Environmental
environmental scientists

Dilhorn House
2 Bulwer Street
Perth WA 6000
Tel: (08) 9328 3488
Fax: (08) 9328 3588
Email: info@ataenvironmental.com.au
Website: www.ataenvironmental.com.au

PF03(V1)

TRANSMITTAL NOTE

66

Date: 12 July 2005

Project No: HDC/2003/001_FMP

129210

To Mr Timothy Dawson

City of Wanneroo

23 Dundebar Rd

WANNEROO WA 6065

Item Description	Quantity
Version 6 Report No. 2000/161: Lot 12 Marmion Avenue, Jindalee Foreshore Management Plan	3

COMMENTS:

As requested	x	**For your information**	
Returned with thanks		**For your comments**	
As discussed		**Please return to ATA**	

METHOD OF DELIVERY:

Courier x **Airbag** **Australia Post** **Hand Delivered**

From: Shaun Grein

Document No:HDC-2003-001-FMP_011_pvdm

MARKHAM & HEATH

LOT 12 MARMION AVENUE, JINDALEE FORESHORE MANAGEMENT PLAN

VERSION 6

JULY 2005

REPORT NO: 2000/161

Environmental
environmental scientists

DISCLAIMER

This document is published in accordance with and subject to an agreement between ATA Environmental **("ATA")** and the client for whom it has been prepared Markham & Heath **("Client")** and is restricted to those issues that have been raised by the client in its engagement of ATA and prepared using the standard of skill and care ordinarily exercised by Environmental Scientists in the preparation of such Documents.

Any person or organisation that relies on or uses the document for purposes or reasons other than those agreed by ATA and the Client without first obtaining the prior written consent of ATA, does so entirely at their own risk and ATA denies all liability in tort, contract or otherwise for any loss, damage or injury of any kind whatsoever (whether in negligence or otherwise) that may be suffered as a consequence of relying on this Document for any purpose other than that agreed with the Client.

QUALITY ASSURANCE

ATA Environmental has implemented a comprehensive range of quality control measures on all aspects of the company's operation and has Quality Assurance certification to ISO 9001.

An internal quality review process has been applied to each project task undertaken by us. Each document is carefully reviewed by core members of the consultancy team and signed off at Director level prior to issue to the client. Draft documents are submitted to the client for comment and acceptance prior to final production.

Document No: HDC-2003-001-FMP_001_pvdm_V6

Report No: 2000/161

Checked by:	Name:	Paul van der Moezel	Date: 12 July 2005
Approved by:	Signed:		
	Name:	Paul van der Moezel	Date: 12 July 2005

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF PLATES

LIST OF APPENDICES

1. INTRODUCTION

1.1 Background

Lot 12 Marmion Avenue, Jindalee, is located on the coast between the beach and Marmion Avenue in Perth's rapidly developing North-West Corridor. Development has commenced in the inland sections of Lot 12 in accordance with the approved Structure Plan for the area. Development of the western part of the property adjacent to the coastline is now being planned through a revision of the Structure Plan for this sector.

Lot 12 contains approximately 800m of coastline which includes both sandy and rocky beaches, steep dunes with some limestone cliffs, and a foreshore reserve containing vegetation generally in good condition. Development of Lot 12 and the Brighton Beach estate east of Marmion Avenue will greatly increase the use of the beach and foreshore areas fronting Lot 12.

This Foreshore Management Plan (FMP) has been prepared to identify the anticipated demands on the foreshore area for facilities such as parking, access, passive recreation, and commercial outlets and to propose management measures to incorporate these requirements into the foreshore area. The FMP addresses the capacity of the foreshore environment to accommodate these demands in terms of the physical nature of the coastline and the environmental characteristics of the foreshore reserve.

The objective of the FMP is to create a coastal area which caters for the anticipated public use of the area, contains amenities appropriate for the coast and protects the key environmental features of the foreshore reserve.

The FMP also examines the management measures prescribed by Hames Sharley Australia (1992) for the Jindalee area in the Coastal Planning Study - Burns Beach to Jindalee report and revises them where necessary in the light of the current development design.

1.2 Location

Lot 12 Jindalee is located along the coast, approximately 35km north/north-west of Perth (Figure 1). It lies to the west of Marmion Avenue, immediately south of Lot 10 Jindalee and immediately north of Lot 5 Quinns Rocks. The southern boundary of the property represents the boundary between the suburbs of Jindalee and Quinns Rocks (Figure 2).

The Foreshore Reserve includes the coastal portion of land immediately to the west of Lot 12 Jindalee (Plate 1).

1.3 Planning Framework

Lot 12 is separated from the coast by the existing foreshore reserve (Reserve 9917). The foreshore reserve is designated as "Parks and Recreation" under the Metropolitan Region Scheme (MRS) and was ceded for recreation purposes as an earlier condition of superlot subdivision of the Jindalee coastal area. Two small segments of Lot 12 adjacent to Reserve 9917 are also included in the P&R Reserve. As a result, the boundary of the "Parks and Recreation" reservation generally follows the boundary of Lot 12 but deviates slightly to the west and east of the cadastral property boundary.

The remainder of Lot 12 is zoned Urban in the MRS and Residential in the City of Wanneroo District Zoning Scheme.

The approved Structure Plan for Lot 12 (Figure 3), prepared by Chappell & Lambert Town Planners, includes the following components:

- Approximately 700 dwellings.
- Public Open Space.
- Commercial and Business Uses.
- Corner Store; and
- Beach-side public node.

The eastern part of the property is currently being developed according to the approved Structure Plan. The western portion of the property adjacent to the Foreshore Reserve is the subject of a revised Structure Plan for this sector. The revised Structure Plan (Figure 4) for the western sector contains predominantly residential lots (mostly R20) and an area of Public Open Space adjacent to the Foreshore Reserve that is intended to function as a coastal activity centre. The coastal activity centre will include commercial facilities such as a café, restaurant, local shops and higher density residential development (up to R60) around a centrally landscaped area that is integrated with the proposed facilities within the Foreshore Reserve.

1.4 State Coastal Planning Policy

A *Statement of Planning Policy: State Coastal Planning Policy* (Coastal SPP) (Western Australian Planning Commission, 2001) was released by the Minister for Planning and Infrastructure in April 2003. The Coastal SPP is consistent with the vision, goal, principles, objectives and policies established in the draft Coastal Zone Management Policy for Western Australia and complements the *Statement of Planning Policy: Environment and Natural Resources Policy*, which requires planning strategies and schemes to identify and where appropriate, include provisions for the sustainable use of the coast.

Under the provisions of Section 5AA of the Town Planning and Development Act 1928, Regional and Town Planning Schemes will be required to have 'due regard' of the Coastal SPP.

The objectives of the Coastal SPP are to provide for:

- protection, conservation and enhancement in areas of landscape, nature conservation, indigenous and cultural significance;
- public foreshore areas and access to these on the coast;
- the sustainable use of the coast for housing, tourism, recreation, ocean access, maritime industry, commercial and other activities in appropriate areas; and
- the location of coastal facilities and development that takes into account coastal processes including erosion, accretion, storm surge, tides, wave conditions, sea level change and biophysical criteria.

The Coastal Planning Policy includes methods for calculating appropriate setbacks to development for coastal protection requirements. In general, however, the Policy identifies that development should be set back a minimum of 100m as a guide.

2. EXISTING ENVIRONMENT

2.1 Climate

The climate in the Jindalee area is a Mediterranean climate, with warm, dry summers and cool, wet winters. Seasonal weather patterns are largely controlled by the position of the Subtropical High Pressure Belt (MP Rogers & Associates, 1998).

As a result of the phenomenon of land/sea-breezes, easterly winds are experienced around Jindalee during the morning switching to sea breezes during the afternoon.

Wind speeds during autumn, summer and spring are typically between 10-30kph in the morning and can reach 40-50kph during the afternoon. Although highly variable, wind speeds during winter generally range from 10-40kph but can reach in excess of 50kph during winter storms (MP Rogers & Associates, 1998).

Tidal range typically varies between 0.5m during spring tides and 0.2m during neap tides (MP Rogers & Associates, 1998).

2.2 Topography & Landform

The topography of the Foreshore Reserve is undulating, ranging from a height of 27m AHD in the southern portion of the reserve to 0m AHD at sea level (Figure 5). Limestone platforms are present at points along the sandy beach and inshore reef is often present.

Two localised low points exist within the elevated section of the Foreshore Reserve. One low point at an elevation of 11m AHD is located in the southern part of the Foreshore Reserve. The second low point is located in the northern part of the Foreshore Reserve and has an elevation of 9m AHD.

The Foreshore Reserve/beach interface is particularly steep along the entire length of the beach and limestone is often present as low cliffs (Plate 2).

The topography of the land to be developed adjacent to the Foreshore Reserve is generally much higher than the reserve with high points of 47m, 44m and 39m AHD in the northern, central and southern sections, respectively. These hills and the valleys between the hills slope down into the Foreshore Reserve.

2.3 Geology & Soils

The geology of the Foreshore Reserve largely comprises calcareous Safety Bay Sands. Tamala Limestone covered by a thin (<0.5m) veneer of calcareous sand is present further inland (Gozzard, 1982). The Tamala Limestone outcrops are common at or below the surface in the foredunes and on the beach itself, particularly in the northern portion of the reserve (Figure 5) (Plates 2 and 3).

The sand is predominantly from the Pleistocene era and has a semi-consolidated nature. The frontal dunes represent the younger phase of the dunal system on Lot 12, displaying less soil development (presence of clay and humus) than further inland. The reserve comprises shallow calcareous sand overlying limestone.

2.4 Vegetation and Flora

2.4.1 Vegetation Composition

Vegetation Types

The Foreshore Reserve contains a mixture of coastal vegetation types that reflect the shallow sandy soils and the abundance of limestone at or close to the surface (Figure 6).

The most westerly portions of the reserve at the top of the primary dunes and down the seaward face contain a thin zone of *Olearia axillaris/Scaevola crassifolia* Low Heath on sandy soils. A short section of limestone cliff near the southern boundary of the reserve contains *Melaleuca huegelii/Spyridium globulosum* Low Closed Heath to 1m high with *Myoporum insulare, Olearia axillaris* and *Scaevola crassifolia* also common. There are no strand vegetation types such as *Spinifex hirsutus* Grasslands in the Foreshore Reserve due to the absence of incipient primary dunes.

The vegetation on the majority of the reserve behind the top of the primary dune is predominantly a *Spyridium globulosum/Olearia axillaris* Open to Closed Heath up to 1.5m high over a disturbed lower shrub layer with *Pelargonium capitatum* dominant. Other common species include *Isolepis nodosus, Lomandra maritima, Trachyandra divaricata, Acanthocarpus preissii* and *Lagurus ovatus*. *Acacia rostellifera* is co-dominant with *Spyridium globulosum* in a section of this vegetation type in the southern part of the reserve.

The middle and northern sections of the reserve contain shallower sand over limestone soils. As a result, the vegetation commonly contains *Melaleuca cardiophylla* shrubs either as a dominant Closed Heath formation where the limestone is close to the surface or in association with *Spyridium globulosum* where the sand is slightly deeper over the limestone.

The northern swale area contains a small stand of *Dryandra sessilis* (Parrot Bush) on limestone soils mixed with *Spyridium globulosum* and *Olearia axillaris* over a weedy understorey with *Pelargonium capitatum, Carpobrotus edulis, Anagallis arvensis* and *Crassula glomerata* dominant. The vegetation on the ridge along the northern boundary is an *Olearia axillaris/Spyridium globulosum/Brachyloma preissii* Low Heath with *Melaleuca cardiophylla* common on the upper slopes.

Vegetation Condition

The condition of the vegetation is mostly Very Good according to the condition scale published in Bush Forever (Government of Western Australia, 2000). Areas in Very Good condition in the reserve have a low density of weeds due mostly to the dense

heath vegetation. Some areas are have weedy patches among the native vegetation and are mapped as being in Good to Very Good condition. The native vegetation in the northern swale area has been significantly disturbed by clearing of the Parrot Bush vegetation and mostly consists of the introduced species Rose Pelargonium (*Pelargonium capitatum*) and other weed species. This area is mapped as Degraded to Good.

The southern low point in the reserve is also severely degraded and over a larger area than the northern swale. The southern swale has few native shrubs and an abundance of Rose Pelargonium, Onion Weed (*Trachyandra divaricata*) and Hare's Tail Grass (*Lagurus ovatus*).

The reserve also contains one main 4WD track that runs parallel to the coast near the top of the cliffs as well as informal access pedestrian tracks down to the beach from the main track. The edges of the tracks are generally weedier than the adjacent bushland.

Vegetation Significance

The shallow sand over limestone vegetation in the Foreshore Reserve is assessed as belonging to Floristic Community Types 29a and S13 while the area of shallow limestone heath vegetation belongs to Type 24. These Floristic Community Types are generally described as follows:

29a Coastal shrublands on shallow sands
S13 Northern *Olearia axillaris- Scaevola crassifolia* shrublands
24 Northern Spearwood shrublands and woodlands

None of these community types is a Threatened Ecological Community at the State or Commonwealth level.

The Foreshore Reserve is included as part of Bush Forever Site 397 (Coastal Strip from Wilbinga to Mindarie). Bush Forever Site 397 comprises vegetation described as the Cottesloe - Central and South Complex and links with bushland to the north and south (Bush Forever Sites 406 and 289) as part of a semi-contiguous north-south vegetated coastal strip (Bush Forever 2000). The area is also part of Greenways 1, 35, and 37 (Alan Tingay & Associates, 1998).

The Cottesloe - Central and South Complex is well reserved in the Perth Metropolitan Region with an area comprising 6442ha proposed to be protected by Bush Forever (2000). This represents approximately 19% of the remaining vegetation of that complex and is above the government's minimum target of 10% protection.

2.4.2 Flora Species

A flora survey of the Foreshore Reserve by ATA Environmental in November 2000 and opportunistically during other site visits up to 2004 has recorded a total of 64 species within the reserve (Appendix 1). This total includes 17 non-native species, which represents 26.6% of the total number of species recorded.

Of the 64 flora species recorded in the reserve, 18 are Monocotyledons and 46 are Dicotyledons. Thirty-one families of flora are represented in the reserve with the greatest number of species recorded in the Poaceae (Grass family, 7 species) and Papilionaceae (Pea Family, six species).

None of the flora species in the Foreshore Reserve is a Declared Rare or Priority Flora species. *Melaleuca cardiophylla* is listed in Bush Forever (Government of Western Australia, 2000) as a significant flora species because it is at the southern limit of its known geographic range.

2.5 Coastal Stability

An assessment of the coastal processes, stability and required development setback has been undertaken previously for the property (Hames Sharley Australia (1992) and MP Rogers & Associates (1998). These studies considered climatic factors, coastal processes and historical movements of the coastline, and assessed the extent of natural protection against the coastal processes and susceptibility to erosion during storm events and long-term trends.

The coastline fronting Lot 12 consists of a narrow sandy beach backed by limestone cliffs and outcrops. The sandy beach widens in the southern section of the coast compared to the northern half. Inshore shallow reefs occur commonly along this section of the coast providing adequate protection from the full force of offshore wave action. The reefs and presence of limestone cliffs and beach rock provides protection from coastal processes and stability of the coastline.

The earlier assessment of Hames Sharley Australia (1992) suggested the coastline fronting Lot 12 was stable between 1941 and 1987 with a small amount of accretion detected. Shoreline mapping information by MP Rogers & Associates (1998) confirmed that the shoreline fronting Lot 12 remained stable between 1941 and 1997.

The Coastal Stability Study conducted by MP Rogers & Associates indicated that erosion from a very severe storm or as a result of the possible Greenhouse-induced climate change would be quite minor due to the strength of exposed limestone rock along the foreshore. A coastal setback allowance of 5-10m was recommended to account for possible future erosion of the area. A safety factor of 20m was also recommended resulting in a total setback of at least 30m from the limestone cliffs (MP Rogers & Associates, 1998). The P&R reserve, including Reserve 9917 and the small segments of Lot 12 are between 95 and 165m from the line of permanent vegetation at the bottom of the primary dunes.

The Coastal Stability Study prepared by MP Rogers & Associates (1998) is included with this report (Appendix 3).

2.6 Aboriginal Heritage

A search of the Aboriginal Sites Register, Aboriginal Affairs Department, revealed no archaeological or ethnographic sites are recorded in the Foreshore Reserve west of Lot 12.

2.7 Social Environment

Due to the rocky nature of most of the coast in front of Lot 12, the beach is currently used only by a few recreational fishermen, beachcombers and people walking dogs. The main swimming beach is located to the south at Quinns Beach Estate.

Currently, access along the beach is possible along a 4WD track located within the Foreshore Reserve (Plates 1 and 4). The track continues into the northern lot with access out to Marmion Avenue through the northern lot. Vehicle access to the southern lot is not possible. The track along the foreshore also links to a 4WD track that passes through the southwest high point and eventually runs adjacent to the southern boundary of the lot within Lot 12. The steepness of the seaward face of the southwestern hill and the sandy nature of the soil means that 4WD access is difficult. This has resulted in the vegetation on the seaward side of the hill being significantly degraded (Plate 4).

Due to the steepness of the primary dunes and the presence of limestone cliffs, there are few access points down to the beach from the track in the reserve. Two tracks currently exist down to the beach, one in the south and one towards the north. Both tracks have steep sections down the cliff face with the southern track on slightly sandier soil (Plate 5).

3. FORESHORE MANAGEMENT OPPORTUNITIES AND CONSTRAINTS

The Foreshore Reserve is expected to experience similar demands and pressures that other beaches have in the Perth Metropolitan Region. However, it has some important physical and biological characteristics that will determine the extent to which these demands can be met.

These important features will need to be considered so that the objectives of the FMP can be achieved, ie to create a coastal area which caters for the anticipated public use of the area, contains amenities appropriate for the coast and protects the key environmental features of the foreshore reserve.

The following opportunities and constraints have been identified for the foreshore area:

Opportunities

- The beach is particularly attractive for fishing and beach walking. Safe swimming is possible in the southern half only.
- The foreshore reserve is significantly elevated and provides views along the coast, especially from key vantage points.
- The coast west of Lot 12 has been stable since at least 1941. The presence of limestone outcrops in the foredunes and at points along the beach restricts the rate of erosion by wave action and by people accessing the beach.
- The two low points in the foreshore reserve are degraded and could be developed for amenities without significant loss of good quality native vegetation.
- The existing 4WD track along the foreshore reserve could be upgraded to a dual use path if required.

Constraints

- The small size of the beach and lack of areas that provide safe and pleasurable swimming indicates that the beach will not be able to accommodate large numbers of people at any one time.
- The steep primary dunes and limestone cliffs restrict access points and type of access to the beach. Provision of beach access for vehicles and the disabled may not be possible without significant disruption of the coastal dunes.
- The vegetation in the reserve is mostly in very good condition and is considered to be regionally significant in Bush Forever. Some clearing of native vegetation will need to occur to accommodate the facilities required to meet the demands on the foreshore area.

Previous coastal planning reports indicate the beach fronting Lot 12 is considered to be a "regional" scale beach in the northern section and a "local" beach to the south (Hames Sharley Australia, 1992). However, ATA Environmental considers that the natural elements of the site render the foreshore area better suited to a "district" beach structure for the reasons outlined below.

Regional beaches are characterised by good quality, useable foreshore areas, which have the potential to attract large numbers of people. Local beaches have a low capacity to attract large numbers of people and thus only attract local residents. District level beaches are intermediate between regional and local beaches and have characteristics that will attract local people as well as people from the nearby suburbs but not in large numbers.

The rocky nature of the Jindalee Beach, and the steep primary dunes and cliffs, particularly in the northern section, suggests that this beach would not attract large numbers of people for swimming at any time of the year (Plate 3). Although the rocky beach outcrops cause the majority of the beach to be particularly inaccessible for large numbers of swimmers, they may provide favourable access points for beachcombing and recreational fishing. The sandy beach in the southern part of the Lot 12 shoreline and also in front of the Quinns Beach estate immediately to the south will attract the majority of swimmers from the local and nearby areas.

The large catchment inland from Lot 12 and the desire of a large number of people to experience the beach environment in one form or another will mean that the coastline in front of Lot 12 and in the area in general will be expected to cater for high demand. Such demands have been changing from the traditional swimming, surfing and sunbaking to one that includes meeting for informal or formal eating and drinking experiences at locations close to the beach. In this regard, the coastline at Lot 12 is considered to be suitable for both beach and 'off-beach' activities with perhaps a greater emphasis on the activities away from the beach itself due to the rocky shoreline.

The revised Structure Plan for the western portion of Lot 12 and this Foreshore Management Plan have combined the characteristics of the coast and the desire for coastal recreational experiences into in a plan that integrates uses in the foreshore reserve with the adjacent residential area.

4. MANAGEMENT PLAN

4.1 Landscape Concept Plan

The management strategies in this Foreshore Management Plan are intended to provide facilities in the Foreshore Reserve that are consistent with the district beach category of the area and are cognisant of the area's physical and environmental constraints.

The physical nature of this part of the coast mean that the focus of activity is likely to be in the reserve itself, with its extensive views and natural environment, rather than on the beach which has some swimming potential in the southern part but limited elsewhere due to the rocky shoreline.

The Foreshore Landscape Concept, prepared by McNally Newton Landscape Architects, provides a graphic presentation of the integration of the proposed facilities into the foreshore reserve (Figure 8). The Concept Plan demonstrates how the amenities are likely to fit within the reserve and illustrates the relationship of the public amenity within the reserve with the adjacent subdivision.

The adjacent subdivision includes the concept of a coastal activity centre to be located at the end of the main east-west road that terminates at the coast in the centre of the lot. The coastal activity centre has been designed to integrate with the foreshore reserve and will include a built-form component within the development area of Lot 12 and a public component in the reserve. The built form component will contain a central formal landscaped Public Open Space surrounded by retail outlets and townhouses. Parking will be provided adjacent to the POS and retail outlets. The parking in this area will act as overflow parking for the foreshore in peak periods.

The strategies proposed to achieve a smooth integration between the coastal activity centre and the foreshore reserve are:

- continuity of open space from the foreshore, through the centre, and back into the surrounding residential development;
- continuity of landscaping treatments within the foreshore reserve and within the adjacent development;
- locating commercial activity directly adjacent to the foreshore reserve;
- a high degree of passive surveillance of the foreshore from the adjacent development;
- direct access to the foreshore and urban parkland to allow a greater sense of community ownership of and participation in, the landscaped open spaces;
- continuity between the car parking within the centre and the car parking within the foreshore; and

- a common approach to stormwater management in the foreshore and the adjacent urban parkland.

The following sections provide a description of the facilities proposed within the foreshore reserve proper. In general terms the facilities will include a southern focal point containing car parking, a beach café, grassy swale for recreation and drainage, formal promenade linking the café with the POS adjacent to the reserve, lookouts, and stairs to the beach. A second grassy swale proposed for the northern portion of the reserve will cater for passive recreation, barbecues, and drainage.

A dual use path is proposed along the length of the foreshore linking Quinns Beach Estate to the south with future development to the north.

4.2 Grassed Area & BBQ Facilities

Two grassed areas are proposed to cater for the demand for passive recreation and picnics within the reserve. The southern grassed area (approx. 1ha) will contain parking, beach access and kiosk facilities. This area is expected to cater for a large proportion of the public requirements in the foreshore reserve due to its location next to the main swimming beach area and the retail and food outlets. The northern grassed area (approx. 1ha) provides an alternative recreation area away from the commercial outlets but still in close proximity to the local houses and beach.

The main philosophy behind the provision of grassed areas within the foreshore reserve as well as the Public Open Space adjacent to the reserve are the constraints of the beach area. The area of beach suitable for swimming is limited to the southern end of the site. The northern end of the beach mostly contains rocky beaches. Therefore, provision of grassed recreational areas would attract people to the foreshore for other activities in addition to swimming and recreational fishing.

Both grassed areas are also proposed to accommodate stormwater drainage from the adjacent residential area. Geotechnical testing has shown that the soils in the proposed drainage areas have suitable infiltration rates for stormwater to filter through the soil to the groundwater, approximately 9-11m below the surface.

Both grassed areas are proposed to contain suitably positioned trees to provide shade without impacting on views. The provision of barbecue facilities in both areas will attract people for picnics. The grassed areas will be in natural swales and as such will provide some protection from strong sea breezes.

4.3 Kiosk/Cafe

Hames Sharley Australia (1992) proposed the development of a kiosk facility for the foreshore area adjacent to Lot 12. This FMP considers the construction of a café or kiosk is an appropriate land use for this local beach node. Development of such a facility will be in keeping with the characteristics of the local beach and can be constructed, designed and managed to minimise impacts on the natural environment.

The proposed café/kiosk facility will be setback from the limestone cliffs rather than being perched right on top of the cliff. This is the setback that was recommended in the coastal stability report and comprises the coastal setback allowance of 5-10m, plus a safety factor of 20m. Nevertheless, the facility is likely to provide extensive views of the ocean and coastline from the proposed location.

The café/kiosk is proposed to be a leasehold arrangement with the City of Wanneroo. The money generated through the leasing of the premises for a café or kiosk could partially fund the costs of managing the foreshore area.

Consideration will be given to the use of the café/kiosk facility as a temporary sales office for the estate during construction and sales of the adjacent stages of subdivision.

4.4 Beachside Commercial Centre

The Hames Sharley report (1992) and the Jindalee Inquiry by Design Study (Department of Planning and Infrastructure) both identified a site for a mixed use node adjacent to the foreshore near Lot 12. The Structure Plan for Lot 12 also included a beachside commercial centre. This commercial centre is proposed as part of the coastal activity centre and will be situated and designed such that it will complement the activities proposed in the Foreshore Management Plan and enhance the attractiveness of the area as a district beach.

4.5 Car Parking

Hames Sharley Australia (1992) proposed a large recreational node in the northern portion of the foreshore including enough room for 150 car bays. However, it is the recommendation of this FMP that the recreational node including the main carpark be located further south in the Seaside Node adjacent to the best swimming beach. It is also recommended to reduce the number of car bays from 150. The Landscape Concept Plan includes provision for about 50 car bays in the southern foreshore reserve, 44 bays adjacent to the POS and beachside commercial centre, and another 20 bays possible as parallel parking within the coastal road adjacent to the northern grassed area. Allowing for approximately half of the parking in the beachside commercial area to be used by users of the foreshore reserve, the total amount of car bays is approximately 92. The reduction in car bays is due to the downgrading of the beach from a major regional facility to a quieter beach attracting mainly local residents.

A location for the carpark in the southern node is proposed to be in the area degraded with coastal weeds (Plate 6). The carpark is proposed to be positioned west of the grassed swale to provide direct access from the carpark to the beach. The open layout and centrally located carpark will ensure a constant flow of people between the grassed area and the beach, discouraging antisocial behaviour that can be linked with isolated carparks. The grassed area will be linked to the southern beach access path around the bottom of the carpark, thereby allowing access between the grass and the beach without traversing through the carpark. The northern link will require traffic

calming and pedestrian islands to allow safe access between the grassed area, kiosk and the beach access path.

The dunes west of the proposed carpark area are currently at a slightly higher elevation than the degraded carpark area. Therefore, it is likely that this higher area will be cut and used to fill the proposed carpark area. The earthworks will allow visitors to the beach to have ocean views from their cars.

4.6 Drainage

The topography of the future residential area adjacent to the foreshore reserve is significantly higher than the reserve. The three ridges and hilltops as well as the valleys between these high points all slope down into the reserve. The design of the residential area has attempted to maintain the natural undulating landscape. Although there will be substantial earthworks to achieve a residential design within acceptable engineering standards, there will still be some steep slopes adjacent to the reserve.

The current strategy to manage urban stormwater is to infiltrate stormwater in as many places as possible along the stormwater treatment path. In sandy coastal areas, infiltration is usually readily accommodated through a variety of management practices including the provision of soak wells on lots, bottomless soakwells in road reserves, "leaky" stormwater pipes, flush kerbs along areas of POS, linear swales and infiltration basins. The steep nature of the residential design adjacent to the foreshore reserve at Lot 12 provides difficulties with regards to using these elements of stormwater management.

While it is proposed to use soakwells in private lots and carparks and leaky pipes, subject to City of Wanneroo approval, the majority of the stormwater will be piped to infiltration basins proposed to be located in the natural low points, ie. the two low points in the foreshore reserve. The two low points contain native vegetation in poor to good condition with an abundance of weeds and some native shrubs in the northern low point. The two swales will be landscaped as grassed picnic areas, thereby functioning as public recreation areas as well as drainage basins. These two functions are considered acceptable if the area is designed so that the areas of greatest inundation are not used as the main grassed area.

The drainage basins will contain gross pollutant traps as well as oil and grease traps.

4.7 Access

The rocky nature of the site and the steep dunal slopes will restrict large numbers of people being attracted to the Foreshore Reserve. However, the site does offer opportunities to attract predominantly local residents. The spectacular views along this portion of the coast should be captured through appropriate planning and strategic placement of access paths and lookout points.

The focus for a major recreational node is positioned along the southern portion of the foreshore with additional recreational demand catered for in the northern grassed area.

The southern area includes a carpark, picnic areas, shade trees, shade shelters, lawn, barbeques, waste disposal facilities, toilets and a café/kiosk. The southern foreshore area has the most suitable stretch of beach with a wider sand area suitable for swimming. By using appropriate fencing along pathways, the impact on the natural foreshore environment will be minimised.

Figure 5 displays the Foreshore Landscape Concept for the study area. This plan details the proposed positions for the construction of recreational facilities.

4.7.1 Dual-Use Path

A Dual-Use Path (DUP) was recommended by Hames Sharley Australia (1992) to run the length of the Foreshore Reserve, running parallel to the coast. The requirement for a dual is supported in this FMP.

The majority of the main DUP will be developed along the existing 4WD track that is located approximately 40-50m east of the cliff top (Plate 4). This location will reduce any impact on vegetation and the Bush Forever site in general. Modification of the existing path is required in the southern portion so that it can link with the Public Open Space in this area which is proposed to be re-contoured to a lower level. The path will link up with the existing dual-use path along the Quinns Beach Estate (Stage 2) foreshore area and a future dual-use path from Lot 10 Jindalee to the north.

The DUP is proposed to be 2.4m wide and constructed of concrete. This construction will allow for emergency and maintenance vehicle access. Seating will be made available at various points along the DUP system.

A second DUP is proposed in the road reserve adjacent to the foreshore reserve. This DUP will link to the promenade proposed at the Seaside Node.

4.7.2 Beach Access Paths

The absence of a primary dune system and the subsequent exposure of the rocky secondary dune system mean the beach-foreshore interface is particularly steep. However it is quite stable, and generally protected from natural erosion processes due to the presence of limestone. Therefore, it is unlikely to succumb to significant erosion by waves or people if managed properly. The construction of raised wooden access paths down to the shore is, therefore, considered a feasible means of access to the beach.

The Hames Sharley Australia report (1992) proposed the northern end of the foreshore as the focus area for recreation and as such, four of the six beach access paths were proposed around this area. However, due to the rocky nature of the northern beach areas ATA Environmental proposes in this report that direct beach access will be focused to the southern area near the proposed Seaside Node.
Two wooden step construction access paths are proposed to traverse down the sandy cliff from either end of the carpark. The southernmost path will be constructed along an existing track (Plate 5). A further beach access path will be constructed in the northern section of the foreshore. This path will follow the existing track toward the

beach. Utilisation of existing tracks will reduce the impact of paths on the existing vegetation.

A third beach access path is proposed from the northern grassed area down the limestone cliff area to the beach. This access path will also need to be a sturdy wooden step construction.

The beach access paths are proposed to be wooden zig-zagging structures, with steps along portions of the path. The paths must zig-zag down toward the beach due to safety and building regulations regarding the grade of the path. The bottom section of the path on the beach sand will consist of wooden poles on the ground linked by chains. This will allow passive movement with the natural movement of the sand and waves.

All beach access paths will be fenced with wooden handrails on either side to restrict access onto the dunes.

Due to the steepness of the primary dunes it would not be possible to construct a path for disabled access (1:14 slope) down to the beach without significant earthworks within the dunes and cliffs or, alternatively, by constructing a highly concertinaed zig-zag structure which would be improbable to use. The facilities within the foreshore reserve and Seaside Node will be accessible for disabled people.

4.7.3 Emergency Beach Access

Emergency vehicle access onto the beach west of Lot 12 by will be extremely difficult, if not impossible, due to the steep limestone cliff faces. Extensive restructuring of the natural cliff face would be required to create suitable grades for vehicle access to the beach. The amount of earthworks required is considered too destructive to the natural environment. Access for emergency vehicles is therefore proposed from the southern Quinns Beach area.

The northern section of Stage 1 of the Quinns Beach development provides opportunities for emergency access onto the Jindalee beach. Although rocky outcrops exist on the beach between the two points, access will not be restricted, as they do not extend right the way to the water line.

A surf life saving club is proposed for one of the lots north of Lot 12 and it is assumed that this facility will have emergency services. However, beach access from the north is not an option as rocky beach outcrops exist at the northern boundary of Lot 12 and will restrict access from here onto the beach west of Lot 12.

4.7.4 Lookout Points

Several lookout point opportunities have been identified in this FMP. Two deck structure lookouts are proposed in the northern section. Both areas are appropriately positioned on slightly elevated dune crest overlooking the beach and have expansive ocean views. The lookouts will be orientated west toward the ocean. One of the lookouts is positioned as part of the northern beach access path between the grassed area and the beach.

Several formal lookout point are proposed the high points in the within the foreshore reserve at the southern end. The highest lookout is actually located within the POS in the southwestern part of the lot and will have views of 360^0, including views of the ocean, the subdivision and the native bush that will be retained in the foreshore reserve.

The formal lookouts are proposed to be raised wooden constructions with wooden handrails to restrict access to the dunes and protect the public. The lookouts could have interpretive material informing the community of interesting details about the Jindalee area.

Other informal areas where people will be able to view the ocean will exist along the dual-use path system.

4.7.5 Fencing

The wooden beach access paths/steps and formal lookout points will be fenced with wooden railing structures. Such fencing will keep people on the paths and lookout points and help protect the vegetated dune system. The DUP will be fenced on the seaward side by ringlock fencing along so that the beach cannot be accessed directly down the cliff face.

A ringlock fence will also run along the foreshore road to restrict access to the reserve.

4.8 Other Amenities

4.8.1 Toilets & Showers

A toilet and shower facility will be installed in association with the proposed kiosk/café in the southern development area. The developer is considering funding of the toilet facilities in exchange for approval to modify the southern dune within the area of Public Open Space that abuts the Foreshore Reserve

4.8.2 Signage

The views from the lookouts associated with the DUP and beach access paths are quite extensive. To enhance these panoramic views, an educational plaque could be erected at these lookouts, providing details of shipwrecks in the local area (eg. the Alkimos wreck to the north). Alternatively, details on vegetation or the general history of the coastline could be displayed.

As introduced in Hames Sharley Australia (1992), signage should be erected at strategic places along the dual-use path system to keep people on the designated pathways. Information signs detailing the species of vegetation growing on the nearby dunes could be erected so people can educate themselves as they walk.

Signs that advise the public of the current revegetation works will be erected in the dunes. These signs will aim to keep people off the dunes and will read as below:

Dune
Revegetation
Underway
Please Keep Off

Safety signs will need to be erected at certain points along the cliff face, particularly around the high-use areas such as the lookout points. These signs will read as below:

DANGER!
Steep Cliffs
Keep to Paths

Adequate signage will help restrict movement over the primary dunes and will assist conservation of the Foreshore Reserve.

4.8.3 Bins

Rubbish facilities will be provided at the southern carpark and around both grassed recreational area. Bins will not be placed elsewhere along the DUP system to encourage people to take their rubbish with them and also to avoid the need to drive council rubbish trucks on the DUP.

Rubbish bins will not be placed on the beach due to the inability to provide vehicular access down to the beach to empty the bins.

4.9 The Foreshore Reserve/Subdivision Road Interface

The subdivision design proposes a low key foreshore road as the main interface between the foreshore reserve and the residential area. The road is located and designed to ensure minimal intrusion into the reserve from earthworks. Only a small amount of battering is proposed from the road into the reserve. The final design will be prepared in consultation with the City of Wanneroo.

The Seaside Node proposes to integrate the residential area with the foreshore reserve. As a result, there is no road proposed separating the development from the reserve. The residential townhouse and POS areas will be slightly more elevated than the foreshore reserve. The boundary between the two areas will be a low retaining wall between. A public promenade is proposed at the top of the retaining wall. The promenade will link in to the DUP within the coastal road reserve. A fence on top of the retaining wall will deter people from accessing the foreshore reserve over the wall.

4.10 Revegetation & Rehabilitation

Public facilities proposed as part of this Foreshore Management Plan will not adversely affect the values of Bush Forever Site 397. Good quality vegetation along the foreshore will be retained thereby maintaining linkage with other vegetated areas along the coastline and with Bush Forever Sites to the north. The area proposed for the development of the Seaside Node is already partly degraded. Informal access to the beach area has resulted in the development of a number of tracks and disturbance to vegetation.

The Foreshore Management Plan proposes to construct formal access routes and rehabilitate other informal tracks that are not required for access. As a result, vegetation clearance will be kept to a minimum and rehabilitation works in degraded areas will enhance the values of the Bush Forever Site.

Areas along the Foreshore Reserve that are currently degraded will be rehabilitated to remove any exotic flora species and replace them with local native species. Revegetation in degraded areas will be undertaken at the same time that construction of the facilities is undertaken. This will reduce the long-term disturbance to the site.

Generally, the DUP and beach access paths have been placed over existing tracks or where disturbance is already present.

The list of local native species to be used in rehabilitation is given in Appendix 2. The list includes species known to occur in the reserve at this location (Appendix 1).

4.11 Environmental Assessment

4.11.1 Impact on Native Vegetation

The Lanscape Concept Plan prioritises the main activity nodes in areas that predominantly contain poor quality native vegetation. However, some native vegetation will be required to be cleared to fully accommodate the proposed facilities. Approximately 1ha of native vegetation is proposed to be cleared. This comprises approximately 3,500m^2 in the northern node and 6,000m^2 in the southern node.

The draft Bushland Policy for the Perth Metropolitan Region Statement of Planning Policy (SPP) 2.8 recently released for public comment provides some guidance with which to assess the acceptability of clearing native vegetation within an existing Bush Forever reserved site. The draft SPP 2.8 states that for existing Bush Forever reserves there is a general presumption against clearing of regionally significant bushland except in certain situations. The exceptions relevant to this Foreshore Management Plan are those where the proposal is:

> "consistent with the overall purpose and intent of an existing reserve" or
> "can be reasonably justified with regard to wider environmental, social, economic or recreational needs and all feasible alternatives have been considered in order to avoid or minimise any direct loss of regionally significant bushland".

To address the first point, the Foreshore Reserve subject of this report was previously ceded as a condition of subdivision for the purposes of recreational. The creation of the reserve preceded the designation of the reserve as a Bush Forever site. Accordingly, the small amount of clearing required is for a purpose consistent with the overall intent of the reserve.

Secondly, the coastal area abutting Lot 12 has been recognised in this report and the earlier Hames Sharley report as an area that is suitable for a range of uses to meet the public's desire to recreate on the coast. The foreshore area in its undeveloped state will not be able to fully accommodate these expectations when Lot 12 is subdivided. Implementation of this Foreshore Management Plan will allow the existing and future beach users to enjoy the many attributes of the coast. In this manner the fully implemented plan will enable the foreshore to perform an important social function for the district. In addition, the local shops and cafes will also provide jobs to boost the economy and employment of the area.

There are no feasible althernatives to siting the facilities in the Foreshore Reserve without clearing more vegetation. The overall affect of the Foreshore Management Plan will be to protect most of the native vegetation in the reserve while providing important social and economic functions. As a result, the limited amount of clearing should be acceptable according to the principles stated in SPP 2.8.

4.11.2 Width of the Foreshore Reserve

The existing Foreshore Reserve ranges in width from about 160m in the north to 95m just south of the Seaside Node. The width of the Foreshore Reserve is measured from the permanent vegetation line to the western edge of the proposed subdivision.

The foreshore area is protected by rocky cliffs in the north and is sandy along the southern section, although beach rock is common and limestone is close to the coast along the entire length. This section of coast has been stable between 1941 and 1997 (MP Rogers & Associates, 1998).

The Foreshore Reserve contains a steep cliff edge along most of the western boundary. From the top of the cliff to the eastern edge of the Foreshore Reserve, the reserve is undulating and contains native coastal heath and 4WD tracks. The width of the reserve allows for provision of parking and other facilities while still maintaining the ecological function of the area.

The width of the Foreshore Reserve is considered adequate to cater for the facilities described in this management plan.

5. IMPLEMENTATION

The developer will be responsible for constructing all the facilities discussed in this FMP including the provision of commercial facilities within the foreshore reserve pending discussion with the City of Wanneroo regarding dune modification in the southern POS area.

Maintenance of the facilities will be the responsibility of the City of Wanneroo after handover. Handover will be 12 months after completion of each item constructed.

Facility	Responsibility
Landscaped grassed areas, including grass, reticulation, bbqs, shade trees, seats	Developer
Dual Use Paths	Developer
Beach Access Paths/Steps (3)	Developer
Lookouts (4)	Developer
Fencing	Developer
Carpark	Developer
Drainage Infrastructure	Developer
Revegetation	Developer
Kiosk/cafe	Developer
Toilet	Developer
Maintenance of all of the above (after 12 months)	City of Wanneroo

REFERENCES

Alan Tingay & Associates (1998). *A Strategic Plan for Perth's Greenways: Final Report.* Alan Tingay & Associates, December 1998.

Government of Western Australia (2000). *Bush Forever.* Western Australian Planning Commission, December 2000.

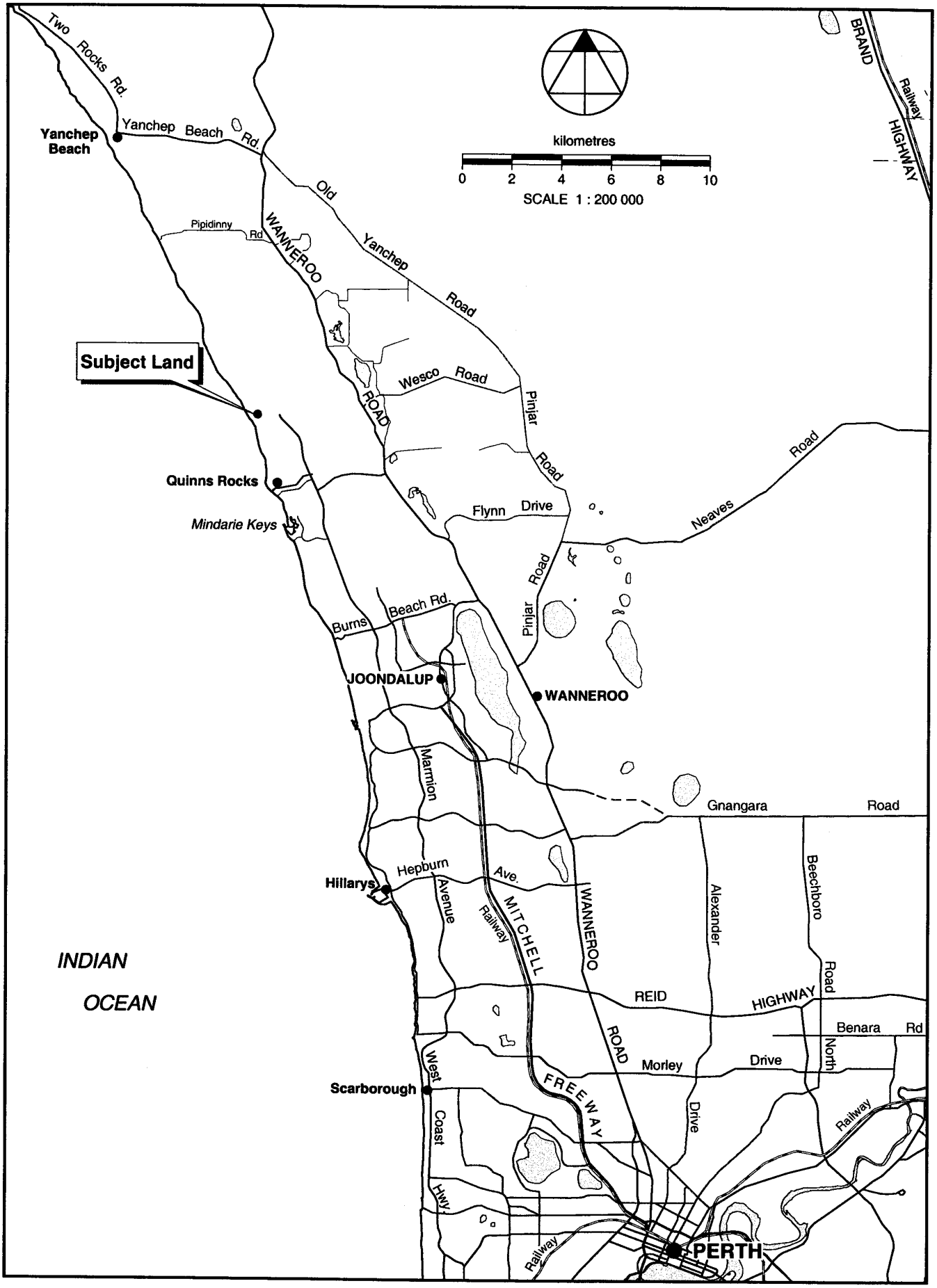
Gozzard J.R. (1982). *Yanchep Sheet 2034 IV, Perth Metropolitan Region, Environmental Geology Series.* Geological Survey of Western Australia.

Hames Sharley Australia (1992). *Coastal Planning Study; Burns Beach to Jindalee; Technical Report.* Prepared for Department of Planning & Urban Development and City of Wanneroo.

MP Rogers & Associates (1998). *Jindalee Coastal Study – Development Set-backs.* Prepared for Alan Tingay & Associates.

Western Australian Planning Commission (2001) *Statement of Planning Policy: State Coastal Planning Policy.*

FIGURES



PRINTED: Wed 15 Dec 04

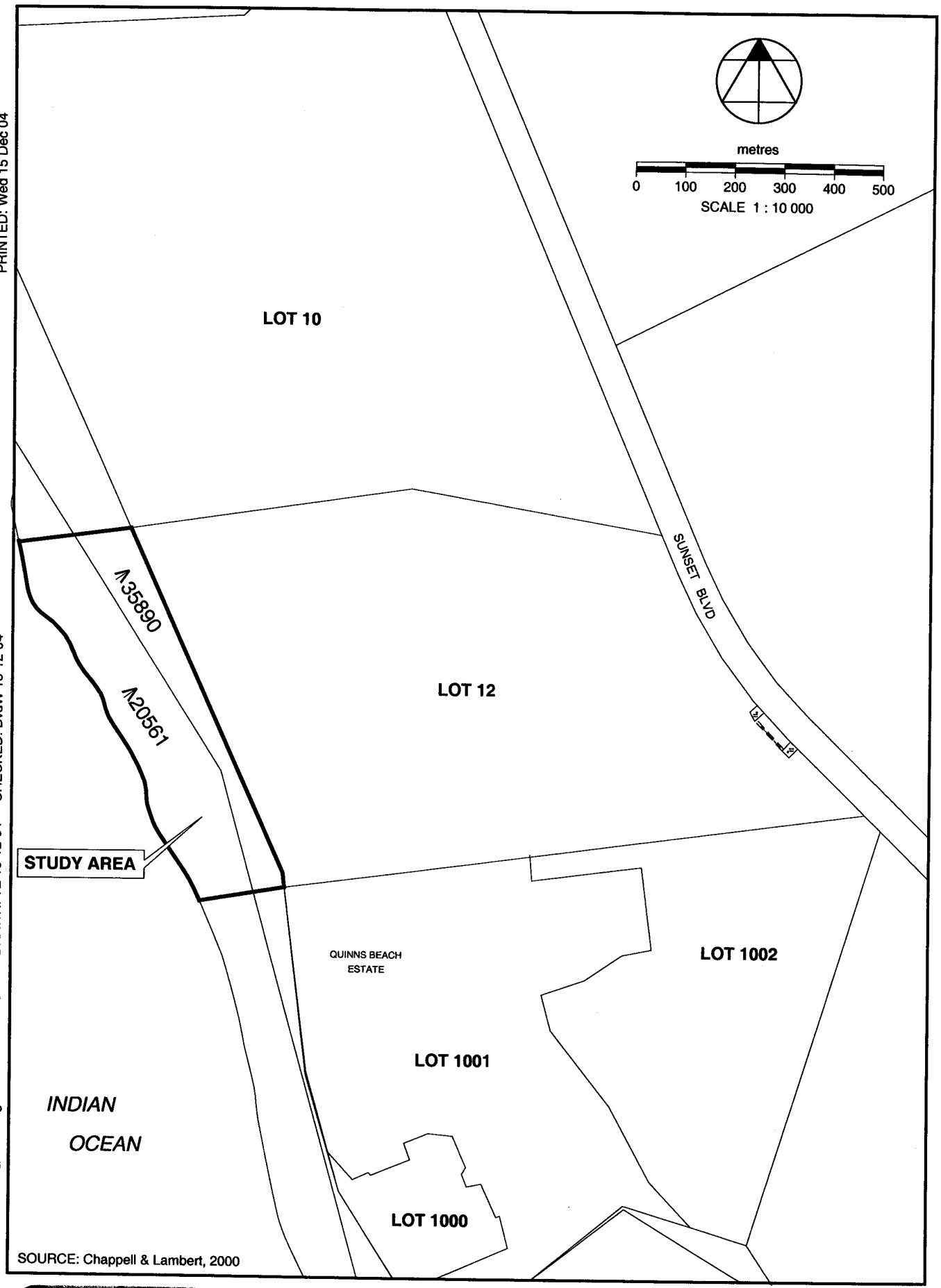
HDC-3-1/FMP/20_161f1.dgn DATUM: AMG DRAWN: TE 15-12-04 CHECKED: BvdW 15-12-04

Environmental
environmental scientists

LOT 12 MARMION AVENUE, JINDALEE
FORESHORE MANAGEMENT PLAN

REGIONAL LOCATION

FIGURE 1



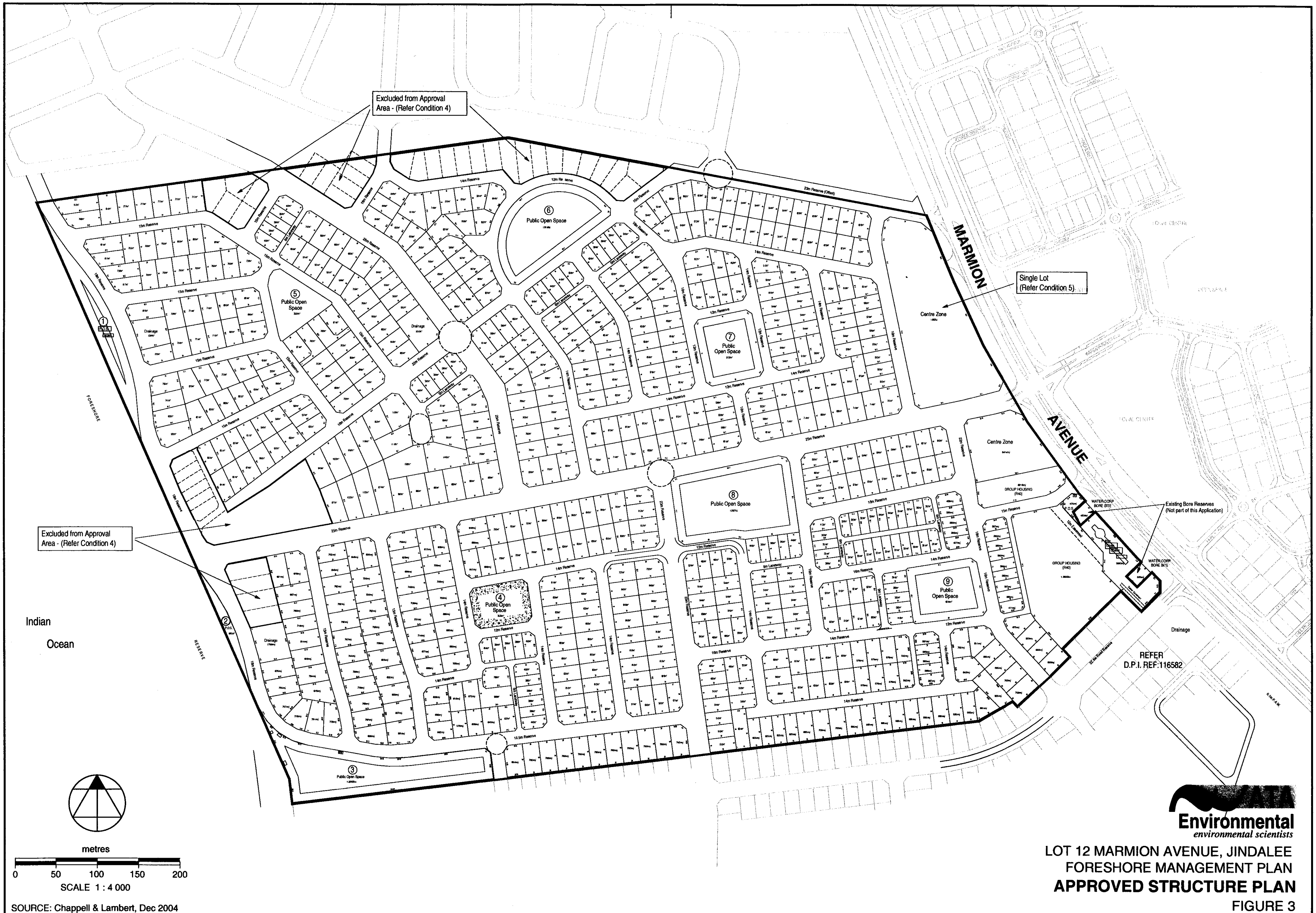
PRINTED: Wed 15 Dec 04
HDC-3-1/FMP/20_161F2.dgn DATUM: AMG DRAWN: TE 15-12-04 CHECKED: BvdW 15-12-04

Environmental
environmental scientists

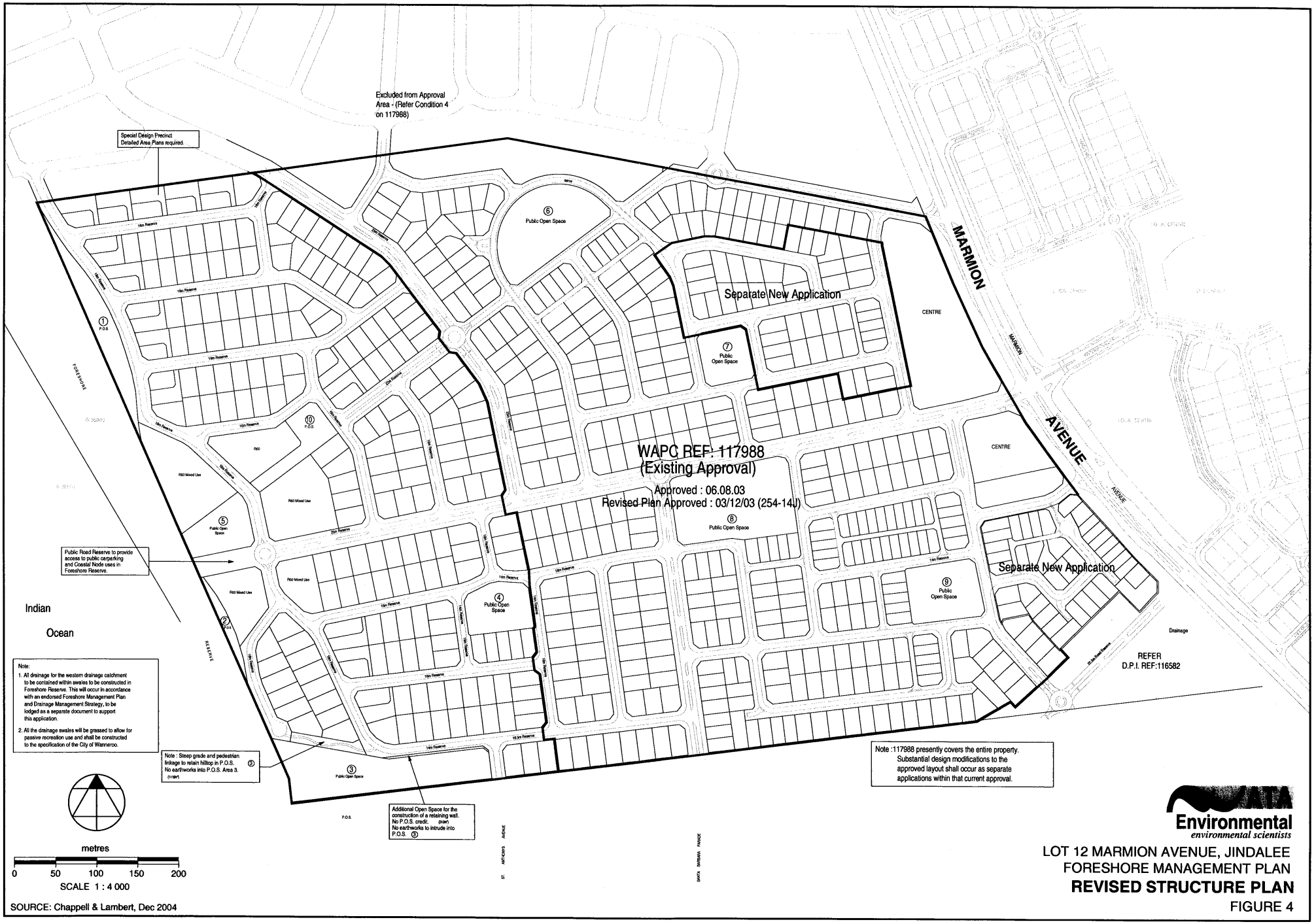
LOT 12 MARMION AVENUE, JINDALEE
FORESHORE MANAGEMENT PLAN

FORESHORE STUDY AREA

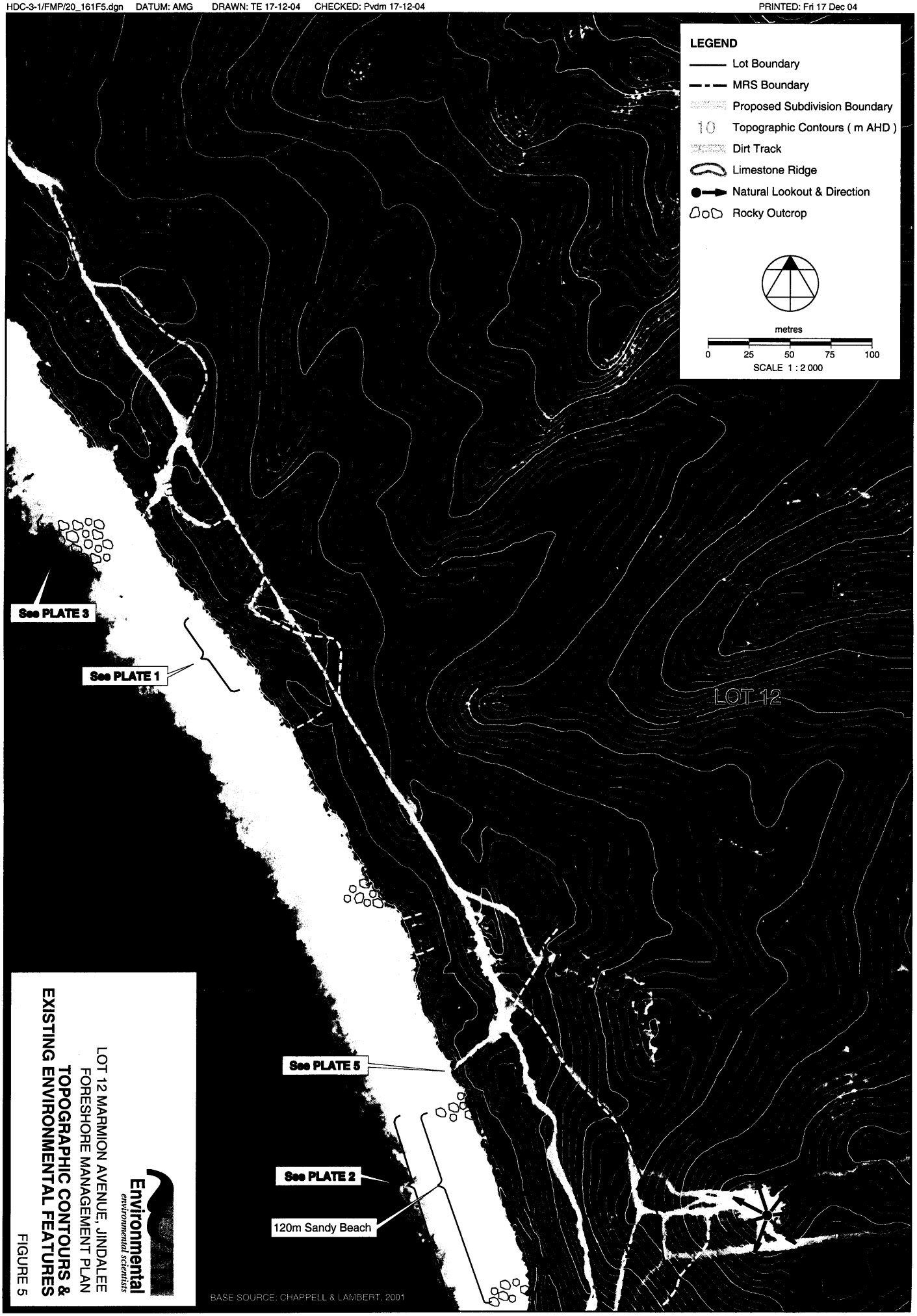
FIGURE 2



MARMION
AVENUE
Single Lot
(Refer Condition 5)
Excluded from Approval
Area - (Refer Condition 4)
Excluded from Approval
Area - (Refer Condition 4)
Centre Zone
Centre Zone
GROUP HOUSING (R40)
Public Open Space
Public Open Space
Public Open Space
Public Open Space
Public Open Space
Public Open Space
Public Open Space
Drainage
Drainage
Drainage
Existing Bore Reserves
(Not part of this Application)
WATER CORP BORE SITE
WATER CORP BORE SITE
REFER
D.P.I. REF:116582
Indian
Ocean
FORESHORE
RESERVE
metres
0 50 100 150 200
SCALE 1 : 4 000
SOURCE: Chappell & Lambert, Dec 2004
Environmental
environmental scientists
LOT 12 MARMION AVENUE, JINDALEE
FOREShore MANAGEMENT PLAN
APPROVED STRUCTURE PLAN
FIGURE 3


Excluded from Approval Area - (Refer Condition 4 on 117988)
Special Design Precinct Detailed Area Plans required.
MARMION AVENUE
Separate New Application
CENTRE
WAPC REF: 117988
(Existing Approval)
Approved : 06.08.03
Revised Plan Approved : 03/12/03 (254-14J)
Public Road Reserve to provide access to public carparking and Coastal Node uses in Foreshore Reserve.
Indian Ocean
FORESHORE RESERVE
Note:
1. All drainage for the western drainage catchment to be contained within swales to be constructed in Foreshore Reserve. This will occur in accordance with an endorsed Foreshore Management Plan and Drainage Management Strategy, to be lodged as a separate document to support this application.
2. All the drainage swales will be grassed to allow for passive recreation use and shall be constructed to the specification of the City of Wanneroo.
Note : Steep grade and pedestrian linkage to retain hilltop in P.O.S. No earthworks into P.O.S. Area 3.
Additional Open Space for the construction of a retaining wall. No P.O.S. credit. (max) No earthworks to intrude into P.O.S.
Note :117988 presently covers the entire property. Substantial design modifications to the approved layout shall occur as separate applications within that current approval.
Drainage
REFER D.P.I. REF:116582
ST ANTHONYS AVENUE
SANTA BARBARA PARADE
metres
0 50 100 150 200
SCALE 1 : 4 000
SOURCE: Chappell & Lambert, Dec 2004
Environmental
environmental scientists
LOT 12 MARMION AVENUE, JINDALEE
FORESHORE MANAGEMENT PLAN
REVISED STRUCTURE PLAN
FIGURE 4

HDC-3-1/FMP/20_161F5.dgn DATUM: AMG DRAWN: TE 17-12-04 CHECKED: Pvdm 17-12-04 PRINTED: Fri 17 Dec 04



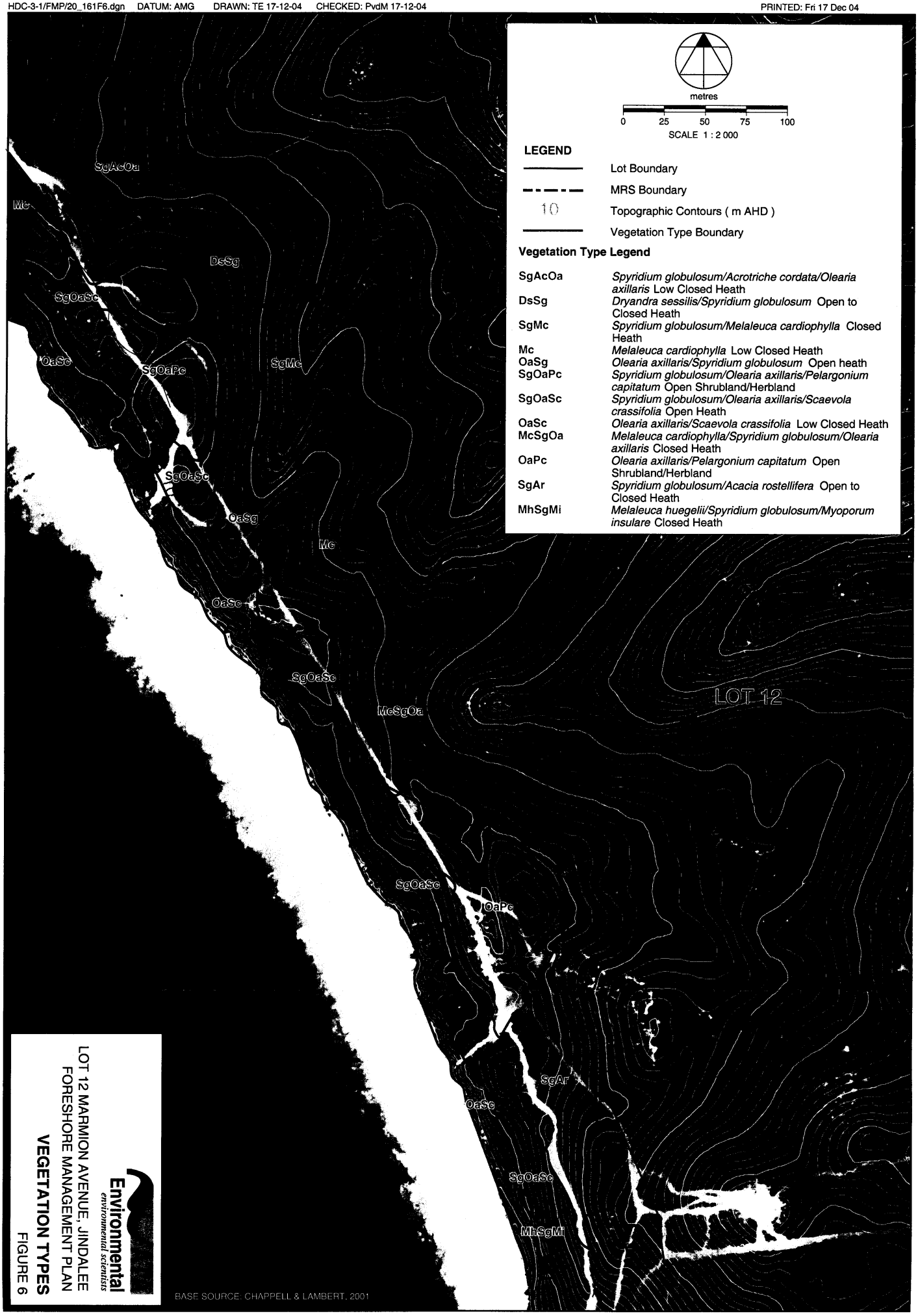
Environmental
environmental scientists

LOT 12 MARMION AVENUE, JINDALEE
FORESHORE MANAGEMENT PLAN

TOPOGRAPHIC CONTOURS & EXISTING ENVIRONMENTAL FEATURES

FIGURE 5

HDC-3-1/FMP/20_161F6.dgn DATUM: AMG DRAWN: TE 17-12-04 CHECKED: PvdM 17-12-04 PRINTED: Fri 17 Dec 04



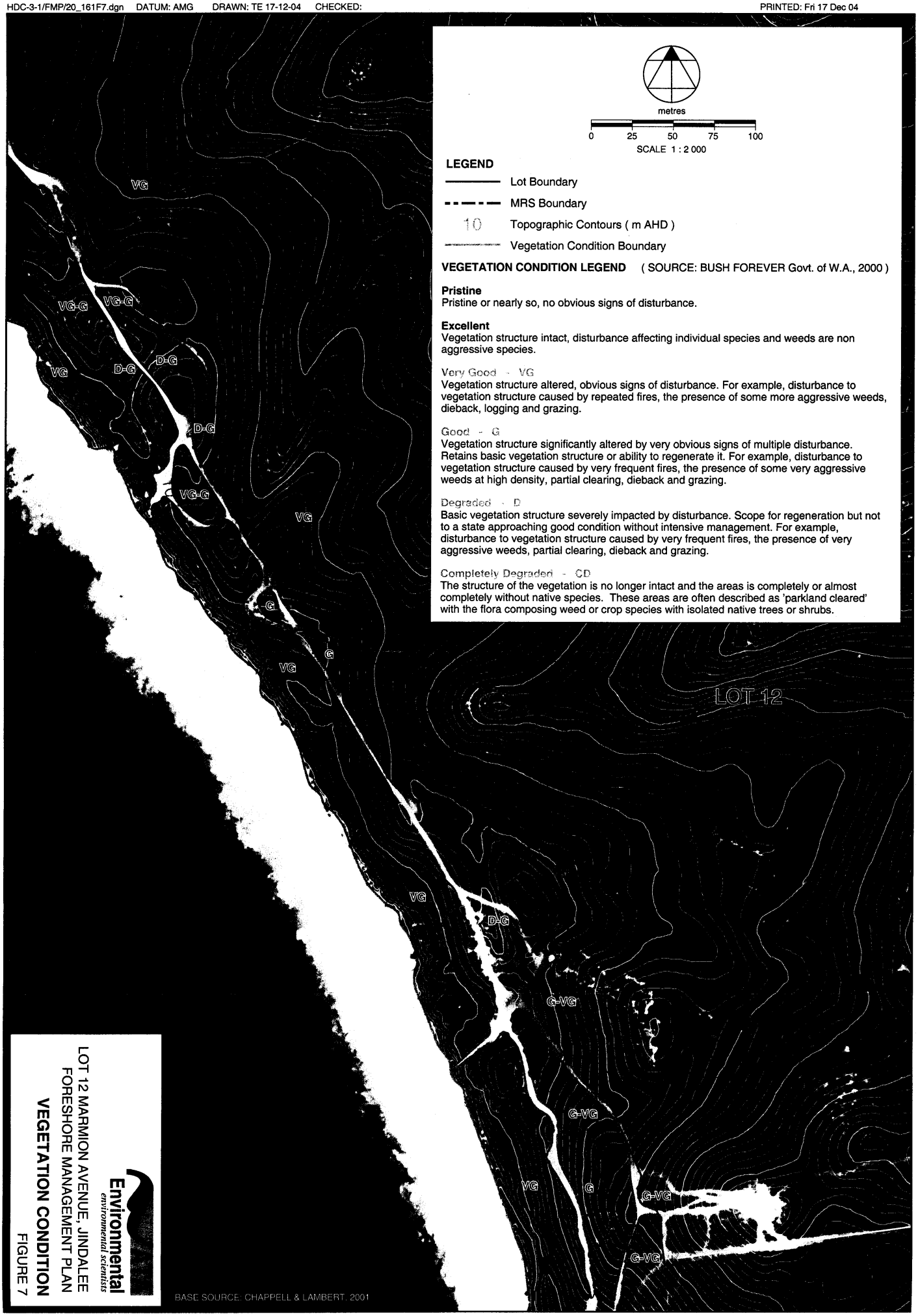
Environmental
environmental scientists

LOT 12 MARMION AVENUE, JINDALEE
FORESHORE MANAGEMENT PLAN

VEGETATION TYPES

FIGURE 6

BASE SOURCE: CHAPPELL & LAMBERT, 2001



Environmental
environmental scientists

LOT 12 MARMION AVENUE, JINDALEE
FORESHORE MANAGEMENT PLAN

VEGETATION CONDITION

FIGURE 7

BASE SOURCE: CHAPPELL & LAMBERT, 2001

PLATES

Plate 1. **Foreshore Reserve (Proposed Formal Lookout Area in Foreground-Surface Limestone Present).**

Plate 2. **Beach Front Showing Limestone Outcrops (The beach at the top of the photograph is the area proposed for the main recreational node).**

Plate 3. **Rocks and seaweed in the northern section of the beach (Hames Sharley Australia (1992) proposed this area as the main recreational node).**

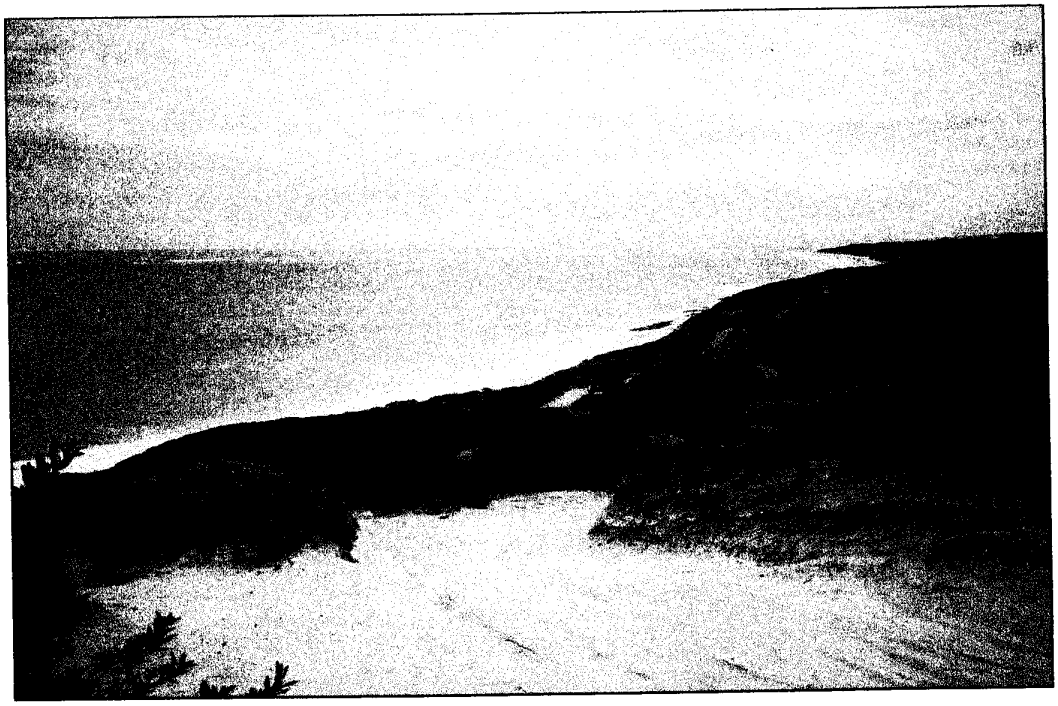


Plate 4. **Dual-use path will follow the existing track running parallel to the beach.**

Plate 5. **The southern beach access path from the carpark will be developed over this existing track (the track will be revegetated with local native species).**

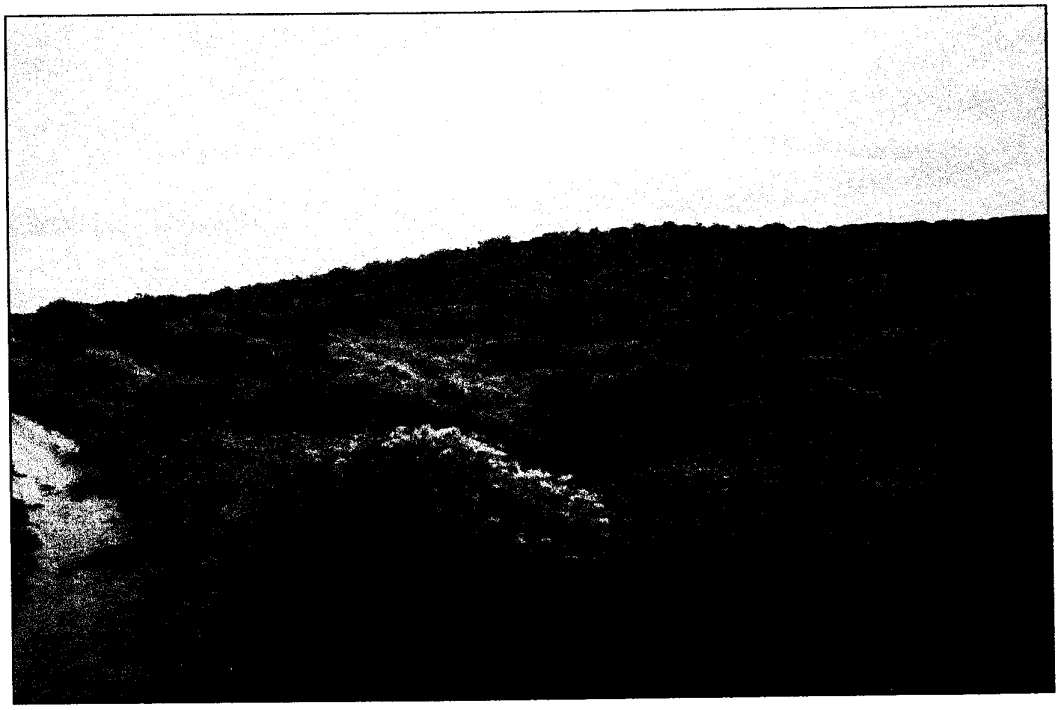


Plate 6. **Area proposed for main carpark and associated facilities (The area is degraded with *Pelargonium capitatum*).**

APPENDICES

APPENDIX 1

FLORA SPECIES LIST

APPENDIX 1
LOT 12 MARMION AVENUE, JINDALEE
FORESHORE RESERVE FLORA LIST

* Naturalised species

MONOCOTYLEDONS

ANTHERICACEAE
Tricoryne elatior

ASPHODELACEAE
Trachyandra divaricata*

CYPERACEAE
Isolepis nodosa
Lepidosperma angustatum
Lepidosperma gladiatum

DASYPOGONACEAE
Acanthocarpus preissii
Lomandra maritima

HAEMODORACEAE
Conostylis aculeata
Conostylis candicans

PHORMIACEAE
Dianella revoluta var. divaricata

POACEAE
Avena fatua*
Bromus diandrus*
Austrostipa flavescens
Lagurus ovatus*
Lolium perenne*
Spinifiex longifolius
Vulpia myuros*

RESTIONACEAE
Desmocladus flexuosus

DICOTYLEDONS

AIZOACEAE
Carpobrotus edulis*
Carpobrotus virescens

ASTERACEAE
Arcthotheca calendula*
Calocephalus brownii
Olearia axillaris
Senecio lautus

BRASSICACEAE
Cakile maritima*
Heliophila pusilla*

CHENOPODIACEAE
Rhagodia baccata
Tetragonia decumbens*
Threlkeldia diffusa

CRASSULACEAE
Crassula glomerata*

DILLENIACEAE
Hibbertia racemosa

EPACRIDACEAE
Brachyloma preissii
Leucopogon parviflorus
Leucopogon racemolesus

EUPHORBIACEAE
Euphorbia terracina*
Phyllanthus calycinus

GERANIACEAE
Pelargonium capitatum*

GOODENIACEAE
Scaevola crassifolia
Scaevola nitida

LAMIACEAE
Hemiandra pungens

LAURACEAE
Cassytha racemosa

MIMOSACEAE
Acacia cyclops
Acacia lasiocarpa
Acacia rostellifera
Acacia saligna

MYOPORACEAE
Eremophila glabra
Myoporum insulare

MYRTACEAE
Melaleuca acerosa
Melaleuca cardiophylla
Melaleuca huegelii

ORBANCHACEAE
Orabanche minor*

PAPILIONACEAE
Gompholobium tomentosum
Hardenbergia comptoniana
Kennedia prostrata
Nemcia capitata
Templetonia retusa
Trifolium sp.*

PRIMULACEAE
Anagallis arvensis*

PROTEACEAE
Dryandra sessilis

RANUNCULACEAE
Clematis microphylla

RHAMNACEAE
Spyridium globulosum

SANTALACEAE
Exocarpus sparteus
Santalum acuminatum

THYMELEACEAE
Pimelea ferruginea

APPENDIX 2

LIST OF SPECIES SUITABLE FOR REVEGETATION

APPENDIX 2
LIST OF SPECIES SUITABLE FOR REVEGETATION

SCIENTIFIC NAME	COMMON NAME	PROPAGATION METHOD
Acacia cyclops	Coastal Wattle	"
Acacia lasiocarpa	Dune Moses	"
Acacia rostellifera	Summer-Scented Wattle	"
Acacia saligna	"Coojong"	"
Alyxia buxifolia	Dysentery Bush	"
Calocephalus brownii	Cushion Bush	"
Carpobrotus virescens	-	"
Dryandra sessilis	Parrot Bush	"
Eremophila glabra	Tar Bush	"
Hardenbergia comptoniana	Native Wisteria	"
Hemiandra pungens	Snake Bush	"
Isolepis nodosa	Knotted Club Rush	"
Lepidosperma gladiatum	Coastal Sword"Sedge	"
Melaleuca acerosa		"
Melaleuca cardiophylla	Tangling Melaleuca	"
Melaleuca hueglii	Chenille Honeymyrtle	"
Myoporum insulare	Blueberry Tree	"
Olearia axillaris	Coastal Daisy Bush	"
Phyllantus calycinus	False Boronia	"
Pimelea ferruginea		"
Rhagodia baccata	Berry Salt Bush	"
Scaevola crassifolia	Thick Leaved Fan Flower	"
Scaevola nitida	-	"
Spyridium globulosum	Basket Bush	"
Templetonia retusa	Cockies' Tongue	"

APPENDIX 3

COASTAL STABILITY REPORT
(Prepared by M P Rogers & Associates)

M P ROGERS & ASSOCIATES PTY LTD

ACN 062 681 252

Unit 3, 135 Main Street, Osborne Park, Western Australia 6017
Telephone: +61 8 9444 4045 Facsimile: +61 8 9444 4341

Our ref: J185: DIS: Letter 97028

5 May 1997

Scott Woodcock
Alan Tingay & Associates
21 Howard Street
PERTH WA 6000

Dear Scott

JINDALEE COASTAL STUDY - DEVELOPMENT SET-BACKS

Please find attached a brief report outlining the coastal engineering study performed for Lot 9 Jindalee. The work was performed on behalf of Whitfords Beach Pty Ltd and as outlined in our proposal (fax 395/96, 11/12/96) and your commissioning facsimile of 16 February 1997.

Briefly, the work involved the following:

- A site inspection and the measurement of beach profiles,
- Analysis of shoreline movement plans to assess long-term coastline changes,
- Assessment of the potential impacts of climate change,
- Assessment of the erosion that could be created by an extreme storm event, and
- Calculation of the required development set-back in view of all of these factors.

Each of these aspects is discussed separately in the attached report.

In conclusion, it is believed that a development set-back of 210 metres from the present-day vegetation line would be adequate from a coastal engineering perspective.

We trust that this is sufficient for your needs. If you have any further queries, please feel free to contact us.

Yours sincerely

Dan Smith
for and on behalf of
M P Rogers & Associates Pty Ltd

1. Site Inspection

An inspection of the coastline adjacent to Lot 9 Jindalee was conducted on 21 March 1997. The primary focus of this field trip was to survey a number of cross-shore beach profiles, which were required for both calculations of long-term beach erosion rates and estimates of erosion during extreme storm events.

For this study, three cross-shore profiles were surveyed using a hand held level and a 100 metre fibreglass tape measure. Using this technique, the levels of adjacent points relative to each other is believed to be accurate to within ± 0.1 metre. The absolute accuracy of the level of the first (most seaward) point is approximately ± 0.3 metres. The accuracy in the horizontal direction is within 0.5 metres.

As shown in Figure 1.1, the locations of the three profiles were spread evenly along the Study Coastline - Profile A at the southern end, Profile B in the centre, and Profile C at the northern end. Plots of each of these cross-shore profiles are presented separately in Figures 2 to 4 respectively.

In addition to performing beach surveys, further evidence of recent changes to the beach was gathered through observations and photographs. It became apparent during the site inspection, that the northern end of the Study Area has experienced sediment accretion and progradation of the coastline in recent years (refer to the top panel of Figure 5). On the other hand, the southern end has recently experienced significant erosion of the foredune and coastline recession (refer to the bottom panel of Figure 5). The shapes of the measured beach profiles at locations A and C are consistent with these observations (see Figures 4 and 2 respectively).

Prior to performing the site inspection, a number of boreholes were sunk by Coffey Partners International in the Jindalee coastal dunes. A total of five sites were investigated, which were evenly spread along the seaward boundary of Lot 9. Borehole penetration generally ranged between 7 and 10 metres. Limestone was discovered at only one site - in the vicinity of the southwestern corner of Lot 9. This was approximately 200 metres inland and the limestone was first encountered at a level of +9.6 metres AHD. These results, together with the absence of beach rock observed during the site inspection, suggest that there is little limestone present in the beach / dune system which may restrict beach erosion.

2. Shoreline Movement Plans

The Department of Transport has prepared three plans covering Jindalee region showing the position of the foreshore vegetation at times when suitable aerial photographs were available (DMH 351-1-1, 351-1-2, and 351-2-1). The vegetation line is generally viewed as a superior indicator of the shoreline position compared to the water line. The use of the waterline introduces the possibility of greater errors due to the influence of varying tides, wave run-up and beach slopes. The preparation of these shoreline movement plans involved the use of aerial photographs and controlled photogrammetric techniques. The accuracy of the position of the vegetation line is expected to be $\pm$ 2 metres.

Shoreline movement plans enable a quantitative comparison to be made of the position of vegetation over the medium to long term. This relates to time-scales of decades rather than years. For this study, the following vegetation lines were utilised:

- October 1941,
- December 1954,
- October 1965, and
- November 1988.

Unfortunately, not all of these extended over all of the coastline adjacent to Lot 9. Coverage for the 1954, 1965 and 1988 lines was complete, however only partial (covering only the southern end of the site) for the 1941 vegetation line.

To facilitate the interpretation and discussion of the shoreline movement analysis, the Study Coastline has been divided into three sectors of comparable length. These have been labelled Northern, Central and Southern Sectors, and are indicated in Figure 1. Assessment of the shoreline movement between 1965 and 1988 has been made for all three sectors. However, due to the incomplete vegetation line coverage, assessment of the 1941 to 1965 period could only be made for the Southern Sector. For the remaining two sectors, the 1954 to 1965 period was analysed.

A summary of the mean rates of shoreline movement for these three periods is presented in Figure 6. This shows that all of the coastline adjacent to Lot 9 has generally been experiencing long-term shoreline recession over the last 40 to 50 years. Depending on the location and the period in time, mean rates of shoreline recession range from about 0.2 m/yr up to nearly 2 m/yr. The most rapid recession occurred in the Southern Sector during 1965-88. Interestingly, much of this same area experienced relatively low rates of shoreline recession ($<$0.5 m/yr) during the earlier analysis period (1941-65).

Adopting the most longest-term view possible for the data (ie. 1941-88 for the Southern Sector and 1954-88 for the Central and Northern Sectors), the mean shoreline movement has been plotted in Figure 7. From this, it can be seen that throughout the last half century, the long-term shoreline recession experienced by the area has been in the order of 1 m/yr.

At the northern end of the site the mean recession is only about 0.5 m/yr, while in a localised area in the Southern Sector this has reached as high as 1.6 m/yr.

In addition to the assessment of shoreline movements, volumetric rates of long-term erosion have also been estimated. These calculations utilised both the shoreline movement information as well as an assessment of the upper and lower limits of the active beach zone, which was made from the surveyed beach profiles and hydrographic charts. Figure 8 presents the mean accretion rates per unit length of beach for the same periods used in Figure 6 (shoreline movement). It is important to note that all of these are **negative** rates of accretion, and hence actually represent **erosion** rates. The figure shows that the Study Area has experienced medium to long-term erosion rates in the order of 5 to 20 $m^3/m/yr$.

A summary of the rates of sediment erosion for each of the three coastline sectors is given below in Table 1.

Table 1 Rates of Sediment Erosion

Coastline	Mean Rate of Sediment Erosion (m^3/yr)		
Sector	1941-65	1954-65	1965-88
Northern	-	5,800	2,300
Central	-	4,000	4,000
Southern	3,100	-	10,000

From this it can be deduced that between 1965 and 1988 the coastline adjacent to Lot 9 Jindalee experienced a mean loss of sediment at a rate in the order of 16,000 m^3/yr.

A summary of the total volumes of erosion for each of the three sectors is given in Table 2.

Table 2 Volumes of Sediment Erosion

Coastline	Mean Rate of Sediment Erosion (m^3/yr)		
Sector	1941-65	1954-65	1965-88
Northern	-	63,000	53,000
Central	-	44,000	92,000
Southern	74,000	-	233,000

3. Extreme Storm Event

During significant storm events, the strong winds generate high steep waves and an increase in water level known as wind set-up. The lower atmospheric pressure associated with the storm system further draws up the water level. These factors, acting in concert, allow the waves to attack the higher portion of the beach that is not normally vulnerable. The initial width of the surf zone can be insufficient to dissipate the increased wave energy of the storm waves. The residual energy is often spent in eroding the beach face, beach berm and sometimes the dunes. The eroded sand is carried offshore with return water flow where it is deposited and forms an offshore bar. Such bars can eventually grow large enough to break the incoming waves further offshore, causing the wave energy to be spent in a wider surf zone (refer to Figure 9).

The technique used to estimate storm erosion of the beaches adjacent to Lot 9 Jindalee focussed on the use of a computer model called SBEACH. SBEACH (Storm induced BEAch CHange) has been developed by the Coastal Engineering Research Centre, which is part of the U.S. Army Corps of Engineers. The model takes into account a variety of factors including wave height, period and direction, tidal elevations, wind speed and direction, duration of the storm, sediment grain size, and an initial beach profile. Using this information, SBEACH estimates the beach profile that would result from these storm conditions.

For this analysis, a very rare / extreme event of 1 in 100 years severity was chosen. It was felt that this was appropriate for long-term planning of coastline development at Jindalee. The key characteristics of this event are summarised below in Table 2.

Table 2 Characteristics of the Extreme (1 in 100 year) Storm

Factor	Value
Storm Duration	96 hours
Offshore Wave Height	Lead Up (36 hrs): 4.0 to 9.4 metres Peak (24 hrs): 9.4 metres: Tail (36 hrs): 9.4 to 4.0 metres
Wave Period	T_p = 11 sec, T_z = 8.8 sec
Astronomical Tide	Diurnal, ranging ±0.3 metres about MSL[1]
Storm Surge (added to astronomical tide to get SWL[2])	Lead Up (36 hrs): 0.3 to 1.0 metres Peak (24 hrs): 1.0 metres: Tail (36 hrs): 1.0 to 0.3 metres
Initial Cross-Shore Beach Profile	Refer to Figure 10

Notes: 1. MSL denotes Mean Sea Level, which is approximates the Australian Height Datum (AHD).

2. SWL denotes the Still Water Level.

For the purpose of assessing storm erosion, the beach profile measured at the southern end of Lot 9 (Location A, see Figure 2). This was chosen because it is the most exposed end of the Lot 9 coastline and has experienced the greatest rate of long-term erosion. The surveyed profile was extended offshore a distance of approximately 6 km using information extracted from hydrographic charts. The resultant cross-shore profile is shown in Figure 10 (only the first 200 metres) as the "Initial Profile"

The results of the SBEACH modelling are also illustrated in Figure 10 (compare the initial and final profiles). This suggests that approximately 30 metres of shoreline recession should be expected as a result of beach erosion during a 1 in 100 year event.

4. Climate Change

Although the so called "Greenhouse Effect" receives much publicity, there is still no definitive evidence available that proves that the Greenhouse changes are occurring or will occur. There is certainly clear evidence that the amount of carbon dioxide and other "Greenhouse Gases" in the atmosphere has increased steadily over the last century, and is continuing to rise. However, the link to global warming and associated sea level rise is still largely based on predictive numerical models of the global atmospheric and oceanic processes. These general circulation models are currently run on coarse grids and have rather rudimentary treatment of ice melting, cloud cover and albedo feed back links and impacts. Pielke (1991) presents a good review of the scientific uncertainty with the present predictions of the "Greenhouse Effect".

Some of the possible impacts on the west coast of Western Australia of Global Warming could be:

- increase in cyclone frequency;
- increase in sea level; and
- changes in regional-scale meteorological features which may lead to changes in the wave climate.

The current knowledge about the potential impacts of Global Warming is extremely limited. This has lead many organisations and authorities to take a low key approach to the issue until more definitive proof is available.

The Institution of Engineers, Australia (1991), has put forward suggestions for assessing the impacts of possible climate change on coastal engineering projects. The report is aimed at ensuring that a responsible review of the possible impacts is made. Designs should be robust and minimise future risk. This document does not say that climate change will definitely happen, but that it now seems likely that it may occur, and therefore engineering design should take this risk into consideration.

The issue of possible climate change and resultant effects on coastal processes is quite complex. As the present level of knowledge is somewhat limited, only a relatively simple assessment of the potential impacts of climate change can be made. The impacts of the possible sea level rise associated with climate change are considered in this study.

The Institution of Engineers, Australia (1991), presents three scenarios for possible changes in the Global Mean Sea Level for the years 2030, 2050 and 2100. These are reproduced in Table 3.

Table 3 Possible Global Sea Level Rise

	2030	2050	2100
Low Scenario	0.10 m	0.16 m	0.32 m
Medium Scenario	0.20 m	0.32 m	0.68 m
High Scenario	0.32 m	0.51 m	1.13 m

Source: Institution of Engineers Australia (1991)

Considering the uncertainty of these scenarios, the design of life of foreshore facilities and the frequency of storm attack, it is appropriate at this stage to allow for a 0.2 to 0.3 metre rise in sea level. This is believed to be a reasonable compromise between present day cost and inconvenience, and future risk.

The impacts on coastal processes of a small rise in sea level would be quite site specific. To date there have been no studies done for the west coast of Western Australia. The most relevant of other works are Bruun (1962), which presents the results of some generalised material, and Gordon (1988) which presents some of the results of research on the east coast of Australia. In very coarse and general terms, both papers suggest that a rise in sea level would generally lead to recession of the coastline at a ratio of roughly 100 to 1. That is, a 0.2 to 0.3 metre rise in sea level may eventually cause a 20 to 30 metre recession of the coastline.

5. Development Set-Back

The determination of a development set-back appropriate from a coastal engineering point of view requires consideration of the following factors:

- Long-term shoreline movement trends,
- Storm erosion, and
- Potential impacts of climate change.

In the formulation of a set-back distance, allowances for each of these factors has been made. In addition, a factor of safety has also been included to account for limitations of the modelling techniques used in the storm erosion analysis and uncertainties regarding the implications of climate change. This is all summarised below in Table 4.

Table 4 Required Development Set-Back

Factor	Allowance
Long-Term Shoreline Recession (100 yrs @ 1.2 m/yr)[1]	120 m
Storm Erosion (1 in 100 yr event)	30 m
Potential Effects of Climate Change	30 m 50
Factor of Safety	30 m
Development Set-Back (from current vegetation line)	**210 m** 230 ~

Notes: 1. The rate of 1.2 m/yr is believed to be an appropriately conservative estimate of the greatest long-term erosion likely to be experienced along the coastline adjacent to Lot 9 Jindalee.

In conclusion, it is believed that a development set-back of 210 metres from the present-day vegetation line would be adequate from a coastal engineering perspective. This is based on the assessment that there is little limestone present in the beach / dune system that may restrict beach erosion. Should fresh information become available to the contrary, the development set-back may be able to be reduced.

6. References

Bruun, P., 1962. Sea Level Rise as a Cause of Shore Erosion. Waterways and Harbours Division, American Society of Civil Engineers, *WWI 88*, pp 117 - 130.

CERC (Coastal Engineering Research Centre), 1977. *Shore Protection Manual*, published by US Army Corps of Engineers.

Gordon, A.D., 1988. A Tentative but Tantalising Link between Sea-level Rise and Coastal Recession in New South Wales, Australia. Chapter in *Greenhouse - Planning for Climate Change*, published by E.J.Brill for CSIRO, Australia.

Institution of Engineers, Australia, 1991. *Climate Change and Coastal Engineering*, published by the National Committee on Coastal and Ocean Engineering.

Peilke, R.A., 1991. Overlooked Scientific Issues in Assessing Hypothesised Greenhouse Gas Warming. *Environmental Software*, 1991, Vol. 6, No. 2.

Figure 1 - Location Diagram

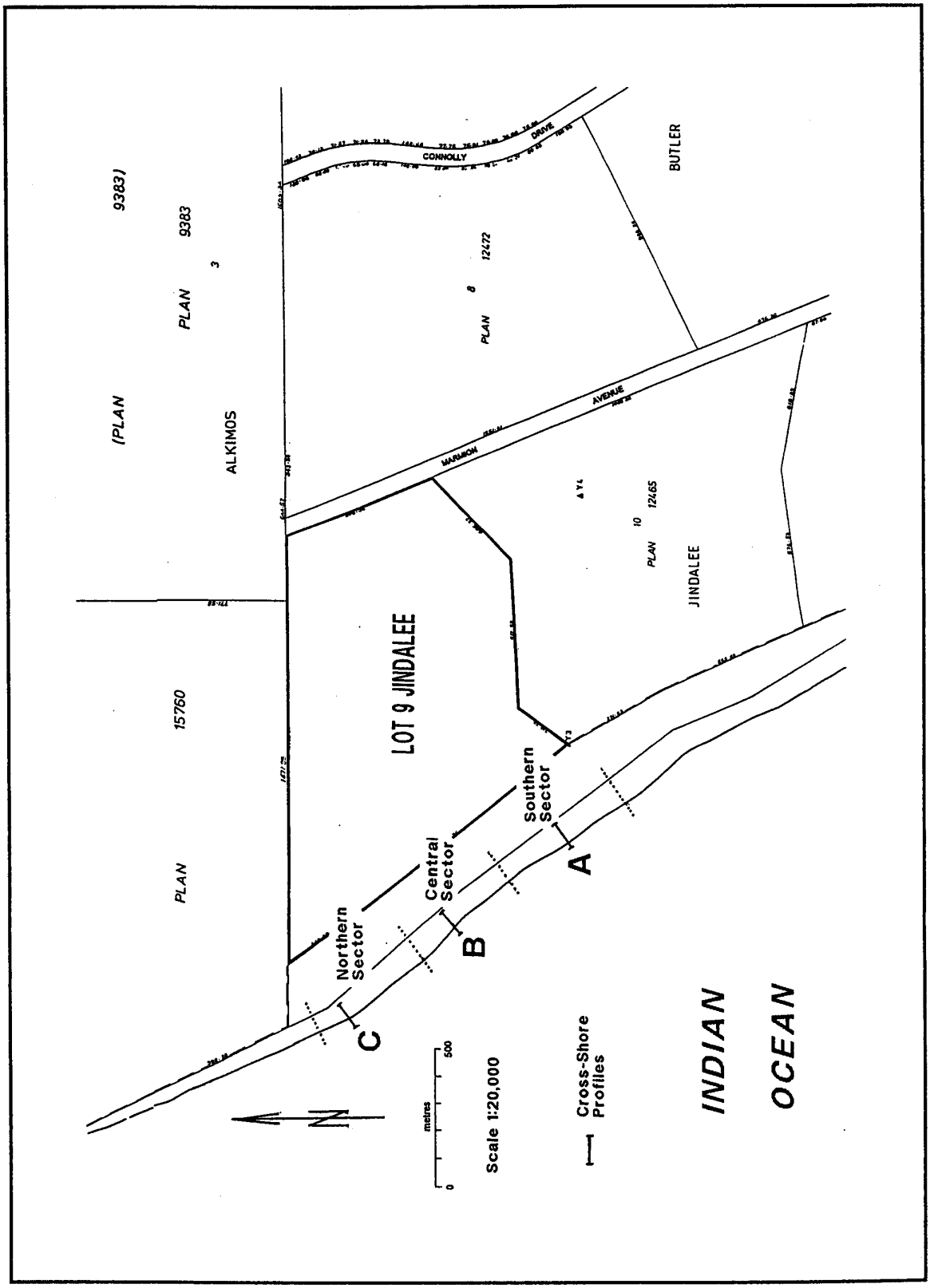


Figure 2 - Beach Profile at Southern End of Site

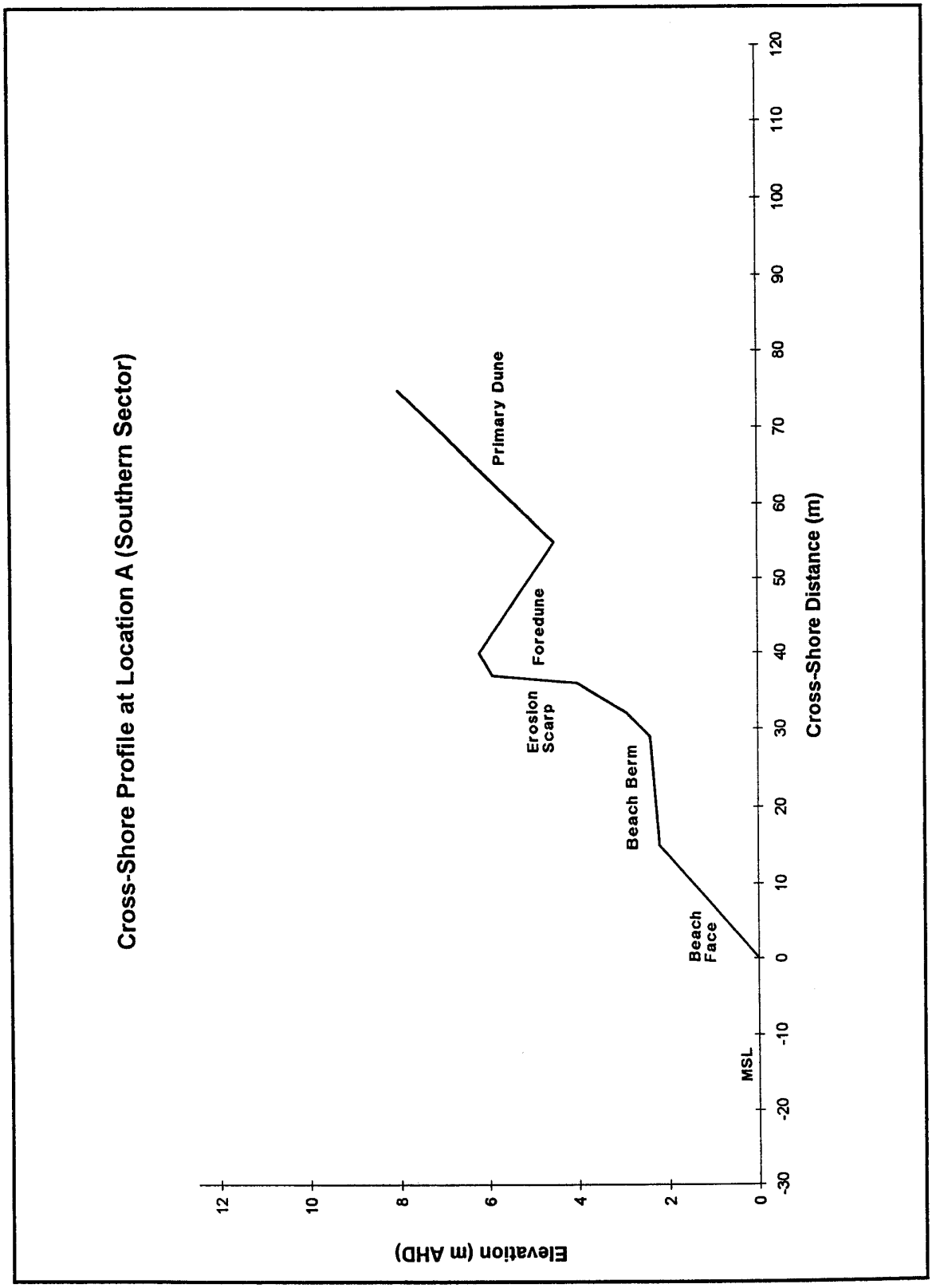


Figure 3 - Beach Profile at Centre of Site

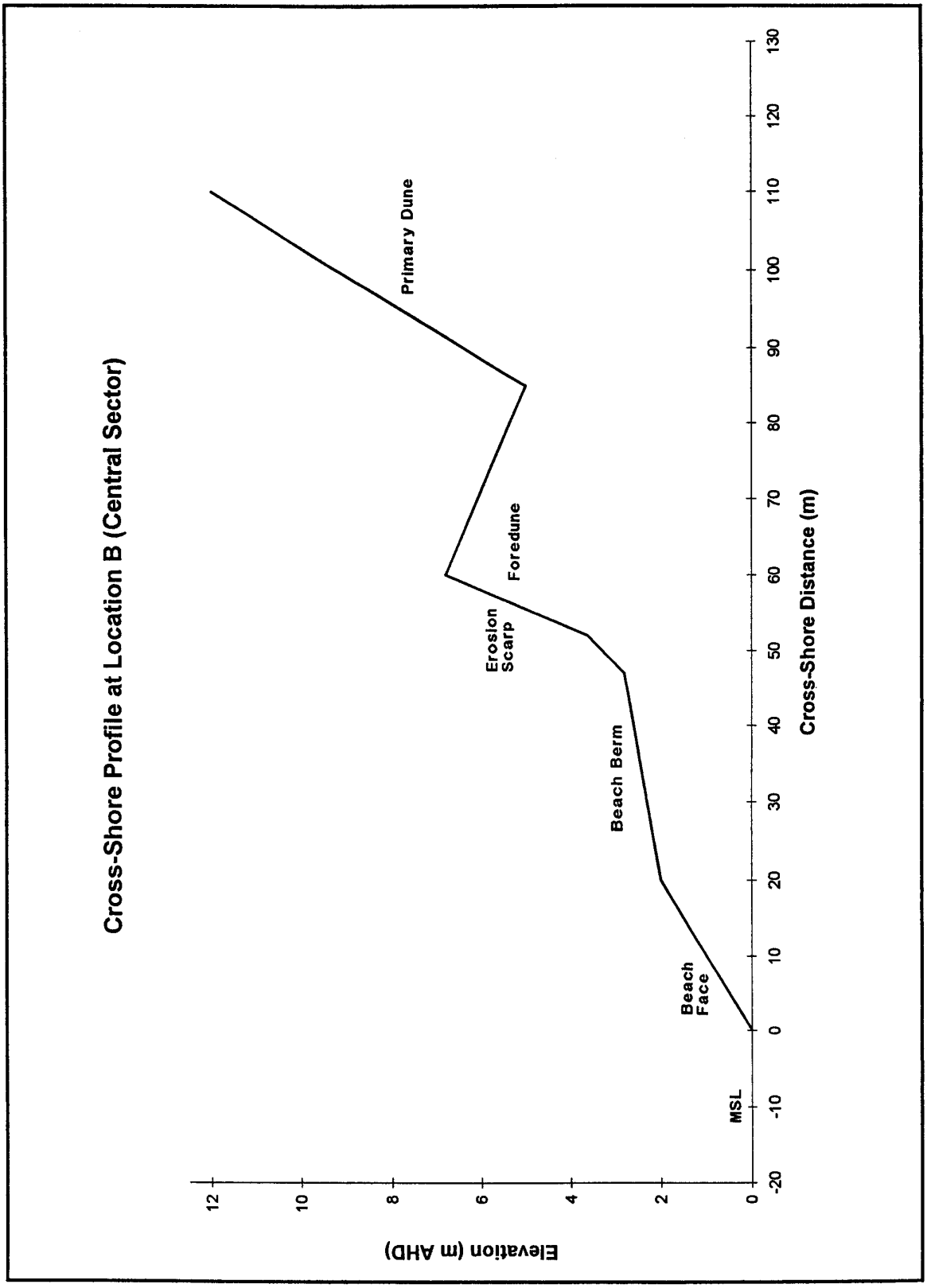


Figure 4 Beach Profile at Northern End of Site

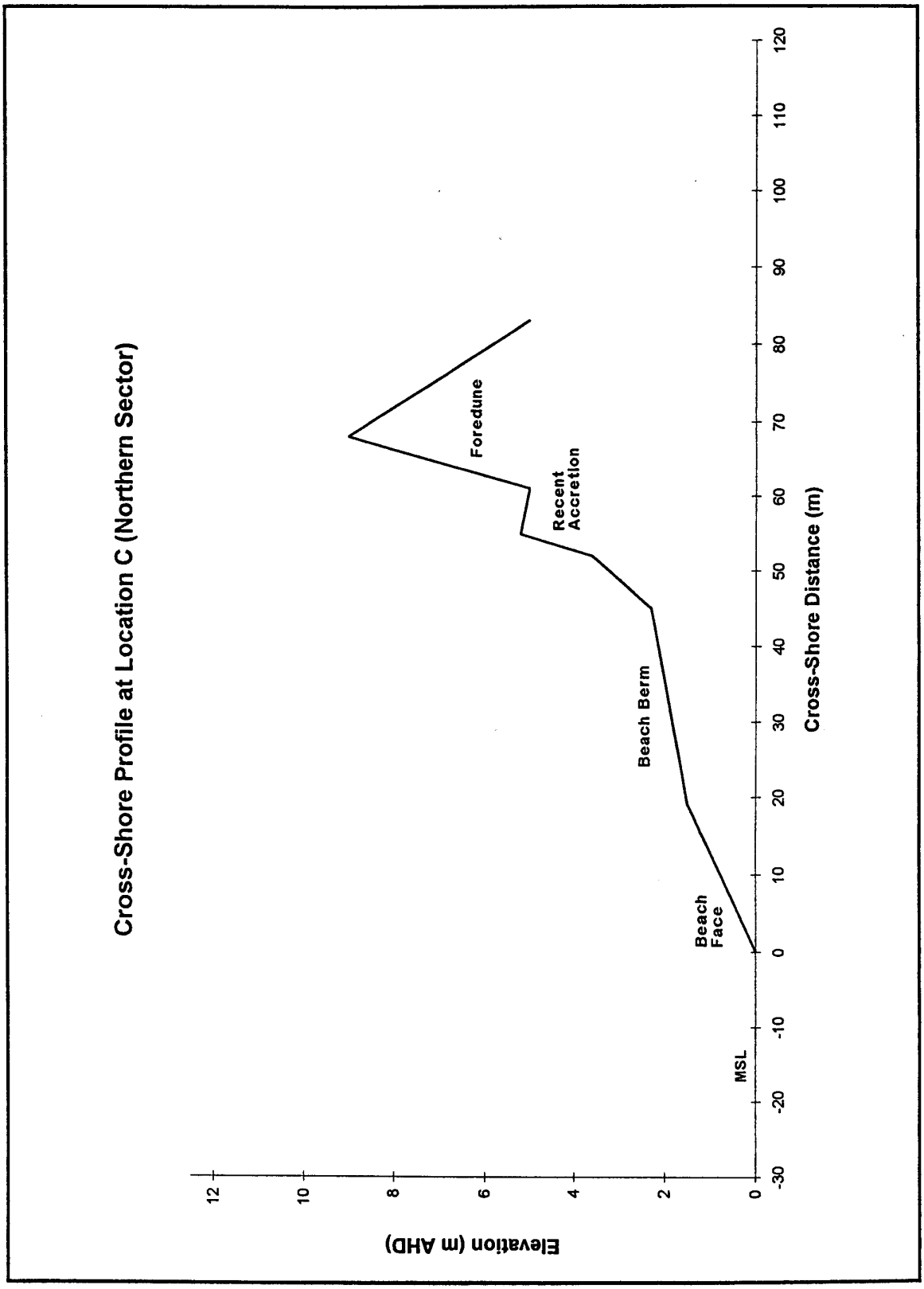


Figure 5 - a) Northern Sector Coastline
b) Southern Sector Coastline

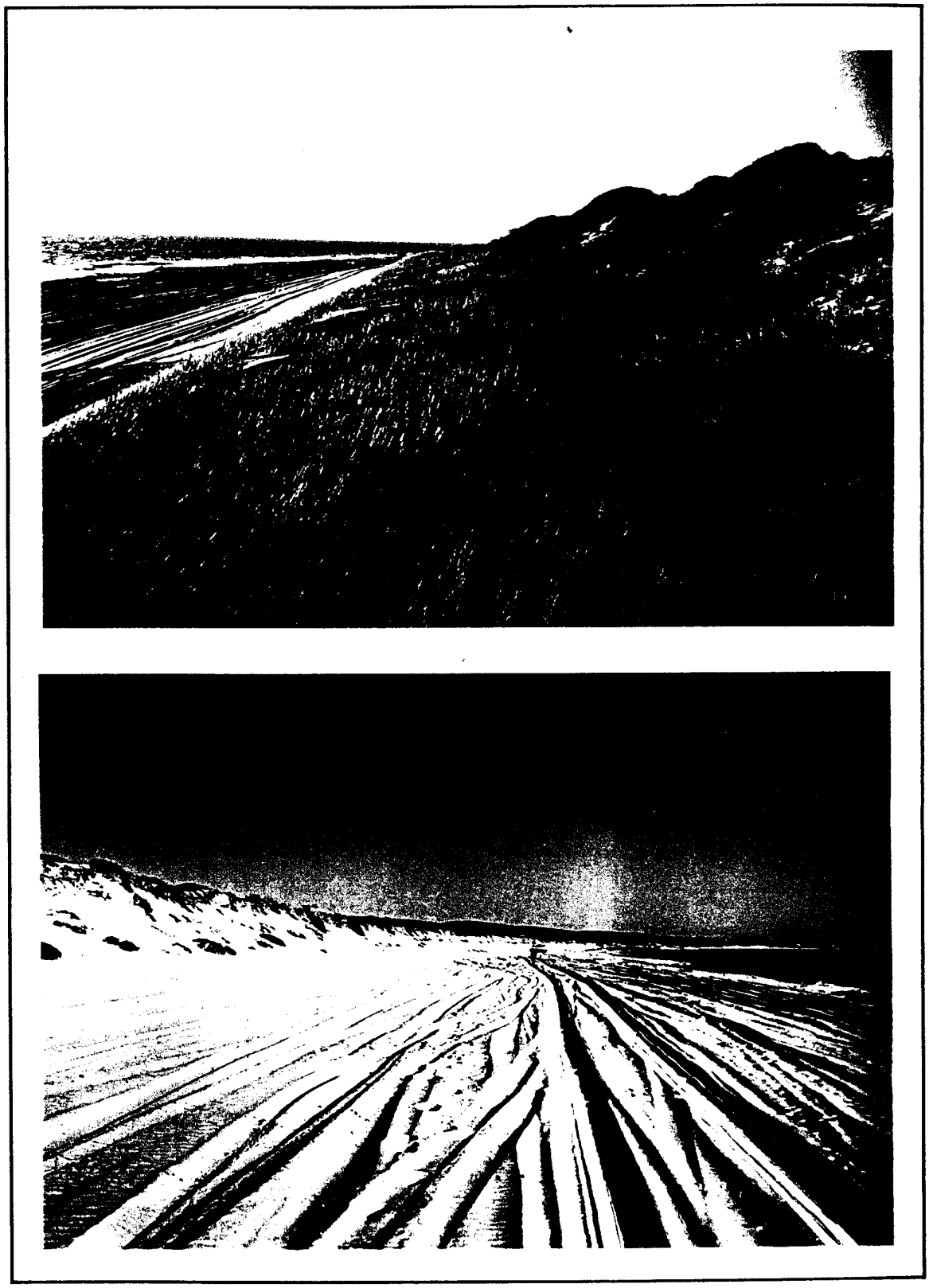


Figure 6 - Shoreline Movement for Lot 9 Jindalee

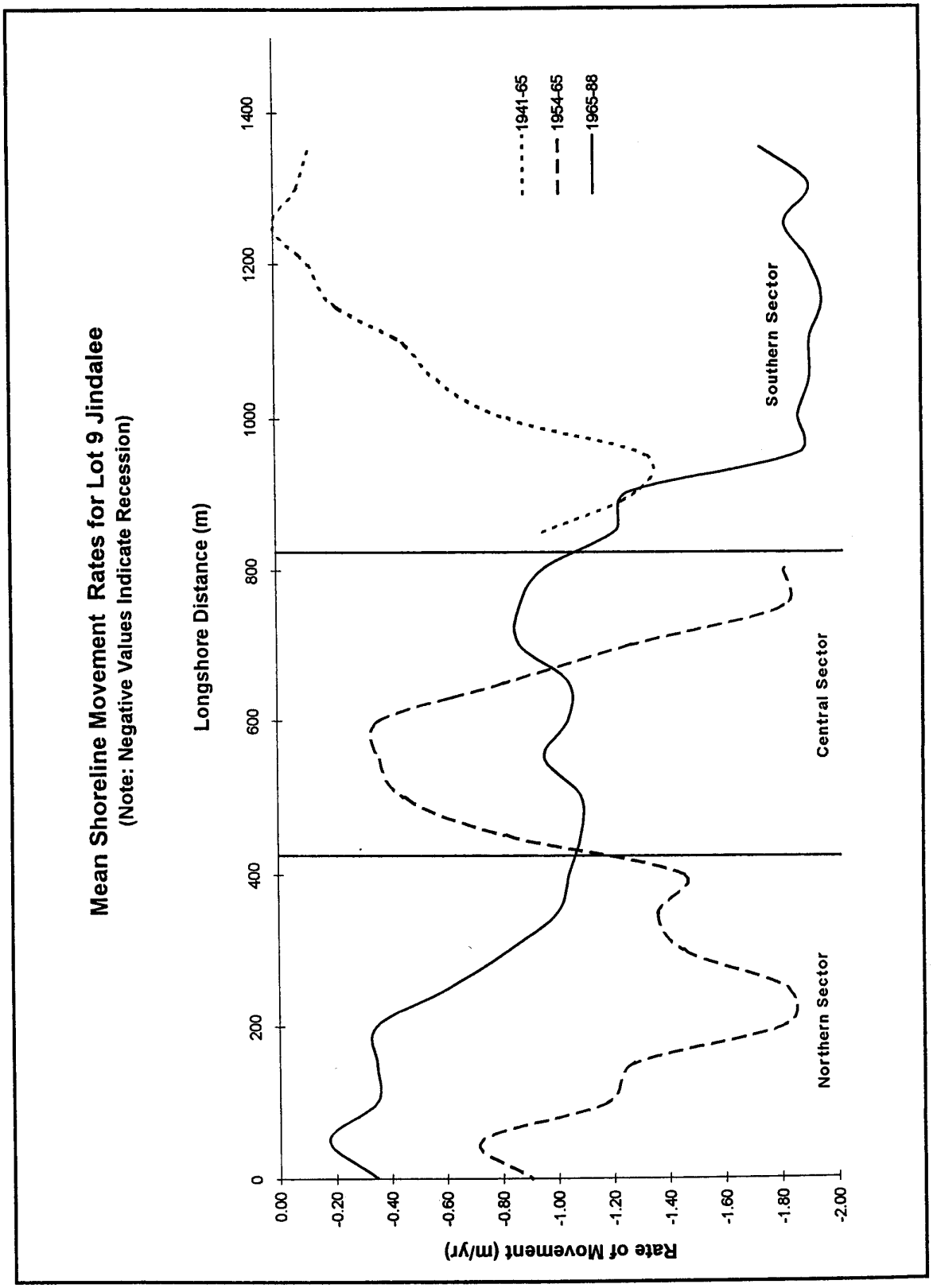


Figure 7 - Shoreline Movement Rates for Lot 9 Jindalee

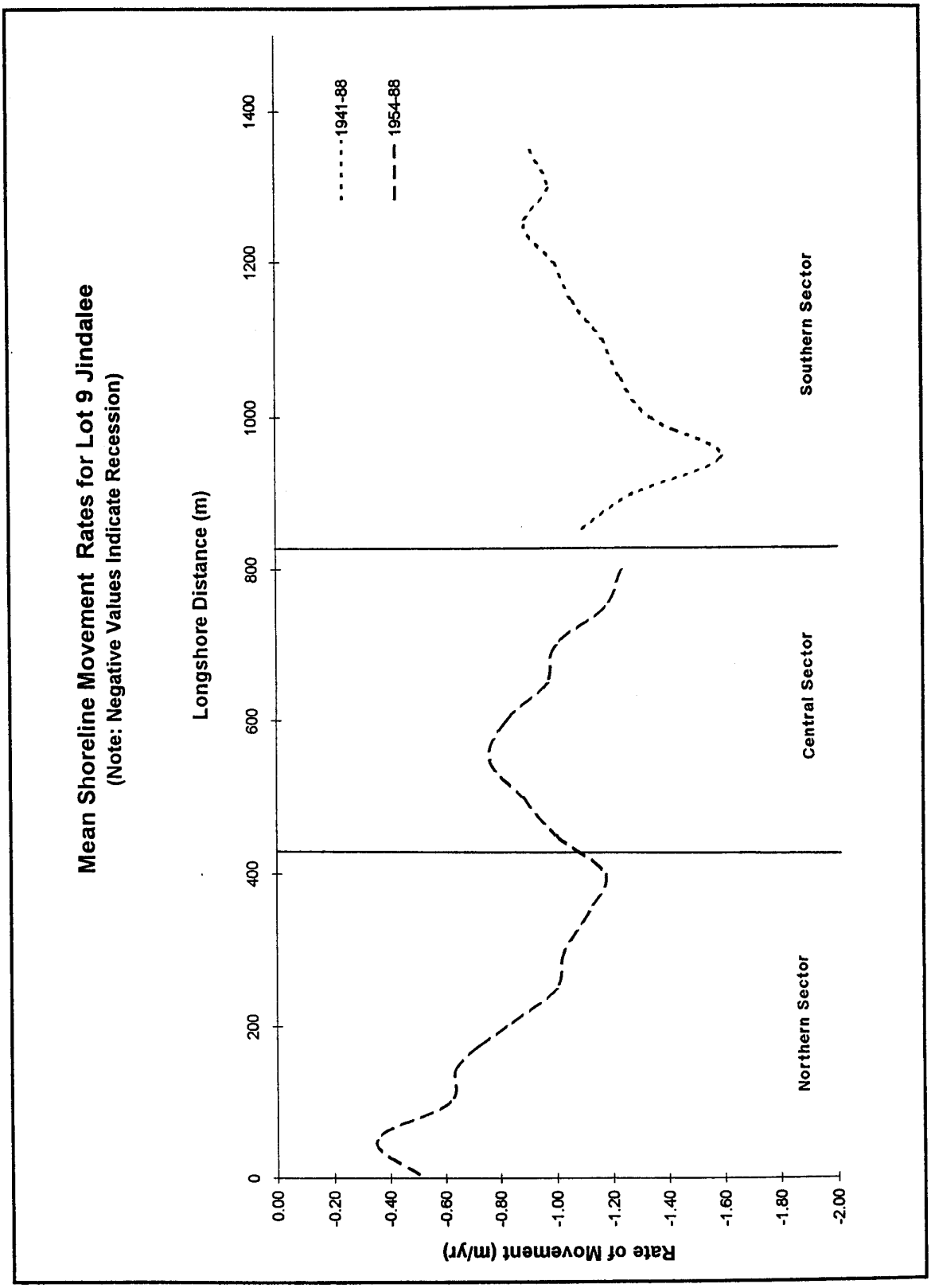


Figure 8 - Unit Erosion Rates for Lot 9 Jindalee

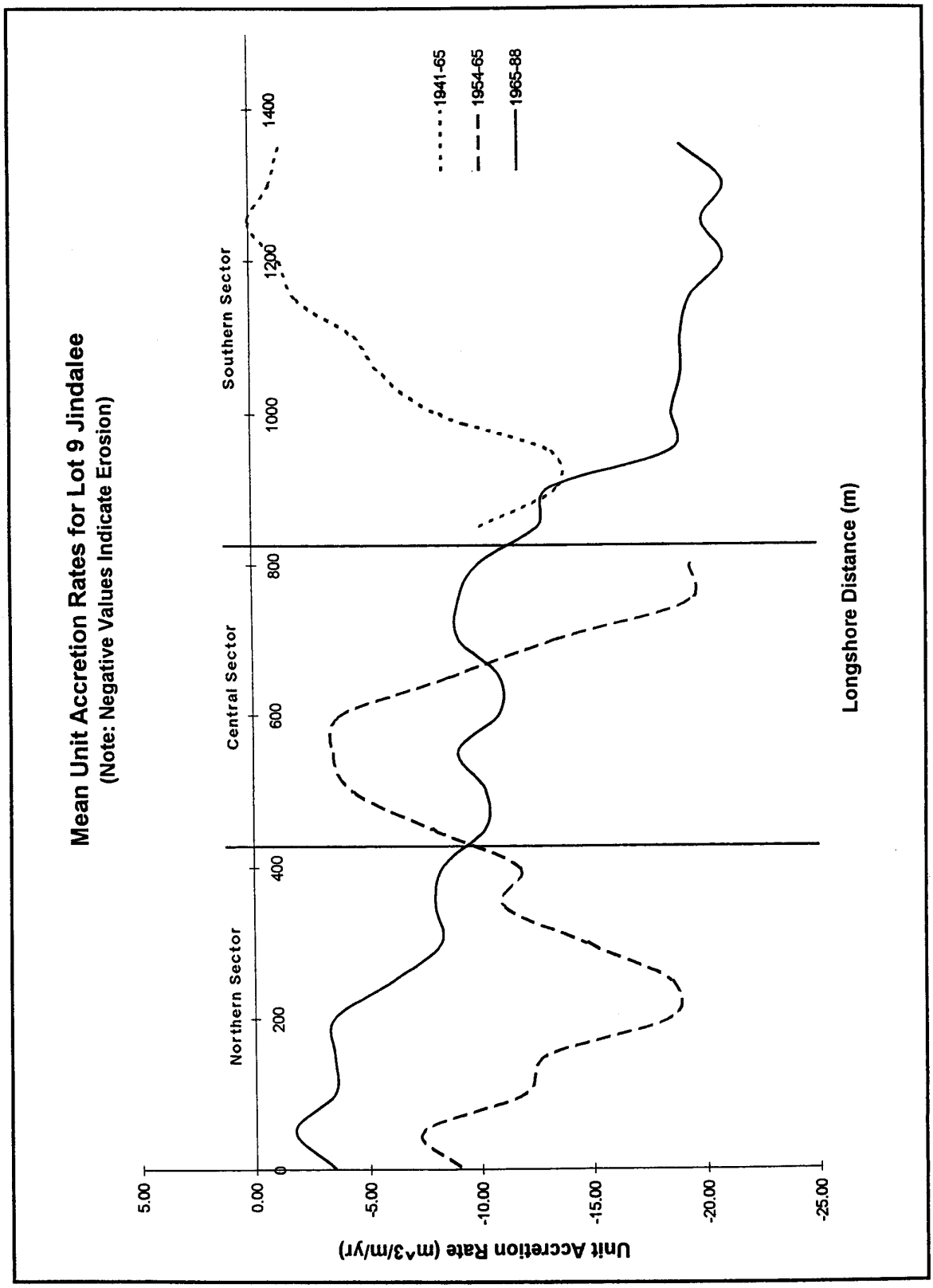
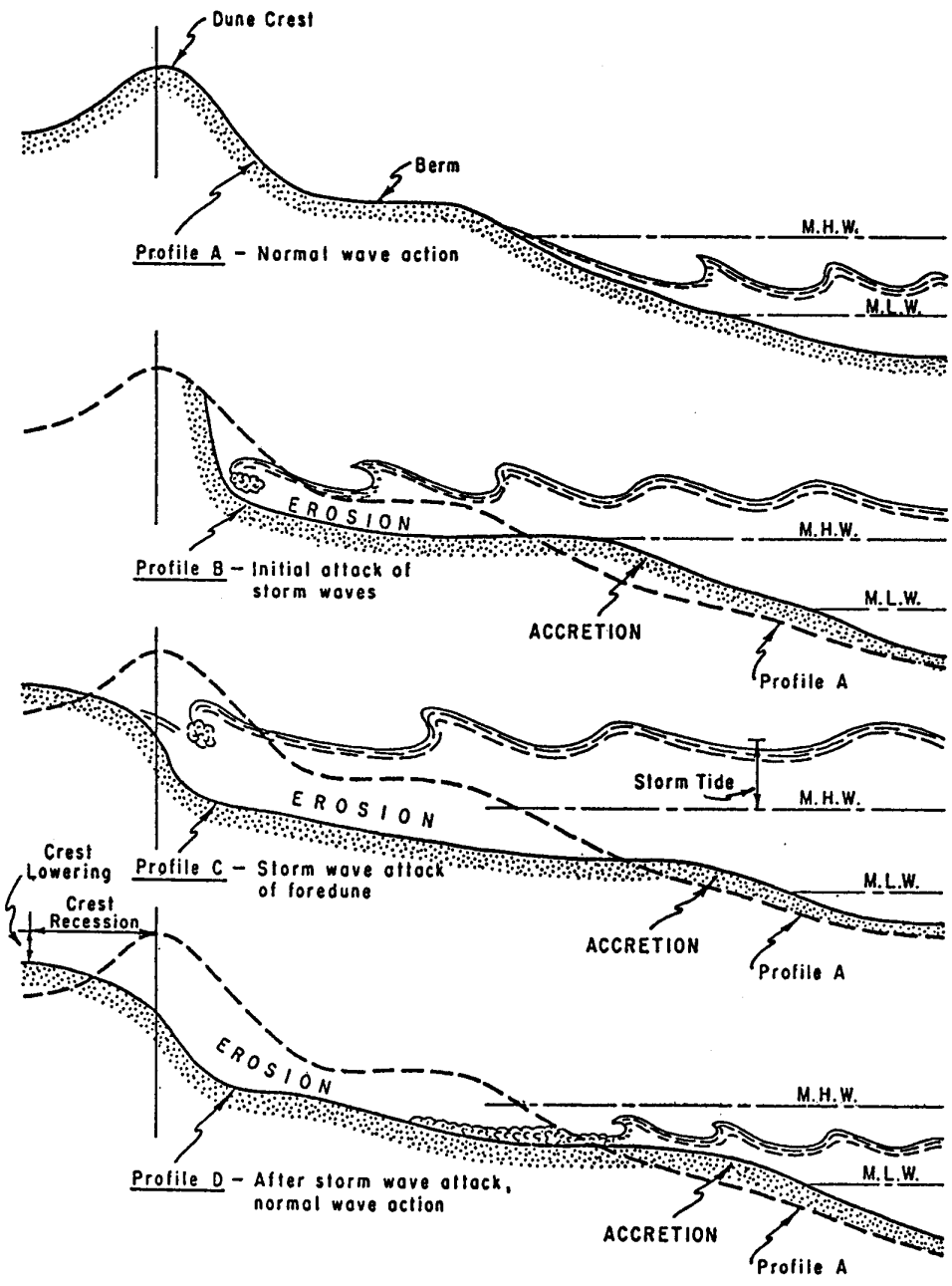


Figure 9 - Storm Wave Attack and Beach Erosion



Source: CERC (1977)

Figure 10 - Storm Erosion Modelling Results