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DEVELOPMENT OF PART OF SYSTEM 6 C70 SOUTH OF THE MAIDENS. BUNBURY ENDOWMENT LAND PART OF LOT 670, AND PARTS OF LOTS 301-4.

CONSULTATIVE ENVIRONMENTAL REVIEW.

prepared by

Hart, Simpson and Associates Pty Ltd

in association with

B.K. Masters and Associates

for

City of Bunbury and Homeswest

JUNE 1994

INVITATION

The Environmental Protection Authority (EPA) invites people to make a submission on this proposal.

The Consultative Environmental Review (CER) proposes further urban development of a small portion of the West Withers Area in the south west corner of the City of Bunbury. In accordance with the Environmental Protection Act, a CER has been prepared by the City to assess the values of the land, and describe land use proposals and management requirements. The CER is available for public review period of 4 weeks from 2 June 1994 closing on 4 July 1994.

Comments from government agencies and from the public will assist the EPA to prepare an assessment report in which it will make recommendations to government.

Why write a submission?

A submission is a way to provide information, express your opinion and put forward you suggested course of action - including any alternative approach. It is useful if you indicate any suggestions you have to improve the proposal.

All submissions received by the EPA will be acknowledged. Submissions will be treated as public documents unless specifically marked confidential, and may be quoted in full or in part in each report.

Why not join a group?

If you prefer not to write your own comments, it may be worthwhile joining with a group or other groups interested in making a submission on similar issues. Joint submissions may help to reduce the workload for an individual or group, as well as increase the pool of ideas and information. If you form a small group (up to 10 people) please indicate all the names of the participants. If your group is larger, please indicate how many people your submission represents.

Developing a submission.

You may agree or disagree with, or comment on, the general issues discussed in the CER or the specific proposals. It helps if you give reasons for your conclusions, supported by relevant data. You may make an important contribution by suggesting ways to make the proposal environmental more acceptable.

.../2

When making comments on specific proposals in the CER:

* clearly state your point of view;

* indicate the source of your information or argument if this is applicable;

* suggest recommendations, safeguards or alternatives.

Points to keep in mind.

By keeping the following points in mind, you will make it easier for your submission to be analysed :

* attempt to list points so that issues raised are clear. A summary of your submission is helpful;

* refer each point to the appropriate section, chapter or recommendation in the CER;

* if you discuss different sections of the CER, keep them distinct and separate, so there is no confusion as to which section you are considering;

* attach any factual information you may wish to provide and give details of the source. Make sure your information is accurate.

Remember to include :

* your name;

* your address;

* date, and

* whether you want your submission to be confidential.

The closing date for submissions is 4 July 1994.

Submissions should be addressed to :

The Environmental Protection Authority
Westralia Square
141 St George's Terrace
PERTH WA 6000

Attention : Simon Smalley (Ph: 09 222 7143)

CONTENTS.

1. SUMMARY.

Lots 301, 302, 303 and 626 in the south-west corner of the City of Bunbury are owned by the City of Bunbury and Homeswest. They are covered by the Environmental Protection Authority System 6 Red Book recommendation C70. The Maidens Reserve lies immediately to the north.

Because of the conservation and recreation values of the area, this Consultative Environmental Review has been prepared to assess the values of the land, and describe land use proposals and management requirements.

ENVIRONMENTAL ASSESSMENT

There are two vegetation associations carrying Tuart (Eucalyptus gomphocephala) which have intrinsically high conservation value and development within them should be minimised as much as possible. Two coastal vegetation associations, heath on stable dunes and heath on primary dunes, have much lower conservation values, are widely distributed in south-west W.A. and are well represented within the conservation estate.

However, the C70 area should not be considered in isolation from surrounding land. The City of Bunbury and Homeswest therefore make commitments that support:

- no urban or other development within the Maidens reserve,
- creation of a Tuart Park as recommended in other planning studies,
- a conservation and recreation corridor linking the C70 area and the Tuart Park with Manea Park to the east, and
- preparation and implementation of management plans for all vegetated land within the south-west corner of the City of Bunbury.

WASTEWATER TREATMENT PLANT

The W.A. Water Authority operates a wastewater treatment plant south of the study area within the Shire of Capel. At present, a 1000 metre buffer zone applies, within which urban and other residential developments should not occur.

WAWA are collecting data for use in a computer model to predict whether the 1000 metre buffer zone can be modified. However, regardless of the model's findings, urban development will not be allowed within 500 metres of the treatment plant.

ASSESSMENT OF ALTERNATIVES

Four key issues affect the assessment of alternative land use proposals for the subject land:

ENVIRONMENTAL PROTECTION

- use of land consistent with its environmental values,
- benefits to the community of retaining undeveloped bushland,
- access and use of beach areas, and
- management of undeveloped bushland areas.

ECONOMIC DEVELOPMENT OF URBAN LAND.

- efficient use of existing infrastructure,
- location of existing facilities and services,
- the design of urban subdivision areas and the resulting interaction with retained bushland, and
- maximising urban development within environmental constraints to meet community needs for residential land.

EQUITY CONSIDERATIONS FOR THE COMMUNITY.

- provision of access to the south Bunbury beach areas for existing and future residents, and
- concentrating urban development near existing suburban and city facilities to reduce travel distances and gain economic and environmental benefits.

QUALITY OF LIFE.

- urban development within an envelope of conservation areas,

- provision of coastal access and nearness to social, cultural and welfare facilities, and

- development of suitable land to create the financial means (via rates) for the City of Bunbury to provide services, including environmental management.

OPTIONS

Four development options were considered within the C70 area:-

OPTION 1: Develop the whole of the currently zoned urban area as presently allowed for with the City of Bunbury's Town Planning Scheme No. 6, together with part of the land owned by Homeswest.

OPTION 2: Allow urban development within the environmental constraints of the entire area as determined by this study to within 500 metres of the boundary of the wastewater treatment plant facilities, together with part of the land owned by Homeswest (see figure, page 5).

OPTION 3: Allow urban develop within the environmental constraints of the study area as determined by this study to within 1000 metres of the boundary of the No. 2 sewerage treatment plant facilities, together with part of the land owned by Homeswest (see figure).

OPTION 4: Conserve the entire C70 area and prevent any future development through appropriate zoning.

Assessment of these four options relative to the four key issues discussed above provides the following matrix:

OPTION	ENVIRONMENTAL BENEFITS	ECONOMIC BENEFITS	EQUITY BENEFITS	QUALITY OF LIFE BENEFITS
1	LOW	HIGH	MEDIUM	MEDIUM
2	MEDIUM TO HIGH	MEDIUM TO HIGH	HIGH	HIGH
3	MEDIUM TO HIGH	MEDIUM	HIGH	HIGH
4	MEDIUM TO HIGH*	LOW	LOW	MEDIUM

* The lower rating base for the City of Bunbury reduces the financial ability of the City to manage all environmental land within its boundaries.

OPTION 2 is preferred on the basis of the above assessment. However, its implementation is dependent on resolving the generation of odours from the No. 2 wastewater treatment plant.

OPTION 3 is the second preference.

Approval is sought for both options, with OPTION 3 to proceed immediately and OPTION 2 to proceed if the final buffer around the wastewater treatment plant allows it.

If OPTION 2 proceeds, urban development will occur within about 40 hectares, representing less than 18% of the 224 hectares of the C70 area. If OPTION 3 proceeds, urban development will occur within about 21 hectares or about 9% of the C70 area. In addition approximately 1.5 hectares will be cleared for the development of a water supply facility on a high point in the south.

COMMITMENTS

Included within both these options are commitments to:

- The creation of two wildlife corridors to provide linkage between The Maidens reserve and native vegetation to the south.

- The road passing through the eastern corridor being fenced to exclude wildlife and having underpasses to allow safe wildlife passage.

- Preparing and implementing management plans for natural bushland within the south-west corner of the City of Bunbury.

- Retaining native trees other than Tuart (due to safety concerns) within areas to be developed for urban purposes.

- A coastal setback for urban development of 130 metres.

SANDBOWL

The Sandbowl is an unvegetated dune lying within both the City of Bunbury and the Shire of Capel. It is moving inland very slowly and is popular with 4WD enthusiasts.

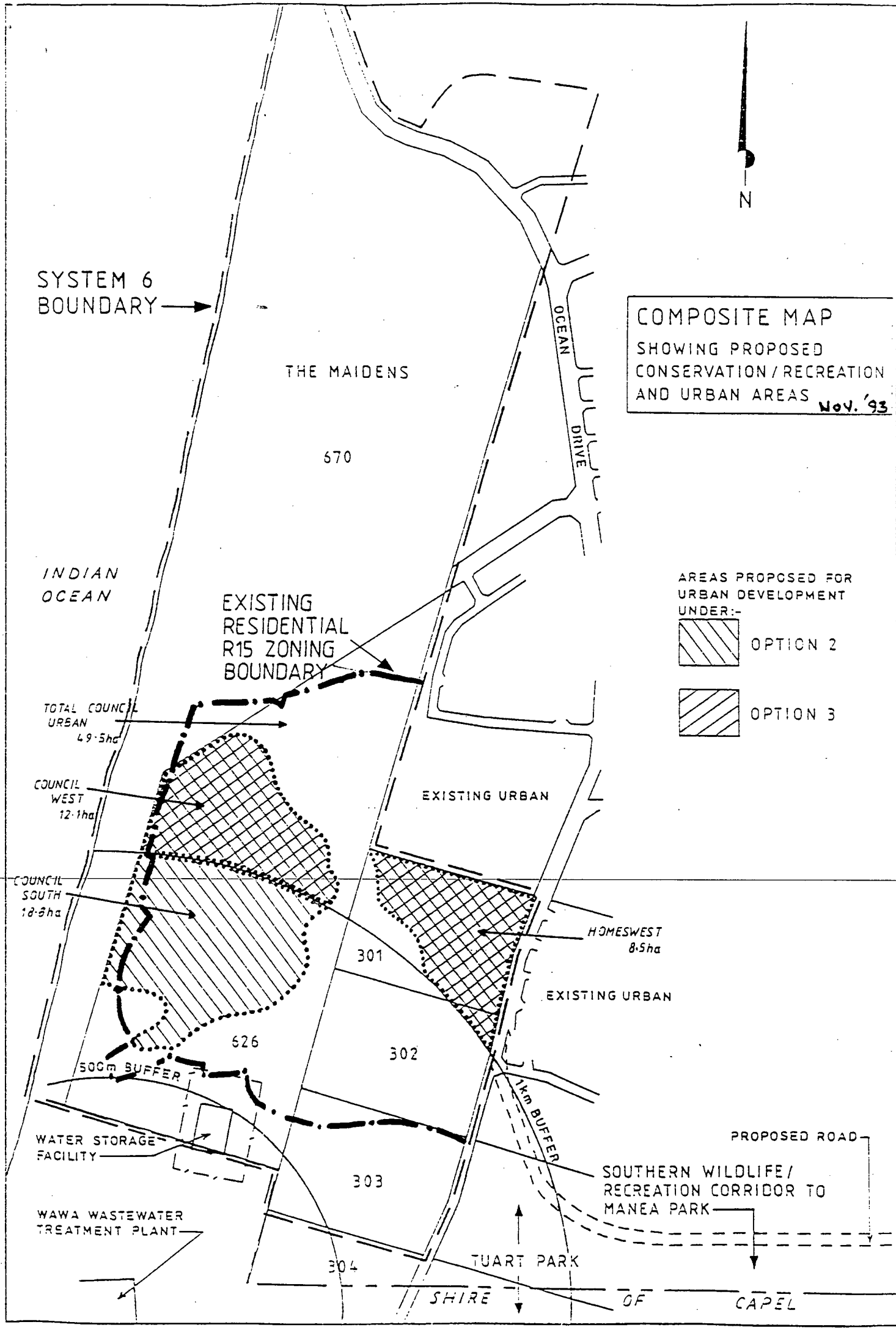
Several options exist for the Sandbowl's future, ranging from retention in its present form to complete revegetation. The City of Bunbury is prepared to allow continued recreational 4WD use of the site, provided that 4WD drivers assist the Council in preparation and implementation of a management plan. This will include:

- provision of volunteer labour to rationalise and revegetate the maze of existing tracks,

- protection of existing vegetation,

- revegetation of dune areas that may be identified in the planning study as needing stabilisation, and

- the education of off-road users in correct off-road behaviour.


SYSTEM 6 BOUNDARY
THE MAIDENS
670
OCEAN DRIVE
INDIAN OCEAN
EXISTING RESIDENTIAL R15 ZONING BOUNDARY
TOTAL COUNCIL URBAN 49·5ha
COUNCIL WEST 12·1ha
COUNCIL SOUTH 18·6ha
EXISTING URBAN
HOMESWEST 8·5ha
EXISTING URBAN
301
626
302
500m BUFFER
1km BUFFER
WATER STORAGE FACILITY
303
PROPOSED ROAD
SOUTHERN WILDLIFE/ RECREATION CORRIDOR TO MANEA PARK
WAWA WASTEWATER TREATMENT PLANT
304
TUART PARK
SHIRE OF CAPEL
N
COMPOSITE MAP
SHOWING PROPOSED CONSERVATION / RECREATION AND URBAN AREAS
NOV. '93
AREAS PROPOSED FOR URBAN DEVELOPMENT UNDER:-
OPTION 2
OPTION 3

2. INTRODUCTION.

Parts of Lots 301-3 and 626 on the south-western corner of Bunbury are areas of native vegetation which have been partially zoned for residential development. The land is owned by the City of Bunbury and Homeswest. Adjacent land to the east is being developed for housing and the owners of the land now wish to look at possible development. The land is covered by a System 6 recommendation (C70), is used for recreation and has been the subject of considerable public interest for conservation as part of the planning process.

The Environmental Protection Authority has required the preparation of a Consultative Environmental Review (CER). This document describes the land, makes a proposal for its development, and discusses how the various interests were reconciled to produce the proposal. Public input was sought during this process and the public input is also discussed.

The land cannot be considered in isolation and the study was extended to consideration of the adjacent Maidens area, an east-west corridor along the southern boundary of Bunbury, a proposed Tuart Park, and the total management of natural bushland to be conserved in the System 6 and surrounding area.

This document has been prepared as part of the formal environmental assessment of the proposal by the Environmental Protection Authority. It is designed to provide information to the public and decision-making authorities so that appropriate decisions can be made.

The EPA guidelines for the review are given in Appendix 1.

3. THE LAND.

3.1 LOCATION AND LAND USE.

The land is parts of Lots 301-3 and 626 on the south-western corner of Bunbury (Map 1, next page). All of the land is in the City of Bunbury.

Lots 301-3 are owned by Homeswest and Lot 626 is owned by the City of Bunbury. The land is currently zoned Residential (the central bulk of the land) or Parks, Recreation and Drainage (the coastal strip and the northern and southern edges) in accordance with previous development plans which have not proceeded. The adjacent Maidens area is on Reserve 670 for Bunbury Endowment and Reserve 35020 for Public Recreation on the eastern side.

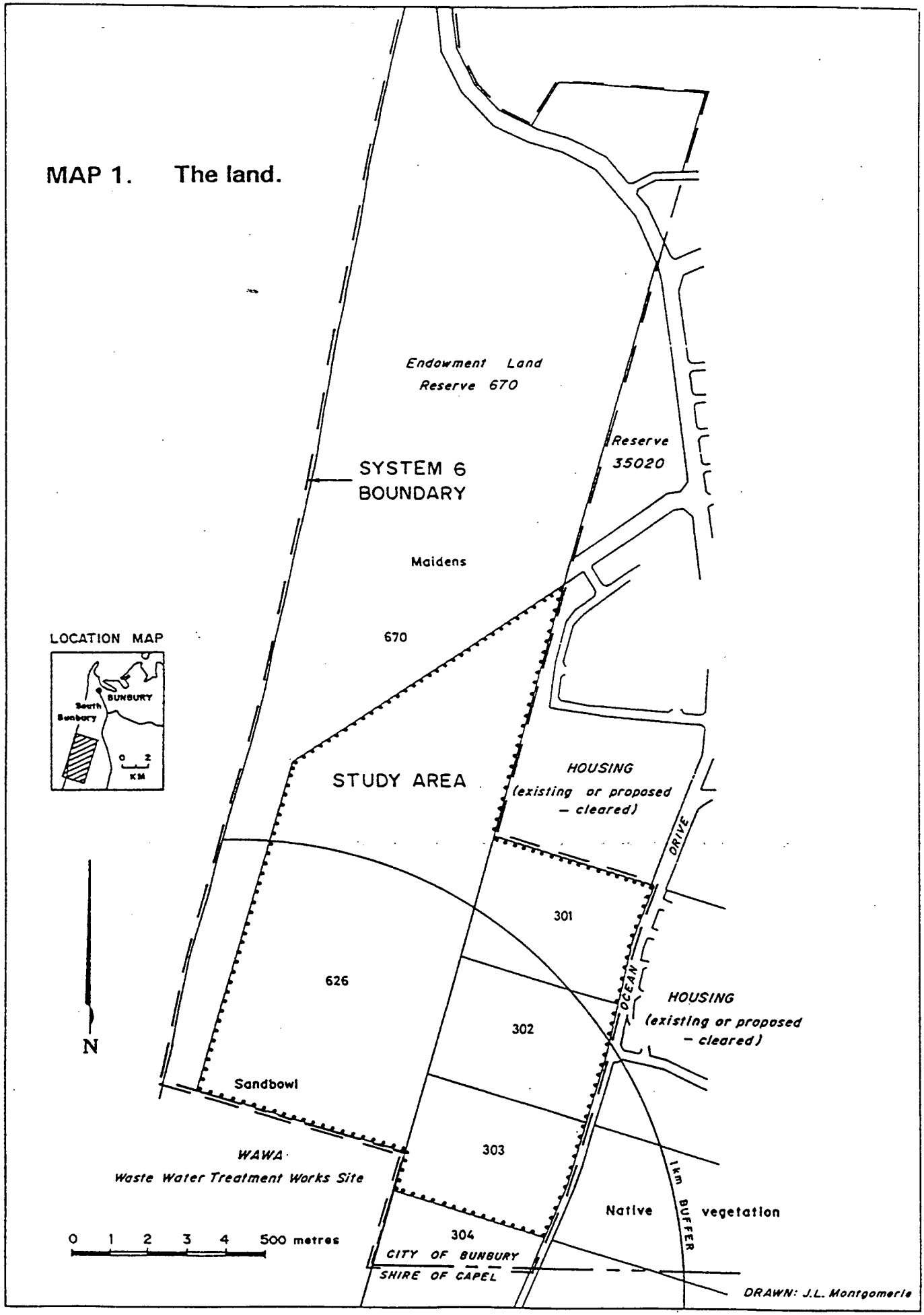
Adjacent land has been or is being developed for conventional housing (Map 1).

The land is covered by System 6 recommendation C70 (Map 1). The recommendation was (EPA 1983), "That areas of Public Open Space, containing attractive and important features such as "The Maidens" and important stands of Tuart, be set aside at the time of subdivision of the coastal land south of Bunbury".

The area is also affected by an existing waste water treatment plant to the south (Map 1), for which the Water Authority of Western Australia (WAWA) currently requires a buffer zone of 1 kilometre, within which some land uses including urban development are prohibited.

The area is also affected by a draft coastal management plan (DPUD 1993) which proposes coastal setbacks but makes few specific recommendations for the area discussed here because of the unresolved issues of the System 6 recommendation, possible development of the land, and the uncertain buffer around the waste water treatment plant.

The area is held under Exploration Licence E70/911 for mineral sands exploration. There is no active exploration and any proposal to explore on the land would be subject to separate environmental assessment.


MAP 1. The land.
Endowment Land
Reserve 670
Reserve
35020
SYSTEM 6
BOUNDARY
Maidens
670
LOCATION MAP
BUNBURY
South
Bunbury
0 2
KM
STUDY AREA
HOUSING
(existing or proposed
– cleared)
DRIVE
301
626
OCEAN
HOUSING
(existing or proposed
– cleared)
302
N
Sandbowl
303
WAWA
Waste Water Treatment Works Site
1km BUFFER
Native vegetation
0 1 2 3 4 500 metres
304
CITY OF BUNBURY
SHIRE OF CAPEL
DRAWN: J.L. Montgomerie

3.2 LANDFORMS AND SOILS.

LANDFORMS.

The site is part of the Quindalup dunes which occur along the entire coast in the region. These dunes are a series starting from the present beach, passing through unstable beach dunes, to older dunes which have been stabilised by vegetation. On the eastern side the dunes fall onto a flatter area which is part of the Karrakatta system, an older set of dunes. Further east, outside the present study area, there are wetlands.

The Quindalup dunes have a characteristic profile with low linear dunes along the coast which rise to larger parabolic dunes further inland, and relatively steep slopes down to the edge of the Karrakatta system. The dunes often exceed 40m in elevation, and may reach 60m.

SOILS.

The soils are white calcareous and quartz sands with increasing organic matter further inland, but become more yellow in the Karrakatta system. Limestone is present at depth below the sands.

The soils along the coast are inherently unstable, and natural blowouts are a feature. There is one large blowout on the southern edge of the study area, known locally as "the Sandbowl" (Map 1).

Despite their instability, the soils are capable of supporting intensive development which requires removal of the vegetation, provided that the development immediately stabilises the new surface with structures or vegetation. Similar landforms have been widely used along the coast for residential and recreational developments.

The coastal dunes are now generally regarded as capable of supporting development but development is often regarded as undesirable for aesthetic reasons and to protect the potentially unstable beach line and dunes.

The beach itself is stable (DPUD 1993).

3.3 VEGETATION AND FLORA.

VEGETATION.

The vegetation of the area was mapped as part of planning studies for the region (Tingay and Associates 1991), but this was not sufficiently detailed for the present study. Accordingly, the vegetation was described and mapped. Most attention was given to the central and eastern vegetation units because these are the most important and the coastal strip is both well known and unlikely to be developed at any time. The mapping extended north to cover all of the Maidens area. The vegetation was divided into the following units, starting from the eastern side (Map 2, next page):

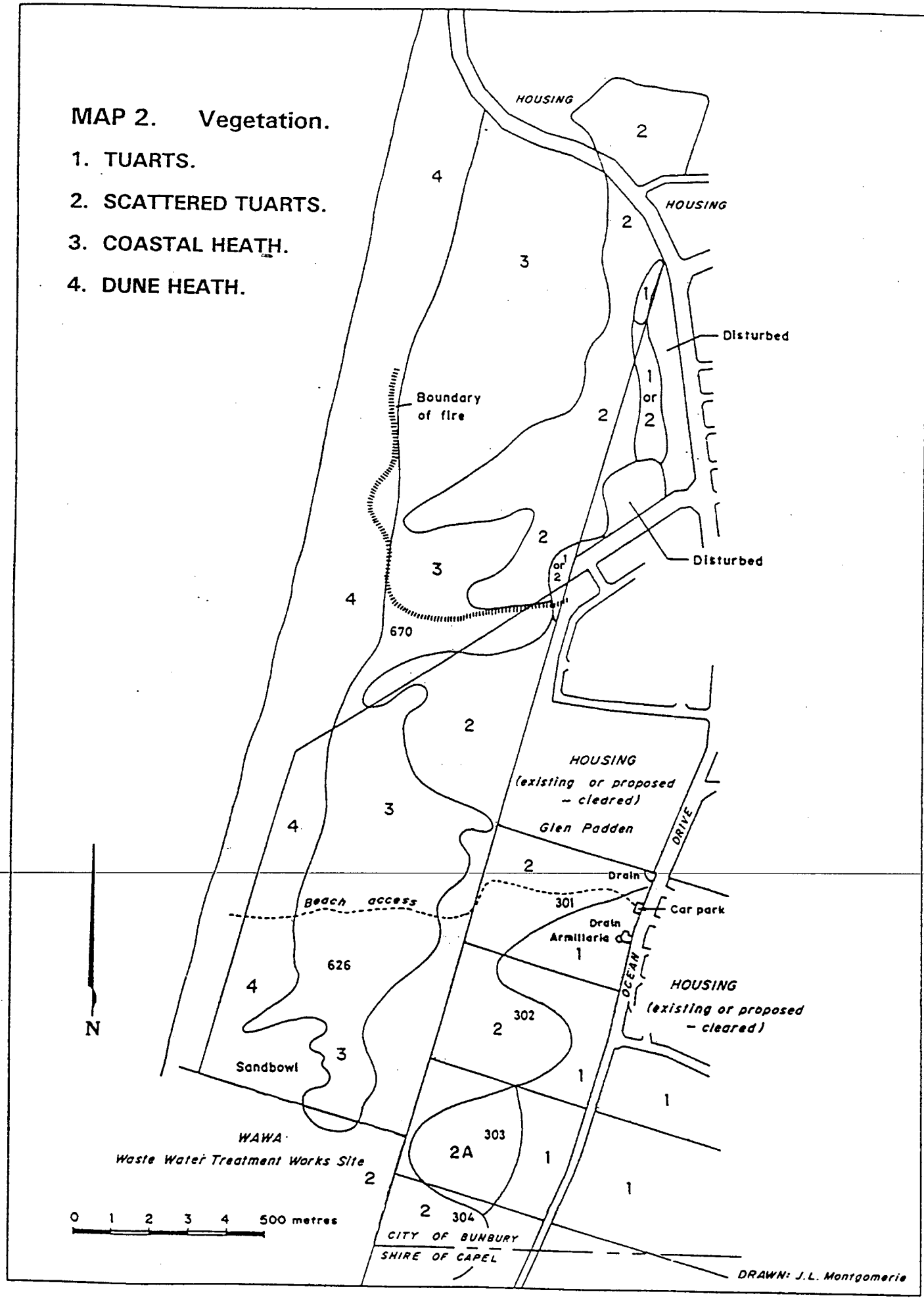
1. Tuart woodland and forest over Peppermint, Banksia and Jarrah on the older dunes.

The Tuarts (Eucalyptus gomphocephala) form woodland and occasionally forest up to 25m in height over mixed open low woodland of Banksia attenuata, B. grandis, Peppermint (Agonis flexuosa) and Jarrah (Eucalyptus marginata) up to 12 m in height over a low heath. Shrubs present in the low heath include Daviesia divaricata, Acacia cochlearis, Phyllanthus calycinus, Grevillea vestita, Xanthorrhoea preissii, Macrozamia riedlei, Eremophila glabra and the Priority 2 species Lasiopetalum membranaceum. On higher ground the shrubs include Hibbertia hypericoides, Persoonia saccata and Synaphea spinulosa. Small thickets of Acacia saligna are present in lower lying areas. Herbaceous plants in the low heath include Acanthocarpus preissii, Corynotheca micrantha, Clematis microphylla, Schoenus grandiflorus, Helichrysum cordatum, Conostylis aculeata, Geranium solanderi and the grasses Danthonia caespitosa, Poa drummondiana, Stipa flavescens and Dichelachne crinita.

This unit is found around the junction of the Quindalup dunes and the Karrakatta system

The Tuart trees are particularly healthy, especially to the south. The understorey is intact and very diverse but a serious weed invasion is starting from the road and tracks. The most threatening weeds are Ehrharta calycina (Veldt grass) and Avena sp. (Wild Oats).

The areas in the north are not in as good condition, particularly in Reserve 35020 where there appears to have been a history of grazing.


MAP 2. Vegetation.
1. TUARTS.
2. SCATTERED TUARTS.
3. COASTAL HEATH.
4. DUNE HEATH.
HOUSING
HOUSING
Disturbed
Boundary of fire
1 or 2
Disturbed
670
HOUSING (existing or proposed - cleared)
Glen Padden
DRIVE
Drain
Beach access
301
Car park
Drain
Armillaria
626
OCEAN
HOUSING (existing or proposed - cleared)
302
Sandbowl
WAWA
Waste Water Treatment Works Site
303
2A
304
CITY OF BUNBURY
SHIRE OF CAPEL
N
0 1 2 3 4 500 metres
DRAWN: J.L. Montgomerie

2. Tuart open woodland on dunes.

The swales and east facing dune slopes support Tuart open woodland up to 20m in height over Peppermint open low woodland up to 7m in height, over coastal heath. Coastal heath species include the shrubs Acacia cochlearis, Jacksonia furcellata, Phyllanthus calycinus, Templetonia retusa, Hibbertia cuneiformis, Thomasia cognata, Acacia lasiocarpa, Spyridium globulosum, Rhagodia baccata, Dodonaea aptera and Santalum acuminatum. Occasional trees of Nuytsia floribunda (Christmas Trees) occur. Herbaceous species include Acanthocarpus preissii and the grasses Poa poiformis, Danthonia caespitosa, Stipa flavescens and Agropyron scabrum. Weeds are invasive here, as described above. Couch grass (Cynodon dactylon) is a problem along firebreaks where it has been spread by earthmoving machinery.

A variant of Tuart open woodland occurs in a low lying southern swale with exposed limestone (2A in Map 2). Tuart trees reach up to 15m in height over a thicket to 3m of Acacia saligna and Diplolaena dampieri. Few Peppermints are present. Shrubs in the understorey heath include Acacia cochlearis, Logania vaginalis, Opercularia hispidula, Myoporum caprarioides, Scaevola nitida, Chorizema diversifolium and Comesperma confertum. The sedges Gahnia trifida and Lepidosperma sp. are also present. The vegetation is generally in good condition and few weeds are present, except in the northern area.

3. Coastal heath on stable dunes.

The stabilised secondary dunes support mixed low heath and heath, with no large trees. The common shrubs are Acacia cochlearis, Jacksonia furcellata, Exocarpos sparteus, Phyllanthus calycinus and Santalum acuminatum. Hibbertia cuneiformis, Rhagodia baccata, Opercularia vaginata, Diplolaena dampieri, Scaevola anchusifolia and Spyridium globulosum are less common. Herbaceous plants include Acanthocarpus preissii, Conostylis aculeata and the grasses Stipa flavescens and Danthonia caespitosa. Wind pruned Peppermints grow as scattered individuals and in thickets, reaching up to 3m in height. Low lying flats between the dunes sometimes support sedges such as Isolepis nodosa and Lepidosperma sp. growing with Pelargonium littorale.

The vegetation is in good condition with limited weed invasion except along the tracks. Trachyandra divaricata (often misidentified as Asphodelus fistulosus) is the most aggressive weed present. Grass weeds include Wild Oats, Lagurus ovatus, Bromus diandrus and Couch.

4. Coastal heath on primary dunes.

Species on the youngest dunes close to the sea include Spinifex longifolius and Tetragonia decumbens with the common naturalised species Arctotheca populifolia, Cakile maritima and Ammophila arenaria.

Behind these dunes the low coastal heath is dominated by Diplolaena dampieri. Other common shrubs include Olearia axillaris, Acacia cochlearis, Hemiandra pungens and Scaevola crassifolia. Lepidosperma gladiatum and Acanthocarpus preissii are also common. In more sheltered leeward positions the heath is taller, exceeding 1 m. There are also occasional small thickets of Peppermint reaching up to 3m in height.

The vegetation is in good condition with little sign of any weed invasion except for Pelargonium capitatum in many places and other common naturalised species along the beach front.

The distribution of these vegetation units follows the topography very closely. The Tuart woodland and forest, with the tallest trees and most diverse tree stratum, is found only on the lower slopes of the inland edge of the dunes and in the flat areas behind the dunes in the Karrakatta system. The Tuart open woodland has scattered Tuarts over heath and is found on the lee slopes of the dunes (with an abrupt end at the crest), in the swales, and in the east-west valleys between the parabolic dunes. The coastal heath occurs in two different forms, one on the windward faces and crests of the large dunes and another on the mobile dunes along the coast.

Most of the Maidens area had been burnt prior to the present survey and could not be examined closely because most of the vegetation had been removed by the fire. The boundary of the fire is shown on Map 2. The Maidens area consists largely of units 2, 3 and 4 in the same sequence as further south, with smaller areas of unit 1 on the eastern edge but these have been heavily disturbed by past activities including grazing, particularly on Reserve 35020.

Unit 1 of the vegetation is part of a much larger unit with a tree stratum of varying densities of Tuart, Peppermint, Jarrah and Banksia, which merges with the Banksia woodlands with some Jarrah typical of Bassendean dunes. True Banksia woodlands are not common locally, and the main areas occur around Dalyellup, five kilometres to the south. In general where the Banksias occur beneath Tuarts there is a prominent shrub understorey and vice versa.

VEGETATION QUALITY.

The condition of the vegetation was assessed by a series of criteria:

1. Tuart health: on a scale of from 0 (all dead) to 5 (all completely healthy).

2. Tuart density: low, medium and high.

3. Presence of young Tuarts: yes or no.

4. Density of the understorey: on a scale of from 0 (none) to 5 (completely normal).

5. Diversity of the understorey: on a scale of from 0 (all dead) to 5 (all completely healthy).

6. Absence of weed invasion: on a scale of from 0 (weeds completely dominant) to 5 (no weeds).

The condition within a vegetation unit was relatively consistent, and average values were assessed as:

Criterion	Unit 1	2	2A	3	4
1. Tuart health.	4+5	3-5	3-5	-	-
2. Tuart density.	Med	Med	Med	-	-
3. Young Tuarts.	Yes	Yes	Yes	-	-
4. Understorey density.	4	4	4/5	4	4/5
5. Understorey diversity.	4	4	4/5	4	5
6. Weed invasion.	3	3/4	4	4	4/5

These criteria could not be applied fully to the Maidens area because of a recent fire which had removed much of the vegetation.

A few significant variations occurred to these average values. Along Ocean Drive south of Glen Padden there was a disturbed strip with serious weed invasion due to previous road works, and there were smaller areas of weed invasion along tracks and where other disturbances had occurred, such as rubbish dumping. A small part of the Maidens reserve isolated north of Ocean Drive has been used for urban development or has been degraded by loss of most of the understorey. There have been several small areas cleared by work on adjacent urban developments in Glen Padden, although one of these has been carefully rehabilitated. Reserve 35020 was generally in poor condition, apparently due to past grazing, and part of it has been used as a sand pit. There are many small unstable areas along the coast, and one large one, known as the Sandbowl, has encroached right through unit 2 almost 500 metres inland. Although spectacular, this blowout is a natural part of the landscape and is actually moving inland very slowly. All of the large dunes, including the Maidens, were formed by similar blowouts in the past which moved inland and eventually became stabilised.

Part of the area 2A in Map 2 appeared to have been excavated for the extraction of marl (a form of limestone) many years ago. The vegetation has regenerated and the only evidence remaining was old heaps of soil and rubbish.

One small patch of severe deaths of Banksia attenuata was found along Ocean Rd (Map 2) which was consistent with the presence of dieback due to the Phytophthora fungi. Two dead trees were tested. No Phytophthora were found, but a fungus which appeared to be Armillaria was found on the dead trees. The damage was accepted as due to Armillaria and not dieback.

FLORA.

The flora of the study area was also examined. A list of the plant species identified in each vegetation unit is given in Appendix 2. This not a complete list of the flora. Most of the field work was carried out in late November 1992 and some additional work was carried out in the Maidens area in June 1993. Many annual species would not have been seen, such as the orchids. As for the vegetation, most attention was paid to the central and eastern areas rather than the coastal strip.

Appendix 2 lists 124 species including 30 weeds, giving a total native flora of 94 species. The number of native species recorded in each unit was:

	Number of species
Unit 1	69
Unit 2	54
Unit 3	32
Unit 4	18

This decline in species abundance parallels the decline in complexity of the vegetation from east to west. The total species list is less than what would be expected in a heathland or woodland elsewhere on the coastal plain, but this low species total is characteristic of Tuart woodlands due to the relatively simple shrub layers.

RARE SPECIES.

Specific searches were made for any rare species. Two Declared Rare Flora species are known from the region. Aponogeton hexatepalus is a rare wetland species but there is no habitat for this species in the study area. Chamelaucium roycei is restricted to swamp margins near Capel and again is there is no suitable habitat.

A full search could not be undertaken for Priority species because of the seasonal constraint, but particular attention was paid to species which might be present.

The only Priority species found was Lasiopetalum membranaceum (Priority 2), which is a small shrub observed flowering in low heath in Tuart woodland in the southern part of the study area. Priority 2 species are defined by CALM as, "Taxa which are known from one or a few (generally less than five) populations, at least some of which are not believed to be under immediate threat (i.e. not currently endangered)". This species occurs in Tuart woodland near the coast from Yalgorup National Park south to Capel. It has also been recorded from Dwellingup on the eastern side of the coastal plain (Marchant et al. 1987) . Although rarely collected this species appears to be reasonably widespread.

INTRODUCED SPECIES.

Weeds are a significant component of the flora and a survey carried out in spring would detect many more annual species. The weeds recorded were grasses (11 species), herbaceous legumes (five species), daisies (four species) and a range of other herbs. In general the weeds are invasive in vegetation units 1 and 2, and to a much lesser extent in 3, but are represented by common naturalised species in the coastal dunes where the species have occupied niches not taken by native species. The most significant weeds are the grasses.

THE TUART ECOSYSTEM.

The System 6 Atlas of Natural Resources (DCE 1980) maps five complexes with Tuart trees (the Karrakatta North, Karrakatta Central and South, Cottesloe, Yoongarillup and Vasse). In combination these complexes have a minimum width of about one kilometre on the north-west side of the Peel Inlet and a maximum of eight kilometres in the Lake Preston area. Around Bunbury, Tuarts occur in belts from 1.5 to 4 kilometres wide. Tuarts occur from the Sabina River east of Busselton north to the Hill River, a distance of over 400 kilometres.

Traditionally Tuarts have been regarded as growing only on shallow sands over limestone, but they occur on a variety of soils including acidic sands with little or no limestone such as on the Leschenault ridge on the east side of the Leschenault Inlet.

Tuart can be readily regenerated (Forests Dept, undated) simply be ensuring a very hot fire which kills the grasses and leaves a clean ash-bed, but young Tuarts are fire-sensitive. An excessive fire frequency favours annual weeds which in turn leads to frequent low intensity fires which both kill the young Tuarts and promote weeds in a cycle of degradation. This trend has probably been exacerbated by past grazing which also promoted weed invasion.

Tuarts readily develop hollows and this gives them a high value for wildlife, but they also regularly drop limbs which makes them dangerous. For this reason Tuarts are rarely retained in urban areas, and are unsuitable as shade trees in recreational areas where people are likely to remain for long periods.

3.4 FAUNA.

A detailed fauna survey has not been carried out in the study area because the fauna of the region is fairly well known. The habitats present are well defined by the natural vegetation units described above. These vegetation units relate directly to the soils and topography and can be interpreted as natural fauna habitat categories.

The vertebrate animal species which could be expected to occur in each habitat are listed in Appendix 3. This list has been drawn up from the records of the W.A. Museum and published sources such as How, Dell and Humphreys (1987). No useful comments can be made about the invertebrate fauna. The fauna of the Tuart lands is better known than that of the coastal heaths, and a short but intensive survey of the reptile fauna concentrating on the coastal heaths was carried out in December 1992. The species identified are also shown in Appendix 3.

Appendix 3 lists nine amphibian, 31 reptile, 85 native bird, and 17 native mammal species which may occur, as well as a suite of introduced mammals and two introduced birds.

The species which are actually present are not known. There is little information available about many of the species, particularly mammals. For example there are no records of the Echidna in the entire region, but this species is common and widespread and could be found almost anywhere. The mammals have also been severely affected by the impact of European settlement, unlike the frogs, reptiles and birds. Some species, such as the Yellow-footed Antechinus and Bush Rat, have not been recorded locally recently but may still be present, while others such as the Brush Wallaby are probably locally extinct but would still occur nearby.

A rich bat fauna is listed in Appendix 3, but most of these species are poorly known. Bats are typically very mobile when feeding, and many would make use of the trees for roosting.

The lists in Appendix 3 have been drawn up conservatively so that all possible species which might be present can be considered.

The number of native species listed as possibly present in each habitat is:

Habitat	1	2	3	4
Amphibians	8	9	8	3
Reptiles	29	30	28	21
Birds	71	77	56	35
Mammals	16	17	12	10
TOTAL	124	133	104	69

The potentially most diverse habitats are 1 and 2 with habitat 4 being the least diverse.

Most fauna species listed in Appendix 3 are common or widespread, and are not restricted to the habitats considered here. The Tuart woodlands include a diverse fauna and the Tuarts themselves are an important habitat feature, particularly for birds. The trees provide roosting and nesting sites and a food resource for many of the bird species and are important to the Brushtail and Ringtail Possums. Frogs and reptiles are not dependent on the Tuarts in the same way, except for obvious tree dwelling species, but some species prefer the heavier leaf litter found in the Tuart woodlands. The legless lizard Aprasia repens, for example, would be expected to be most common in the dense leaf litter.

Few species are restricted to the coastal heaths. These are small birds which prefer open areas of low vegetation. The coastal heaths have fewer species of conservation interest because this habitat is widespread along the coast.

RARE SPECIES.

One mammal species listed in Appendix 3 is gazetted in Schedule 1 under the Wildlife Act as likely to become extinct or rare.

The Western Ringtail Possum Pseudocheirus occidentalis is rare in total and now occupies a severely reduced area. It is a leaf eating species, and is now found mainly in Peppermint vegetation as well as forest to the east. This species is likely to be present in vegetation units 1 and 2 where it would use the Peppermints and Tuarts. The area to the south towards Busselton is well known as a major stronghold of this species. It is able to survive in even remnants of Peppermint vegetation, such as at Peppermint Grove near Capel and within the Busselton townsite.

Three bird and one reptile species are gazetted in Schedule 2 as otherwise in need of special protection.

Baudin's Cockatoo Calyptorhynchus baudinii was noted by Storr and Johnstone (1988) to be moderately common south of Harvey in eucalypt forests, and feeding on the seeds of Marri, Banksia grandis and B. littoralis. It is unlikely that the present study area is a significant habitat for this species, however it would occur intermittently while passing through to other areas.

Carnaby's Cockatoo Calyptorhynchus latirostris breeds mainly to the north and east (Storr 1991) but has been known to breed occasionally as far south as Bunbury and nests in hollow eucalypts (Storr and Johnstone 1988, Garnett 1992). After breeding it tends to disperse westward. It feeds on a variety of native shrubs and eucalypts as well as pine trees. It is endangered by loss of breeding trees in the wheatbelt and fragmentation of its habitat. Again, the present study area is unlikely to be a significant habitat for this species but it will be present at times.

The Peregrine Falcon has a world-wide distribution and is threatened over most of its range. The major reasons for its decline in numbers are attributed to birth defects and egg-shell thinning due to pesticide ingestion, falconry, illegal trade, and destruction as a pest in some areas (Garnett 1992, Kennedy 1990). The Australian subspecies is affected by pesticides in relatively small areas subject to intensive agriculture and Garnett (1992a) considers its status as secure in Western Australia. This species would be present as an erratic visitor.

The Carpet Python belongs to a subspecies which occurs only in the south-west of Western Australia and could be found in any of the habitats in the project area. It shelters in hollow trunks and limbs, disused burrows, caves, rock crevices and beneath boulders, and often occurs around human settlements (Wilson and Knowles 1988). The major threats to its survival include habitat destruction and predation of young snakes by foxes and cats. It is often killed close to human settlements when it is mistaken for a large venomous species.

Another bird of interest which may be present in the area is the Masked Owl. This subspecies is considered to be rare by Garnett (1992) and is known to occur in forest and woodland in a broad coastal strip around southern and eastern Australia. In Western Australia it inhabits forest dominated by Tuart (Garnett 1992). Major threats to its survival include destruction of nest trees and pesticide ingestion. This species could be protected by retaining old trees with nest hollows.

INTRODUCED SPECIES.

Introduced animals are represented by a suite of mammals (rabbit, cat, fox, mouse and rat) found in almost any site in the South-West, and two birds. The birds are the Laughing Turtle-Dove which is found mainly around human settlements or disturbed areas and has little impact on the native fauna, and the Kookaburra which is common and feeds on many small native animals. Both of these introduced birds are widespread and common.

All of these introduced species are common and widespread, and any control would need to be part of a larger regional programme.

3.5 HYDROLOGY.

The study area has not been investigated by drilling but the general Bunbury area has been the subject of two surveys by the Geological Survey of W.A. known as the Bunbury shallow-drilling groundwater investigation (Commander 1984) and the Picton borehole line study (Wharton 1980). Other information was obtained from records of seventeen private bores in the Withers area.

The study area is underlain by a relatively simple sedimentary sequence:

Formation	Thickness	Lithology
Safety Bay Sand	40m	Calcareous quartz sand dunes
unnamed	4m	Sand associated with Tamala limestone
Tamala Limestone	15m	Aeolian and marine calcarenite
Yarragadee	500m	Interbedded sand, shale and siltstone
Cockleshell Gully	1000m+	quartz sand with interbedded silty-shale and carbonaceous shale.

The Bunbury Basalt has not been found to occur beneath the study area.

All of these sediments are capable of holding water. The Safety Bay Sand and the unnamed sand beneath it are generally too high in the landscape to retain water for long periods, and gravity forces the water down until it encounters a silt or clay layer, or meets the groundwater. Horizontal flow then occurs either west to the sea or east to the wetlands.

The Tamala Limestone is mostly lithified but the calcium carbonate ensures that it is cavernous and potentially a good aquifer. Experience from the Leschenault Peninsula has shown that water discharged onto the surface quickly drains into the groundwater.

The Yarragadee Formation is considered one of the most productive aquifers in the southern part of the Swan Coastal Plain. It contains much sand and little clay or secondary cementation, and water quality is high.

The Cockleshell Gully Formation was tested by one of the Picton bore holes near the corner of Bussell Highway and Robertson Drive. Water quality and available volume were high.

Commander (1984) indicates that there is narrow north-south zone immediately inland from the coast where water flows upwards from the Yarragadee Formation into the sands and limestones of the superficial formations. There is no bore data to confirm that this actually occurs within the study area, but such movement may be present along the eastern edge of the high sand dunes. This may explain the apparent speedy regeneration that occurred to sections of Tuart vegetation (in unit 2A in Map 2) that had been damaged by marl extraction many years ago. This also helps to explain the vigorous health and density of the understorey beneath the Tuarts on the west side of Ocean Road.

3.6 HERITAGE VALUES.

Formal surveys have not been carried out in the study area but there are no known features of European cultural interest and no sites of significance to Aboriginal culture known to the W.A. Museum.

3.7 RECREATION.

A survey of coastal recreation in the Bunbury area (Cole and Gepp 1992) did not extend to the present study area, but provides good background information. From casual observations, parts of the present study area are used extensively for recreation, particularly in the north. This is primarily related to the Maidens area and the beach front, with major beach access points in the north from Ocean Road and for four wheel drive vehicles through the centre of the proposed development area (Map 2). Apart from fishing and four wheel drive vehicle driving, it can be expected that the other major attraction of this beach is its remoteness and cleanliness. Recreation in the proposed development area is otherwise limited to walking, jogging and running for a variety of reasons along the one major road and the network of firebreaks in the area.

Recently, the Bunbury City Council has announced a major upgrade of the recreational facilities within the System 6 area. These facilities include a walk trail through the Maidens area, picnic facilities, playground equipment and a toilet block, at a total cost of about $126,000.

The large blowout, known as the Sandbowl, is used extensively for off road vehicle driving and there is a network of tracks leading to the bare sandy area.

As Bunbury expands and the surrounding area is further developed for housing the demand for all forms of recreation can be expected to increase.

3.8 CONSERVATION VALUES.

The conservation values of the land considered here can be derived from three sources:

- the presence of rare species,
- the presence of valuable landforms, vegetation types, habitats or communities, and
- the local and regional context of the land.

RARE SPECIES.

Only one plant of conservation significance was found. This was Lasiopetalum membranaceum, a Priority 2 species which although rarely collected is apparently widespread. Priority species have no legal protection and the presence of this species alone is insufficient to place a high value on the land.

Several rare animal species are probably present. The most significant is the Ringtail Possum which is a seriously endangered species both locally and in total. It is largely dependent on the Peppermint tree, and the region to the south is known to be a stronghold of this species. The actual or probable presence of this species gives the land conservation value. No other fauna species gives the land such a high value.

VALUABLE LANDFORMS, VEGETATION TYPES, HABITATS OR COMMUNITIES.

The landforms of the study area are common along the coast, but the Maidens area is a landform of significance because of the size of the dunes, their form and their aesthetic appeal.

The vegetation, habitats and communities can be considered together because they are closely related.

Tuart communities are widespread along the coast in a relatively narrow strip, and while Tuart is popularly regarded as growing mainly alone and on shallow sand over limestone, it also commonly occurs on a variety of soils and often mixed with Jarrah and Marri on the eastern side of its coastal distribution. A typical example can be seen along Bussell Highway to the east of the area considered here.

Tuart is a valuable timber tree and large numbers of trees were felled for timber. This felling progressed to the point that few large trees were available and harvesting has now essentially stopped.

Although the Tuart-dominated communities are widespread, most of this area has been cleared (Beard and Sprenger 1984) and many of these communities have been degraded by loss of the understorey although the Tuart trees themselves remain. Examples of this are common around Bunbury and north along the Old Coast Road. Tuart vegetation occurs in 24 of the areas recommended for conservation in the System 6 review, as well as in the Ludlow Forest and Minninup Block, and the Tuart itself is well represented in reserves. Despite this, areas of Tuart-dominated vegetation in good condition are now scarce in total and poorly represented in reserves.

Ludlow, where Tuart forest is best developed, has lost almost the entire understorey due to past land use practices. The understorey has been effectively replaced by weeds. The original vegetation of this Tuart forest is not known but it was likely to have been dominated by native grasses and herbaceous species, with few shrubs.

The Minninup Block south of Bunbury has considerable Tuart over Banksia and is essentially intact native vegetation. The areas of Tuart over Peppermint have little natural understorey and tend to be dominated by weeds.

There are considerable areas of Tuart woodlands and forests to the immediate east of the area considered here and to the south, and these are in good condition (Tingay and Associates 1991) but none of these are reserved for conservation. Tingay and Associates (1991) describes the Tuart woodlands over heath (unit 2) in the present study area as being in poor condition (p. 14 and Map 7) unlike the Tuart woodlands immediately to the east which are described as being in good condition (p. 15). This appears to be an error as the areas are continuous and appear to have had the same history of land use. Any difference between these areas is a natural vegetation density difference due to soil and topography.

Trudgen (1984) described the vegetation of the Leschenault Peninsula to the north of Bunbury. Although there are considerable areas of Tuart woodlands, they have a very limited understorey and must be regarded as partly degraded. There are considerable areas of Tuart vegetation in good condition in Yalgorup National Park, but these have not been mapped. Trudgen (1991) described

the vegetation of the coastal area around Mandurah and found Tuart communities to be common and in good condition unlike most other areas of Tuart. This good condition was sufficient to give them a very high conservation value.

The Tuart-dominated communities are very sensitive to disturbance and fire. Much of the Tuart country has historically been used for grazing, and there have been major changes in fire patterns. A cycle of disturbance, weed invasion and excessive fire frequency has been set up, and most Tuart areas now show the impact of this degrading influence. Young Tuarts are fire sensitive and are killed before they can reach a sufficient size to survive fires. Normal bushfires or grass fires are not hot enough to achieve Tuart regeneration. Regular low intensity fires therefore prevent the regeneration of Tuarts, damage the understorey and promote weeds.

More recently, Tuarts have been affected by a form of tree decline believed to be due to excessive insect attack (Fox and Curry 1980). This is poorly understood but may be related to the increasing disturbance and isolation of the remaining Tuart trees or to changes in fire patterns. Chilcott (1992) re-examined this problem and concluded that in fact only the Tuarts near urban and particularly industrial areas were in decline and that the Tuarts in rural areas were not affected even where they were in vegetation which had been badly degraded by grazing or loss of the understorey. Chilcott concluded that air pollution was the most likely cause.

The vegetation, habitats and communities represented by the Tuart woodlands and forests in the present study area must all be given a high conservation value because of their good condition and because of the general scarcity of this unit in good condition, particularly in conservation reserves. It must be emphasised that the Tuart itself is widespread and is well represented in Reserves, but that Tuart-dominated vegetation in good condition is not.

The coastal heath units are part of common and widespread units which occur along much of the coast. These have been well reserved in many areas and will be further protected by the general trend to avoiding coastal development.

LOCAL AND REGIONAL CONTEXT.

The local and regional context of the land gives it the highest values.

Map 3 (next page) shows the extent of uncleared land locally within the City of Bunbury.

It is clear from Map 3 that the land discussed here is a large area of remnant vegetation. It is also the only area which has the potential to join up the Maidens area with Manea Park, the only other large area of native vegetation locally. This linkage has been widely discussed as a "green belt" from the Maidens to Manea Park and possibly further north east.

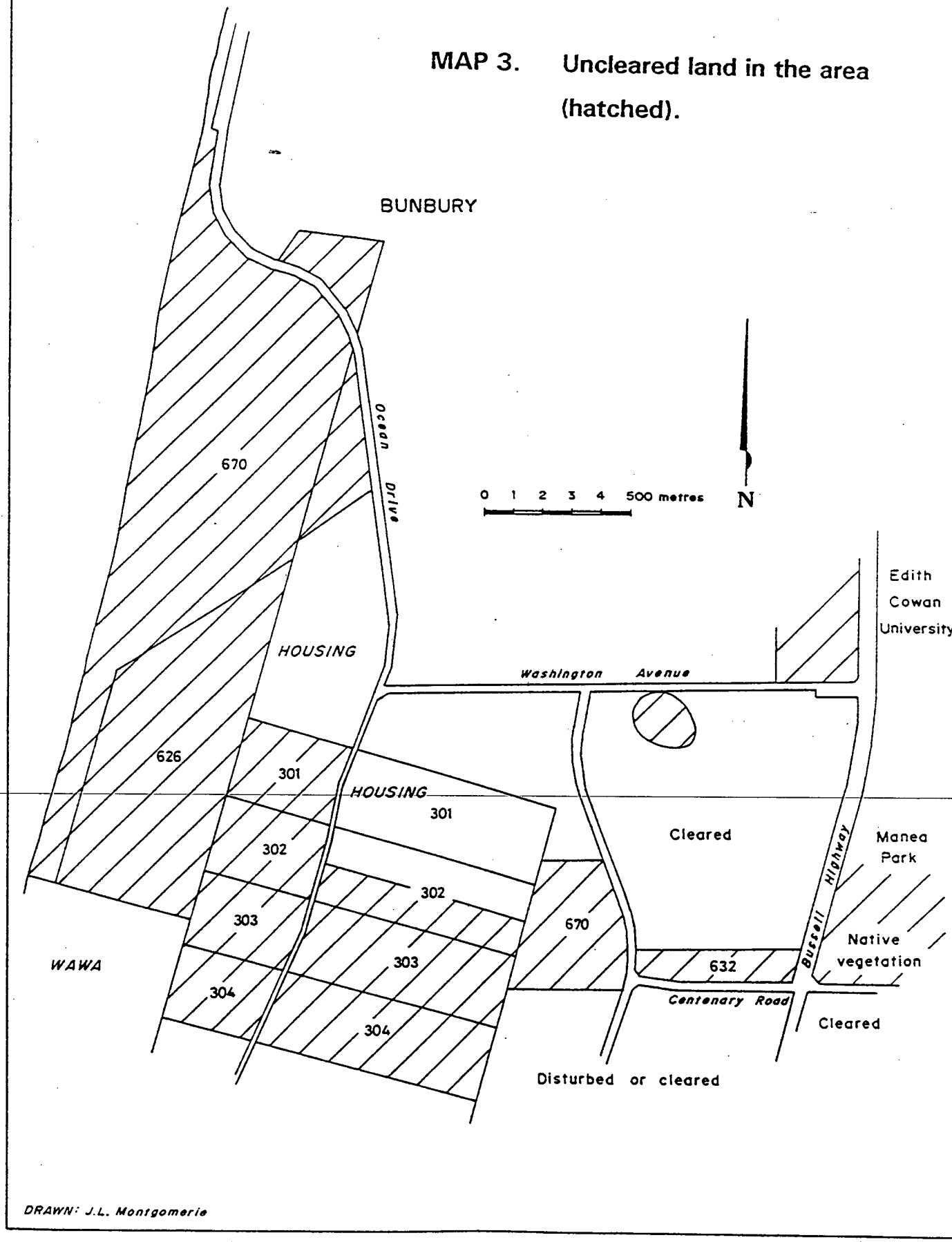
This green belt is seen as preserving the conservation value of the land itself, achieving the possibility of linking all of the larger areas of native vegetation, allowing for the possible movement of plants and animals along this corridor, and has value for appropriate low-key recreation.

Planning for development of the region has also considered these possibilities.

The Usher-Stratham Environmental Study (Tingay and Associates 1991) made specific recommendations for the establishment of open space from the Maidens across into the Tuart woodlands to the east of Ocean Road.

The Usher, Gelorup and Dalyellup District Structure Plan (Thompson, Taylor and Burrell 1992) describes two options and a final suggested Structure Plan, all incorporating some linkage from the Maidens across to Manea Park although the exact lay out was not discussed and seen as subject to disagreement by various interested parties.

The Bunbury-Wellington Region Plan (DPUD 1993a) generally supported the Structure Plan but was unable to make specific recommendations because of the uncertainty over the land considered here and questions over the buffer to be defined by the Water Authority of Western Australia around the waste water treatment plant.


MAP 3. Uncleared land in the area (hatched).
BUNBURY
Ocean Drive
670
0 1 2 3 4 500 metres
N
Edith Cowan University
HOUSING
Washington Avenue
626
301
HOUSING
301
302
302
303
303
304
304
WAWA
Cleared
Manea Park
Bussell Highway
670
632
Native vegetation
Centenary Road
Cleared
Disturbed or cleared
DRAWN: J.L. Montgomerie

3.9 PUBLIC OPEN SPACE.

The Public Open Space in Bunbury has been reviewed in a draft report to the Bunbury City Council. Almost 200 individual pieces of Public Open Space (POS) were examined and their values were determined. These values were grouped and the provision of various types of Public Open Space in Bunbury was assessed.

The study found that:

- City of Bunbury Town Planning Scheme No. 6 currently provides over 1200 hectares of land that are reserved for parks and drainage (Public Open Space), although some of this remains in private ownership.

- This represents 400% of the requirements of the most generous standard of Public Open Space as recommended by other Australian and overseas standards.

- Bunbury has some 460 square metres of Public Open Space per person which is 4 to 12 times greater than Perth metropolitan local authorities.

- The Public Open Space currently existing in Bunbury is of a generally high quality when compared against Public Open Space quality goals.

- A need was seen for additional development and management of open space to take advantage of these qualities.

- There are numerous opportunities for recreational and wildlife linkages or corridors to be created or expanded, including a coastal linkage along the entire west coast of the City from the current project area to the outer harbour and including a south boundary linkage from the current project area to Manea Park.

Based upon this study, it could be argued that urban development of the C70 area should be largely constrained by conservation values and that other values, such as recreation, are already well served by existing Public Open Space land. However, the Bunbury City Council accepts that urban bushland has an increased range of values over and above what similar land in a rural setting may hold. As stated in the draft National Trust policy on urban bushland, all the real and perceived values of urban bushland remnants should be fully assessed as part of the planning process.

Accordingly, the amount of land within the C70 area to be set aside for recreation and for its intrinsic value, as well as for conservation, is far in excess of what would otherwise be the case. Similar large areas of reserved land are expected to be allocated when detailed urban planning extends south into the Shire of Capel with a significant area of land to be incorporated in the proposed Tuart Park.

3.10 CURRENT MANAGEMENT.

The City of Bunbury currently undertakes significant management within the general Maidens area. This includes:

- firebreak maintenance.
- revegetation where erosion is excessive,
- chemical control of garden weeds on the perimeter,
- some fencing to control access,
- formalising walking trails by signs and closure of some existing tracks, and
- controlled burning.

This level of management is probably not adequate to deal with the increasing pressures from urban development and recreational use of the land, and particularly with increasing pressure from fires.

4. THE PROPOSAL.

4.1 APPROACH TO DEVELOPMENT.

The land considered for development here cannot be examined in isolation, and this CER discusses all of the C70 System 6 area and the land which could be used for a southern corridor across Bunbury. Management of the land also needs to be considered together with any proposals for reservation of land.

4.2 THE PROPOSED DEVELOPMENT.

Vegetation units 1 and 2 have been assessed as having high intrinsic conservation value so that development within them should be discouraged as much as possible. Vegetation units 3 and 4 have a lower conservation value and could be used for development.

Before this conclusion can be applied it is necessary to examine the other major constraint on development of the land.

REQUIREMENT FOR A BUFFER ZONE AROUND THE NO. 2 SEWERAGE TREATMENT PLANT.

The No. 2 sewerage plant is to be upgraded to accept the total sewage discharge from the City of Bunbury, future residential developments in the northern part of the Shire of Capel and possibly flows from existing treatment plants at Eaton and Australind. Currently, the plant is designed to serve a population of 19,000. Prior to the closure of the No. 1 plant in North Bunbury, the No. 2 plant will be upgraded to cater for a population of some 38,000 people.

The Bunbury-Wellington Regional Plan envisages a regional population expansion to between 86,500 and 108,600 people by the year 2011. On these projections, the No. 2 wastewater treatment plant can be expected to expand to cater for a population of about 57,000 or 4 times its current capacity.

The WAWA buffer zone requires that no urban or other sensitive developments occur within 1000 metre of the inner plant boundary of the No. 2 treatment plant facilities. This 1000 metre buffer extends into land that is currently zoned for urban development within Bunbury Town Planning Scheme No. 6.

This environmental study has identified areas which may be suitable for urban development both outside the 1000 metre buffer zone and within the 500 to 1000 metre section of the buffer. The proponent considers that 500 metres represents both the physical limit to urban development and the closest likely approach within which unpleasant odours from the No. 2 treatment plant cannot realistically be excluded.

These potential development areas are considered to have comparatively low environmental values and their development for urban and related purposes will cause only a small reduction in the conservation and environmental values of the site and region.

Delineation of the 1000 metre buffer zone has been achieved by determining the likely extent of strongly smelling odours emanating from the sewerage treatment plant. Since a number of variable factors control the creation and movement of odours, the zone itself is somewhat variable, depending on:

- weather patterns,
- topography,
- vegetation,
- treatment plant design,
- treatment plant operation and maintenance,
- wastewater disposal techniques, and
- variation in sewerage quality.

The first three factors are essentially controlled by the site's existing physical and natural environment and, as such, are a separate issue to the next three factors which are primarily related to the economics of plant design and operation.

The Water Authority has consistently maintained that there should be a 1000 metre buffer zone within which urban development should not proceed. This position is reflected in the Bunbury-Wellington Planning Study where reference is made on page 169 to the buffer zone requirements of the plant. The width of the buffer is dependent upon weather patterns, plant design and operating techniques, amongst others.

The Water Authority will be carrying out further research and computer modelling for the No. 2 treatment plant, to allow the extent of unacceptably high odours to be determined. At present, WAWA do not have sufficient site readings of wind and other climatic factors to allow the model to show the behaviour of odours with any accuracy. Readings are required over a range of weather conditions, particularly summer months, and it may take many months to several years before these figures are fully available.

In summary, urban development close to the No. 2 treatment plant should take account of the following:

- the cost of design and maintenance of the upgraded treatment plant, so as to keep odour levels to below acceptable levels beyond the 1000 metre buffer zone boundary, and possibly to reduce odour levels so that some urban development within the 500 to 1000 metre zone may be possible,

- the economic development of urban land within areas having suitable economic and environmental characteristics so as to allow for urban expansion, together with efficient utilisation of existing infrastructure, and

- accessibility of the beach and recreation areas, together with possible commercial and welfare facilities.

The area within the 500 to 1000 metre section of the buffer zone could be made available on environmental grounds, but it is a question of weighing the economics of an increased cost for sewerage treatment and maintenance in order to reduce the currently applicable 1000 metre buffer.

This CER document raises the possibility of maximising the urban development benefits within environmental constraints when the final design and cost and hence buffer configuration is known.

DISCUSSION OF ALTERNATIVES.

The opportunities and constraints for undertaking the full range of possible activities within the buffer area, from all to no urban development, can be considered under the headings of environmental protection, economic aspects of urban land development, equity considerations for existing residents of south-west Bunbury, and general quality of life issues.

The key issues are:

ENVIRONMENTAL PROTECTION

- Utilisation of land consistent with its environmental values as determined by this study.
- The short and long term benefits to the community of retaining undeveloped bushland areas.
- Access and enjoyment of beach areas in the south west corner of the City of Bunbury.
- Maintenance and enhancement of undeveloped bushland areas.

ECONOMIC DEVELOPMENT OF URBAN LAND

- Efficient use of existing infrastructure.
- The location and convenience of existing facilities such as shops, public transport and other social, welfare and medical services.
- The design of urban subdivision areas and the resulting interaction with retained bushland, along with providing appropriate access to the south Bunbury beach areas.
- Maximising urban development with existing environmental constraints in order to provide an equitable solution that meets community needs for residential land.

EQUITY CONSIDERATIONS FOR THE COMMUNITY

- Provision of access to the south Bunbury beach areas for the large number of residents within the south west corner of the City as well as for future residents in the north west section of the Shire of Capel, as an alternative to the existing high usage Back Beach in central Bunbury.

- Concentration of urban development near existing suburban and city facilities in order to reduce travel distances and gain economic as well as environmental benefits.

QUALITY OF LIFE

- Urban development within an envelope of conservation areas, provision of coastal access and proximity to social, cultural and welfare facilities in order to provide a high "quality of life" to both residents and the general regional community.

- Residential development of suitable land within the Bunbury area creates the financial means, via rates, for the City of Bunbury to provide services to the local and broader community, including environmental management.

Four development options have been considered within the C70 area as part of this study. They are:

OPTION 1. Develop the whole of the currently zoned urban area as presently allowed for with the City of Bunbury's Town Planning Scheme No. 6, together with the land owned by Homeswest.

OPTION 2. Allow urban development within the environmental constraints of the entire area as determined by this study to within 500 metres of the boundary of the No. 2 sewerage treatment plant, together with the land owned by Homeswest which is not included in the proposed Tuart park.

OPTION 3. Allow urban develop within the environmental constraints of the study area as determined by this study to within 1000 metres of the boundary of the No. 2 sewerage treatment plant facilities together with the land owned by Homeswest which is not included in the proposed Tuart park.

OPTION 4. Conserve the entire C70 area and prevent any future development through appropriate zoning.

An assessment of these four options in relation to the four key issues discussed is given here as a matrix of the degree of benefit given:

OPTION	ENVIRONMENTAL BENEFITS	ECONOMIC BENEFITS	EQUITY BENEFITS	QUALITY OF LIFE BENEFITS
1	LOW	HIGH	MEDIUM	MEDIUM
2	MEDIUM TO HIGH	MEDIUM TO HIGH	HIGH	HIGH
3	MEDIUM TO HIGH	MEDIUM	HIGH	HIGH
4	MEDIUM TO HIGH*	LOW	LOW	MEDIUM

* The lower rating base for the City of Bunbury reduces the financial ability of the City to manage all environmental land within its boundaries.

While there is subjectivity inherent in this assessment of benefits, the matrix allows comparison of four complex issues and highlights the most and least advantageous options.

While OPTION 2 is preferred on the basis of the above assessment, its implementation is dependent upon resolving the generation of odours from the No. 2 sewerage treatment plant. This can only be achieved by future successful negotiations between WAWA and the City of Bunbury.

OPTION 3 is the proponent's second preference and, subject to environmental approval being gained, it can proceed immediately with the support of WAWA.

This CER therefore aims at gaining approval for both OPTION 2 and OPTION 3, with implementation of the former option subject to agreement being reached between WAWA and the City of Bunbury over the nature and financing of the No. 2 sewerage treatment plant upgrade.

Accordingly, the development proposed under Option 3 is to leave the majority of the land undisturbed and develop two smaller areas for conventional urban development with full facilities including deep sewerage and one area as a water supply facility. In this way most of the land will be preserved as a conservation park. The development will also be integrated with the use of other land nearby, and in particular the large conserved area will form a link between the Maidens area to the north and other areas owned by the proponent to the east. In this way maximum use will be made of the combined areas to be kept as native vegetation. Under Option 2 a larger area of coastal heath will be developed.

The proposed development of the land is shown in Map 4 (next page), and the integration of this development into the surrounding areas to form a southern corridor is shown in Map 5.

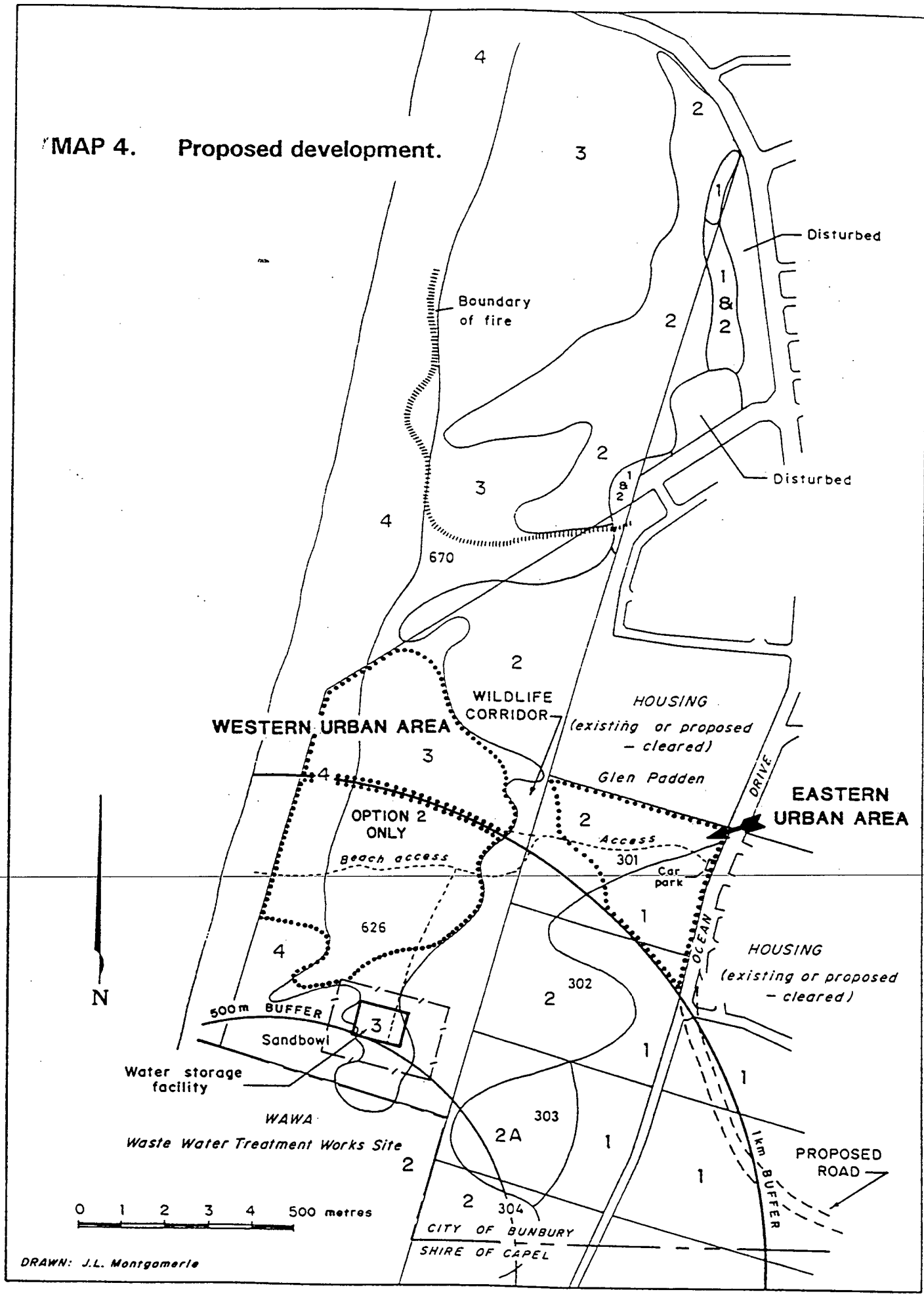
The development has the following components:

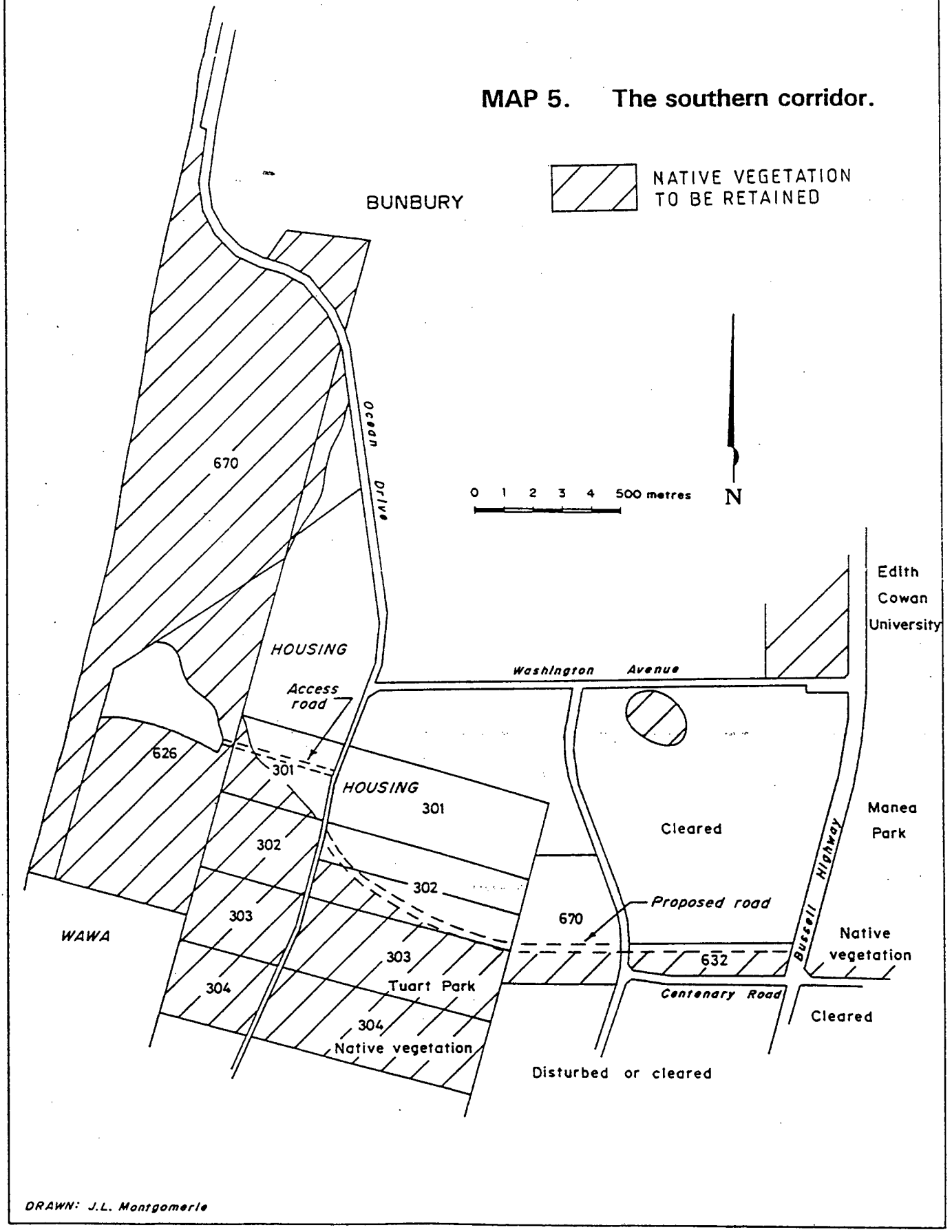
WESTERN URBAN AREA.

This area is mainly in vegetation unit 3 (coastal heath) which is not of high conservation value in its own right. The area proposed for urban development is constrained by the presence of Tuarts on the east, Tuarts and large sand dunes on the north, the coastal setback on the west and the WAWA buffer on the south. This land is flatter than the surrounding dunes, and relatively low-lying so that it will not be visible from further north. It was partly selected from the contours of the land. There is similar topography to the south, but this is within the 1000 metre Water Authority buffer.

This area occupies 12.1 hectares of coastal heath, with an additional 18.8 hectares possibly available under option 2.

This land is within Lot 626 owned by the Bunbury City Council and is part of the System 6 area C70. Its development for urban use is seen as a trade-off for areas of vegetation on another block of Endowment Land (Reserve 670) further east and Lot 632 north of Centenary Avenue owned by the City of Bunbury. These two areas will complete the conservation corridor linking the Maidens to Manea Park, with a minimum width of approximately 100 metres.


MAP 4. Proposed development.
Disturbed
Boundary of fire
Disturbed
670
WILDLIFE CORRIDOR
HOUSING (existing or proposed – cleared)
WESTERN URBAN AREA
Glen Padden
DRIVE
EASTERN URBAN AREA
OPTION 2 ONLY
Access
Beach access
301
Car park
626
OCEAN
HOUSING (existing or proposed – cleared)
302
500m BUFFER
Sandbowl
Water storage facility
WAWA
Waste Water Treatment Works Site
303
2A
1km BUFFER
PROPOSED ROAD
304
CITY OF BUNBURY
SHIRE OF CAPEL
N
0 1 2 3 4 500 metres
DRAWN: J.L. Montgomerie


MAP 5. The southern corridor.
NATIVE VEGETATION TO BE RETAINED
BUNBURY
Ocean Drive
0 1 2 3 4 500 metres
N
670
HOUSING
Access road
626
301
HOUSING
301
302
302
303
303
304
304
WAWA
Tuart Park
Native vegetation
Washington Avenue
Edith Cowan University
Cleared
Manea Park
Proposed road
670
632
Bussell Highway
Native vegetation
Centenary Road
Cleared
Disturbed or cleared
DRAWN: J.L. Montgomerie

WILDLIFE CORRIDOR.

To maintain a wildlife corridor between the Maidens and the southern corridor a strip of vegetation with a minimum width of 100 metres will be left between the two urban areas. Most of this will be Tuart vegetation, and will provide habitat for species requiring the Tuarts.

Where the access road crosses this corridor it will be restricted to two lanes and will have wildlife underpasses constructed beneath it with fences to prevent the fauna entering the road.

EASTERN URBAN AREA.

An area of Tuart on the north-eastern corner adjacent to existing developed areas will be developed on Lot 301 owned by Homeswest. This will be offset by retention of an area of Tuart outside the area considered here on Lot 303 also owned by Homeswest (Map 5). This new area will be part of a Tuart Park which will form part of the conservation corridor linking the Maidens to Manea Park.

This is an area of 8.5 hectares of Tuart vegetation.

Typical views of the two areas proposed for development are given in Plates 1 and 2 (next page).

In total, there will be about 21 hectares, or about 9% of the C70 area, developed for urban use if option 3 proceeds, and some 40 hectares, representing less than 18% of the C70 area, if option 2 proceeds.

WATER SUPPLY FACILITY.

The Bunbury Water Board proposes to build a water supply facility on a high point in the southern end of the area considered here (Map 4). Due to the need for a high point, there is limited scope for moving this facility. The site is 4.5 hectares but only the central 40% will be cleared with the rest remaining as a buffer. The outside walls will also be rehabilitated so that the final cleared area will be 30-35% of the 4.5 hectares. The cleared area will be mainly within vegetation unit 3 with a small area within the edge of the adjacent Tuart unit 2. The buffer will extend into unit 2. The access track will be integrated into other access tracks, and will form part of the firebreak system. This facility will require the clearing of an additional 1.5 hectares of coastal heath.

PLATE 1. A typical view of the proposed western urban area, with the boundary formed by the Tuart woodland.

PLATE 2. A typical view of the eastern urban area.

PROTECTION OF THE MAIDENS.

The Maidens area has been assessed as having high conservation, recreation and other values, and no development is proposed except for appropriate recreation.

Reserve 35020 is seen as part of the Maidens area, but because of its degraded state it is likely to be used more for recreation than conservation.

EAST-WEST CORRIDOR.

A corridor is proposed which links the Maidens, the coastal setback land and the wildlife corridor, the Tuart Park, part of the eastern Endowment Land on Reserve 670, Lot 632 and Manea Park (Map 5).

This corridor will be south of a road required from Ocean Road across to Parade Road to prevent a major road cutting through the Tuart Park south to Capel.

This corridor has clear values for recreation, for aesthetics, and for allowing for the movement of species, and it also protects a complete cross section of the vegetation and landforms from the coast inland to Manea Park.

Management of this corridor will be by the Bunbury City Council and the Shire of Capel, and the implementation requires the agreement of the Shire of Capel and future planning decisions.

MANAGEMENT OF NATURAL LANDS.

There is a clear need for additional management of all the natural lands to stop the present degrading influences and to protect the lands from increasing urban pressure and recreational use. This will require the preparation of appropriate management plans to address fire, weed and feral animal control, access by people, recreational activities, rehabilitation, and related issues.

The Bunbury City Council has made a series of commitments to proper management of conservation and public open space land within the project area:

- establishment of adequately resourced, community-based management committees where appropriate,

- controlling access through the proper design of the subdivision and the sensible siting of roads, tracks and fencing,

- control of exotic plants including weed species by appropriate methods,

- implementation of rehabilitation programs using appropriate erosion control methods and revegetation,

- formulation of a fire management program, incorporating strategic firebreaks, controlled burning and other methods consistent with protecting natural and other values of the area,

- continued use of Council Rangers to assist in law enforcement and education of public use of bush areas, and

- implementation of public consultation programs to assist in educating the public in the correct use, enjoyment and understanding of conservation and public open space land.

Appropriate planning of the development is also required. For example, in both of the urban developments proposed here and in other areas to the south east there will be house blocks backing onto the native vegetation areas. This will limit access to the land and direct access to selected points. Local experience has shown that areas which have restricted access by having houses backing onto them have better quality vegetation than areas with unrestricted access.

OTHER USES OF THE LAND.

Within the balance of Lot 626 there would be minor developments such as an upgraded access road to the beach to replace the present informal four wheel drive track, and limited recreational facilities. These will be essentially within vegetation units 3 and 4 and are seen as compatible with the System 6 recommendation.

MANAGEMENT OF THE SANDBOWL.

The possibility of flattening and revegetating the Sandbowl was considered, thus extending southwards the land potentially suitable for urban development. This was rejected because it would impact on existing recreational users and WAWA. There will be active management of the Sandbowl, either to revegetate the area or manage it as a recreational area with the involvement of off-road vehicle users. The future of this land is uncertain, and this is discussed in Section 6.6.

NATIVE TREES WITHIN URBAN AREAS.

Where possible native trees (Banksias, Peppermints and the few Jarrahs) will be retained within urban areas, but this will not include the Tuarts because of the significant safety risk from falling limbs.

4.3 NEED FOR THE PROPOSAL.

The owners of the land accept that much of it needs to be conserved as native vegetation, and that the conserved areas require active management. The development proposed here is seen as giving the necessary balance between conserving the area in accordance with the System 6 recommendation and other regional planning considerations, and deriving an income from development of the land. Without any development there will be no income from the land and more limited opportunities for providing the greater degree of management which the land requires to maintain and enhance its conservation values.

The areas proposed here for urban development are small and will not destroy any of the conservation values attributable to the land.

The present development also requires that final decisions be made on the development and management of all land in the area. Previous planning studies have made general proposals, but no specific actions have been taken. Without these decisions the possibility of conserving a continuous strip of vegetation may be lost through other actions and lack of management of the lands. Lot 632 north of Centenary Avenue for example is in need of rehabilitation work if it is to remain as a potential part of a corridor linking the Maidens area with Manea Park.

Without active management of fires and other factors, the native vegetation areas discussed here will continue to degrade and will lose some of their conservation values. An integrated plan for the System 6 area, the Tuart Park, Manea Park and the linkages is seen as an essential part of the proposed development.

5. PUBLIC CONSULTATION.

It is intended to invite public consultation on the Consultative Environmental Review report during the advertising period for submissions.

A display will be located at the City of Bunbury Administration Office entrance foyer and a public consultative meeting will be held during the advertising period to outline the assessment process and respond to enquiries.

In addition, the proponents will circulate copies of the report to interested groups and individuals and make relevant information available for perusal.

6. IMPACTS AND MANAGEMENT.

6.1 ALTERNATIVES.

The alternatives considered have been described in the introduction to the proposed development because it was not possible to explain the proposed development without having considered the alternatives.

The opportunities and constraints presented by the four options can be summarised as

1. Develop the majority of the land in line with previous proposals.

Opportunities: This would meet coastal setback and other planning requirements.

Constraints: This would not achieve the aim of the System 6 recommendation and would not comply with the current 1km buffer around the waste water treatment plant.

2. Develop part of the land in accordance with the conservation values of the land and local and regional planning considerations, and take the opportunity to integrate the development with surrounding areas. This represents both options 2 and 3 and is dependent on the final outcome of the position of the buffer around the wastewater treatment plant.

Opportunities: This achieves a high degree of protection of the conservation value of all the lands in the area, and all conservation and planning goals are met or exceeded.

Constraints: There will be only limited income to the proponents.

3. Abandon urban development of the area. This represents option 4.

Opportunities: There will be complete protection of all of the System 6 area.

Constraints: There will be no income to the proponents and this would probably lead to less active management of the land considered here or the surrounding land. In the medium to long term this could be disastrous for the quality of the conserved areas, particularly as the surrounding area becomes urbanised. The future of the corridor from the Maidens to Manea Park is not guaranteed.

Option 1 was rejected as inappropriate. Option 4 was rejected as not achieving the dual aims of appropriate urban development and conservation.

Option 2 was chosen as the most appropriate but cannot be implemented at this stage. Option 3 is the second choice but can be implemented immediately without compromising option 2. Options 2 and 3 are the basis of the proposed development, with Option 3 to proceed once environmental approvals are obtained and option 2 only if a reduced buffer around the wastewater treatment plant can be agreed upon.

The Maidens area has not been considered as a potential development site except for recreation.

6.2 LAND USE.

The proposed development will result in the zoning of small areas as urban residential, while the remainder will be protected with a zoning allowing for conservation and appropriate recreational use. This protection will be extended to all of the coastal vegetation, the corridor extending south from the Maidens as well as the corridor linking these areas to Manea Park.

This zoning meets all of the conservation and planning proposals which impinge on the area, including the System 6 recommendation, the Bunbury Coastal Plan, the Usher, Gelorup and Dalyellup District Structure Plan and the Bunbury-Wellington Region Plan.

This proposal will also see the corridor from the Maidens to Manea Park protected, in accordance with public interest which has been expressed.

6.3 COASTAL SETBACK.

The proposed coastal setback is the existing edge of Lot 626, which is approximately 130 metres from the coast.

A distance of 100 metres separating the seaward edge of permanent vegetation from the seaward edge of urban development would normally be acceptable, based on many factors, as outlined in the draft Bunbury Coastal Plan (DPUD 1993), including the actual topography, vegetation and its conservation value, shoreline stability, dune stability, soil development, existing land use and proposed adjoining uses, current and potential demand for recreational activity, heritage features, access, public attitudes and management objectives.

The topography of the coastal zone is steep with undulating dunes reaching as high as 21 metres, but averaging between 10 and 15 metres in height. As well, the diversity of dune topography is greatest in this 100 metre wide zone, with the dunes generally flattening out further inland.

Vegetation is well established over most sections of the proposed setback zone. It consists of commonly occurring plant species and has only a low intrinsic conservation value, although the function that it performs in stabilising the dunes is of great importance.

The shoreline stability of this section of coastline is high. As stated in the draft Bunbury Coastal Plan, the "stability of vegetation line from 1941 to 1987 indicates supply of sediment to foreshore has remained constant". Figure 3 of that report shows that this section of shoreline is "stable".

Dune stability is also high, with only one major existing breach in the frontal dune system at the Sandbowl. Elsewhere, there are minor areas of bare or poorly vegetated sand but the dunes themselves have remained stable. Appropriate management of the dune systems within the setback zone will ensure long-term stability.

Soil development is poor throughout and further inland for several hundred metres. This is consistent with the geologically young nature of the dune system and with the poorer nature of the siliceous and calcareous sands in the dunes. As clay and organic matter accumulated beneath vegetation, there is a tendency for them to be leached downwards towards the water table, thus slowing down the rate at which soil develops.

The setback is considered appropriate for the existing land use (low key recreation) and for proposed adjoining uses (urban development with controlled access through the dunes to the beach). Bunbury City Council has no plans for placing high usage facilities within the setback zone that could cause unacceptably high impacts from excessive usage of the zone.

Current demand for recreational activities away from the beach is low and consistent with the proposed setback zone. Future recreational use will be at a higher level, but facilities such as car parks, walkways and stairways to the beach will be carefully planned and installed so as to ensure a low level of recreational impact.

No heritage features of natural or cultural value are known from the proposed setback zone.

Bunbury City Council will provide suitable access from the urban area through the dunes to the beach.

There is an existing setback width of less than 50 metres for most older urban areas from Hastie Street northwards.

The proponents believe that a 130 metre setback zone is more than adequate for the long-term management needs of the zone itself and adjoining urban and associated areas.

In fact, a 100 metre width would be consistent with past studies. The Usher-Stratham Environmental Study (Tingay and Associates 1991) states in Section 3.2.2 that, "development should be separated from the coast by a foreshore reserve designed to protect views of the coast with a set back of 100m from the line of permanent vegetation as a guideline for the width of such a reserve". The Country Coastal Planning Policy No. DC 6.1 (State Planning Commission, undated) suggests that, "a setback of 100 metres should be regarded as a guideline for a wind erosion buffer and for public recreation purposes where landforms are stable. Setbacks will be greater where there is evidence of coastal recession and where landforms are unstable".

Since the landforms are stable in the project area and since there is no evidence of coastal recession, a 130 metre setback distance is easily consistent with the Commission's recommendations.

Further support for the suitability of only a 100 metre setback distance is found in the DPUD report on Coastal Reserves and Building Setbacks within Geographe Bay (DPUD 1992). For most of the 30 kilometre section of coast studied, a setback distance of 100 metres or less is generally favoured. This is in spite of the dune systems within this portion of Geographe Bay coast containing much smaller volumes of sand and hence being a much less effective buffer to erosion during severe storm events.

For example, most of the Shire of Busselton's coastal dune system attains heights of less than 5 metres. By contrast, dunes within this study area average 10 to 15 metres, suggesting a contained volume of sand some 4 to 8 times greater than dunes further south. This much greater volume provides a significant increase in the ability of the dunes to withstand erosive forces before erosion extends inland beyond the inner edge of even the 100 metre setback zone.

6.4 HYDROLOGY.

There will be no surface flows of water except local drainage within the urban areas. Development of two urban areas within the study area will have various impacts on groundwater beneath the site.

Impacts on Groundwater Quantities.

As stated in Section 3.5, there are several aquifers underlying the coastal dune system. The shallowest aquifer occurs within the high permeability dunes. However, the elevation above sea level of the proposed western urban area (between 20 and 30 metres) suggests that domestic bores here will be deeper and more expensive to construct than in most other parts of Bunbury. Only a few bores are expected to be installed in this area.

Within the eastern urban area, the depth to groundwater will be much shallower, probably less than 10 metres. More home owners are likely to install bores, suggesting that there may be a moderate groundwater extraction rate there.

Deeper aquifers within the study area (within the Tamala Limestone and Leederville Formation) are unlikely to be drawn upon by domestic users, because of the cost of installing bores a further 10 to 30 metres in depth.

Should the City of Bunbury wish to install a high capacity bore for servicing playing fields or similar, they would require a license from the Water Authority of W.A., who would ensure that water extraction rates did not exceed the sustainable yield of the affected aquifer.

Counteracting the extraction of groundwater by domestic users would be an increase in water entering the groundwater due to urban development. Removal of natural vegetation invariably leads to a larger percentage of rainfall entering the groundwater, and water tables rise as a consequence of this.

Such a rise in shallow groundwater is unlikely to have a marked physical effect on the urban or surrounding areas. The thickness of high porosity sand beneath both urban development sites is such that an increase in water table of one or more metres is not expected to result in surface water levels in low-lying sections of the study rising by more than a few centimetres.

Similarly, should there be an increase in water flow laterally, the overall rises in adjacent groundwater or surface water levels would be minimal. The surrounding urban areas are themselves built on highly porous quartz sands and the overall impact of urbanisation on groundwater volumes is predicted to be of no consequence.

Under a worst case scenario, larger volumes of surface water may flow into the wetland chain that runs down the eastern side of the Quindalup dune system. In Perth, urbanisation surrounding formerly seasonally wetlands such as Lake Claremont has turned them into permanently wet areas. However, large areas of bushland will be present within and adjacent to the project area and any rise in surface water levels will only cause the wetland chain to flow a little more strongly over the winter and spring periods.

Impacts on Groundwater Quality.

Urbanisation can have noticeable impacts on the quality of groundwater beneath. Although the proposed urban sites within the project area will be deep sewered, nutrients from lawns and gardens and heavy metals and organic compounds from road surfaces and illegal or accidental sources will reduce groundwater quality.

These impacts are unlikely to be of concern.

Soils that are high in limestone (calcium carbonate) have a moderately high capacity to react with phosphorous present within groundwater and precipitate out insoluble calcium phosphate compounds (for example, see Lance 1977). Studies in Perth (Gerritse et al. 1990) have found that, even in long established suburban areas, groundwater quality exceeds drinking water standards.

Processes that operate to maintain high water quality include denitrification and death of pathogens when more than 2 metres of unsaturated sand is present beneath a site. Volatile organics appear to be in diffusional equilibrium with levels in the urban atmosphere, while heavy metals are largely absorbed onto soil particles.

Overall, urban development of the two small sites within the project area is expected to have minimal adverse impacts on groundwater quality.

6.5 CONSERVATION VALUES.

The proposed urban development under Option 3 will result in the loss of approximately 8.5 hectares of Tuart vegetation and 12.1 hectares of coastal heath, as well as 1.5 hectares of coastal heath for the water storage facility, from the System 6 area. This will be compensated by conserving a larger area of similar Tuart vegetation along the southern edge of the City of Bunbury and in the Shire of Capel in the Tuart Park, and other areas which are vegetated with Tuart over Banksia in good condition and a small wetland. These other areas have an increased value because together they form a corridor between the Maidens and Manea Park, the two largest areas of native vegetation remaining in the southern part of Bunbury. Option 2 would remove an additional 18.8 hectares of coastal heath.

The most important conservation values identified in the Tuart vegetation are as habitat for the Ringtail Possum and as a chance to conserve Tuart woodland with a reasonably intact understorey which is otherwise scarce regionally. The coastal heath has no specific high conservation values, and its main value is as part of the larger area of intact native vegetation.

There will be no net loss of conservation values because the land to be developed will be replaced by land with the same or higher values and which will be protected from development. In addition the present development will require the preparation of a comprehensive management plan for all conserved areas. This would include fire, weed and feral animal control, access control, rehabilitation, and deliberate management to maximise the conservation values of the land such as the presence of rare species.

The large coastal dunes are seen as having value in their own right and have not been considered for development.

No significant conservation values will be destroyed by the proposed development.

6.6 RECREATION.

The major existing recreational activities on the land will not be prevented and more appropriate facilities for them will be provided.

The existing beach access will be improved, with a car park and other facilities which provide for access without causing degradation of the area. Degradation is likely to result if the present uncontrolled vehicle use were to increase along the sandy access track and parking area close to the beach.

Passive recreation such as walking and running, nature observation and cycling would be compatible with the conservation purpose of the land, and would be encouraged by providing appropriate paths and access. These paths would encourage access but prevent the physical disturbance of the vegetation.

Both the upgraded beach access and smaller paths could be integrated into the network of firebreaks which will be required, to minimise any additional clearing.

THE SANDBOWL.

The Sandbowl occupies an area of about 6 hectares and is an unvegetated section of the coastal dune system that extends inland from the frontal dune for almost 500 metres. Due to the action of strong westerly winds, it continues to move inland, enveloping native vegetation as it proceeds. Despite its appearance, its rate of progress inland is very slow and likely to be less than one metre per year.

While the leading edge of this moving dune is causing a loss of vegetation types 2 and 3 (scattered tuart woodland and coastal heath), this process of sand being blown from the beach to form large dunes is entirely natural. Without this process having operated in the past, the topographic features of "the Maidens" and much of Bunbury's elevated coastal country would not exist.

At present, the Sandbowl is entirely located within the one kilometre buffer zone that surrounds the WAWA sewerage treatment plant. It is therefore unlikely to be required for any use other than recreation or wastewater infiltration ponds while this buffer zone remains in force.

Approximately one third of the Sandbowl falls within the Shire of Capel and is owned by the Water Authority of W.A. Discussions with WAWA staff have revealed that the Authority intends to construct a wastewater infiltration pond within the bare sand centre of the Sandbowl and dispose of treated water from the Number 2 treatment plant immediately to the south. WAWA also intends to open discussions with Bunbury City Council with the aim of purchasing the section of the Sandbowl within Bunbury. This will then make it easier to undertake the proposed wastewater treatment.

The present uncontrolled use of the Sandbowl is causing damage. Continued inappropriate use of the Sandbowl will have two potential impacts. Firstly, stabilisation of the moving sand by vegetation establishment will be reduced since vehicles, horses and heavy foot traffic can damage coastal vegetation. Secondly, damage to existing vegetation may increase the amount of sand moving inland. While the rate of inland movement is not likely to increase due to human impacts, the area of moving sand can grow quite significantly.

There appear to be five options open to the Bunbury City Council when considering the future of that section of the Sandbowl within its boundaries:

1. Do nothing and allow continued four wheel drive and other usage of the site, so that more vegetation is lost and dune advance eastwards continues.

2. Ban all impact human activities within the site, with dune stabilisation and associated works being funded out of ratepayer contributions.

3. Allow continued but restricted use of the site, on the condition that all users become involved in the preparation and implementation of management plans for the site.

4. Approach WAWA with a view to achieving a cost sharing arrangement for management of the whole of the Sandbowl incorporating one of the above 3 options.

5. Offer the land containing their section of the Sandbowl to WAWA for incorporation into the Number 2 Treatment Plant's buffer zone and thus allowing the Sandbowl to be used for WAWA's preferred use of a wastewater infiltration area.

The Bunbury City Council favours two options at present: either options 3 and 4 in combination or option 5 in isolation.

Options 3 and 4 combined:

On a trial basis, the Council is prepared to adopt options 3 and 4 in combination in an attempt to have those sections of the community using the site accept some responsibility for their usage.

Accordingly, after holding mutually satisfactory negotiations with WAWA, the Council proposes to request the Four Wheel Drive Club of Bunbury and other existing or potential users of the site to be formally and actively involved in management of the Sandbowl. The priorities for management include:

- rationalisation of the existing network of tracks so that only one track leads into the site and one track leads out,

- rehabilitation by appropriate methods of tracks no longer required, as determined by the rationalisation study,

- determining what sections of the Sandbowl are the source of sand that is picked up by the wind and moved inland,

- brush matting, revegetation and the use of other techniques to stabilise those sand source areas.

- fencing off all places where vehicular and pedestrian access is not allowed,

- erection of Council-supplied signs,

- assistance in community education of responsible use of the Sandbowl and other coastal dune areas, and

- assistance in the enforcement of Council regulations controlling vehicle and other use of the Sandbowl through training and the appointment of honorary rangers.

These actions will result in some sections of the Sandbowl being closed to vehicle use and revegetated, other areas will have vehicles confined to small areas only, and the remaining robust sections will remain open to responsible use.

The Council will organise fence erection and revegetation days on site, to which volunteers from user groups and the broader community will be invited. The success of these and other community involvement activities will largely determine whether part of the Sandbowl is retained for four-wheel drive use or not.

Council will seek to gain the support of the Shire of Capel for this community management program. Both local authorities and WAWA may then need to gazette the site under legislation controlling the use of off-road vehicles on Crown land.

The Council does not envisage turning all four-wheel drive users of the site into voluntary rangers so that enforcement of regulations can be achieved. Instead, the Council is seeking to establish a sense of ownership over and responsibility for the Sandbowl by those members of the community who wish to use it.

After training provided by the Council, a small number of appropriate people may be made Honorary Rangers with powers to assist in vehicle, animal and pedestrian use of the Sandbowl. Clear instructions will be given that the pursuit of offenders will not be encouraged: the tasks of these Rangers will be to educate Sandbowl users who willingly stop when approached and to advise Council staff of illegal activities in those situations when offenders will not stop.

Clearly, the implementation of this option will require detailed discussion between Council staff and affected users of the Sandbowl. If it is not possible to achieve an agreement between all parties such that the management actions stated above can be achieved, then the Council will adopt option 2: the complete closure of the Sandbowl to all users.

Option 5:

Bunbury City Council has not yet commenced negotiations with the WAWA about the possible sale of their portion of the Sandbowl to WAWA. The advantages of adopting this option are that the Bunbury City Council is recompensed for the sale of the land, all management actions become the responsibility of a single body (WAWA), and WAWA are able to pursue their plans to use the Sandbowl for waste water infiltration.

Since this option may have implications for future uses of land adjoining or within several hundred metres of the Sandbowl, this option will require careful investigation before the Council supports it.

As well, the Council is conscious of the recreational usage of the Sandbowl by four-wheel drive users and, since many of these users are residents and ratepayers of Bunbury, it is appropriate that the Council seeks their views before deciding whether to fully accept this option.

The Council has also made commitments including having community-based management committees for open space areas.

6.7 CUMULATIVE IMPACTS.

Most areas of native vegetation in the southern Bunbury area have been cleared for urban development, and the remaining areas are suffering increasing degradation due to too frequent fires, physical disturbance, rubbish dumping, weed invasion, fragmentation, dieback and other influences. The cumulative effect of these impacts is to degrade the conservation values of the land. The only way that these cumulative impacts can be controlled is by firstly designating appropriate conservation areas as part of the planning process, and secondly by actively managing these areas so that the conservation values are maintained.

Bunbury is well supplied with public open space areas, some with native vegetation, but the proposal described here and associated management plans is seen as an excellent opportunity to limit these cumulative impacts in the south Bunbury area and to improve the management of the areas which are to be retained for their natural conservation values.

6.8 MANAGEMENT.

The management responsibility for the conservation areas discussed here would rest with the City of Bunbury. These responsibilities would extend to:

- Preparation of detailed management plans for all of the area including the Maidens and the corridor discussed here from the coast to Manea Park. The issues which need to be addressed have been discussed above. The single most important issue is seen as managing fire because this has the potential to rapidly degrade the ecological values of the land.

- Progressive implementation of the management plans as resources permit.

- Rehabilitation of some areas, particularly the disturbed areas within the Maidens and two areas on either end of Lot 632 north of Centenary Avenue. This rehabilitation would be seen as an integral part of the management plan. This rehabilitation would require primarily weed control, seeding and replanting with local species, feral animal control, pedestrian movement control, and fire control.

- The encouragement of the formation and involvement of local interest and support groups who could provide input, education, people, resources and support which would never be available solely from paid Council officers or commercially.

The operational management of the proposed urban developments will be the responsibility of the proponents (Bunbury City Council and Homeswest). Both have extensive experience locally and any minor problems such as dust and noise will be handled by conventional means. Environmental management will extend to such things as control of sand spill into adjacent areas.

7. COMMITMENTS.

The commitments made in this CER are listed here and numbered, along with the agency responsible for carrying out the work and the regulatory authority.

1. Commitment: The subdivisions will be deep sewered.

   Responsibility for action: Proponents.

   Regulatory authority: WAWA.

2. Commitment: A wildlife corridor of 100 metres will be included to provide a continuous habitat with Tuart trees between the Maidens and the Tuart park.

   Responsibility for action: Proponents.

   Regulatory authority: EPA.

3. Commitment: The areas to be cleared will be compensated for by preserving other areas of native vegetation.

   Responsibility for action: Proponents.

   Regulatory authority: DPUD.

4. Commitment: The access road to the western urban area will be fenced and have wildlife underpasses.

   Responsibility for action: Proponents.

   Regulatory authority: EPA.

5. Commitment: The Maidens area will be protected from all development.

   Responsibility for action: Proponents.

   Regulatory authority: DPUD.

6. Commitment: The areas of native vegetation which will be preserved will form a continuous corridor between the Maidens and Manea Park.

   Responsibility for action: Proponents.

   Regulatory authority: DPUD.

7. Commitment: All natural lands will be managed for the protection of conservation and open space values by:

- the establishment of adequately resourced, community-based management committees where appropriate,

- controlling access through the proper design of the subdivision and the sensible siting of roads, tracks and fencing,

- the control of exotic plants including weed species by appropriate methods,

- the implementation of rehabilitation programs using appropriate erosion control methods and revegetation,

- the formulation of a fire management program, incorporating strategic firebreaks, controlled burning and other methods consistent with protecting natural and other values of the area,

- the continued use of Council Rangers to assist in law enforcement and education of public use of bush areas, and

- the implementation of public consultation programs to assist in educating the public in the correct use, enjoyment and understanding of conservation and public open space land.

Responsibility for action: Proponents.

Regulatory authority: EPA.

8. Commitment: The management of all areas of native vegetation will be integrated and will be achieved by the adoption of formal management plans. The Bunbury City Council will accept responsibility for these lands. In particular a comprehensive management plan listing the management required and priorities in implementation will be prepared for the Maidens area and the east west corridor to Manea Park.

Responsibility for action: Proponents.

Regulatory authority: EPA.

9. Commitment: There will be rehabilitation of some areas, particularly the disturbed areas within the Maidens and two areas on either end of Lot 632 north of Centenary Avenue. This rehabilitation would be seen as an integral part of the management plan.

   Responsibility for action: Proponents.

   Regulatory authority: EPA.

10. Commitment: Access to native vegetation areas will be controlled by designing the subdivisions so that house lots back onto areas of native vegetation.

    Responsibility for action: Proponents.

    Regulatory authority: Proponents.

11. Commitment: Public access to the beach will be upgraded and suitable facilities will be constructed to allow appropriate use of the area.

    Responsibility for action: Proponents.

    Regulatory authority: DPUD.

12. Commitment: Appropriate recreational use of the areas of native vegetation will be promoted and suitable facilities will be developed.

    Responsibility for action: Proponents.

    Regulatory authority: Proponents.

13. Commitment: The existing appropriate recreational use of the Sandbowl area will be encouraged if users become involved in management of the site and a suitable agreement can be reached with the Shire of Capel.

    Responsibility for action: Proponents.

    Regulatory authority: Proponents.

14. Commitment: Native trees will be retained within the urban areas as far as possible, except for Tuarts because of the safety risk.

    Responsibility for action: Proponents.

    Regulatory authority: Proponents.

15. Commitment: There will be a coastal setback of 130 metres.

    Responsibility for action: Proponents.

    Regulatory authority: DPUD.

16. Commitment: The proponents will control any environmental impacts during construction by using standard techniques. Possible impacts are noise, lights, dust and sand spill.

    Responsibility for action: Proponents.

    Regulatory authority: Proponents.

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PROPOSED STRUCTURE PLAN, REZONING AND SUBDIVISION FOR BUNBURY ENDOWMENT LAND - PART LOT 670 GEOGRAPHE WAY, WEST WITHERS, CITY OF BUNBURY

CONSULTATIVE ENVIRONMENTAL REVIEW GUIDELINES

Overview

In Western Australia all environmental reviews are about protecting the environment. The fundamental requirement is for the proponent to describe what they propose to do, to discuss the potential environmental impacts of the proposal, and then to describe how those environmental impacts are going to be managed so that the environment is protected.

If the proponent can demonstrate that the environment will be protected then the proposal will be found environmentally acceptable; if the proponent cannot show that the environment would be protected then the Environmental Protection Authority (EPA) would recommend against the proposal.

Throughout the process it is the aim of the EPA to advise and assist the proponent to improve or modify the proposal in such a way that the environment is protected. Nonetheless, the environmental review in Western Australia is proponent driven, and it is up to the proponent to identify the potential environmental impacts and design and implement proposals which protect the environment.

For this proposal, protecting the environment means that the natural and social values associated with the System 6 recommendation for the 'South Bunbury Coastal Land' (Recommendation C70) are protected. Where they cannot be protected, proposals to mitigate the impacts are required.

Purpose of a Consultative Environmental Review

The primary function of a CER is to provide the basis for the EPA to provide advice to Government on protecting the environment. An additional function is to communicate clearly with the public so that the EPA can obtain informed public comment. As such, environmental impact assessment is quite deliberately a public process. The CER should set out the series of decisions taken to develop this proposal at this place and time and why.

Objectives of the review

The Consultative Environmental Review should have the following objectives:

- to place this project in the context of the regional environment and the progressive development of resources in the region, including the cumulative impact of this development;
- to explain the issues and decisions which led to the choice of this project at this place at this time;
- to set out the environmental impacts that the project may have; and
- for each impact, to describe any environmental management steps the proponent believes would avoid, mitigate or ameliorate that impact.

The CER should focus on the major issues for the area and anticipate the questions that members of the public will raise. Data describing the environment should be directly related to the discussion of the potential impacts of the proposal. Both should then relate directly to the

actions proposed to manage those impacts.

Key issues

The critical issue for the proposal is likely to be the management of attractive and important features such as the coastal dunes and 'The Maidens', and important stands of tuart (*Eucalyptus gomphocephala*) forest. It is critical therefore that the CER shows a detailed understanding of conservation, landscape and social values in the area, and whether they are represented elsewhere. The conservation values of areas to be disturbed should be examined in detail. Any proposals the proponent has with respect to the potential locations of development zones and zones for conservation should be indicated clearly in relation to landscape contours and specific landscape features.

The key issues for this project should be clearly identified and the content of succeeding sections determined by their relevance to these issues.

In this case the key issues should include:

- the reasons for selection of the preferred subdivision site and the alternatives considered;

- flora, fauna and ecosystems:
  - land units and their secure representation elsewhere;
  - rare and poorly known flora, fauna and communities, shown on distribution maps;
  - inter-relationships of the biota and environment;

- coastal management:
  - set backs from foreshore areas;
  - dune stability and landscape protection;
  - management of remnant vegetation;
  - management of public access;

- buffer protection from the Water Authority of Western Australia facility which includes, potentially expanded waste water treatment plant, proposed water treatment plant, proposed septage treatment plant;
  - establishment of the odour and risks buffers from this facility in consultation with the Water Authority of Western Australia;

- water supply, zones of influence, impacts on flora, fauna and plant communities in the region and impacts on other users;
  - protection of superficial groundwater quantity and quality;
  - maintenance of surface water drainage patterns particularly overland flow;
  - management of sewage and waste water treatment;

- operational management issues:
  - dust and noise control;
  - management of the subdivision area and its interaction with conservation reserves, including rehabilitation of 'The Maidens';
  - feral fauna, weed, access and fire control for lands reserved for conservation purposes;

plus any other key issues raised during the preparation of the report.

Public participation and consultation

A description should be provided of the public participation and consultation activities undertaken by the proponent in preparing the CER. It should describe the activities undertaken, the dates, the groups and individuals involved and the objectives of the activities. Cross reference should be made with the description of environmental management for the proposal which should clearly indicate how community concerns have been addressed. Where these

concerns are dealt with via other departments or procedures, outside the EPA process, these can be noted and referenced here.

Detailed list of environmental commitments

The commitments being made by the proponent to protect the environment should be clearly defined and separately listed. Where an environmental problem has the potential to occur, there should be a commitment to rectify it. They should be numbered and take the form of:

a who will do the work;

b what the work is;

c when the work will be carried out; and

d to whose satisfaction the work will be carried out.

- All actionable and auditable commitments made in the body of the document should be numbered and summarised in this list.

APPENDIX 2. LIST OF THE FLORA.

All species recorded are listed by vegetation unit, with common names where they are available (largely following Bennett 1991).

The vegetation units are:

1. Tuart woodland and forest over Peppermint, Banksia and Jarrah.
2. Tuart woodland over Peppermints and heath.
3. Coastal heath on stable dunes.
4. Coastal heath on primary dunes.

Introduced species are identified by an asterisk (*).

Species	Common Name	Vegetation 1	2	3	4
NON FLOWERING VASCULAR PLANTS					
ZAMIACEAE					
Macrozamia riedlei	Zamia	+			
FLOWERING PLANTS					
AIZOACEAE					
Carpobrotus virescens	Coastal Pigface	+	+	+	+
Tetragonia decumbens	Sea Spinach				+
AMARANTHACEAE					
Ptilotus stirlingii		+			
ANTHERICACEAE					
Arnocrinum preissii		+			
Corynotheca micrantha		+	+		
Sowerbaea laxiflora	Purple Tassels	+			
Thysanotus arenarius	A Fringe Lily	+	+		
Tricoryne elatior	Yellow Autumn Lily	+	+	+	
APIACEAE					
Eryngium rostratum	Blue Devil	+	+		
APOCYNACEAE					
Alyxia buxifolia	Camel Bush		+	+	
ASPHODELACEAE					
*Trachyandra divaricata	Onion Weed		+	+	
ASTERACEAE					
*Arctotheca populifolia	Dune Capeweed				+
Asteridea pulverulenta	Common Bristle Daisy	+	+	+	
*Carduus tenuiflorus	Slender thistle	+			
Helichrysum cordatum	Tangle Daisy	+			
*Hypochaeris glabra	Smooth Catsear	+	+		
Olearia axillaris	Coastal Daisybush	+	+	+	+
Senecio lautus	Coastal Groundsel		+	+	
*Sonchus oleracea	Common Sowthistle	+	+		
BRASSICACEAE					
*Cakile maritima	Sea Rocket				+
CARYOPHYLLACEAE					
*Petrorhagia velutina	Velvet Pink	+	+		

Species	Common Name	Vegetation 1	2	3	4
CHENOPODIACEAE					
Rhagodia baccata	Berry Saltbush	+	+	+	+
CYPERACEAE					
Gahnia trifida	Coast Saw-sedge		+		
Isolepis nodosa	Knotted Club-rush			+	
Lepidosperma gladiatum	Coast Saw-sedge	+	+		+
Lepidosperma sp. B		+	+	+	
Lepidosperma sp.			+		
Schoenus grandiflorus	Large Flowered Bogrush	+	+	+	
DASYPOGONACEAE					
Acanthocarpus preissii		+	+	+	+
DILLENIACEAE					
Hibbertia cuneiformis	Cutleaf Hibbertia	+	+	+	
Hibbertia hypericoides	Yellow Buttercups	+			
Hibbertia racemosa	Stalked Guinea Flower	+			
EPACRIDACEAE					
Conostephium preissii				+	
Leucopogon sp.		+		+	
EUPHORBIACEAE					
Beyeria sp.		+			
Phyllanthus calycinus	False Boronia	+	+	+	
FABACEAE (PAPILIONACEAE)					
Bossiaea eriocarpa	Common Brown Pea	+	+		
Chorizema diversifolium			+		
Daviesia divaricata	Marno	+			
Gompholobium tomentosum	Hairy Yellow Pea	+	+		
Hardenbergia comptoniana	Native Wisteria	+	+	+	+
Hovea trisperma	Common Hovea	+			
Jacksonia furcellata	Grey Stinkwood	+	+	+	+
Jacksonia sternbergiana	Stinkwood	+			
Kennedia coccinea	Coral Vine		+		
Kennedia prostrata	Running Postman	+		+	
*Lupinus cosentinii	Sandplain Lupin	+			
*Medicago sp.		+			
*Melilotus indica	King Island Melilot	+		+	
Templetonia retusa	Cockies Tongues	+	+		
*Trifolium campestre	Hop Clover		+		
*Vicia sativa	Common Vetch	+			

Species	Common Name	Vegetation 1	2	3	4
GERANIACEAE					
Geranium solanderi		+	+		
*Pelargonium capitatum	Rose Pelargonium	+		+	+
Pelargonium littorale		+		+	
GOODENIACEAE					
Scaevola anchusifolia			+	+	
Scaevola crassifolia		+		+	+
Scaevola nitida		+		+	
HAEMODORACEAE					
Conostylis aculeata	Prickly Conostylis	+	+	+	
IRIDACEA					
*Romulea rosea	Guildford Grass		+		
LAMIACEAE					
Hemiandra pungens	Snake Bush		+	+	+
LAURACEAE					
Cassytha racemosa	Dodder Laurel	+	+	+	+
LOBELIACEAE					
Lobelia tenuior	Slender Lobelia	+	+		
LOGANIACEAE					
Logania vaginalis	White Spray		+		
LORANTHACEAE					
Nuytsia floribunda	Christmas Tree		+		
MIMOSACEAE					
Acacia cochlearis	Rigid Wattle	+	+	+	+
Acacia lasiocarpa	Panjang		+		
Acacia pulchella	Prickly Moses	+			
Acacia saligna	Orange Wattle	+	+	+	
Acacia willdenowiana	Grass Wattle	+			
MYOPORACEAE					
Eremophila glabra	Tar Bush	+			
Myoporum caprarioides	Slender Myoporum		+		
MYRTACEAE					
Agonis flexuosa	Peppermint	+	+	+	+
Eucalyptus gomphocephala	Tuart	+	+		
Eucalyptus marginata	Jarrah	+			

Species	Common Name	Vegetation 1	2	3	4
ORCHIDACEAE					
Pterostylis sp.			+		
OROBANCHACEAE					
*Orobanche minor	Lesser Broomrape	+	+		
OXALIDACEAE					
*Oxalis pes-caprae	Soursob	+	+		
PHORMIACEAE					
Dianella divaricata	Flax Lily	+	+		
POACEAE					
Agropyron scabrum	Common Wheatgrass	+	+		
*Ammophila arenaria	Marram Grass				+
*Avena sp.	Wild Oats	+	+	+	
*Briza maxima	Blowfly Grass	+	+		
*Bromus diandrus	Great Brome	+		+	
*Cynodon dactylon	Couch Grass	+	+	+	
Danthonia caespitosa	Common Wallaby Grass	+	+	+	
Dichelachne crinata	Longhair Plumegrass	+			
*Ehrharta calycina	Perennial Veldtgrass	+			
*Ehrharta longiflora	Annual Veldtgrass	+			
*Lagurus ovatus	Hare's Tail Grass	+	+	+	
*Lolium perenne	Perennial Ryegrass		+		
*Lolium rigidum	Wimmera Ryegrass		+		
Poa drummondiana	Knotted Poa	+			
Poa poiformis	Coastal Poa	+	+		
Spinifex longifolius					+
Stipa flavescens		+	+	+	
*Vulpia membranacea	One-glume Fescue	+	+		
POLYGALACEAE					
Comesperma confertum			+		
PRIMULACEAE					
*Anagallis arvensis	Pimpernel	+	+		
PROTEACEAE					
Banksia attenuata	Candle Banksia	+			
Banksia grandis	Bull Banksia	+			
Grevillea vestita		+			
Hakea prostrata	Harsh Hakea	+			
Persoonia saccata	Snottygobble	+			
Synaphea spinulosa		+			
RANUNCULACEAE					
Clematis microphylla	Slender Clematis	+	+		

Species	Common Name	Vegetation 1	2	3	4
RESTIONACEAE					
Loxocarya flexuosa			+		
RHAMNACEAE					
Spyridium globulosum		+	+	+	+
RUBIACEAE					
Opercularia hispidula	Hispid Stinkweed		+		
Opercularia vaginata	Dog Weed	+	+	+	
RUTACEAE					
Diplolaena dampieri	Beach Rose	+	+	+	+
SANTALACEAE					
Exocarpos sparteus	Broom Ballart	+	+	+	+
Santalum acuminatum	Quandong	+		+	+
SAPINDACEAE					
Dodonaea aptera			+		
SCROPHULARIACEAE					
*Bellardia trixago	Bellardia		+		
*Dischisma arenarium			+		
SOLANACEAE					
Anthocercis littorea	Yellow Tailflower		+		
STERCULIACEAE					
Lasiopetalum membranaceum		+			
Thomasia cognata		+	+		
STYLIDIACEAE					
Stylidium junceum	Reed Triggerplant	+			
VIOLACEAE					
Hybanthus calycinus	Native Violet	+	+		
XANTHORRHOEACEAE					
Xanthorrhoea preissii	Blackboy	+			
Xanthorrhoea brunonis		+			

APPENDIX 3. FAUNA.

The vertebrate fauna species expected to occur (X) or the reptiles found (F) in each habitat are listed.

The habitats are the same as the vegetation units:

1. Tuart woodland and forest over Peppermint, Banksia and Jarrah.
2. Tuart woodland over Peppermints and heath.
3. Coastal heath on stable dunes.
4. Coastal heath on primary dunes.

Introduced species are identified by an asterisk (*).

HABITATS	1	2	3	4
AMPHIBIAN SPECIES				
LEPTODACTYLIDAE-Frogs				
Crinia georgiana	X	X	X	
C. glauerti		X		
C. insignifera	X	X	X	
Heleioporus eyrei	X	X	X	
H. psammophilus	X	X	X	
Limnodynastes dorsalis	X	X	X	X
Pseudophryne guentheri	X	X	X	
HYLIDAE				
Litoria adelaidensis	X	X	X	X
L. moorei	X	X	X	X
REPTILE SPECIES				
GEKKONIDAE-Geckos				
Phyllodactylus marmoratus	X	F	F	
PYGOPODIDAE-Legless Lizards				
Aprasia repens	X	X	X	X
Lialis burtonis	X	X	F	X
Pygopus lepidopodus	X	X	X	X
AGAMIDAE-Dragon Lizards				
Pogona m. minor	X	X	X	X
SCINCIDAE-Skinks				
Bassiana trilineata	X	F	X	
Cryptoblepharus plagiocephalus	X	F	F	
Ctenotus fallens	X	F	F	X
C. impar	X	X	X	
Egernia kingii	X	X		
E. napoleonis	X	X	X	
Hemiergis quadrilineata	X	F	F	X
Lerista distinguenda/elegans	F	F	X	X
Menetia greyii	X	X	X	X
Morethia lineoocellata	F	F	F	X
M. obscura	X	X	X	X
Spenomorphus australis	X	X		
Tiliqua r. rugosa	X	X	F	X

HABITATS	1	2	3	4
VARANIDAE-Monitors				
Varanus gouldii	X	X	X	X
V. rosenbergi	F	X		
TYPHLOPIDAE-Blind Snakes				
Ramphotyphlops australis	X	X	X	X
BOIDAE-Pythons				
Morelia spilota imbricata	X	X	X	X
ELAPIDAE-Elapid Snakes				
Drysdalia coronata	X	X	X	X
Echiopsis curta	X	X	X	X
Elapognathus minor		X		
Neelaps bimaculatus	X	X	F	X
Notechis scutatus occidentalis	X	X	X	X
Pseudonaja affinis affinis	X	X	F	X
Rhinoplocephalus gouldii	F	X	X	
R. nigriceps	X	X	X	
Simoselaps bertholdi	X	X	X	X

HABITATS	1	2	3	4
BIRD SPECIES				
ACCIPITRIDAE				
Elanus notatus, Black-shouldered Kite		X	X	X
Lophoictinia isura, Square-tailed Kite	X	X	X	X
Haliastur sphenurus, Whistling Kite	X	X	X	X
Accipiter fasciatus, Brown Goshawk	X	X	X	X
A. cirrhocephalus, Collared Sparrowhawk	X	X	X	X
Aquila audax, Wedge-tailed Eagle	X	X	X	X
Hieraaetus morphnoides, Little Eagle	X	X	X	X
Circus assimilis, Spotted Harrier	X	X	X	X
C. aeruginosus, Marsh Harrier	X	X	X	X
FALCONIDAE				
Falco peregrinus, Peregrine Falcon	X	X	X	X
F. longipennis, Australian Hobby	X	X	X	X
F. berigora, Brown Falcon	X	X	X	X
F. cenchroides, Australian Kestrel		X	X	X
PHASIANIDAE				
Coturnix novaezealandiae, Stubble Quail		X	X	X
TURNICIDAE				
Turnix varia, Painted Button-quail	X	X		
COLUMBIDAE				
Streptopelia senegalensis, Laughing Turtle-Dove*		X	X	
Phaps chalcoptera, Common Bronzewing*	X	X	X	
CACATUIDAE				
Calyptorhynchus baudinii, Baudin's Black-Cockatoo	X	X		
C. latirostris, Carnaby's Black-Cockatoo	X	X		
Cacatua roseicapilla, Galah		X	X	
LORIIDAE				
Glossopsitta porphyrocephala, Purple-crowned Lorikeet	X	X		

HABITATS	1	2	3	4
POLYTELITIDAE				
Polytelis anthopeplus, Regent Parrot	X	X	X	
PLATYCERCIDAE				
Purpureicephalus spurius, Red-capped Parrot	X	X		
Platycercus icterotis, Western Rosella	X	X		
Barnardius zonarius, Port Lincoln Ringneck	X	X	X	
Neophema elegans, Elegant Parrot	X	X		
N. petrophila, Rock Parrot			X	X
CUCULIDAE				
Cuculus pallidus, Pallid Cuckoo	X	X	X	
C. pyrrhophanus, Fan-tailed Cuckoo	X	X	X	
Chrysococcyx basalis, Horsfield's Bronze-Cuckoo	X	X	X	
C. lucidus, Shining Bronze-Cuckoo	X	X	X	
STRIGIDAE				
Ninox novaeseelandiae, Southern Boobook	X	X	X	
TYTONIDAE				
Tyto alba, Barn Owl		X		
T. novaehollandiae, Masked Owl		X		
PODARGIDAE				
Podargus strigoides, Tawny Frogmouth	X			
AEGOTHELIDAE				
Aegotheles cristatus, Australian Owlet-nightjar	X			
CAPRIMULGIDAE				
Caprimulgus guttatus, Spotted Nightjar		X	X	X
APODIDAE				
Apus pacificus, Fork-tailed Swift	X	X	X	X

HABITATS	1	2	3	4
ALCEDINIDAE				
Dacelo novaeguineae, Laughing Kookaburra*	X	X	X	
Halcyon sancta, Sacred Kingfisher	X	X		
MEROPIDAE				
Merops ornatus, Rainbow Bee-eater	X	X	X	
HIRUNDINIDAE				
Hirundo neoxena, Welcome Swallow	X	X	X	X
Cecropis nigricans, Tree Martin	X	X		
MOTACILLIDAE				
Anthus novaeseelandiae, Richard's Pipit		X	X	X
CAMPEPHAGIDAE				
Coracina novaehollandiae, Black-faced Cuckoo-shrike	X	X	X	
Lalage sueurii, White-winged Triller	X	X		
MUSCICAPIDAE				
Petroica multicolor, Scarlet Robin	X	X		
Eopsaltria georgiana, White-breasted Robin		X		
E. griseogularis, Western Yellow Robin	X	X		
Pachycephala pectoralis, Golden Whistler	X	X	X	
P. rufiventris, Rufous Whistler	X	X	X	
Colluricincla harmonica, Grey Shrike-thrush	X	X		
Rhipidura fuliginosa, Grey Fantail	X	X		
R. leucophrys, Willie Wagtail	X	X	X	X
SYLVIIDAE				
Cinclorhamphus mathewsi, Rufous Songlark	X	X		

HABITATS	1	2	3	4
MALURIDAE				
Malurus splendens, Splendid Fairy-wren	X	X	X	X
Stipiturus malachurus, Southern Emu-wren			X	X
ACANTHIZIDAE				
Smicrornis brevirostris, Weebill	X	X		
Gerygone fusca, Western Gerygone	X	X		
Acanthiza pusila apicalis Brown Thornbill	X	X	X	X
A. inornata, Western Thornbill	X	X		
A. chrysorrhoa, Yellow-rumped Thornbill	X	X	X	
NEOSITTIDAE				
Daphoenositta chrysoptera, Varied Sittella	X	X		
CLIMACTERIDAE				
Climacteris rufa, Rufous Treecreeper	X			
MELIPHAGIDAE				
Anthochaera carunculata, Red Wattlebird	X	X	X	
A. chrysoptera, Little Wattlebird	X	X	X	
Lichenostomus virescens, Singing Honeyeater	X	X	X	X
Melithreptus brevirostris, Brown-headed Honeyeater	X	X		
M. lunatus, White-naped Honeyeater	X	X		
Lichmera indistincta, Brown Honeyeater	X	X	X	X
Phylidonyris novaehollandiae, New Holland Honeyeater	X	X	X	X
P. nigra, White-cheeked Honeyeater			X	X
P. melanops, Tawny-crowned Honeyeater			X	X
Acanthorhynchus superciliosus, Western Spinebill	X	X	X	X
EPHTHIANURIDAE				
Ephthianura albifrons, White-fronted Chat			X	X

HABITATS	1	2	3	4
VESPERTILIONIDAE-Bats				
Nyctophilus major, Greater Long-eared Bat	X	X	X	X
N. gouldi, Gould's Long-eared Bat	X	X	X	X
N. geoffroyi, Lesser Long-eared Bat	X	X	X	X
Chalinolobus gouldii, Gould's Wattled Bat	X	X	X	X
C. morio, Chocolate Wattled Bat	X	X	X	X
Falsistrellus mackenziei, Great Pipistrelle	X	X	X	X
Eptesicus regulus, King River Eptesicus	X	X	X	X
MURIDAE-Native Rodents				
Rattus fuscipes, Bush Rat	X	X	X	
INTRODUCTED MAMMALS				
MURIDAE				
R. rattus, Black Rat*		X		
Mus musculus, House Mouse*	X	X	X	X
LEPORIDAE				
Oryctolagus cuniculus, Rabbit*	X	X	X	X
CANIDAE				
Vulpes vulpes, Fox*	X	X	X	X
FELIDAE				
Felis catus, Feral Cat*	X	X	X	X

HABITATS	1	2	3	4
DICAEIDAE				
Dicaeum hirundinaceum, Mistletoebird	X	X		
PARDALOTIDAE				
Pardalotus punctatus, Spotted Pardalote	X	X	X	
P. striatus, Striated Pardalote	X	X	X	
ZOSTEROPIDAE				
Zosterops lateralis, Silvereye	X	X	X	X
GRALLINIDAE				
Grallina cyanoleuca, Australian Magpie-lark	X	X	X	
ARTAMIDAE				
Artamus personatus, Masked Woodswallow	X	X	X	X
A. cinereus, Black-faced Woodswallow	X	X	X	X
A. cyanopterus, Dusky Woodswallow	X	X	X	X
CRACTICIDAE				
Cracticus torquatus, Grey Butcherbird	X	X	X	
Gymnorhina tibicen, Australian Magpie	X	X	X	
Strepera versicolor, Grey Currawong	X	X		
CORVIDAE				
Corvus coronoides, Australian Raven	X	X	X	X

HABITATS	1	2	3	4
MAMMAL SPECIES				
DASYURIDAE-Predatory Marsupials				
Antechinus flavipes, Yellow-footed Antechinus	X	X		
Phascogale tapoatafa, Brush-tailed Phascogale	X	X		
Sminthopsis griseoventer, Common Dunnart	X	X	X	X
PERAMELIDAE-Bandicoots				
Isoodon obesulus, Southern Brown Bandicoot#		X		
PSEUDOCHEIRIDAE-Ringtail Possums				
Pseudocheirus peregrinus, Common Ringtail Possum#	X	X		
PHALANGERIDAE-Brushtail Possums				
Trichosurus vulpecula, Common Brushtail Possum	X	X		
BURRAMYIDAE-Pygmy Possums				
Cercartetus concinnus, Western Pygmy-possum	X	X		
TARSIPEDIDAE-Honey-possum				
Tarsipes rostratus, Honey-possum		X	X	
MACROPODIDAE-Kangaroos				
Macropus fuliginosus, Western Grey Kangaroo	X	X	X	X
MOLOSSIDAE-Mastiff-bats				
Nyctinomus australis, White-striped Mastiff-bat	X	X	X	X