Geography

-In each H.S.C year these same 2 unit subjects were undertaken.

Tertiary

University of Wollongong	Bachelor of Environmental Science 1985 - 1988 Honours in Environmental Science 1989 - 1990	

Awards :- Ecological Society of Australia (ESA) Travel Grant

Society Membership :- Australian Mammal Society
Australian Flora & Fauna Research Programme; University of Wollongong
Ecological Society of Australia
Life Member of the University of Wollongong Union

Current Employment

1991 Currently employed by the Roads & Traffic Authority (RTA) as an Investigations Officer
This job involves working with computer generated maps using the Genamap programme.

Research Employment History

1990 (June) - 1991 (July) Environmental Science & Services Tully Millstream Hydro-electric Scheme Ravenshoe Queensland (Mammal Survey using Radiotracking equipment)

Roslyn Muston & Associates (Wollongong NSW)
March 1990 Tomerong Highway By-pass Fauna Survey
Contractor : Roads & Traffic Authority
October 1989 Helensburg Embankment Fauna Survey.
Contractor : State Rail Authority (SRA)
November 1989 Metropolitan Embankment Fauna Survey. Contractor SRA

1990 - 1991 University of Wollongong (NSW) First Year Biology Demonstrator

February 1991 Kestel Research (Australian Capital Territory) A one week fauna survey, and evaluation of, several remnant forested patches within the Bega Valley, New South Wales.

April 1991 University of Wollongong Three day, three night fauna survey of vegetated patches along the proposed routes for the Gerringong, Berry Bypass (NSW) Contractor : Roads & Traffic Authority

May 1991 University of Wollongong Three day, three night fauna survey of proposed logging coupe (Deua State Forest NSW) Contractor : Wilderness Society Wollongong

August 1991 University of Wollongong three day, three night fauna survey for the North Kiama Bypass.

Voluntary Work Experience

1991 (August) Follow up fauna survey of the February 1991 Bega Valley survey

1991 (April) Voluntary Assistance on Powerful, Masked and Sooty Owl Survey with the Forestry Commision (Eden District NSW)

1991 (Feb) Ground Parrot census Barren Grounds Nature Reserve (NSW)

1990 (Feb) Platypus Survey with Tom Grant (Braidwood NSW)

1987 Bungonia State Recreational Area (NSW) as a Ranger

CURRICULUM VITAE

PERSONAL

Name	Mark OOI
Address	32 Halstead St Hurstville 2220
Telephone	(02) 570 4156
Date of birth	18th December 1968

EDUCATION

Secondary 1986 Higher School Certificate
Sydney Technical High School
Aggregate 329

Tertiary 1990 Bachelor of Environmental Science
University of Wollongong

This course has covered all of the basic natural sciences; Geography, Biology, Chemistry and Geology.

It also provided a sound grounding in all aspects of environmental science work within the following areas:

Ecology of communities and ecosystems
Engineering - environmental and experimental
Ethics - environmental context
Chemistry - environmental and analytical
River studies
Coastal studies
Human impact on the environment
Remote sensing
Flora and fauna surveys
Field work

DEGREE RELATED EXPERIENCE

REPORTS AND PROJECTS

Conservation inventory of remnant forest in West Dapto. Report completed for Wollongong City Council as part of final year requirements.

Flood management proposal: solution to hypothetical problem in a riverside community.

The Antarctic Ozone Hole: a literature review.

Coastal dune systems: effects on urban areas close to dune areas.

Waste management strategy: solution to hypothetical problem of waste disposal in pristine alpine environment.

INVOLVEMENT IN CONSULTANCIES

Bega Valley native fauna study (University of Wollongong/ National Estates Programme)

Faunal study of revegetation site in Cringila; Port Kembla Steelworks (University of Wollongong/ BHP Slab and Plate Products)

Weed survey in Royal National Park (J. Speight & J. Tsekas/ N.S.W. NP & WS)

AVIFAUNA REPORT

Kiama Municipal Council

January 1992

LOCAL ENVIRONMENTAL STUDY

Land in the vicinity of Blue Angle Creek, Gerroa

REVIEW & SURVEY OF AVIFAUNA

Richard Jordan for
Quality Environmental Management
Pty Limited
Environmental Scientists
& Community Consultants
131 Balgownie Rd BALGOWNIE 2519
Phone (042) 85 2552 Fax (042) 85 2551

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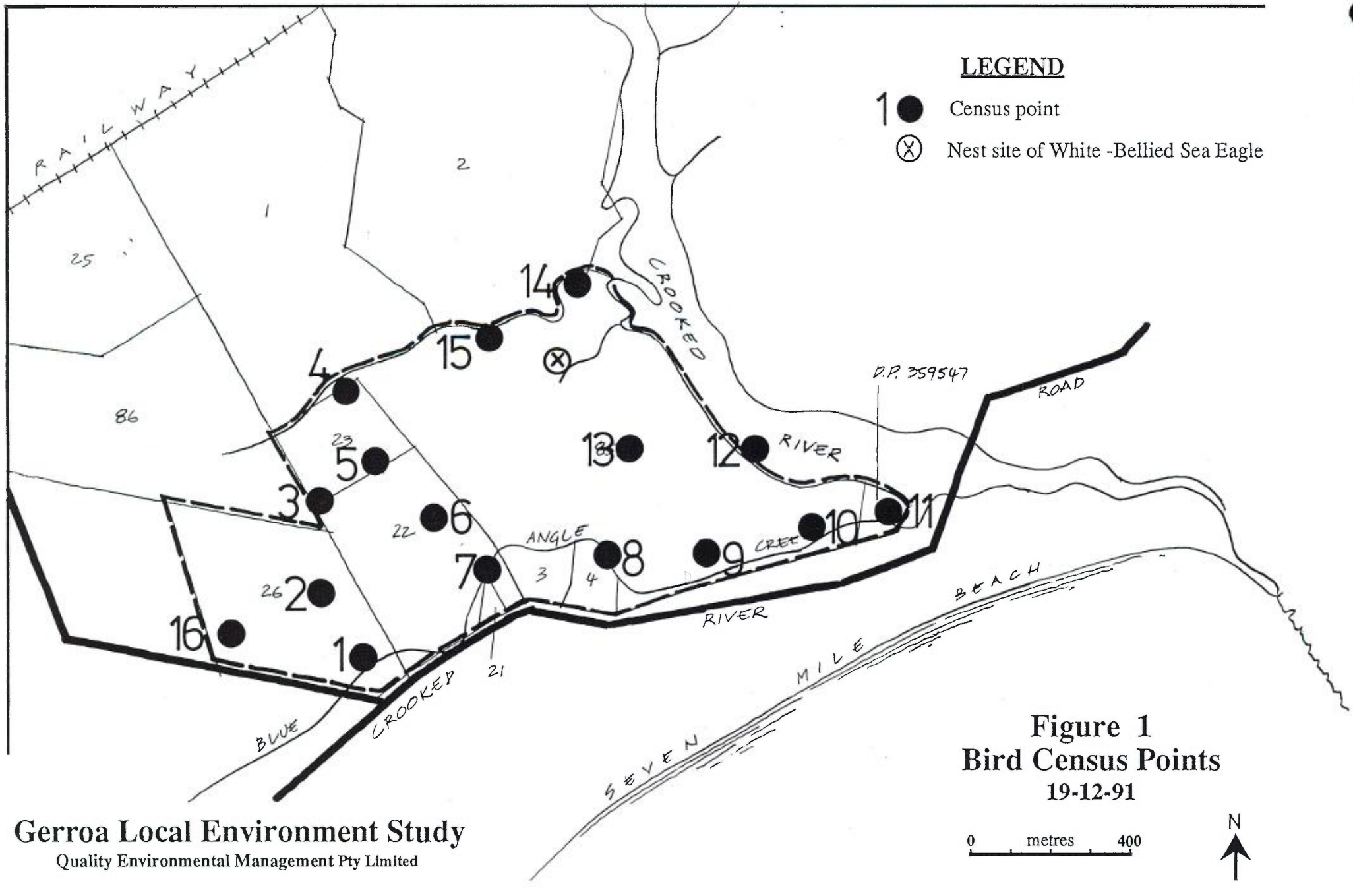

Figure 1
Bird Census Points
19-12-91

0 metres 400

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Gerroa Local Environment Study

Quality Environmental Management Pty Limited

1. INTRODUCTION

This report investigates the avifauna using land adjacent to Blue Angle Creek, Gerroa, NSW (see map). A survey by ornithologist Richard Jordan was prepared on behalf of Quality Environmental Management Pty Limited for inclusion in a Local Environmental Study.

1.1 LITERATURE REVIEWED FOR THE STUDY

Literature considered relevant to this study includes:

a) *EIS for Sand Extraction From Land Owned by Cleary Bros (Bombo) Pty Ltd at Gerroa, NSW* (Nov 1988). This reference includes a list of birds recorded by Dr K Mills over a number of years within an area approximately 15 kilometres by approximately 18 kilometres (277 km^2) in which the study area is located.

b) *A Landscape Report prepared for Cleary Bros (Bombo) Pty Ltd (July 1989 revised October 1989)* - Dr Kevin Mills. A list of bird species associated with wetland habitats in the Illawarra District - prepared by Dr Kevin Mills.

c) *Proposals for Expansion of Sand Extraction Operations - Cleary Bros (Bombo) Pty Ltd, Gerroa* (Aug 1990) - Dr Kevin Mills. A list of Schedule 12 Rare and Endangered Fauna known to occur, or which could occur, in or near the development sites at Gerroa.

d) *Birds of Bailey Island* (1982). A list of all species recorded on several visits to Baileys Island up to 1982 - prepared by Mrs Carol Virtue, Seven Mile Beach Road, Berry.

The bird lists contained in references a), b), and c) represent an estimate of likely diversity of species in the area. They do not represent detailed field census prepared specifically to assess the avifauna value of the study area.

The bird list included in reference d) is the result of a number of field trips by an experienced local ornithologist to the study area. Any species noted in this list and not recorded in a survey conducted on 18 December 1991 by Richard Jordan have been added to the annotated bird list (Table 1).

2. BIRD SURVEY

2.1 METHODOLOGY

A familiarisation visit was made to the survey area on the morning of 17 December 1991. This was followed by a systematic census of the area on the morning of 18 December 1991 (0600 - 1030 hrs). Point counts were conducted from 16 census points (Figure 1). All birds seen or heard from each point during a ten minute period were recorded (Table 2). Points were selected to cover all available habitats within the survey area.

Birds nomenclature is from Blakers *et al* (1984) *The Atlas of Australian Birds*. RAOU, Melbourne University Press.

Classification of abundance is as taken fromGibson J D (1989) *The Birds of the County of Camden (including the Illawarra Region)*. Second Edition. Illawarra Bird Observers Club.

3. AVIFAUNA OF THE STUDY AREA

The list in Table 1 has been compiled from data collected during the census conducted on 18 December 1991 and incorporates additional species from a list drawn up in 1982 (C Virtue). Table 2 indicates the location of species observed or heard during the census.

All birds in the list below are classified as either common or moderately common unless otherwise stated.

TABLE 1 BIRD SPECIES IN THE STUDY AREA

Common Name	Scientific Name	Observations
Australian Pelican	*Pelecanus conspicillatus*	One bird on the Crooked River
Great Cormorant	*Phalacrocorax carbo*	One bird on Crooked River
Little Black Cormorant	*Phalacrocorax sulcirostris*	Two birds on Crooked River
Little Pied Cormorant	*Phalacrocorax melanoleucos*	One bird on Crooked River
Pacific Heron	*Ardea pacifica*	From a 1982 list (C Virtue) - at Crooked River. Likely still to occur from time to time
White-faced Heron	*Ardea novaehollandiae*	One bird at Crooked River
Great Egret	*Egretta alba*	One bird at Crooked River
Little Egret	*Egretta garzetta*	One bird on Crooked River
Eastern Reef Egret	*Egretta sacra*	From a 1982 list (C Virtue) near the mouth of Crooked River
Rufous Night Heron	*Nycticorax caledonicus*	One bird roosting in the council-owned forest at the mouth of Blue Angle Creek. An uncommon species
Sacred Ibis	*Threskiornis aethiopica*	Two birds at Crooked River and occasional birds overflying the area
Black Swan	*Cygnus atratus*	From a 1982 list (C Virtue) - on Crooked River. Likely to occur there from time to time
Pacific Black Duck	*Anas superciliosa*	Four birds in the creek on the northern boundary of the property
Chestnut Teal	*Anas castanea*	Four birds in small creeks at survey points 3 and 15
Whistling Kite	*Haliastur sphenurus*	From a 1982 list (C. Virtue) - Likely to still occur in the area from time to time
Grey Goshawk	*Accipiter novaehollandiae*	From a 1982 list (C. Virtue) - Present status uncertain. This uncommon species is valuable to forest clearance
White-bellied Sea-Eagle	*Haliaeetus leucogaster*	One adult bird flying over the large cleared block - near to a known nest location in a large eucalypt (see map). An immature bird was seen alighting on this nest on 12 August 1991 (G Leonand pers comm) See special conservation comments below
Little Eagle	*Hieraatus morphnoides*	From a 1982 list (C. Virtue) - Likely to still occur in the area from time to time
Peregrine Falcon	*Falco peregrinus*	A single female bird hunting Topknot Pigeons in the area of the large cleared block. This species is uncommon in the County of Camden and is classified as vulnerable and rare fauna in Part 2 of Schedule 12 of the National Parks & Wildlife Act (1974). See special conservation comments below.
Brown Falcon	*Falco berigora*	A single bird in the large cleared area
Masked Lapwing	*Vanellus miles*	Several birds on the ground in the large cleared area and also along Crooked River. this species has benefited from clearing operations
Silver Gull	*Larus novaehollandiae*	A few birds at Crooked River
Topknot Pigeon	*Lophoaimus antarcticus*	A flock of 20 birds seen at survey points 13 and 14 being harried by a Peregrine Falcon
Yellow-tailed Black-Cockatoo	*Calyptorhynchus funereus*	A number of birds heard around forest areas, and two seen flying over the Crooked River road bridge
Gang-gang Cockatoo	*Callocephalon fimbriatum*	From a 1982 list (C. Virtue) - probably still an occasional visitor to forest areas. Classified as rare and vulnerable fauna in Part 2 of Schedule 12 of the National Parks & Wildlife Act (1974). See special conservation comments below

Table 1 cont... Common Name	Scientific Name	Observations
Galah	*Cacatua roseicapilla*	A few birds feeding on the ground in the large cleared area. This species has benefited from clearing operations
Sulphur-crested Cockatoo	*Cacatua galerita*	Two birds heard near survey point 7
Rainbow Lorikeet	*Trichoglossus haematodus*	A few birds seen overflying the area
Little Lorikeet	*Glossopitta pusilla*	From a 1982 list (C. Virtue) - probably still an occasional visitor to flowering eucalypts. An uncommon species
Crimson Rosella	*Platycercus elegans*	A few birds seen throughout the survey area
Pallid Cuckoo	*Cuculus pallidus*	This migratory species was heard near survey point 14
Brush Cuckoo	*Cuculus variolosus*	Several birds heard in forest areas throughout the survey areas. A migratory species
Fan-tailed Cuckoo	*Cuculus pyrrhophanus*	A single individual of this migratory species heard in the area
Horsfields Bronze-Cuckoo	*Chrysococcyx basalis*	From a 1982 list (C. Virtue) - An uncommon migratory species likely still to occur in the area from time to time
Common Koel	*Eudynamys scolopacea*	A single individual of this scarce migratory species heard in the survey area
Channel-billed Cuckoo	*Sythrops novaehollandiae*	A single individual of this scarce migratory species heard in the survey area
White-throated Needletail	*Hirundapus caudacutus*	A flock of around 100 birds was feeding in the air above the survey area
Azure Kingfisher	*Ceyx azurea*	From a 1982 list (C. Virtue) - still likely to occur along creeks
Laughing Kookaburra	*Dacelo novaeguineae*	Small numbers throughout the survey area
Sacred Kingfisher	*Halycyon sancta*	This bird is an uncommon summer migrant. It was located at several points in the survey area
Dollarbird	*Eurystomus orientalis*	An uncommon summer migrant which was located in unusually large numbers throughout the large cleared block
Welcome Swallow	*Hirundo neoxena*	From a 1982 list (C. Virtue). Likely to still occur in the area
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*	Small numbers were seen throughout the survey areas
Eastern Yellow Robin	*Eopsaltria australis*	A common species in and around the survey area
Jacky Winter	*Microeca leucophaea*	From a 1982 list (C. Virtue). Likely to still occur in forest areas
Crested Shrike-tit	*Falcunculus frontatus*	From a 1982 list (C. Virtue). Likely to still occur in forest areas
Golden Whistler	*Pachycephala pectoralis*	A single bird located in forest near survey point 9
Rufous Whistler	*Pachycephala rufiventris*	A common migrant species located throughout the survey area
Grey Shrike-thrush	*Colluricincla harmonica*	Small numbers located on the edge of forest
Black-faced Monarch	*Monarcha melanopsis*	A migratory species found in small numbers in forest throughout the area
Leaden Flycatcher	*Myiagra rubecula*	An uncommon migratory species found in small numbers on the edge of forest throughout the area
Rufous Fantail	*Rhipidura rufifrons*	A migratory species found in small numbers in Plot 26
Grey Fantail	*Rhipidura fuliginosa*	Found in small numbers throughout the survey area
Willie Wagtail	*Rhipidura leucophrys*	From a 1982 list (C. Virtue). Likely to still occur in the area

Table 1 cont... Common Name	Scientific Name	Observations
Brown Songlark	*Cinclorhamphus cruralis*	A single record from a 1982 list (C Virtue). a scarce species in the area
Eastern Whipbird	*Psophodes olivaceus*	This species was found in forest throughout the survey area
Superb Fairy-wren	*Malurus cyaneus*	This species was found in forest and woodland fringes throughout the survey area
Variegated Fairy-wren	*Malurus lamberti*	This species was found in the fringes of denser vegetation around the large cleared area
Southern Emu-wren	*Stipiturus malachurus*	From a 1982 list (C. Virtue). Occurred in rank vegetation along Blue Angle Creek. This vegetation has since been extensively cleared and sprayed with herbicide. Not located in this survey. A scarce species, which is the subject of further conservation comments below
White-browed Scrubwren	*Sericornis frontalis*	A common bird where dense ground cover exists throughout the survey areas
Brown Gerygone	*Gerygone mouki*	Found in forest throughout the survey area
Brown Thornbill	*Acanthiza pusilla*	An abundant species in woodland and forest throughout the survey area
Yellow Thornbill	*Acanthiza nana*	An abundant species in all forest with a casuarina element throughout the survey area
Varied Sittella	*Daphoenositta chrysoptera*	From a 1982 list (C. Virtue). A nomadic species still likely to occur in the area from time to time
White-throated Treecreeper	*Climacteris leucophaea*	A species found in small numbers throughout the study area
Red Wattlebird	*Anthochaera carunculata*	Heard in the vicinity of Crooked River
Little Wattlebird	*Anthochaera chrysoptera*	From a 1982 list (C. Virtue). Likely to still occur from time to time
Noisy Friarbird	*Philemon corniculatus*	From a 1982 list (C. Virtue). A nomadic species still likely to occur in the area
Noisy Miner	*Manorina melanocephala*	Found along the edge of pasture at survey point 16
Brown-headed Honeyeater	*Melithreptus brevirostris*	From a 1982 list (C. Virtue). A nomadic species still likely to occur in the area
White-headed Honeyeater	*Melithreptus lunatus*	From a 1982 list (C. Virtue). A migratory species still likely to occur in the area - especially in spring and autumn
Lewins Honeyeater	*Meliphaga lewinii*	A common bird throughout the wetter forests of the survey areas
Yellow-faced Honeyeater	*Lichenostomus chrysops*	Widespread in tall eucalypts throughout the survey area. Likely to be present in large numbers during autumn migration
New Holland Honeyeater	*Phylidonyris novaehollandiae*	Small numbers on the edge of the large cleared area
Scarlet Honeyeater	*Myzomela sanguinolenta*	From a 1982 list (C. Virtue). An uncommon nomadic species still likely to occur in the area
Eastern Spinebill	*Acanthorhynchus tenuirostris*	This small honeyeater species was common throughout the survey area
Mistletoebird	*Dicaeum hirundinaceum*	One individual of this species located at survey point 4
Spotted Pardalote	*Pardalotus punctatus*	A species found in samall numbes in eucalypts throughout the survey area
Striated Pardalote	*Pardalotus striatus*	A single individual located near Crooked River
Silvereye	*Zosterops lateralis*	A species found in good numbers throughout the survey area

Table 1 cont... Common Name	Scientific Name	Observations
Red-browed Firetail	*Emblema temporalis*	A ground-feeding finch found in small numnbers in disturbed land at the edge of the large cleared area
Double-barred Finch	*Poephila bichenovii*	From a 1982 list (C. Virtue). This species previously occurred in vegetation along Blue Angle Creek, which has since been extensively cleared
Red-whiskered Bulbul	*Pyconotus jocosus*	An introduced species found to be common in forest along Blue Angle Creek
Common Starling	*Sturnus vulgaris*	An introduced species found near the Crooked River road bridge
Olive-backed Oriole	*Oriolus sagittatus*	A single individual of this migratory species located in forest - plot 26
Figbird	*Sphecotheres viridis*	From a 1982 list (C. Virtue). A scarce species likely to still occur from time to time
Spangled Drongo	*Dicrurus hottentottus*	From a 1982 list (C. Virtue). An uncommon migratory species likely to still occur from time to time
Satin Bowerbird	*Ptilonorhynchus violaceus*	Found in small numbers throughout the survey area
Australian Magpie-lark	*Grallina cyanoleuca*	Found in small numbers along Crooked River
Grey Butcherbird	*Cracticus torquatus*	Small numbers of this species heard in forest
Australian Magpie	*Gymnorhina tibicen*	Small numbers found in the large cleared area
Pied Currawong	*Strepera graculina*	Small numbers in all habitats throughout the survey area
Australian Raven	*Corvus coronoides*	Small numbers in all habitats throughout the survey area

TABLE 2 CENSUS DATA

Based on a census conducted on 18 December 1991

Species	Census point (see map)															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Australian Pelican												1				
Great Cormorant												1				
Little Black Cormorant												2				
Little Pied Cormorant												1				
White-faced Heron												1				
Great Egret												1				
Little Egret												1				
Rufous Night Heron											1					
Sacred Ibis												2				
Pacific Black Duck													4	4		
Chestnut Teal			4												4	
White-bellied Sea-Eagle					1											
Peregrine Falcon												1	1	1		
Brown Falcon						1										
Masked Lapwing								1					2		2	
Silver Gull												1				
Topknot Pigeon													20	20		
Yellow-tailed Black-Cockatoo											2	2	2			
Galah						1		2	1	10					6	
Sulphur-crested Cockatoo							2									
Rainbow Lorikeet														2		
Crimson Rosella		2					2		2	2			4			2
Pallid Cuckoo														1		
Brush Cuckoo	1	2	2	1		2	1								1	
Fan-tailed Cuckoo									1							
Common Koel					1											
Channel-billed Cuckoo			1	1										1		
White-throated Needletail	<----------ca 100 birds overflying---------->															
Laughing Kookaburra			2					2	2			2	2		2	2
Sacred Kingfisher	2	1	1				1	1	1							1
Dollarbird				2		1	1	2		2		2	4			2
Black-faced Cuckoo-shrike	1	1		1												2
Red-whiskered Bulbul	3		1	1	1	2	1		1							
Eastern Yellow Robin	1	1		1		1		2	2							
Golden Whistler									1							
Rufous Whistler	3	3	3		3		1	1	2				1	2	1	1
Grey Shrike-thrush					1	1	2									
Black-faced Monarch			1	1	1		1	2								
Leaden Flycatcher		1				1	1		1	1						
Rufous Fantail	2	2	1													1
Grey Fantail		1	1	3	2	2	1	2	2	2	1			1	1	
Eastern Whipbird	4	4	2			2	2		2	2	2			2		
Superb Fairy-wren							2	2	2	2				2	3	2
Variegated Fairy-wren						3	4					3				
White-browed Scrubwren	2						1		1		2					
Brown Gerygone	2	2	2		2	2		2	2	2	4					
Brown Thornbill		2	1				2		1		5	2		2	1	
Yellow Thornbill	5		3	2	3		3	4	4		4	6		4	4	
White-throated Treecreeper	3	2	1	1	1	2	1		1	2						

Species cont..	Census point (see map)															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Red Wattlebird												1			1	
Noisy Miner																2
Lewins Honeyeater	1	2	1	1	1	1	1		2							1
Yellow-faced Honeyeater			2	1				2		1			1	2	2	
New Holland Honeyeater							2		2							
Eastern Spinebill	2						1	1	2	3				1		1
Mistletoebird				1												
Spotted Pardalote	1		1	2		2			2	2	2			2		2
Striated Pardalote												2				
Silvereye	4				3	5	2	3	2		2					
Red-browed Firetail						4										
Common Starling													1			
Olive-backed Oriole	1				1											
Satin Bowerbird				1				1		1						1
Australian Magpie-lark						1						1	1			1
Grey Butcherbird	1	1	1		1	1										2
Australian Magpie	1	1	2	2						2			1	4	3	4
Pied Currawong			1					1	1	1	1		1			
Australian Raven	2	4		4			2		3			4	3		5	

4. DISCUSSION OF SURVEY RESULTS

4.1 GENERAL

The observations shown in Table 1 do not indicate actual bird numbers, as the detectability of different species in such a survey can vary greatly. However, they provide a measure of the relative abundance of each species at the different survey sites during the survey. The weather at the time of the survey was ideal with no wind and almost complete cloud cover.

Avifauna in the surveyed area (Figure 1) was found to be abundant and diverse. A total of 68 bird species were recorded in a four hour period. This is exceptional for such a small area, and is likely to be the result of the diversity of habitat available with an abundance of 'boundary areas' between open and more closed habitat. Forest types vary from dense littoral rainforest to open woodland with scattered large trees and includes disturbed areas with lantana thickets. There are also several small creeks and the Crooked River.

Two birds found in the survey area are listed as vulnerable and rare fauna under the National Parks and Wildlife Act (1974) - Schedule 12 Part 2. These are discussed below, as are three other species of conservation significance.

The more general significance of the area for avifauna is also discussed.

4.2 SPECIES OF CONSERVATION SIGNIFICANCE

4.2.1 Listed as Rare and Endangered Fauna

Peregrine Falcon ***(Falco peregrinus)***
The abundant population of small birds in the survey area would certainly be attractive to this raptor.

Gang-gang Cockatoo ***(Callocephalon fimbriatum)***
This bird feeds on the fruits of eucalypts and other tree species. It appears to use the survey area only sporadically. It requires cavities in large trees for breeding purposes and the availability of suitable trees may limit population size.

4.2.2 Other Species of Conservation Significance

White-bellied Sea-Eagle ***(Haliaeetus leucogaster)***
Although not rare this bird occurs in small numbers only. Nest sites are few and need special protection from disturbance. The active nest site in the large cleared area (see map) should receive such protection.

Dollarbird ***(Eurystomus orientalis)***
The large cleared area contained an unusually large population of this uncommon migrant.

Southern Emu-wren ***(Stipiturus malachurus)***
This scarce species seems to have become extinct in the survey area since 1982. This is probably due to extensive clearing of vegetation along Blue Angle Creek, including the spraying of herbicide along the banks.

4.3 GENERAL CONSERVATION CONSIDERATIONS

The census data and Virtue's records indicate that the survey area has a wealth of bird life. Although only five bird species are of special conservation significance, the unusual diversity, especially of migratory bush birds, is worthy of note.

These migrants include:
Pallid Cuckoo (f), Brush Cuckoo (f), Fan-tailed Cuckoo, Horsfields Bronze-cuckoo, Common Koel (f), Channel-billed Cuckoo (f), White-throated Needletail, Sacred Kingfisher, Dollarbird, Rufous Fantail (f), White-naped Honeyeater, Yellow-faced Honeyeater, Olive-backed Oriole (f) and Spangled Drongo (f). Those species marked (f) generally require forested habitat.

The abundance of migratory species is quite exceptional and indicates the importance to these birds of such diverse vegetation along the east coast flyway. Although similar vegetation is available in nearby Seven Mile Beach National Park, such good bird habitat adjacent to coastal areas is coming increasingly under threat and it is important that as much as possible be given conservation protection. A number of migratory and sedentary species require forested habitat, but no species found to be present had any special association with SEPP No. 26 littoral rainforest. All the forest species were found in all types of forest in the survey area.

Limited time was available for bird survey work and other species may be present, especially at other times of the year. No time was available for a survey of nocturnal birds. There is a possibility that the Powerful Owl could be found in the area, a very rare bird with special conservation significance. The Powerful Owl is sometimes associated with littoral rainforest if good populations of prey species (large arboreal mammals) are present.

ARCHAEOLOGICAL REPORT

AN ARCHAEOLOGICAL ASSESSMENT OF LAND PROPOSED FOR REZONING AT BLUE ANGLE CREEK, GERROA, NSW

Kerry Navin

January 1992

DRAFT

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Report to Quality Environmental Management Pty Ltd on behalf of the Kiama Municipal Council

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INTRODUCTION

The Kiama Municipal Council resolved in February 1990 to prepare a Draft Local Environmental Plan in respect of land at Baileys Island and in the vicinity of Blue Angle Creek, Gerroa. The LEP proposes to change the present zoning of the land under Kiama Local Environmental Plan No 5 from Rural 1(a) to Rural Environmental Protection 7(1).

The subject land is located in the Illawarra, north of Blue Angle Creek and west of the Crooked River at Gerroa. Adjacent to, and east of the site is Seven Mile Beach National Park. The land affected by the proposed LEP is owned by Cleary Brothers (Bombo) Pty Ltd, Breen Holdings Pty Ltd, Mr. and Mrs. P. Cook and Kiama Municipal Council.

The areas under investigation are commonly referred to as the 'middle and northern (Bailey's Island) pits'. Also included within the area are Portion 22 and 23, Parish of Broughton. (Figure 1).

The land currently has a number of uses. Some areas are designated protected areas of Littoral Rainforest by State Environmental Planning Policy No 26, some areas are commercially mined for sand and others are used for grazing cattle and are partially cleared.

This report forms the Aboriginal archaeology component of the environmental investigations carried out by Quality Environmental Management P/L in respect to the Draft Local Environmental Plan.

PURPOSE AND FUNCTION OF THIS REPORT

This report aims to review previous archaeological work carried out in the study area, and based on this review and site inspections, to evaluate the present status of the archaeological resource within the area.

The function of the report is to provide information relevant to an assessment of whether the archaeological resource in the study area is of sufficient significance to merit particular consideration in the rezoning application for the subject land.

METHODOLOGY

Owing to the limited resources of this project, investigation was restricted to:

- a review of previous relevant reports and other printed material available to the consultant;
- consultation with the NPWS Southeast Region, regional archaeologist, Ms Sue Feary;
- field inspection totalling approximately 7 hours on two separate occasions. Fieldwork was restricted to a reconnaissance level only, with the objective of relocating known sites and familiarisation with the local context. No systematic survey or site recording was conducted.

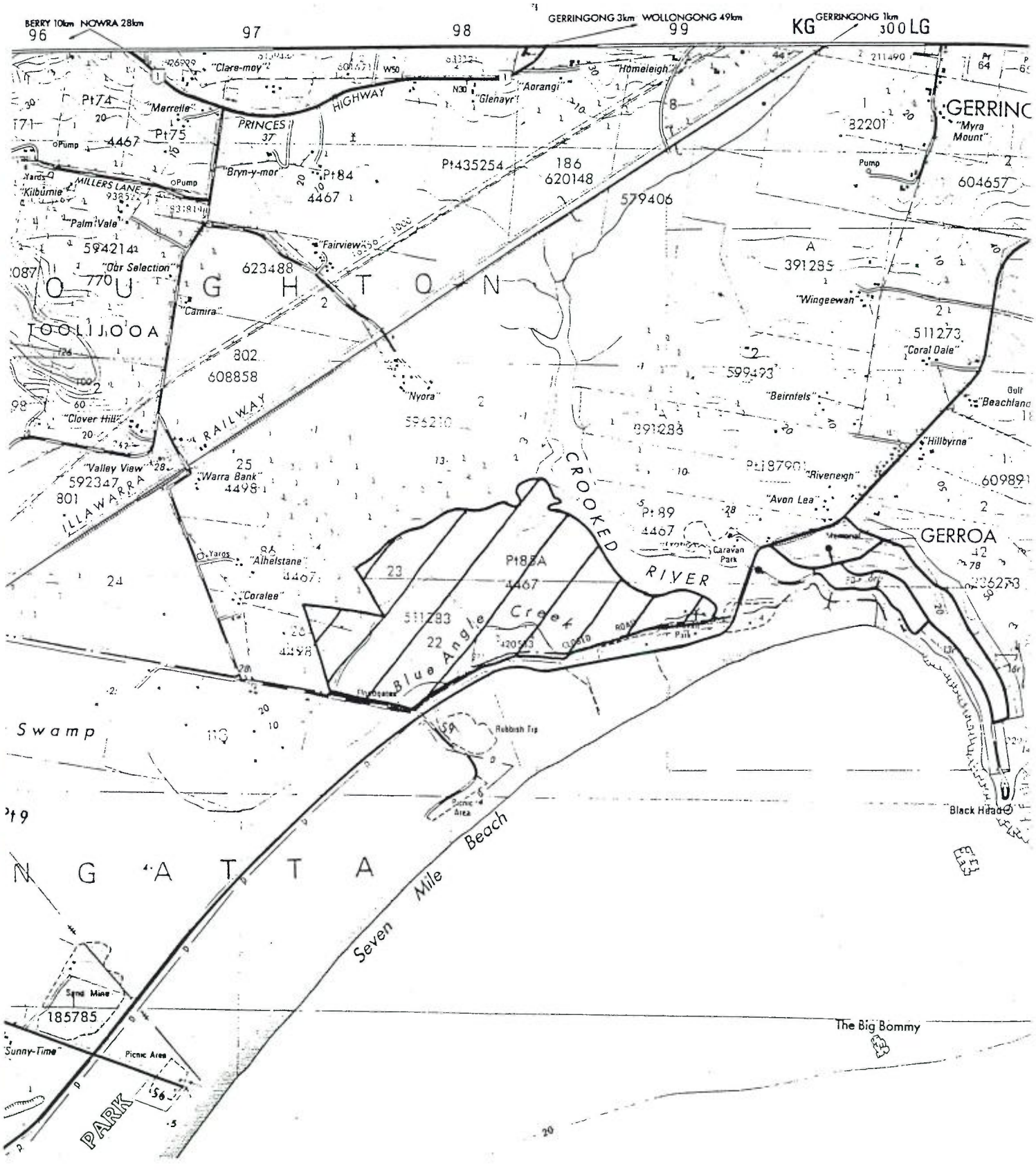

Figure 1: The Study Area (Gerroa 1:25,000 topo)

ENVIRONMENTAL CONTEXT

The study area is bounded to the east by Seven Mile Beach Road and Blue Angle Creek, to the north by the Crooked River and to the south by an unnamed private (Cleary Bros) road. The western boundary is variously defined by an unnamed tributary of the Crooked River, the western limit of area D.P. 23 and a part of the boundary of D.P. 26.

The area is a sequence of sand dunes located in the confluence of the Crooked River and Blue Angle Creek.

Vegetation within Portion 22 and 23 comprises a zonation between littoral rainforest, *Eucalyptus botryiodes* open forest and *Melaleuca* swales. A large portion of the eastern end of the study area has been cleared. Present vegetation consists of various stands of trees over a herb ground cover. The middle pit area is vegetated with a *Eucalyptus botryiodes* forest overstorey with a disturbed native shrub and lantana understorey.

Disturbance to the area has resulted from vegetation clearance and logging, ploughing and stick raking and removal of sand to various depths, from 30–50cm to several metres in both the middle and northern pit areas. Roads and tracks have been constructed across the areas and artificial drains and pits constructed.

SUMMARY OF PREVIOUS WORK

A number of archaeological surveys and investigations have been carried out within the areas referred to as the southern, middle and northern pits on Cleary Bros. property at Gerroa. The area known as the 'southern pit' is not included in this present environmental study. However most of the previous archaeological investigations of the Gerroa sand mining area include the southern pit, and results of investigations in that area are relevant to the present study.

Mr John Walker, a local resident, located an extensive midden site in 1986 (grid references: 298700.6150000 Gerroa 1:25,000 topo). This site, subsequently designated NPWS Site No 52-5-0206, is located on an elevated sand body adjacent to the Crooked River in the northern pit area. This site will be referred to as Site 206 in this report.

Colley (1988a) carried out a reconnaissance level survey of proposed sand mining areas for Anutech Pty Ltd and noted that 'extensive surface scatters of archaeological material were found in most places where the ground surface was visible' (1988a:1).

Colley:

- relocated Site 206 and recorded it as a 'low density midden scattered across most of the cleared area near the river ... the midden consisted of at least pipi, mussel, whelk (*Pyrazus ebeninus*) and oyster (*Ostrea angasi*) shells mixed with charcoal and a few stone tools' (1988a:2, 3).

- located a discontinuous surface scatter of shell midden over an area at least 100m x 50m at the northern end of the existing sand quarry (the southern pit). The midden consisted 'primarily of pipi (*Donax deltoides*) and mussel (*Mytilus planulatus*) shells mixed with charcoal and quartz and silcrete flakes ... In some places discrete areas of shells and/or stone tool scatters were visible on the ground surface which may represent relatively undisturbed portions of midden' (1988a:2).

- noted a few discrete midden deposits 'consisting of low density scatters of shell (mainly pipi and mussel), charcoal and animal bone (small marsupial)' in the vicinity of the 'horseshoe shaped' quarry in the middle pit area (1988a:2).

Colley recommended that 'quarrying should cease until the area can be properly examined to locate and record the archaeological sites' (1988a:3).

A further site inspection was carried out by Allan Lance of Anutech Pty. Ltd. several weeks later. This investigation 'confirmed the findings of the initial study that there are widely dispersed shell deposits along the length of the beach ridge and local concentrations of Aboriginal stone artefacts' (1988b:1).

Subsequent to Lance's site inspection a number of changes were made to Colley's report (1988b). This second report is the one which was included in the 1988 EIS prepared by Dames & Moore. This report is very similar to Colley's 1988a report with the exception of one paragraph in Section 1 and most of Section 4 - 'Recommendations & Discussion'. Aboriginal concerns, which had previously been in Section 4, was moved into a Section 5. (1988b:3, 4).

Lance (Colley 1988b):

- noted that immediately north of the existing sand extraction area (in the southern pit) 'a dense lag of stone artefacts remain on the ground surface. The shell midden has been severely disturbed by clearing and removal of the upper soil horizons. Several *in-situ* Aboriginal fireplaces were seen exposed in wheel ruts crossing this area and warrant further investigation' (1988b:3).

- noted that the shell midden along the length of the beach ridge, particularly between areas A and B [ie between the northern extent of the existing sand extraction area in the southern pit and the 'horseshoe shaped' area in the middle pit areas], although with the exception of the area adjacent to Crooked River [presumably Site 206], comprise only ashy soil, small numbers of stone artefacts and pipi shells' (1988b:4).

- noted that 'the midden deposits near Crooked River contain a greater variety of shellfish species, including those derived form estuarine environments' (1988b:4).

Recommendations in this report were:

i. to permit sand mining in a small, previously disturbed area to the east of the concentration of stone tools near the existing sand extraction area in the southern pit, 'during which time further archaeological studies must be carried out along the remainder of the proposed sand extraction area to the north, to determine the importance of the archaeological deposits' (1988b:3).

ii. to carry out a monitor each time areas of previously undisturbed ground containing sites was disturbed (if following the necessary site investigations, sand quarrying were permitted in the proposed southern extension area), and

iii. to reserve an area of midden to allow the preservation of a sample of these sites.

Lance (1989) carried out further archaeological investigations within the land owned by Cleary Bros. which included 'mapping of the study area and the archaeological deposits contained in and around sand quarries; the systematic collection of stone artefacts exposed on the beach ridge; a programme of augering to identify intact shell midden deposits; and the excavation of two areas of undisturbed shell midden located by augering' (p1).

This report was subsequently critically reviewed by three members of NPWS staff (Feary 1990; Ross 1990 & Wellington 1990).

The report was considered to be 'lacking in detail about the excavation, recording and analysis methodologies. In particular there were no larger scale maps showing the precise location of recorded sites, auger holes, excavations or artefact collections' (Feary 1990:3).

Lance located seven areas of archaeological material in the course of his investigation. Four of these are located in the southern pit area and three are within the present study area and are described below.

1. A diffuse scatter of shell midden including pipi, estuarine and rock platform species along vehicle and walking tracks near Crooked River and Blue Angle Creek, extending for approx. 250m x 2m.

2. A stratified shell midden near Crooked River with some midden exposed on the ground surface by ploughing. This site, Lance concluded, had been partially destroyed by clearing and ploughing, but still contained intact midden deposits. He estimated the site dimensions to be 40 x 15m. (1989:18)

3. A diffuse scatter of shell and stone artefacts exposed around the edges of a materials testing pit.

Lance concluded that 'the largest sites appear to have already been disturbed or destroyed by sand extraction or ploughing. Of the sites located during the study, it appeared that the densest and most diverse deposits were located at the southern edge of the area under investigation' (1989:17).

Feary 1990 inspected the Gerroa sand mining area in July, 1990 with other officers of the NSW NPWS and located

- a number of previously unrecorded pipi middens in the northern pit area on tracks adjacent to Blue Angle Creek;

- four small pipi middens on the south-western side of the middle pit.

Feary also argued that the dimensions of Site 206 were larger than those stated by Lance (Feary 1990:3).

Lance 1990 replied to Feary's critique of his 1989 report. He carried out a further inspection of the sand mining area and noted

- further localised shell midden in areas which had been subject to recent clearance in the northern pit area.

- that since his previous inspection, Site 206 had been subsequently 'largely destroyed' as a result of clearing in the vicinity of the northern pit area (1990:10).

Ms. Feary informed the consultant that another inspection of the sand mining area was recently carried out by **Ms. Marjorie Sullivan (nd)** on behalf of National Heritage Studies Pty. Ltd. Ms. Feary accompanied Ms. Sullivan on this inspection. The report on this study has not been lodged with the NSW NPWS. The consultant's attempts to contact National Heritage Studies and requests to view the report have been unsuccessful to date.

Ms. Feary, however, informed the consultant that further areas of midden shell were located in the course of Ms. Sullivan's inspection. Refer below.

EVALUATION OF THE EXISTING DATA BASE

The considerable number of inspections and investigations so far carried out in the study area should provide a good data base for site location, dimension and content criteria and facilitate assessment of the archaeological resource of the area. However, various limitations are evident in the work to date.

The most apparent and major weaknesses in the data base are:

- the lack of map grid references for any of the sites located as a result of archaeological survey. It is often difficult to determine exactly where sites are, and which sites are being discussed in the various reports.

- the poor standard of site recording. Descriptions of sites and their current condition are generally sketchy. NPWS Site Recording Forms - the primary means by which site information is recorded by the archaeologist and stored by the NPWS in the Register of Aboriginal Sites - have not been completed for any of the sites. Consequently none of the sites appear on the NPWS computer data base and none have been allocated site numbers (such as 52-5-0206).

- the shortcomings of Lance's 1989 report as defined by the NSW NPWS and outlined above.

- the disagreement between Lance and Feary on site interpretation in the area, particularly with regards to pipi midden sites.

- the difficulty in obtaining access to the results of the most recent survey undertaken in the area by Ms. Marjorie Sullivan.

- there has been no specific investigation of oral traditions amongst local south coast Aboriginal communities for information relevant to the study area. This is despite initial evidence suggesting that oral histories remain relevant to the historic Aboriginal occupation of the Crooked River estuary area (Colley 1988:3).

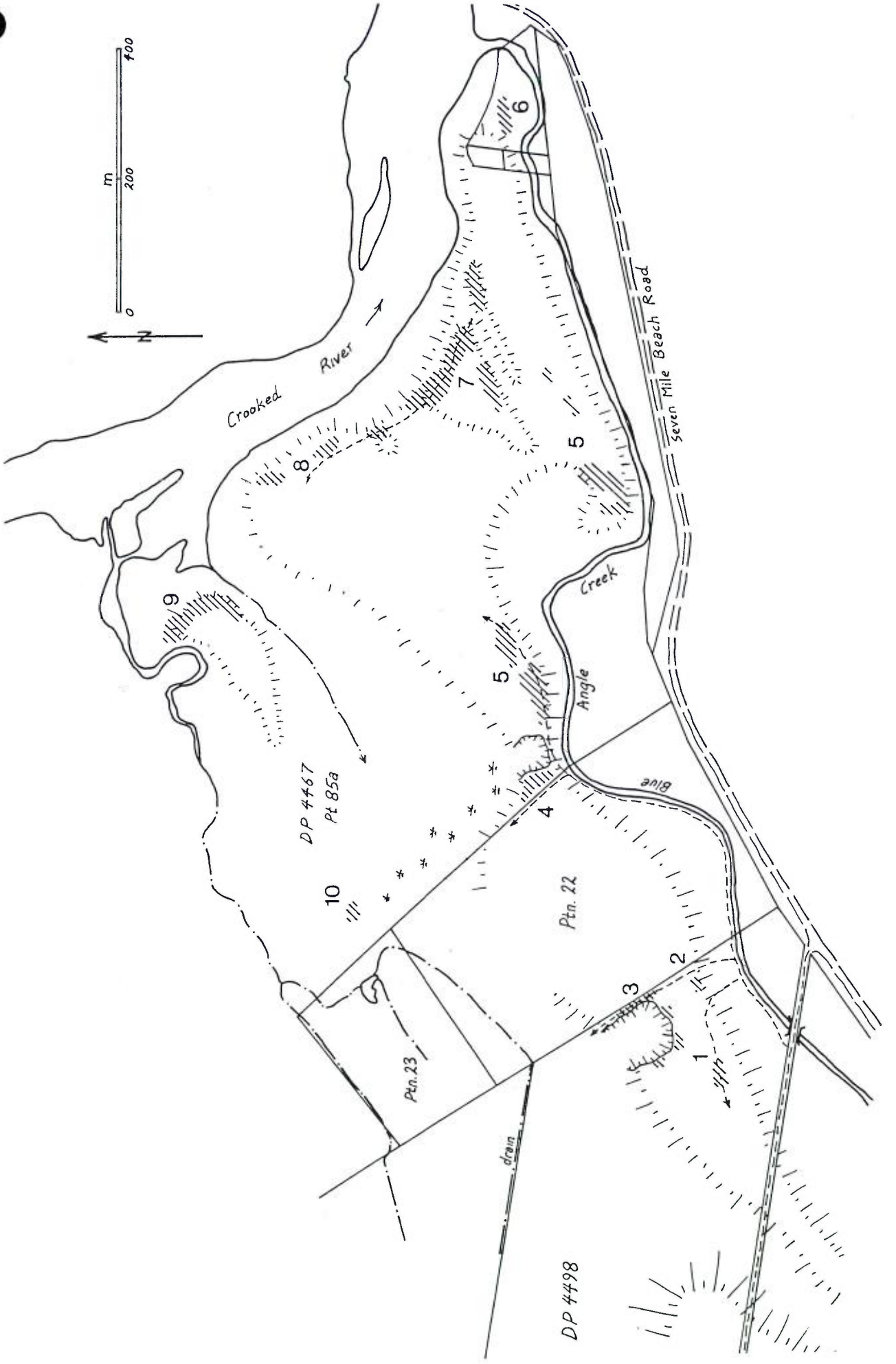

Figure 2 Locations of Shell Material – numbers correspond to numbers in text

SITE INSPECTION

The brief for this present study did not include a comprehensive or systematic survey of the study area. However two reconnaissance level inspections of the study area were carried out in the course of the investigations.

A familiarisation inspection was carried out with personnel from Quality Environmental Management on December 17, 1991. This involved walking around most of the perimeter of the area and inspecting various parts of the study area. Any areas of midden shell were noted on a 1:4000 map of the sand mining areas produced by BHP engineering 1989. (Figure 2).

A second inspection was carried out with Ms. Sue Feary, Regional Archaeologist, South-Eastern Region, NSW NPWS, on January 7, 1992. Mr. George Lasek of Cleary Bros. Pty. Ltd. and Mrs. Anne Whitteron of Quality Environmental Management Pty Ltd accompanied the archaeologists on this inspection.

The aim of this inspection was to clarify the location of various sites and midden shell occurrences located in previous surveys by Lance, Feary and Sullivan. These areas were also noted on the above mentioned map. A brief inspection of the archaeological sites in the vicinity of the southern and 'brickies' pit was also made at this time.

NB. Further detailed archaeological investigation of the sites in the southern pit area is scheduled to be carried out in February, 1992, by students from the Australian National University. The students will attend a summer school at the site, run by Mr. Wilfred Shawcross of the ANU.

THE KNOWN ARCHAEOLOGICAL RESOURCE

The following list of archaeological sites is based on previous recordings and on site inspections carried out in the course of this present investigation. A number of occurrences have not been listed, as insufficient information is available to determine even their approximate location eg. Lance (in Colley 1988b) - 'the shell midden along the length of the beach ridge, particularly between areas A and B'.

THE MIDDLE PIT AREA

1. Scatter of pipi and mussel shell on track. This site has been exposed as a result of the track cutting through surface sand deposits. (Noted by Colley 1988b?, Navin 1992)

2. Scatter of pipi shell on track. This site has also been exposed as a result of the track cutting through surface sand deposits. (Navin 1992)

3. Numerous scatters of shell, predominantly pipi, evident around the edges of the 'horseshoe shaped' pit. This material has been exposed and consequently disturbed as a result of sand mining activities. (Colley 1988a, Feary 1990, Navin 1992)

THE NORTHERN PIT (BAILEYS ISLAND) AREA

4. Scatters of shell, predominantly pipi, on high sand body adjacent to, and west of, sand testing pit. This material is fragmented, but appears relatively undisturbed. (Lance 1989, Navin 1992)

5. Scatters of shell, predominantly pipi, intermittently along the large elevated sand area adjacent to, and north of, Blue Angle Creek. The area has been variously disturbed as a result of vegetation clearance, tracks, and topsoil removal to a depth of approximately 30cm, as evidenced by the pedestals of sand around the bases of large trees. Some areas have also been bulldozed and possibly ploughed. (Lance 1989?, Lance 1990, Feary 1990, Navin 1992)

6. Scatter of shell, predominantly pipi, in DP359457, near the confluence of Crooked River and Blue Angle Creek visible in walking tracks – probably associated with the old house/hut site. (Navin 1992)

7. NPWS Site No 52-5-206. In 1989 Lance noted that this site had been partially destroyed by clearing and ploughing, but still contained intact midden deposits. In 1990 Lance noted that the site had subsequently been 'largely destroyed' as a result of clearing in the northern pit area. (Walker 1986, Colley 1988a & b, Lance 1989 & 1990, Feary 1990, Navin 1992)

8. Scatter of shell adjacent to the Crooked River and south of unnamed creek. The shell noted here is in a highly disturbed context, with recently cleared vegetation evident and topsoil bulldozed into large spoil heaps. (Navin 1992)

9. Shell material scattered along an elevated area adjacent to the Crooked River and between two unnamed creeks. This area has been extensively cleared and the northern-most portion was used for as a base for logging the land to the west (pers comm Mr. George Lasek 1991). Disturbance has occurred in this area as a result of the vegetation clearance and it appears that some surface material has been removed. Spoil heaps are evident in the area. (Sullivan nd, Navin 1992)

10. Shell material incorporated in dam spoil – *Ostrea* sp, *Nerite* sp, *Pyrazus* sp, *Austrocochlea* sp, *Donax* sp. adjacent to Portions 22/23. (Sullivan nd, Navin 1992)

Based on these site locations it is possible to propose several site location characteristics for sites within the study area.

Shallow or surface pipi middens are distributed discontinuously along the top of dune ridges adjacent to and in close proximity to the Blue Angle Creek swale. These sites appear to be restricted to the near surface of the present soil profile. The density of shell and the likelihood of finding artefacts increases as you get closer to the Crooked River estuary. Similarly the likelihood of finding estuarine species increases.

Sites located within approximately 300m of the Crooked River estuarine environment are more likely: to contain greater diversity of shellfish species; to contain lithic artefacts; to display evidence of, or have the potential to, extend subsurface to considerable depth, and to occur within a palaeosol.

The majority of sites identified in the study area are located on elevated landforms adjacent to wetlands, and in particular the crests of dune ridges.

PORTIONS 22 and 23

Portions 22 and 23 have not been the subject of archaeological survey according to the information contained in the previous investigations documented above. Other than to carry out a brief inspection, these areas were not surveyed in the course of this present investigation.

AREA BETWEEN BEACH ROAD AND BLUE ANGLE CREEK

This area has not been the subject of archaeological survey according to the information contained in the previous investigations documented above. The area was not surveyed or inspected in the course of this present investigation.

THE POTENTIAL ARCHAEOLOGICAL RESOURCE

Based on the past experience of sites being exposed by vegetation clearance and other earthworks, it is considered highly likely that further unrecorded sites occur within the study area.

Given the apparent extent of land surface disturbance which has occurred in both the northern and middle pit areas, it is reasonable to assume that sites restricted to the upper soil levels have experienced considerable disturbance. Potential exceptions to this are Portions 22 and 23 and the area between Beach Road and Blue Angle Creek. A section of dune ridge, continuous with that containing sites 1-5, occurs within Portion 22 adjacent to the Blue Angle Creek swale.

Based on the structure of the vegetation extant on the ridge, sites which potentially occur on this landform will be less disturbed than elsewhere in the study area. Based on site distribution elsewhere in the study area, and in the southern pit area, the potential for shallow pipi middens in this landform is considered to be high. This remnant dune section has considerable archaeological potential as it represents the least disturbed area within the dunal site complex present in the study area.

Sites 7 (52-5-206), 9 and 10 appear to be associated with fossil soil horizons or palaeosols. Lance detected cultural material within a sub-surface dark grey layer to depths of 33cm at site 7. The elevated context of sites 7 and 9 provide the potential for considerable site depth.

Given these characteristics, these sites and the associated dunal landforms fringing the estuary wetlands must be considered to have archaeological potential beyond that indicated from the present surface disturbance. One potential site type for which there is as yet no physical evidence is burials. Burials are known to occur in comparable topographic locations and sediments elsewhere along the NSW south coast. It is relevant to note in this context that Colley (1988:3) documents evidence from a local Aboriginal elder stating that the Crooked River area is believed to be the location of an Aboriginal and European burial site. Mr Dick Henry, Chairperson of the Illawarra Local Aboriginal Land Council, also mentioned to the consultant two known burials from the Crooked River Estuary.

Without a comprehensive program of sub-surface testing, this potential cannot be further defined or assessed.

ASSESSMENT OF THE ARCHAEOLOGICAL RESOURCE WITH RELEVANCE TO THE REZONING PROPOSAL

Based on the available database, it is clear that the study area originally contained a relatively high density of sites, which consisted of various site types, and indicated a variety of subsistence strategies and site location preferences.

Despite the potential for sub-surface archaeological material in estuarine fringing areas, the disturbed nature of the majority of the study area and the probable surface or near surface character of most of the archaeological material means that the majority of the known archaeological resource has limited or low significance.

Based on this assessment, a proposal to rezone the total study area based on the significance of the archaeological resource would be difficult, if not impossible to support.

The available database indicates that no archaeological survey or recording has occurred in the areas defined as Portions 22, 23, and the area between Beach Road and Blue Angle Creek. The absence of direct information makes it impossible to make specific assessments about these land portions with regard to the rezoning proposal.

However, based on the lesser degree of land disturbance which has occurred in these areas (as evidenced by the surviving vegetation), and the distribution of archaeological sites on comparable adjacent topographic features, the potential for archaeological sites to occur is considered to be moderate, where locally elevated and well drained ground occurs adjacent to wetland or swale areas.

It could be anticipated that any sites occurring in these areas are likely to be less disturbed than the known sites in the adjacent areas. As surviving sites located within a now substantially disturbed site complex, their archaeological significance is potentially high. Without information from area specific archaeological investigations, it cannot be determined whether these areas include archaeological resources which would warrant protection from a Rural Environmental Protection 7(1) zoning.

REFERENCES

Colley, S. 1988a (October) **An Archaeological Survey of a Proposed Sand Quarry Near Gerroa, South Coast, NSW.** Report by Anutech Pty Ltd to Dames & Moore Pty. Ltd.

Colley, S. 1988b (December) **An Archaeological Survey of a Proposed Sand Quarry Near Gerroa, South Coast, NSW.** Report by Anutech Pty Ltd to Dames & Moore Pty. Ltd.

Dames & Moore Pty Ltd November 1988 **Sand Extraction from Land Owned by Cleary Bros. (Bombo) Pty. Ltd. at Gerroa, NSW. Environmental Impact Statement.** Hardcastle & Richards Pty. Ltd. in association with Dames & Moore Pty. Ltd.

Feary, S. 1990 **Report to Kearns & Garside** Re: Aboriginal Sites Within Area Affected by Bridon Pty Ltd - Application for Sand Mining at Gerroa.

Lance, A. 1989 **Archaeological studies of a sand extraction development at Seven Mile Beach, New South Wales.** Report by Anutech Pty. Ltd. to Dames and Moore Pty. Ltd.

Lance, A. 1990 **Further report on archaeological sites at Cleary Bros. Gerroa sand extraction.** National Heritage Studies.

Ross, A. 1990 Unpublished notes to Ms. Sue Feary from Ms. Anne Ross NPWS.

Wellington, R. 1990. Notes appended to Lance's 1989 report - 'Archaeological studies of a sand extraction development at Seven Mile Beach, New South Wales'.

VISUAL ANALYSIS REPORT

VISUAL ANALYSIS FOR

PROPOSED REZONING OF LAND AT BLUE ANGLE CREEK, GERROA

BY GUTTERIDGE HASKINS & DAVEY PTY LTD

FOR QUALITY ENVIRONMENTAL MANAGEMENT

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6 January 1992
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CONTENTS

1. INTRODUCTION

This report has been prepared for Quality Environmental Management Pty Ltd in response to a commission from Kiama Council, relating to proposed changes to the zoning of the subject land.

The proposal is to rezone land adjacent to Blue Angle Creek at Gerroa from Rural 1(a) to Rural Environmental Protection 7(1), and to include these changes in a draft Local Environmental Plan (LEP) for the area. (Figure 1)

The purpose of this report is to consider the visual analysis in relation to the proposed rezoning, and with regard to the possible use of the site for sand extraction. Numerous reports have been prepared on the visual impacts of sand mining proposals, and it was the first task within the scope of this study to review these previous works.

Following the perusal of this existing information, a site inspection and reconnaissance of the surrounding area was undertaken, and assessments made with regard to previous studies and on-site observations.

It is considered that visual studies undertaken to date have adequately addressed the visual amenity of the area immediately surrounding the site, and of the site in a regional context. There is, however, some degree of variation within the findings, relating to the potential visual impacts of the proposals for sand extraction. All parties appear to be in agreement that the site is part of an area of significant scenic quality.

Location map

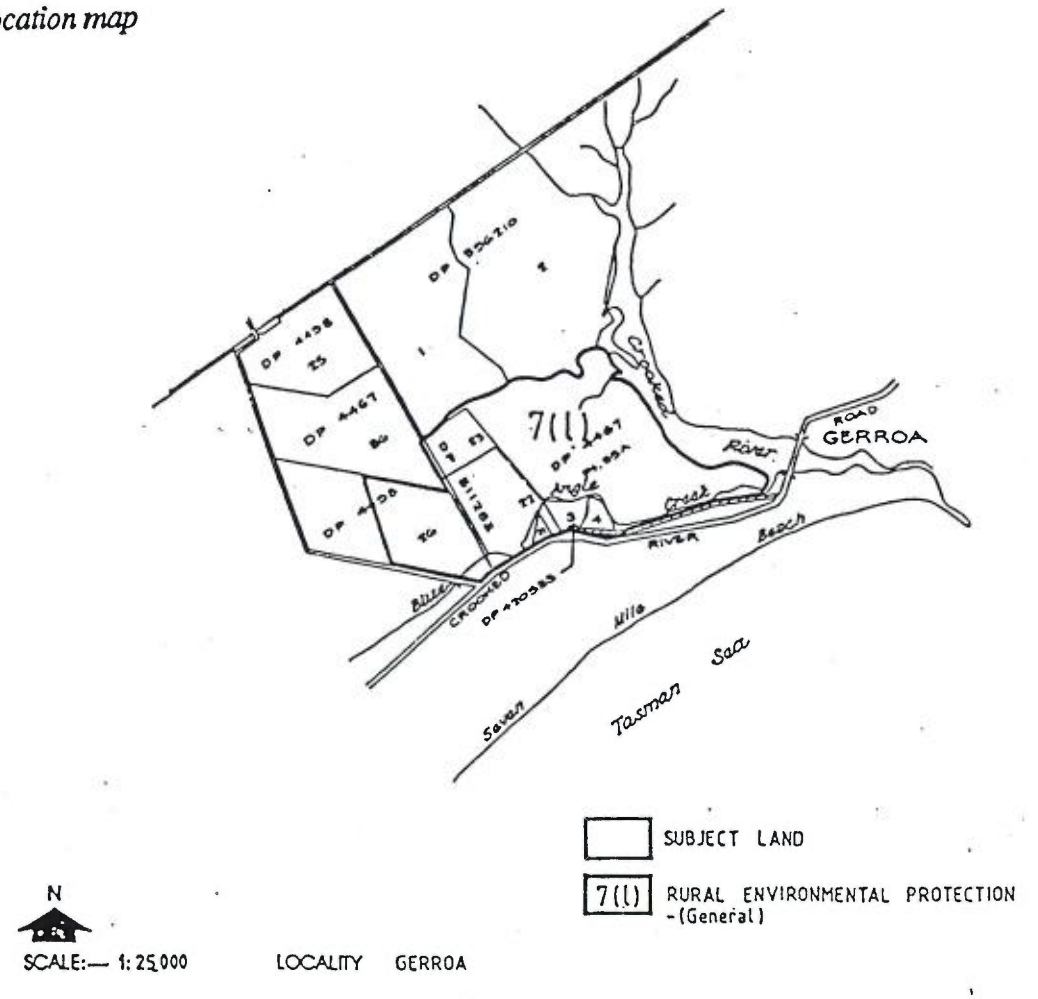


FIGURE 1: Location and Proposed Zoning of Study Site

2. EXISTING VISUAL CHARACTER

With relation to the proposed study, visual character can be described in terms of both the regional scenic environment into which the site fits, and the character within the site itself.

2.1 Regional Landscape

The subject site is located just south of Gerroa on the costal plain and is 50 kms south of Wollongong. The site is bounded by Crooked River to the north, Seven Mile Beach Road to the east, and an unnamed creek to the west.

The coastal plain is located within a zone that is considered to be of high regional visual significance. Within the area there is wide visual variety resulting from a number of landscape types, such as the escarpment face, which provides a spectacular scenic backdrop; prominent headlands; and the coastline which is characterised by dunes backing sandy beaches.

Variations to the general topography in localised areas provide more visible landscape features with visual variety being a major component of many views.

TOPOGRAPHY: The landform in the area around the subject site is dominated by the Gerroa Headland which rises 80 metres above sea level. This high ground continues along the coastline to the north, while to the south down to Crooked River the level drops steeply to flat coastal plains which contain areas of swamp. (Figure 2) To the west are rolling hills which run into the Illawarra Escarpment in the distance. (Figure 3) The site itself is located on a gently undulating terrain of low vegetated sand dunes.

VEGETATION: Most of the vegetation which remains in the area is concentrated along the coastal edge, in the Seven Mile Beach National Park and adjacent land holdings. This vegetation is typical of sand dune communities throughout the coastal area.

HYDROLOGY: The subject site is bounded on the northern edge by the Crooked River which drains from west to east towards the coast. Blue Angle Creek runs throughout the site in a north–south direction, draining northwards into the Crooked River.

LANDSCAPE UNITS: Within the local region, several landscape units, each with definitive characteristics, have been identified by Kinhill Engineers, and have been summarised below.

- Coastal Headland – comprises rolling to hilly landscape, and is used predominantly for agricultural purposes. Little vegetation is found and these headlands are highly visible.
- Headland Settlement Areas – houses are located to take advantage of ocean views and are generally arranged in regular patterns. Few tall trees exist here, and planting is a combination of native and exotic species.
- Coastal Plains, Cleared – generally cleared for agricultural purposes with isolated pockets of trees remaining. Land often subject to flooding.
- Coastal Plains, Forested – characterised by a continuous tree cover with dense undergrowth which results in a very enclosed landscape type.
- River Wetlands – vegetation density is variable and is subject to tidal variation.
- Undulating – this landscape unit comprises those areas of slight relief within the coastal plain. This land is mostly cleared and supports pockets of housing.
- Swamp Plains – these are areas of low–lying water bodies.

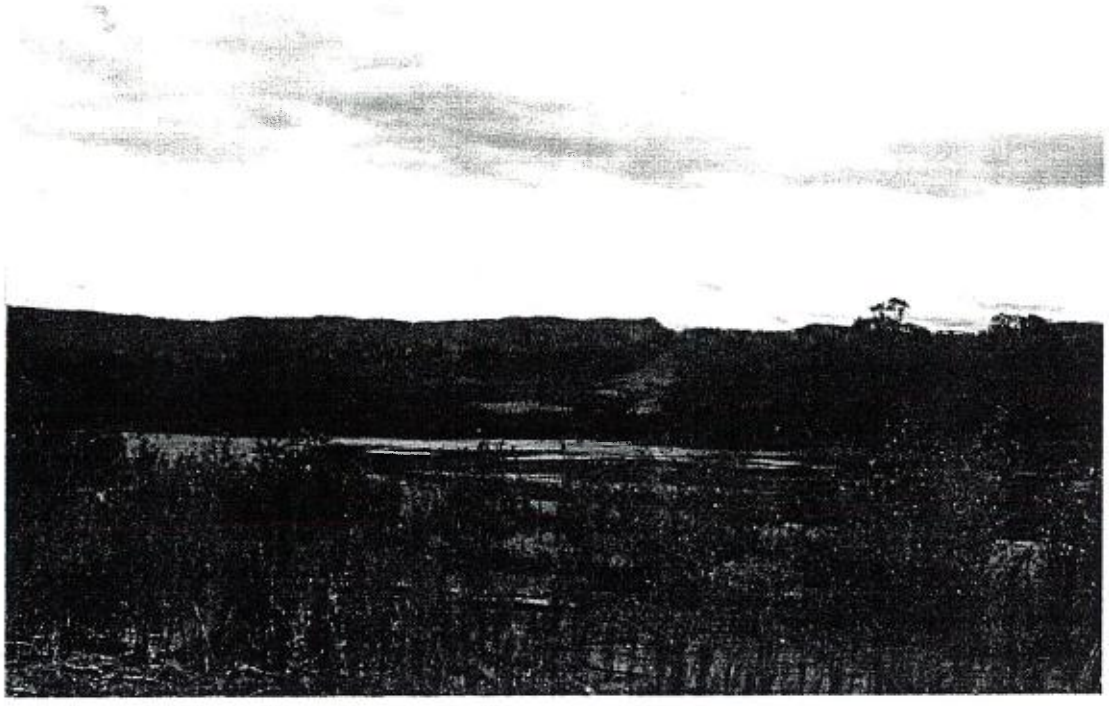


FIGURE 2: View from edge of site across Crooked River to the Illawarra escarpment

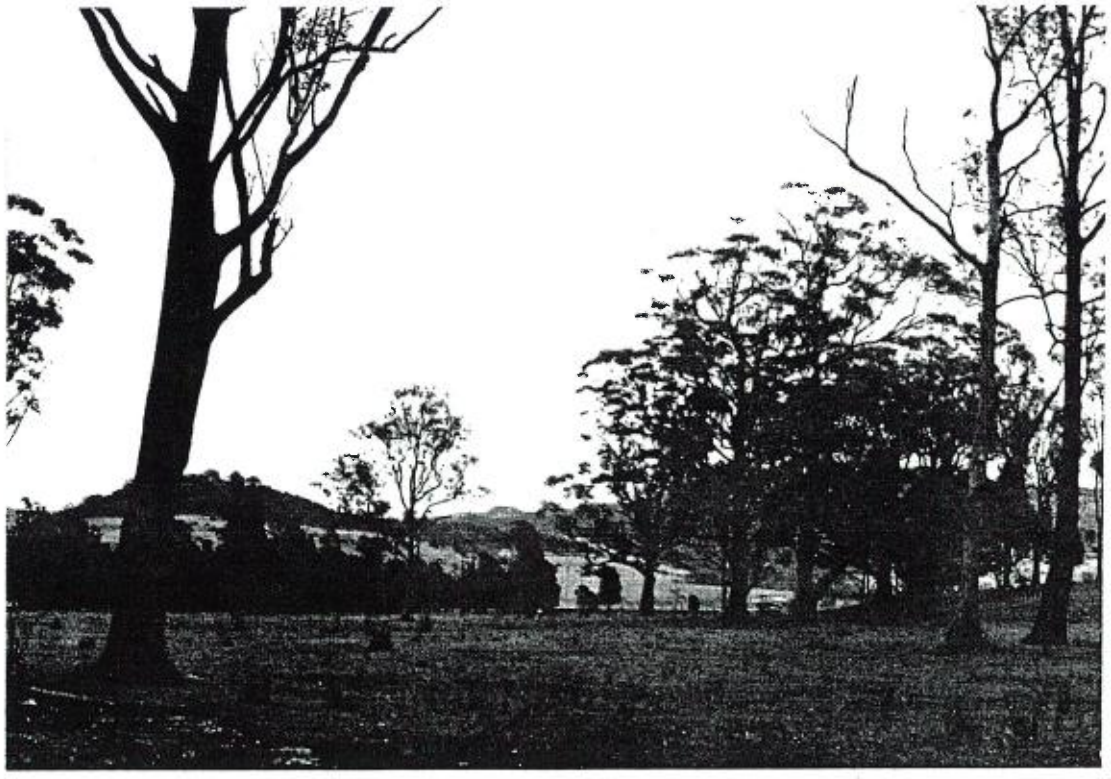


FIGURE 3: Looking south-west from edge of site across adjoining rural lands

- Rolling Hills – comprises the hilly country to the west of the coastal plain, and exhibits large areas of remnant vegetation on crests of hills.

2.2 Existing Visual Character Within the Subject Site

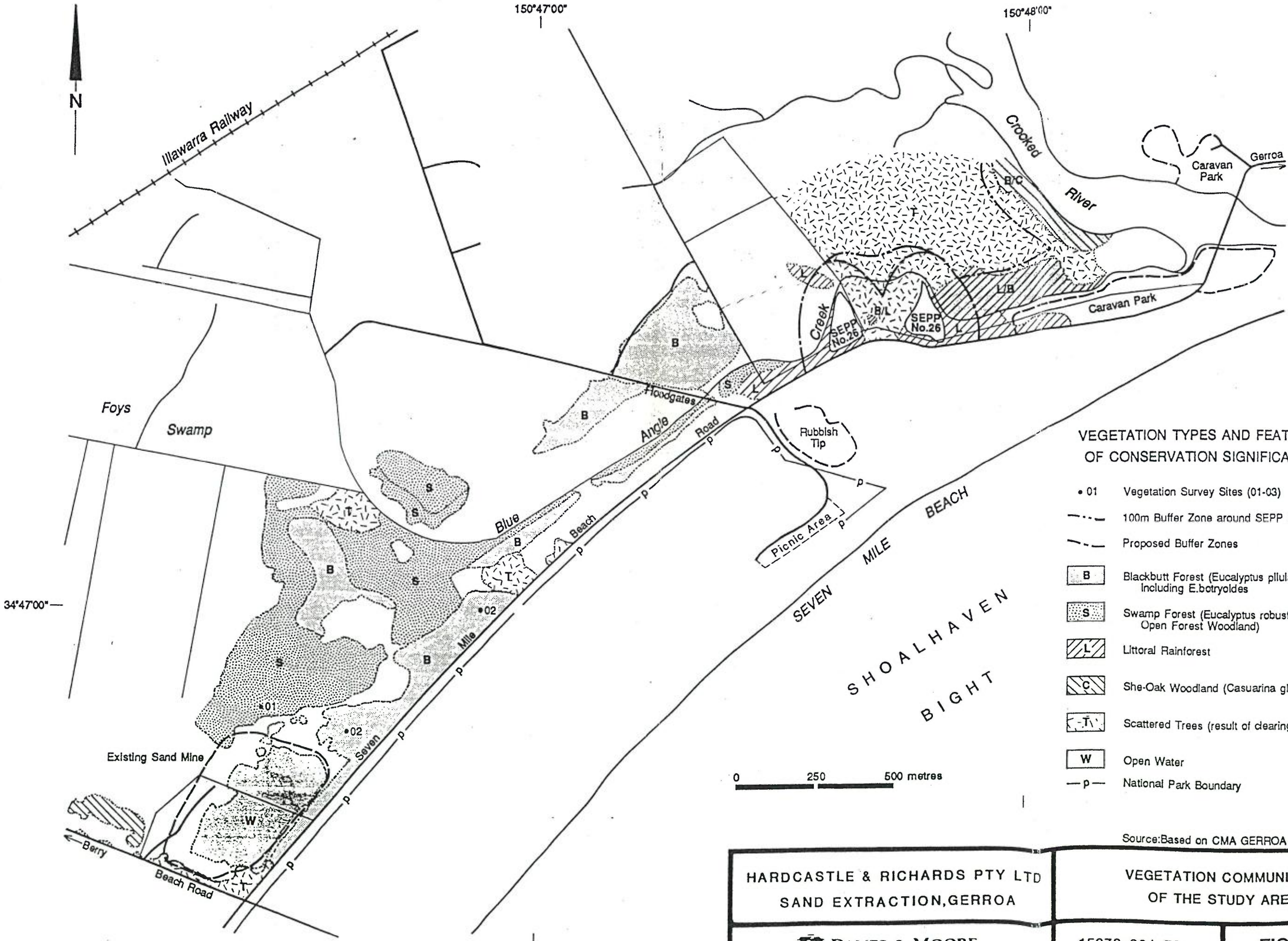
Within the site itself, a number of landscape character types can be identified based predominantly on the existing vegetation communities or the land uses which have occurred within these zones. Three main groups are described below, based on classifications described in the EIS prepared by Hardcastle and Richards Pty Ltd. (Figure 4)

BLACKBUTT FOREST (*Eucalyptus pilularis*, Open Forest) including *Eucalyptus botryoides* (Figure 5)
This forest consists of an upper canopy of tall trees up to about 20 metres in height, together with a dense understorey of shrub vegetation. This community is predominantly enclosed in character with texture and detail being the dominant elements. The blackbutt forests are common along the south coast, though much clearing has occurred within the immediate vicinity of the site.

SWAMP FOREST (*Eucalyptus robusta*, Open Forest Woodland)
A much more dense and low growing vegetation community, dominant trees reach approximately 10 metres in height and have a dense canopy cover. Understorey is composed of a variety of shrub species also in a dense configuration. Landscape character is enclosed with texture and detail being the dominant elements.

SCATTERED TREES (Result of Clearing) (Figures 6 and 7)
Almost half of the subject site is composed of an area in which all the understorey vegetation has been cleared, leaving only major canopy trees scattered throughout the area. This clearing has resulted in the opening up of distant views to the west, however foreground views to the Crooked River are restricted by a screen of trees which remain along the river's edge. Landscape character is panoramic composed of fore, middle and background views with the line and form of exposed tree trunks being the dominant feature.

In association with these three main landscape units within the site, two smaller pockets have been identified. These areas are Littoral Rainforest areas adjacent to Seven Mile Beach Road (included in SEPP26); and she–oak woodland bordering Crooked River. None of these areas is proposed to be further disturbed as part of the mining extraction operations. Also, the middle extraction site presently contains a large hole which creates a significant opening in the canopy cover when viewed from within. (Figure 8)



Source:Based on CMA GERROA 9028 - 2 - N, 1986

HARDCASTLE & RICHARDS PTY LTD SAND EXTRACTION, GERROA	VEGETATION COMMUNITIES OF THE STUDY AREA
DAMES & MOORE	15278-004-70 FIGURE 4

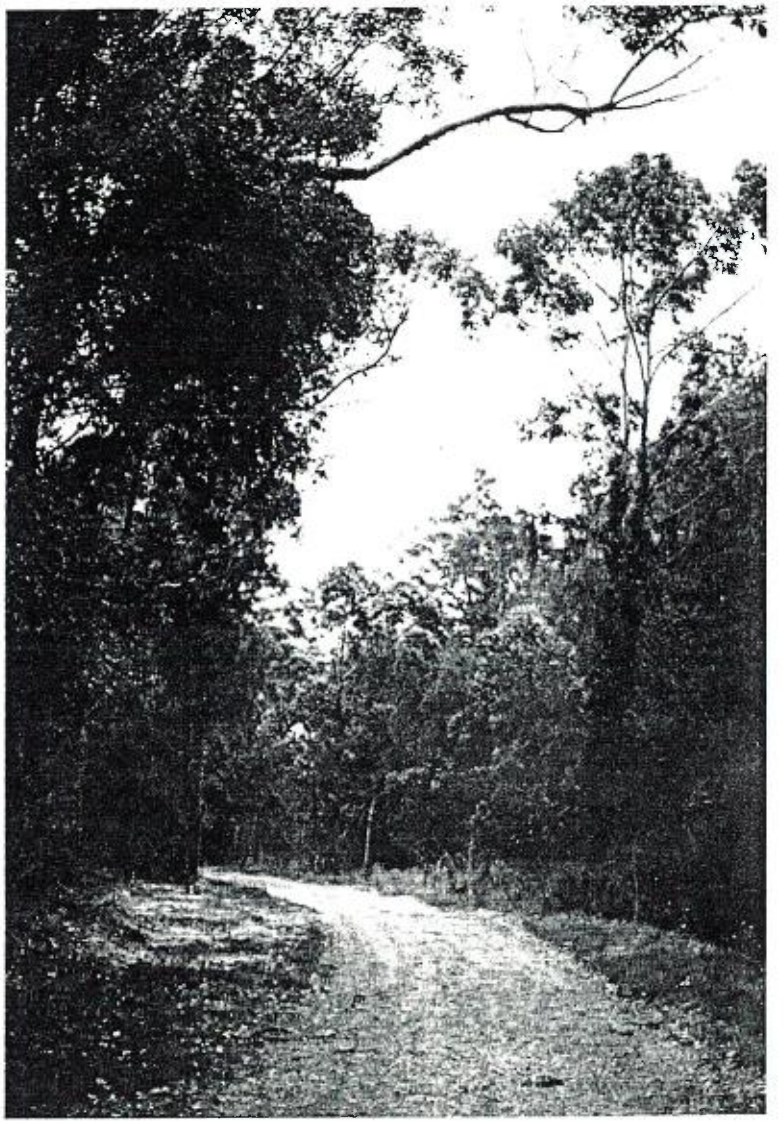


FIGURE 5: Blackbutt Forest on south-eastern portion of site

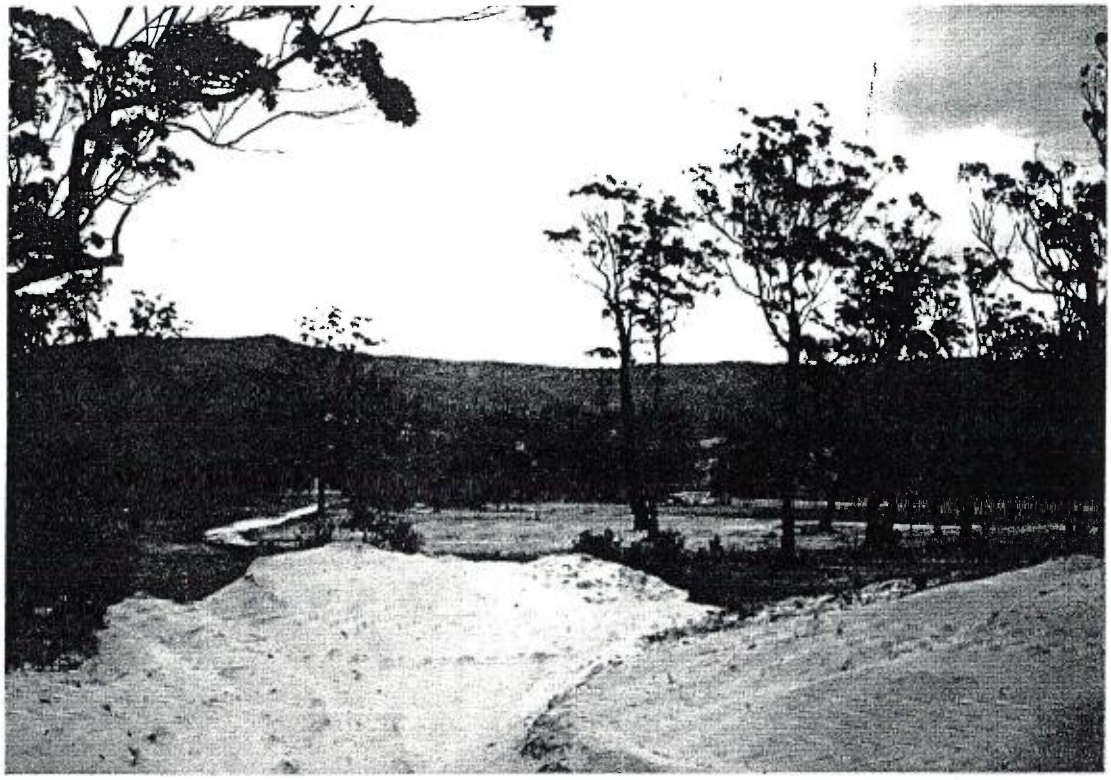


FIGURE 6: Open cleared area containing remnant canopy trees, looking west

FIGURE 7: Open cleared area containing remnant canopy trees, adjacent to Crooked River

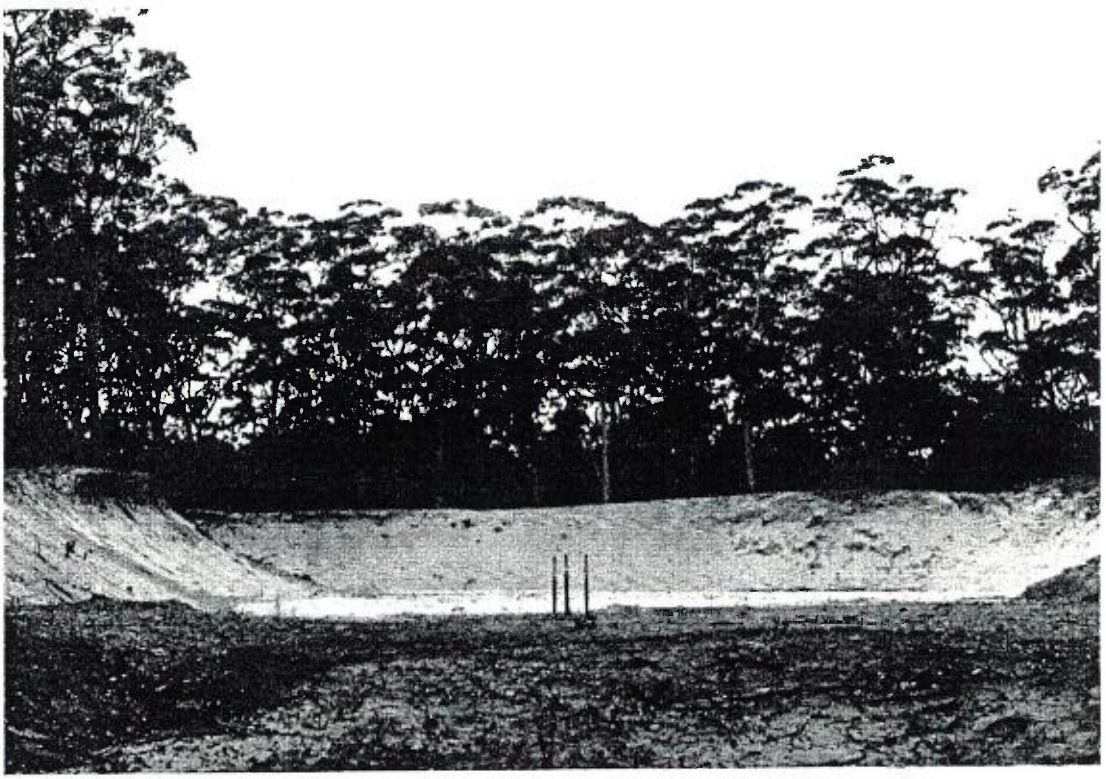


FIGURE 8: The existing site of the middle extraction area

3. SCENIC QUALITY

3.1 Regional Landscape

The scenic quality of the Gerroa costal strip has been documented in a number of reports, and most agree that the area immediately surrounding the study site is of significant scenic quality.

The National Trust of Australia (NSW) in their document *Illawarra Region Landscape Study* identify the Shoalhaven River Flats as a "Proposed Scenic Landscape". The New South Wales Department of Environment and Planning however, in their document *Illawarra Regional Plan – Illawarra Region Landscape and Environmental Study,* consider the area to be of only Low–medium Scenic Quality, with the remainder of the northern coastal strip being of medium ranking.

Kinhill Engineers have ranked the landscape units described in Section 2.1 as High, Medium, or Low, based on a number of factors such as areas which contribute to regional landscape character; areas which have features of distinctive value; and areas of high landscape quality.

The identified rankings are as set out below:

Coastal Headland	HIGH
Headland Settlement	LOW
Coastal Plains, Cleared	LOW
Coastal Plains, Forested	HIGH
River Wetlands	MEDIUM
Undulating	MEDIUM
Swamp Plains	LOW
Rolling Hills	HIGH

According to this ranking, the subject site, which would fall within the landscape unit of "Coastal Plains – Forested", is considered to have HIGH scenic quality.

Although the Department of Planning considers the site to have only a Low–Medium rating, they have detailed specific guidelines with regard to sand mining operations. The following quote is from in the background to the *Illawarra Regional Environmental Plan No. 1 (1986).*

> "Visual impact is important and where possible, operations should be screened from public places. This may be achieved by maintaining areas of vegetative cover, by tree planting, or by limiting extraction to areas concealed by ridgelines from travel routes, habitation, recreation areas, or other public places. Rehabilitation and restoration should be pursued by backfilling, tree planting, and recontouring surfaces."

3.2 Scenic Quality Within The Subject Site

As stated in Section 2.2, there are three main landscape types identified within the site which would be effected by sand mining proposals, based on existing vegetation communities. The scenic quality of these communities can be assessed with regard to other communities which occur on the site, but cannot correctly be compared on a broader scale with landscape units described from a regional point of view.

Both the Blackbutt Forest and the Swamp Forest exhibit a continuous canopy and understorey cover of species with similar form, shape and colour. This results in a lack of visual variety and little variation to the flat landform also contributes to this lack of visual amenity. It is considered that in this context the scenic quality of these forest areas *from within the site itself* would be determined as being Low.

In contrast, in the northern portion of the site where clearing of understorey vegetation and some canopy trees has taken place, this has opened up the site to provide panoramic views to the west and beyond to the escarpment. The retention of screen planting adjacent to Crooked River breaks up and filters the view in places, further increasing the visual variety. (Figure 9) Glimpsed views are also afforded to adjoining development such as the Seven Mile Beach Caravan Park. (Figure 10)

The clearing of understorey vegetation not only opens up more distant views but changes the dominant foreground feature from one of dense green foliage to linear, scattered tree trunks through which more distant features are visible. This visual variety would result in the scenic quality of this cleared area *from within the site itself* being determined as having a Medium to High ranking.

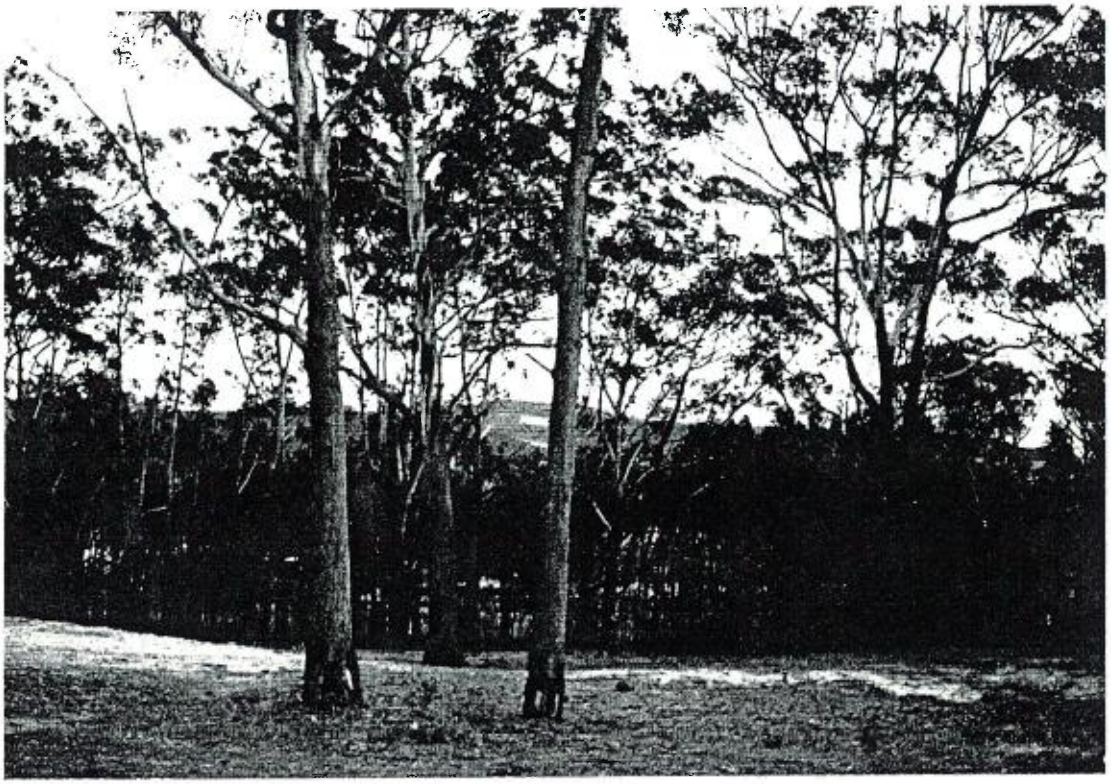


FIGURE 9: Buffer of vegetation which has been retained along Crooked River

FIGURE 10: Seven Mile Beach Caravan Park as seen from within subject site

4. VIEWS TO THE SITE

Due to local landform patterns of the low-lying coastal plains surrounded by hilly country to the west and coastal headlands to the north, it is inevitable that the subject site, located on the coastal plain, will be visible from numerous vantage points. None of the existing documentation disputes the fact that the site is highly visible as a whole, but disagreement does arise as to the visual impact of proposed sand mining activities and the wholesale clearing of vegetation which would accompany this operation.

A number of vantage points have been identified, as set out below.

GERROA HEADLAND (Figure 11)
Gerroa Headland provides probably the most scenic and panoramic views of the coastal plain, and as such the subject site is highly visible from this outlook, occurring in the midground view. Despite the fact that significant clearing has occurred on the site at ground level, much of the upper storey canopy remains and this gives the impression of continuous vegetation cover within the forested coastal zone.

TOOLIJOOLA (Figure 12)
This settlement is in the higher hilly ground to the west of the coastal plain. Land use is predominantly rural but there are a number of farmhouses which overlook the study area. Views from this location are, however, long distance and the treed coastal plain provides a backdrop to closer foreground features.

PRINCES HIGHWAY (Figure 13)
The Princes Highway mostly traverses the higher ground to the west of the coastal plain, in a north-south direction. Panoramic views of the coast and ocean beyond are afforded along much of this section of the roadway, and extensive views of the subject site from certain locations are readily available. As with Toolijoola however, these views are long distance and the tree cover provides a distant texture within a much broader picture.

SEVEN MILE BEACH ROAD
Seven Mile Beach Road runs along most of the eastern boundary of the study site, and is bounded on both sides by dense forest vegetation. It is this vegetation which restricts views into the site and gives the road a predominantly enclosed landscape character.

SEVEN MILE BEACH CARAVAN PARK
Seven Mile Beach Caravan Park is located adjacent to part of the eastern boundary of the proposed northern extraction area and as such is subject to localised foreground views of the subject site. These views are restricted however, by a vegetation screen which borders the site and which is proposed to be reinforced should extraction of sand take place.

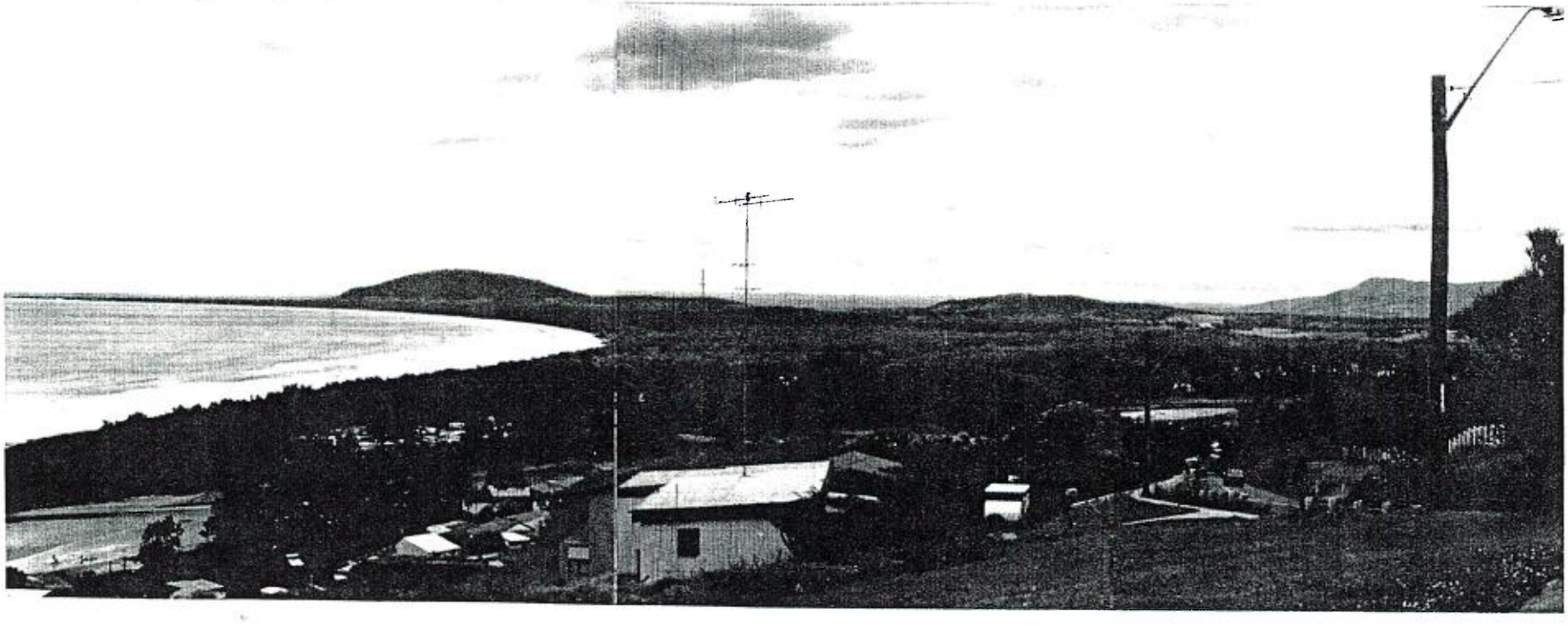


FIGURE 11: View southwards from Kingsford Memorial on Gerroa Headland, with subject site visible in the middle ground

FIGURE 12: View of forested coastal plain from Toolijoola, looking north-east

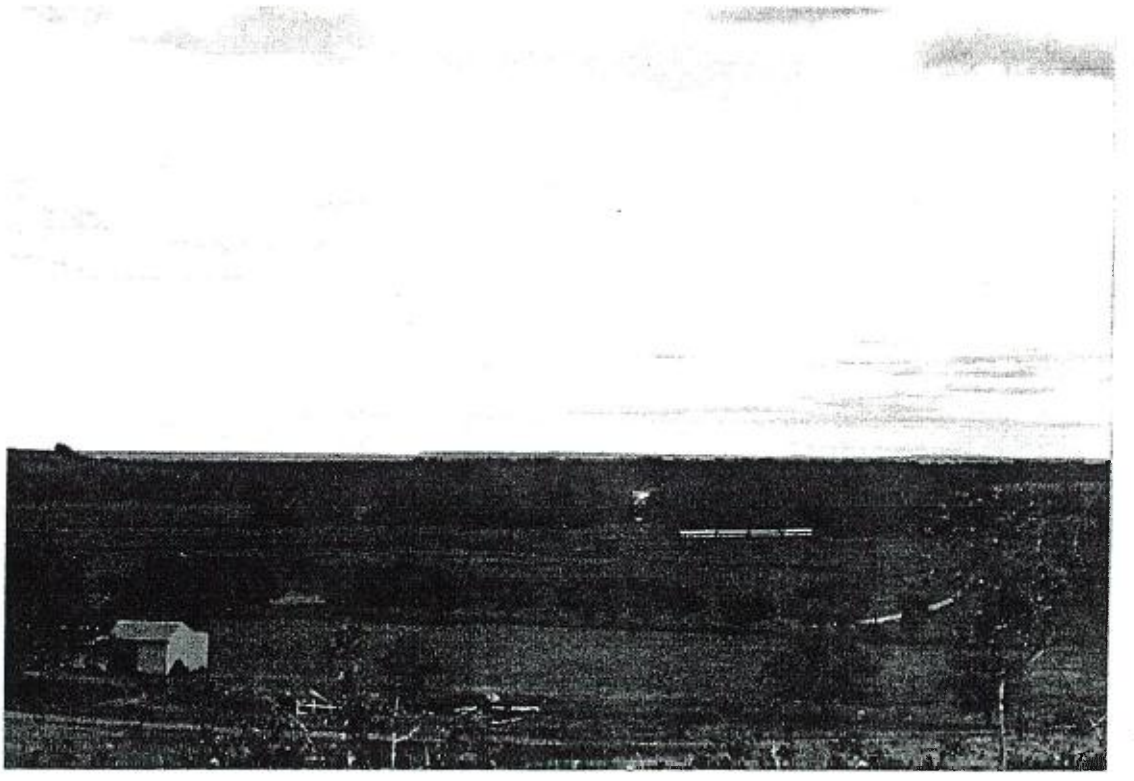


FIGURE 13: View of forested coastal plain from the Princes Highway, looking eastwards

5. ASSESSMENT OF VISUAL IMPACT

It is this area of consideration which has produced the most varying conclusions among the documents which have been made available on the subject of visual analysis.

Kinhill Engineers consider that the subject site in it's context on the forested coastal plains is of high regional significance due mainly to the remaining continuous canopy cover. In the proposed northern extraction area large scale clearing of the mining site would result in a change of landscape character from one of continuous canopy cover to a large body of water.

The 1988 Environmental Impact Statement prepared for Cleary Bros by Hardcastle and Richards in Association with Dames and Moore, set out a number of different criteria to determine visual significance. Factors considered include scale, form, colour, movement and activity, character, and contrast and change over time.

The proposed middle extraction area is considered to have minimal visual impacts due to its smaller scale and screened location. It is suggested that (the proposed northern extraction area) would have significant visual impact on the existing environment in the short term due to the size of the operation. A large area of canopy vegetation would be cleared resulting in changes to the character of the area, but in time this would be rehabilitated.

The EIS states that given the scenic quality of the adjacent National Park and the buffer zones between the road and the mining sites, the potential of this impact is considered to be minimal. Any visual impact is likely to be short term since the sites would be rehabilitated.

For the purpose of this report an investigation was made of the existing literature together with an on-site survey and surrounding viewpoint location survey. From this information the following comments can be made regarding assessment of the visual impact which would result from large scale clearing of the existing vegetation.

It is considered that in a regional context, the forested coastal plains have a high visual significance. This is due to their highly visible location on the low-lying coastal plain, and the limited extent of continuous vegetation cover in other nearby locations.

From within the site itself, the more heavily vegetated areas are considered to have low visual amenity due to their visual sameness, while the partially cleared portion of the site affords a high degree of visual variety and amenity. Statements that large scale clearing of the proposed northern extraction area would result in a significant change in the landscape character within the site are correct. However, the stated short term nature of these changes is questionable, because rehabilitation would not involve complete revegetation but the creation of water bodies within the extraction pits. Therefore the landscape character within the site where the extraction is proposed, would be permanently changed from its present appearance.

The main consideration for assessing the visual impact of the proposed sand mining is the effects which would be seen from longer distance viewpoints. It has already been established that the continuous vegetation cover which includes the study site can been seen from a number of vantage points around the site.

The highest and most panoramic of these viewpoints is from the Gerroa Headland. This vantage point overlooks the whole site, which forms the middle ground of a wider view. (Figure 11) The

existing hole in the canopy in the middle extraction site cannot be seen from this vantage point, and its proposed small scale expansion is not considered to make it any more visible. The northern extraction site, where some clearing has already taken place, is relatively well hidden by the vegetation buffer which has been retained along the banks of the Crooked River, and the canopy trees which are still scattered throughout the site. Some glimpses of the bare ground surface is visible through the trees, but the continuous canopy cover does not appear to be interrupted.

This view however, would change should all of the large eucalypts within this area be removed. The she-oak woodland along the rivers edge would not be sufficiently tall to screen the sand extraction operations in this location. This effect could be ameliorated by the retention and enhancement of a wide buffer of taller trees behind the she-oak woodland.

From both the Princes Highway and Toolijoola Road the site appears as a continuous vegetation cover however some clearing is evident from the Princes Highway. Due to buffers of vegetation between the site and the highway this cleared area does not have a major impact on the overall scenic quality. Any further clearing would need to be supplemented with a reinforcement of buffer planting to reduce any perceived impacts. The elevation and orientation of Toolijoola Road is not conducive to extensive views over the subject site and clearing is not evident from this locality.

The final two areas from which foreground views of the mining operations may be seen are Seven Mile Beach Caravan Park and Seven Mile Beach Road. Both the road and the caravan park could potentially be impacted by the extraction proposals, but from a visual point of view existing and proposed vegetation buffers would negate this possibility.

6. CONCLUSIONS AND RECOMMENDATIONS

As would be expected from the previous section on assessment of visual impact, contrasting opinion on the recommendations for the subject site is inevitable. Although it is not the purpose of this report to determine the suitability of the site for sand extraction, in the context of the proposed re-zoning it is useful to present a summary of those opinions which will contribute to the ultimate decision making process.

Kinhill Engineers, in their report *Gerroa Sand Extraction - Landscape Assessment and Visual Impacts* state that sand mining in the northern extraction area should not go ahead. It is considered that no further impact would result from continued mining of the southern site, and that extraction from the middle site on it's own would not have any significant visual impacts. It is claimed however, that mining of the northern extraction site, either alone or in conjunction with the middle site would have considerable visual impact in the immediate vicinity and also from longer distance viewpoints. Safeguards such as buffer zones around extraction areas and along adjoining roads are recommended.

In reply to Kinhill's report, Cleary Bros also prepared a visual assessment for the proposed sand extraction sites at Gerroa, in which it is stated that the proposed development will have negligible visual impact from any location, either at close distance or from long distance viewpoints. Views into the sand extraction area will be suitably screened by buffer zone planting adjacent to Seven Mile Beach Caravan Park and by understorey vegetation planting adjacent to Crooked River.

Cleary Bros also state that the loss of canopy from clearing of the proposed mining sites would not lead to a loss of scenic value. This fact is supported by the comment that the screen provided by the upper canopy along the Crooked River will conceal any clearing of the canopy vegetation. It is also considered that the middle extraction site would not be visible from Gerroa Headland, Toolijoola Road, or Seven Mile Beach Road.

From visual surveys taken both within the site and from surrounding vantage points, the following conclusions and recommendations can be made.

As previously stated, from a regional point of view the site has a high visual significance within the broader scale landscape. This high significance is due mainly to the continuity of vegetation cover within the landscape unit of forested coastal plain. It therefore follows that in this context, the continuity of the canopy cover should be maintained wherever possible.

Proposals for sand extraction within the study area would require the wholesale clearing of a large part of the site which presently supports a reduced but still visually continuous canopy cover. It is from long distance, high viewpoints that this degree of clearing would be most visible.

The Gerroa Headland, and in particular the Kingsford Smith Memorial provides the most panoramic views over the site. If the remainder of the tree cover in the presently partially cleared area were to be removed, the yellow sandy earth surface would be highly visible as it is not considered that the existing she-oak woodland on the banks of the Crooked River would be tall enough to provide effective screening.

However, if a buffer of taller trees were also retained and enhanced along this edge, the canopy would continue to appear unbroken. Upon completion of mining operations, the strongly contrasting yellow colour of the sandy soil would be further reduced by vegetation and rehabilitation.

Other long distance views are not likely to be greatly impacted and additional buffer and boundary planting would further reinforce the appearance of a continuous canopy cover. These views are from a long enough distance that the site appears as a background feature within a much broader viewshed.

Viewpoints closer to the site such as Seven Mile Beach Caravan Park and Seven Mile Beach Road have the potential to be adversely effected by the visual intrusion of mining operations, however existing and proposed boundary screen planting will negate these impacts. Cleary Bros have already demonstrated that landscape amelioration techniques are effective in screening foreground views and it is proposed that similar techniques would be applied to the proposed extraction areas. It should be noted though, that much of this screening would already be in place, particularly adjacent to the caravan park and along Crooked River, if extensive clearing in these buffer zones had not already been undertaken.

Finally, there is little doubt that should sand mining of the site be carried out, the existing landscape character within the site would change. Though this quality is considered to be ranked Medium to High in some locations, this value is only perceived from within the site itself and is not therefore of a regional or public value, and the impact of this loss would be highly localised. These areas are not readily visible from adjoining lands and increased buffer planting around the boundaries would further isolate the interior of the site.

From a visual point of view, it would be difficult to support the proposed re-zoning as it has been demonstrated that any perceived impacts of the mining operations could be significantly reduced or removed without any major long-lasting reduction of the contribution which the site makes to the overall visual amenity of the region.

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COASTAL HAZARDS & SAND RESORCE REPORT

KIAMA MUNICIPAL COUNCIL

COASTAL HAZARDS ANALYSIS AND SAND RESOURCE ASSESSMENT FOR GERROA DRAFT LOCAL ENVIRONMENTAL PLAN

JANUARY, 1992

Webb, McKeown & Associates Pty Ltd
117 York Street, Sydney
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COASTAL HAZARDS ANALYSIS AND SAND RESOURCE ASSESSMENT FOR GERROA DRAFT LOCAL ENVIRONMENTAL PLAN

TABLE OF CONTENTS

1. INTRODUCTION

This report has been prepared for Kiama Municipal Council (KMC) as part of a joint environmental study being undertaken by Quality Environmental Management (QEM).

The report represents a comprehensive review of the information available and capable of being assessed within the timeframe set for the study. A list of reference documents is included at Chapter 5. Discussions were also held with a number of relevant parties including:

- Mr C Stoddard - Kiama Municipal Council,
- Mr T Gibbs - Kiama Municipal Council,
- Mr G MacRae - Department of Mineral Resources,
- Mr I Paterson - Department of Mineral Resources,
- Mr S Thorley - Coffey Partners,
- Mr K Steggles - Dunmore Sand and Soil,
- Mr D Segal - South Coast Equipment,
- Mr A Roper - Public Works Department,
- Mr A Webster - Shellharbour Shire Council.

The report covers the area adjacent to Blue Angle Creek at Gerroa, proposed by KMC for re-zoning to Rural Environmental Protection, as set out in their letter to QEM dated 10 September, 1991. The importance of the sand resource in terms of local and regional demand has been examined. The impact of the current zoning, environmental protection, and proposed sand extraction, on coastal hazards such as flooding, erosion and water pollution has also been examined.

2. COASTAL HAZARDS

2.1 Beach Erosion and Recession

The subject site is at the rear of a beach ridge system that was formed progressively during the mid to late Holocene period, as marine sediments were delivered to the seaward face of the barrier following the stand still in sea level (some 6500 years ago) (References 1 and 2).

Carbon dating shows the ridges decreasing in age towards the east, with the present day beach along the eastern edge. A cap of finer aeolian sand overlies the coarser beach ridge sand and extends west to the underlying estuarine clays.

The existing beach face and dune vegetation system do not indicate active beach erosion or long term beach recession. The dunal vegetation is well developed, the foredunes contain dense low shrubs and small trees. The incipient foredune has a good covering of grass and succulents. Aerial photography dating back to 1949 further confirms that the position of the beach face has not changed markedly over the past 40 years.

On the basis of the above, the subject site at the back of the beach ridge system is unlikely to be affected by beach erosion in the foreseeable long term.

2.2 Tidal Flows

The subject site is bounded on three sides and intersected by waterway and drainage channels which are at least partially tidal when the Crooked River entrance is open.

The entrance of the Crooked River to the Ocean is characterised by a wide low beach foredune across the face of the entrance, and a shallow channel along the north bank following the natural breakwall formed by the Gerroa headland.

The entrance dune progressively builds under wave action often closing the entrance channel. When closed, water levels inside the estuary increase due to wave overtopping and catchment runoff. Build up of the dune, and the increase in estuary water level, continues until the dune is overtopped or it is mechanically opened.

In recent years entrance closure has also been associated with water quality problems, and mechanical opening has been used as a means of improving water quality by increasing tidal flushing.

Over the last 10 years or so the marine delta has moved from a position downstream of the Beach Road Bridge to a position some 150 metres upstream of the bridge. For the preceding 30 years the position of the delta had remained substantially stable. By contrast, the channels upstream of the delta have remained remarkedly stable since 1949 with little variation in the position of channels, banks and seagrass areas.

This recent extension of the marine delta does not appear to be associated with clearing or sand extraction operations in the catchment. A more likely cause would appear to be the works undertaken in the entrance channel, such as the mechanical opening or possibly construction of a new road bridge.

2.3 Flooding

There are very little flood data available for the Crooked River Catchment. However, low level flooding of farm land is often reported when the entrance channel is closed.

Because of the nature of the catchment and drainage paths, flood levels at the subject site are determined by a combination of rainfall runoff and elevated ocean level. The 1% Annual Exceedance Probability ocean water level for the Shoalhaven River entrance has been estimated (Reference 3) at 2.1m AHD. The storm event capable of producing such levels would most probably also be associated with high rainfall over several days.

Therefore, under such conditions flood levels inside the estuary at the subject site could also be expected to exceed the elevated ocean level predicted for the Shoalhaven entrance.

Inundation of the subject site by floodwaters under the existing zoning, or an environment protection zoning, would probably only have a marginal effect. A substantial proportion of the site would remain above the peak flood level, and most of the area that would be flooded is already subject to high groundwater conditions.

If sand extraction were to proceed, a full flood study should be undertaken. This would be required to properly define flood levels so that measures to avoid and mitigate flood damage, such as inundation of the extraction pits, could be designed. This would include such things as the minimum height for bund walls and floodway requirements, etc.

Maximum flood flow velocities at the site would largely depend on the ocean water level at the time peak runoff occurred. These could readily be determined during the proposed flood study. During major flood events, velocities through the entrance channel would be very high and drainage from Foys Swamp would probably caused substantial erosion along Blue Angle Creek.

2.4 Bank Erosion

Substantial clearing and disturbance of the land has occurred adjacent to Blue Angle Creek over recent years. This together with improved drainage of Foys Swamp has led to minor bank erosion along the creek. Continued clearing and disturbance is likely to exacerbate this problem.

During a major flood event, flow velocities in the creek will be high. Consequently under existing conditions substantial erosion could be expected, particularly in the highly disturbed areas. Re-establishment of the vegetation cover would reduce flow velocities and the likelihood of erosion whilst at the same time increasing flood levels somewhat.

If sand extraction were to proceed, erosion of the buffer dunes or bund walls separating Blue Angle Creek from the excavation pit could result in breaching of the walls and flooding of the pit. Breakthrough into the pit could have a major impact on the course of the waterway.

Note, some existing bank erosion in Blue Angle Creek near the confluence with the Crooked River is probably related to changes in the position of the marine delta as described in Section 2.2, rather than improved drainage of Foys Swamp and bank clearing operations.

2.5 Water Quality

The Crooked River estuary already experiences periods of poor water quality, particularly when the entrance is closed. Investigations are currently being made as to the source of the water quality problems, however these are likely to be associated with:

- agricultural fertilisers,
- sewage disposal,
- night soils and garbage disposal,
- increased urbanisation,
- land clearing for agriculture and sand mining.

Water samples analysed for the November 1988 EIS (Reference 4) indicated relatively high turbidity levels in the area near where drainage from the subject site (see Section 2.2) enters the Crooked River. The EIS attributes these high levels to clearing "probably for agricultural activities". Indeed, nearby clearing of the subject site would appear a very likely explanation. Inspection of the site on 17 December 1991, following moderate rain confirmed a high level of suspended solids in drainage water coming from the recently cleared and disturbed area.

Continued land clearing and disturbance is likely to maintain turbidity levels in the estuary. Sand extraction operations if they proceed would need to be carefully planned and monitored to avoid runoff of high turbidity water.

Further, water quality could be very seriously affect if sand extraction proceeded and the bund walls were breached. This could lead to the flushing of large quantities of washery fines from the pits and into the estuary. Such an occurrence would have long term detrimental impacts on turbidity levels in the estuary and on the biota.

The washery fines would also be relatively high in pyrites, and any material left above water level would oxidise and hence increase acidity levels in the catchment groundwater and runoff (References 6 and 16).

2.6 Groundwater

Recent formalisation of drainage channels in the northern half of the subject site will have lowered the water table in the areas surrounding the channels. However, because of the low lying nature of most of the area drained, the effect on groundwater levels can only be marginal. The resultant impact of this work on the existing vegetation is likely to be relatively small (as only very large trees remain), however it is more likely to affect re-generation of the area.

Disturbance of the surface and the construction of access roads may have affected permeability, however given the nature of the natural dune sands this impact is not expected to be significant. During the site visit on 17 December 1991, after formalisation of the drainage, several areas in the north western portion of the site had visible surface water.

Any future sand extraction will need to be operated as a relatively closed system, with bund walls to prevent water flowing into or out of the extraction pit. Under these conditions there could be some changes in groundwater flow rates and directions, and this

would need to be investigated, particularly near important vegetation or habitat areas, prior to extraction proceeding.

Safeguards would also need to be in place to prevent groundwater contamination during extraction operations due to fuel, oil or chemical spillages. The formation of acid leachate by the exposure to pyrites to oxidising conditions after extraction and stock piling above the water table would also have to be monitored and remedial action taken if necessary. Samples from the site tested for Cleary Bros (Bombo) (Reference 6) show moderately low levels of pyrites. However, the number of samples was very small and from stratum with low lithic content. Although most of the pyrites could be returned to the pit bed below water level after sand processing, this aspect of the operations requires further investigation and planning prior to any further area being developed.

3. SAND RESOURCE

3.1 Quality

The results of eight bore holes undertaken for Cleary Bros (Bombo) on the subject site (Reference 6) indicates that there are three main sediment units:

Unit 1: well sorted fine to medium grained sand with little shell, probably of aeolian deposit, generally above 0.0 AHD.

Unit 2: moderately well to poorly sorted, fine to very course grained sand with some shell and gravel. A variety of beach, barrier washover and marine delta deposits, generally below 2.0m AHD.

Unit 3: estuarine mud, rising from around -10.0m AHD on the north-eastern edge of the site to outcrop at the western edge.

Unit 1 sands are generally too fine and well sorted for general use as concrete sand, and need to be blended with coarser sands, thus limiting their potential value. Some parts of the deposit with low shell content would be suitable for foundry sand, however demand is limited and numerous sites closer to the main Sydney market are available.

The most likely use of the Unit 1 sand resource is therefore as fill sand.

Unit 2 sands should generally be suitable for use in concrete following processing to remove the fines and larger shell fragments and gravels. The sands also contain a variable percentage of lithic materials, a significant proportion of which will be pyrites, most of which will be removed with the fines. However, the borehole at the northern end of the subject site between zero and 7.0m AHD shows a shell content between 16% and 40%. This log is particularly significant because it is the drill hole closest to the main excavation area. If this result is typical of a substantial proportion of the northern Unit 2 sands, a large part of the potential resource will be suitable only as fill sand.

The Unit 3 estuarine clays are also likely to be quite high in pyrites and it is not proposed to extract this material. Any Unit 3 material and the washery fines high in pyrites will need to be returned to the bed of the excavation pit below water level to avoid oxidation and the production of acid runoff (Section 2.6).

3.2 Quantity

The volume of extractable material has been checked assuming the extraction profiles, bank side slopes, buffer zones, etc., as nominated in the assessment of the resource prepared for Cleary Bros (Reference 6) in August, 1990.

Insufficient information is available to clearly define the lower (Unit 3) limit of the extractable resource, however, the profiles as given would appear to intersect with Unit 3 material at the lower western limit of the "northern site". The volumetric calculation also appears to be slightly overstated and insufficient allowance appears to have been made for shell, gravel and fines content, as well as possible loose packing of the saturated sediments.

Similar deposits at Primby (South Coast Equipment) and Dunmore (Dunmore Sand and Soil) provide an 85% recovery rate or between 1.2 and 1.3 tonnes/m^3 rather than the 1.5 tonnes/m^3 used for the assessment of the Gerroa resource (Reference 6).

Given the available information an extractable quantity of approximately 1.0M tonnes from the "northern site" and 300 000 tonnes from the "middle site" appears reasonable, with a substantial proportion (at least 20%) being suitable for fill sand only.

3.3 Market Demand

The supply of substantial quantities of foundry sand for the main Sydney market from Gerroa appears most unlikely for the foreseeable future.

The Department of Minerals and Energy are currently revising their analysis of sand resources in the Illawarra Region. An approach based on three areas has been adopted:

- northern - Wollongong to Gerroa,
- southern - Shoalhaven,
- western - Southern Highlands.

The total extraction rate from the area in 1989/90 was of the order of 970 000 tonnes. Of this approximately 420 000 tonnes was produced and consumed in the northern area. Extraction from the existing Gerroa pit operated by Cleary Bros (Bombo) was of the order of 60 000 tonnes of which approximately 50% went to the southern (Shoalhaven) area. In August 1990 (Reference 6) Cleary Bros (Bombo) estimated future production of concrete sand from the site would be between 50 000 and 75 000 tonnes per annum.

A major constraint to increasing output from a particular site is the local market demand. Transport costs become a major aspect of the pricing structure if the material is transported over substantial distances. Consequently it is cheaper for Cleary's to purchase sand from South Coast Equipment for work in the Wollongong area (and vice versa).

3.4 Existing Supply Sources

Because of the impact of transport costs on price, the level of supply is unlikely to change unless the pattern of demand changes. Although demand inevitably changes as new areas are developed, such changes are unlikely to be dramatic.

The northern Illawarra area is currently supplied from four main areas. From discussions with the suppliers these have the following estimated reserves:

- Primby - South Coast Equipment - $1.3M tonnes,
- Dunmore - Dunmore Sand and Gravel - $1.5M tonnes,

•	Dunmore - Shellharbour Municipal Council	-	$1.0M tonnes,
•	Gerroa - Cleary Bros (Bombo)	-	$1.4M tonnes,
	TOTAL	-	$5.2M tonnes.

In addition to these approved reserves, an EIS is currently being prepared for the removal of over 2.0M tonnes of sand from Lake Illawarra. Both the proponent, South Coast Equipment, and the PWD are confident that this proposal will proceed.

Based on the above reserve estimates and projected use rates, there would appear to be sufficient sand for between 18 and 28 years supply from Gerroa for the projected local concrete market. Also approximately 12 years supply is currently approved within the Illawarra Region, with a possible 17 years if Lake Illawarra is approved. Note, the above estimate does not allow for variations in the quality versus quantity of the sand available. However the available resource is generally suitable for concrete use although it tends to be towards the finer limits. The material from Lake Illawarra is expected to be high quality concrete sand.

3.5 Future Supply

In addition to the sources mention in the previous section there are a large number of potential sources of sand which could be developed to take up any future shortfall. These include:

- friable sandstone from the Southern Highlands,
- friable sandstone from the Darkes Forest area,
- blast furnace sand,
- relic beach deposits in the Minnamurra area,
- relic beach deposits on Seven Mile Beach,
- marine aggregate off Bass Point.

All of these sites at present are not highly suited for development for a variety of cost and environmental reasons. However, they do represent a very substantial potential supply source.

4. SUMMARY

The main problems with the existing zoning relate to increased erosion, particularly along Blue Angle Creek during major flood events, and increased turbidity in the estuary as a result of the clearing operations. There would also be some lowering of ground water levels as a result of the recent formalisation of drainage channels through the area.

If sand extraction were to proceed (as proposed by Cleary Bros (Bombo), Reference 6) there would be further changes in groundwater levels and flow patterns. It is not possible to quantify the impact of these changes given the available information, and further investigation would be required, particularly near important vegetation and habitat areas. Flooding of the excavation pits or erosion along Blue Angle Creek could also occur. This may result in a breakthrough into the excavation pits which would exacerbate changes to the creek alignment and mobilise large quantities of washery fines.

Following any substantial mobilisation of fines, turbidity in the Crooked River estuary would increase with a consequent adverse impact on the biota. Any pyrites in the fines deposited above water level would oxidise and contribute to increased groundwater acidity.

The value of the sand resource to the Illawarra Region is substantial. However, as with all non-proven resources, there is a tendency to overstate its quality, quantity and value. This would appear to be the case at Gerroa. Until the extent and quality of the resource are more clearly defined, future demand is identified, and alternative sources developed or rejected, it is possible to develop a number of scenarios from the available information which give the resource a greater or lesser degree of importance.

There are however a number of factors which currently mitigate against the importance of the Gerroa resource:

- a high proportion of the sand may not be suitable for concrete and would be used as fill material,

- the existing approved resource at Gerroa is capable of supplying the projected local demand for around 20 years,
- the site is currently the most remote from the major markets in the northern region,
- the currently approved Illawarra Region resource is of the order of 10 to 12 years supply (high when compared to the Sydney market),
- there are a number of other potential sources (such as Lake Illawarra) which may be developed over the next few years.

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