BAYFORM HOLDINGS PTY LTD

CITY OF GERALDTON-GREENOUGH
TPS No.1A AMENDMENT No.4

ENVIRONMENTAL REVIEW
(EPA ASSESSMENT No. 1561)

VOLUME I - REPORT

VERSION 4

16 December 2008

REPORT NO: 2006/067

ATA Environmental
environmental scientists

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AN INVITATION TO COMMENT ON THIS ENVIRONMENTAL REVIEW

The City of Geraldton-Greenough invites people to make a submission on this Environmental Review (ER).

The ER was prepared for Amendment No.4 to the City of Geraldton-Greenough Town Planning Scheme No. 1A for the proposed re-zoning of land in the Cape Burney area from numerous Local Scheme Reserves ('Dune Preservation' and 'Parks and Recreation') and zones ('Residential', 'Residential Development', 'Commercial' and 'General Farming') to 'Development'.

In accordance with the *Environmental Protection Act 1986* as amended, this ER has been prepared to describe the proposed Amendment and its likely impact on the environment.

The ER is available for public review in accordance with the advertising period determined by the Western Australian Planning Commission from **5th January 2009** to **16th February 2009**.

After receipt of comments from Government departments and from the public, the City of Geraldton-Greenough will forward submissions to the Environmental Protection Authority (EPA). The EPA will prepare an Assessment Report with recommendations to the Government, taking into account issues raised in public submissions.

Why write a submission?

A submission is a way to provide information, express your opinion and put forward your suggested course of action - including any alternative approach.

It is useful if you indicate any suggestions you have to improve the proposed Scheme Amendment.

All submissions received by the City of Geraldton-Greenough will be acknowledged. Submissions will be treated as public documents unless provided and received in confidence subject to the requirements of the Freedom of Information Act, and may be quoted in full or in part in the EPA's report.

Submissions may be fully or partially utilised in compiling a summary of the issues raised or where complex or technical issues are raised, a confidential copy of the submission (or part of it) may be sent to the proponent.

The summary of issues is normally included in the EPA's Assessment Report.

Why not join a group?

If you prefer not to write your own comments, it may be worthwhile joining with a group interested in making a submission on similar issues.

Joint submissions may help to reduce the work for an individual or group, as well as increase the pool of ideas and information.

If you form a small group (up to ten 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 ER 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 proposed Scheme Amendment more environmentally acceptable.

When making comments on specific elements of the ER:

- clearly state your point of view;
- indicate the source of your information or argument if this is applicable; and
- 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 the issues raised are clear. A summary of your submission is helpful.

- Refer each point to the appropriate section, chapter or recommendation in the ER.

- If you discuss different sections of the ER, keep them distinct and separate, so there is no confusion as to which section you are considering.

- Attach any factual information you 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:

16th February 2009

Submission should be emailed to: tonybrun@cgg.wa.gov.au or addressed to:

Chief Executive Officer
City of Geraldton-Greenough
PO Box 21
GERALDTON WA 6531

Attention: **Mr Tony Brun**

DISCLAIMER

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

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QUALITY ASSURANCE

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

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

Document No: BHO-2005-001-REPT_001_pz_V4

Report No: 2006/067

Checked by: Signed: 

Name: Paul Zuvela Date: 16 December 2008
Manager – Environmental Planning

Approved by: Signed: 

Name: Dr Paul van der Moezel Date: 16 December 2008
Principal

EXECUTIVE SUMMARY

This Environmental Review (ER) has been prepared in accordance with the Environmental Protection Authority's (EPA) decision to formally assess Amendment No.4 to the City of Geraldton-Greenough's Town Planning Scheme (TPS) No.1A for the Cape Burney area. The purpose of Amendment No.4 is to introduce zonings and reservations for the Cape Burney area to facilitate the development of the land for residential purposes and associated development, including commercial, tourism and community land uses and to reserve land adjacent to the coast.

The EPA has identified some environmental factors which are relevant to the scheme area and require consideration. Where a Scheme Amendment is subject to an assessment by the EPA, the responsible authority (City of Geraldton-Greenough) is required to prepare a report (referred to as an Environmental Review (ER)).

The purpose of this ER is to provide information related to the proposed amendment that will enable the EPA to evaluate the potential impacts of the amendment on the environment. This report provides information on the key environmental issues relevant to the Scheme Amendment so that the potential impact of the proposed re-zoning can be assessed. The relevant environmental factors and management strategies proposed are summarised in Table 1.

Indirectly related to the Scheme Amendment though relevant to environmental management of the amendment area is the State Agreement between Bayform Holdings Pty Ltd and the State of Western Australia. Subject to resolution of Native Title matters, this State Agreement will eventually result in the exchange of the 214ha Victoria Location 11939 parcel of land in the amendment area from Crown ownership to Bayform's ownership in return for the transfer of the 422ha Victoria Location 2584 (located south of the Greenough River). VCL 11939 consists mostly of bare dune with approximately 70ha of native vegetation. VCL 2584 is comprised mostly of native vegetation with a small area of bare dune. This land exchange will result in a significantly greater area of high quality native vegetation and fauna habitat being protected in the conservation estate.

The State Agreement also requires Bayform to stabilise the mobile Southgate Dunes. This mobile dunal system is migrating in a northerly direction due to prevailing winds. The gradual migration of this dunal system will be stopped by the ultimate urbanisation of the amendment area. Details of the stabilisation program are contained in the Southgate Dunes Stabilisation Strategy.

The proposed Scheme Amendment will result in the creation of a new zoning in the City of Geraldton-Greenough's TPS No. 1A called 'Development' Zone. A single Zone will enable future planning for the amendment area to proceed in a flexible and responsive manner.

The developer will be required to prepare and submit a Structure Plan for the entire landholding to the local authority and the WAPC for endorsement. It is proposed that the ultimate land use for the amendment area will be residential development and a range of complementary land uses including schools, commercial and community nodes, Public Open Space and tourism/residential/commercial precincts.

The Structure Plan will identify areas for vegetation retention as well as define a coastal foreshore reserve that is based on coastal processes and environmental attributes.

TABLE 1
SUMMARY OF ENVIRONMENTAL FACTORS, EPA OBJECTIVES, POTENTIAL IMPACTS AND ENVIRONMENTAL MANAGEMENT MEASURES

Environmental Factor	EPA Objectives	Existing Environment	Potential Impacts	Environmental Management Measures	Potential Outcomes
Vegetation Communities and Significant Flora	To maintain the abundance, diversity, geographic distribution and productivity of flora at species and ecosystems levels through the avoidance or management of adverse impacts and improvement in knowledge. Protect Declared Rare and Priority Flora consistent with the provisions of the *Wildlife Conservation Act 1950*, and the *Environment Protection and Biodiversity Act 1999*. Protect other flora of conservation significance.	The amendment area is comprised of approximately 200ha of bare dune, approximately 250ha of native vegetation and approximately 120ha consisting of cleared grazing land adjacent to Brand Highway. Vegetation in the amendment area is dominated by Coastal heath on the primary dunes and Closed Heath dominated by *Acacia rostellifera* on the inland protected dunes and flats. Ten vegetation types were described and mapped. The different types are reasonably uniform in their composition but local variations do occur. Furthermore, the vegetation types often grade into each other, forming a mosaic of vegetation types in some areas. Remnant vegetation in the amendment area is in Very Good condition, particularly the foredunes and more exposed faces of the primary dunes where the harsh conditions do not allow weed species to grow. No Threatened Ecological Communities were identified in the amendment area. The area mapped as *Melaleuca huegelii – Acacia rostellifera* (MhAr) Scrub in the northern portion of the amendment area is considered to be of local conservation significance. A total of 68 species were recorded in the amendment area. This included 35 native species and 33 introduced species. No species of Declared Rare or Priority Flora were recorded within the amendment area	Implementing the land exchange agreement between Bayform and the State of Western Australia will result in the vesting of approximately 400ha of very good quality native vegetation with the crown in exchange for approximately 214ha of land that has approximately 70ha of native vegetation with the balance as bare sand dune. Re-zoning to 'Development' zone will facilitate development of the subject land which potentially could result in clearing of approximately 250ha of native vegetation including areas of local significance. No species of Declared Rare or Priority Flora will be adversely impacted. No Threatened Ecological Communities will be adversely impacted.	Representative vegetation types to be retained in the proposed development will be identified at the Structure Plan stage including the *Melaleuca huegelii/Acacia rostellifera* vegetation. Coastal vegetation will be retained in the foreshore reserve. In order to manage the retained vegetation a Vegetation Management Plan will be prepared at subdivision stage to the satisfaction of the local authority on advice from the Department of Environment and Conservation. The developer will implement the Plan at subdivision stage. The Vegetation Management Plan will include: • Aims and long term management objectives for the area; • Description of the area, including size, location, topography and major features; • Aboriginal and European history of the area; including prior land uses, ownership or other relevant data; • Biodiversity and ecological values of the area, including links to other areas; • Description of predevelopment flora and fauna – including flora and fauna that have been located in the area and identification of any threatened, endangered or priority species; • Details of how the assessment was conducted, including details of any transects, monitoring points or sampling; • Details of risk assessment for site including risk to flora and fauna from adjacent urban development – from people, litter, pets, road traffic, changes in hydrology, nutrients, pollutants etc; • Proposed management strategies to protect flora and fauna; particularly any endangered, threatened or priority species; • Proposed management strategies for the control of feral animals; • Reference Legislation and Policy relevant to the Management Plan; • Risks from fire, and to community from fire; • Risks to community from biting insects, snakes and pathogens;	Implementation of the land exchange agreement will increase the area of native vegetation protected in reserves in the City of Geraldton-Greenough. This tract of native vegetation stretches from the coast inland to the Greenough River. Representative vegetation types will be retained within the future development of the subject land. Areas of locally significant vegetation will be protected in Public Open Space. No declared rare flora, priority flora species or threatened ecological communities will be affected by the amendment.

Environmental Factor	EPA Objectives	Existing Environment	Potential Impacts	Environmental Management Measures	Potential Outcomes
				• Detailed management programs to address issues identified in risk assessments; • Management and maintenance programs for weed control, fire control, and rehabilitation or restoration of areas of degraded vegetation; • Native species of local provenance to be used in rehabilitation/landscaping works for areas of Public Open Space; • Description of monitoring programs to be conducted during and after development has occurred; • How the local community will be included in the management of the area; and • Responsibility for conducting and financing, monitoring, restoration management and education programs. A Foreshore Management Plan will be prepared that protects the integrity of the coastal foreshore vegetation.	
Specially Protected (Threatened Fauna)	Protect specially protected (threatened) fauna and priority fauna, consistent with the provisions of the *Wildlife Conservation Act 1950* and the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*. Protect other fauna of conservation significance.	No species listed under the *Wildlife Conservation Act* 1950 or as Endangered or Vulnerable under the *Environment Protection and Biodiversity Conservation Act 1999* were recorded in the amendment area. Only the Rainbow Bee-eater (listed as Migratory) was recorded on site. No significant trees containing hollows suitable for breeding birds were recorded within the subject land and species of Black Cockatoo are unlikely to either forage or nest in the subject land.	Future development of the amendment area will result in the loss of faunal habitat and the loss of sedentary species, however more mobile species area expected to move to adjacent areas of habitat.	Areas of representative habitat types will be identified for retention at the Structure Plan stage and where possible, habitat should be retained in corridors to assist faunal movement. A Vegetation Management Plan will be prepared by the developer at subdivision stage to the satisfaction of the local authority on advice from the Department of Environment and Conservation. The developer will implement the Plan at subdivision stage. This management plan will consider the management and enhancement of faunal values of retained vegetation as well as the control of feral animals. It is unlikely that the proposed development of the subject land will substantially modify, destroy or isolate an area of important habitat for any of these species, or seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significantly proportion of the population of any of the listed fauna species. A Foreshore Management Plan will be prepared that protects the integrity of the coastal foreshore vegetation.	Positive impact through an increase in protection of habitat associated with the land exchange agreement. Including the protection of an extensive band of native vegetation extending from the coast to the Greenough River. There will be no loss of significant fauna habitat. Proposed habitat loss and/or modification will not have a significant impact on the Rainbow Bee-eater given that it has many other available habitats for feeding and breeding in the adjacent areas. None of the species listed as being recorded or predicted in the region are likely to be significantly impacted.

Environmental Factor	EPA Objectives	Existing Environment	Potential Impacts	Environmental Management Measures	Potential Outcomes
Coastal Landforms, Processes and Foreshore	To maintain the integrity of landscape and landforms by maintaining their ecological functions and environmental values.	Southgate Dunes is an area of bare mobile sand approximately 3km long and 1.2km at its widest point, extending along the coast immediately north from the Greenough River mouth (Alan Tingay and Associates, 1998). The dune system is migrating in a northerly direction due to prevailing winds. The coastline is characterised by sandy beaches with localised areas of beach containing exposed limestone shelf. The northern 1,200m of shoreline experienced significant erosion between 1942 and 1975, but has since experienced a moderate accretion trend. The balance of the shoreline has been relatively stable. Nearshore currents along the coastline adjacent to the amendment area appear to move in a northward direction. This littoral drift contributes, to some extent, to the transport of fine sediments and deposition of this sediment on to northern beaches.	Stabilising Southgate Dunes is a condition included in the State Agreement between the State of Western Australia and Bayform that potentially could interrupt the sand supply feeding beaches further north of the subject land. The existing landform will be modified as a part of the stabilisation strategy and ultimate development of the subject land. Construction of infrastructure within the coastal setback area may potentially be subject to coastal processes.	A foreshore reserve consistent with M P Rogers and Associates recommended coastal setback and with ATA Environmental's (2005) Geraldton-Greenough Coastal Strategy and Foreshore Management Plan will be identified for retention in public open space at the Structure Plan stage. At subdivision stage to the satisfaction of the local authority on advice from the Department of Environment and Conservation. The developer will implement the Plan at subdivision stage. The developer will be required to prepare a detailed Foreshore Management Plan at subdivision stage to the satisfaction of the local authority on advice from the Department for Planning and Infrastructure. The following principles and components will apply to the development of the foreshore reserve and will be incorporated into the Foreshore Management Plans: • Development of nodal access to concentrate beach use in selected areas; • All access formalised by construction of roads, paths and car parks; • Fenced dual use paths and pedestrian access ways; • Incorporation of a highly scenic cycle route along edge of, or within, the foreshore reserve as part of a regional system; • Structures such as pavilions, boardwalks adopted as public facilities which enhance beach access yet offer foreshore protection; • Use of fencing and signage as integral methods of access control; and • Coastal rehabilitation/stabilisation and revegetation undertaken for degraded areas. Implementation of the Foreshore Management Plan by the developer at subdivision stage. In accordance with the State Agreement, Bayform will stabilise the mobile Southgate Dunes system. In simple terms, this involves the re-grading the subject land to final development levels (refer to Figure 4 for conceptual cross-sections showing modified	The gradual migration of Southgate Dunes in a northerly direction will be stopped by the ultimate urban development of the dunes. A foreshore reserve will be identified and retained to avoid adverse impacts on the future development arising from coastal processes and to protect the coastal environment from degradation. The existing landform on the subject land will be modified as a part of the dune stabilisation works. The modified landform will consist of a broad north-south trending ridge over the current Southgate Dunes area, retain the existing low point just to the east of the current dunes and grade the land up to the Brand Highway. The modified landform will be on a reduced scale to the existing landform. Implementation of a Foreshore Management Plan will result in the provision of recreational facilities within and immediate adjacent to the foreshore reserve. Emphasis will be on nodal activity in the foreshore area to concentrate usage, leaving large tracts of beach in its current form.

Environmental Factor	EPA Objectives	Existing Environment	Potential Impacts	Environmental Management Measures	Potential Outcomes
				landform), spreading of loamy soil across the site and seeding with cereal rye. Long-term stabilisation will be achieved with urbanisation of the subject land.	
Greenough River Watercourse	To maintain the integrity, ecological functions and environmental values of watercourses.	Greenough River Road runs very close to the Greenough River (less than 10m from the water edge in places) with the foreshore margins being reserved as Parks and Recreation. The existing foreshore reserve is particularly narrow due to the position of Greenough River Road. On the northern side of Greenough River Road, the land is currently zoned 'Resort Development' which is outside of the amendment area. The riverbank is characterised by a gentle slope and is predominantly grassed with small areas of degraded native vegetation. Native vegetation north of the river mouth is considered to be in Good condition. The Greenough River provides an important drought refuge for waterbirds as it contains water year-round.	Activities that may individually or cumulatively influence environmental values of the Greenough River include: • The application of nutrients and use of chemicals in the catchment associated with current and future land uses; • Construction contributing erosion and the export of sediment; • Inappropriate stormwater management; • Introduction of weed and pest species; and • Increased human activity along the Greenough River.	The amendment area is mostly separated from the Greenough River by various local reserves. It is proposed that the existing foreshore reserve will be retained and developed to maximise community use. To guide future management a Foreshore Management Plan will be prepared and will include strategies for managing: • Community use and recreational opportunities; • Rehabilitation and restoration of the foreshore area; • Landscaping and installation of community facilities; and • Stormwater management. A Local Water Management Plan will be prepared by the developer at subdivision stage to the satisfaction of the local authority on advice from the Department of Water and implemented at subdivision. The plan will specifically address issues such as (but not limited to) stormwater management and nutrient control.	The amendment will not result in any change to the size of the existing Greenough River foreshore reserve. The Greenough River foreshore reserve will be developed to maximise community use and landscaped and rehabilitated in accordance with the objectives of the Geraldton-Greenough Coastal Strategy and Foreshore Management Plan.
Water Quality	To ensure that the quality of water emissions do not adversely affect environment values or the health, welfare and amenity of people and land uses by meeting statutory requirements and acceptable standards.	The southern extent of the amendment area lies close to a small portion of the Greenough River. The Greenough River is an intermittently estuarine river as the river mouth is blocked by a sandbar during the dry summer months but winter flows breach the sandbar. Greenough River is classified as moderately saline with an average salinity of 37,100mg/L (Department of Agriculture, 2005). Total nitrogen and total phosphorous levels are classified as moderate. Rudds Gully, a minor tributary of the Greenough River, is located in the south-eastern edge of the amendment area, bordering Brand Highway and is a perennial watercourse. Separation between the groundwater table and the natural surface is generally more than 5m over the majority of the amendment area,	Possible adverse nutrient export and drainage impacts on the Greenough River or the marine environment may occur. Development in the vicinity of the Greenough River watercourse may result in temporarily interrupted or altered water balances, water quality and flow rates.	Water sensitive urban design principles will be applied to the development. Majority of stormwater generated on site will be infiltrated; hence, application of a treatment train approach including non-structural controls will be implemented in order to manage water quality. Development in the 100 year ARI floodplain will be a minimum building floor level of 0.5m above the floodplain level. A landscape buffer to be retained along Rudds Gully with no filling to occur in this buffer. Detailed site specific investigations will be required at subdivision stage, to determine key infiltration parameters for the site for modelling of individual basin size and storage requirements. Internal subject land sub-catchment delineation will be determined at this stage. The results of these investigations will be documented in a Local Water Management Plan for the subject land.	Stormwater generated on site will be infiltrated where possible. Implementation of structural and non-structural controls will maintain existing water quality. Allowance for conveyance of 100 year flood will be maintained as a part of the future development.

Environmental Factor	EPA Objectives	Existing Environment	Potential Impacts	Environmental Management Measures	Potential Outcomes
		though ranging up to 35m in elevated areas.		The future development will be serviced with a reticulated sewerage service.	
Noise	To protect the amenity of the community from noise impacts associated with the development or land use by ensuring that statutory requirements and acceptable standards are met.	The major source of noise in the amendment area at present is Brand Highway. Two loggers were installed to collect data. L_{A10} The noise level exceeded for 10% of the time (in this instance, the noise level exceeded for 6 minutes in each 1-hour period). The average over a five day period varied from 63db(A) to 67db(A). L_{Aeq} The equivalent continuous noise level for the 1-hour period (sometimes referred to as the average noise level). The average over a five day period varied from 56db(A) to 59db(A). L_{A90} The noise level exceeded for 90% of the time (in this instance, the noise level exceeded for 54 minutes in each 1 hour period). The average over a five day period varied from 60db(A) to 65db(A).	Noise received at residences located adjacent to the Brand Highway in the year 2026 could, depending on the setback from the Highway, exceed both the Main Roads Western Australia 'Noise Level Objectives' and objectives of the Western Australian Planning Commission (WAPC) Draft Planning Policy for Road and Rail Transport Noise for exposure level 2.	For future traffic flows, if the road surface was upgraded to dense graded asphalt, and with a landscaped buffer located to the west of the Brand Highway, no noise amelioration would be required. However, if the road were retained as chip seal, then an earth bund would need to be incorporated into sections of the landscaped buffer. Although compliance is likely to be achieved, it is recommended that 'Quiet House' design be included in the first row of residence located adjacent to the Brand Highway. The proposed internal criteria with a bedroom and living area of 35dB(A) and 40dB(A) respectively. Outdoor entertainment areas should be designed or located such that they comply with a L_{Aeq} noise level during the night period of 50dB(A). For the first row of residences adjacent to the Brand Highway, it is also recommended that notification of vehicle noise be stated on the titles and that in these cases, the proponent satisfy the "Appropriate Authorities" that acceptable internal noise levels can be achieved. This may require the submission of an acoustical report prepared by a suitably qualified consultant.	Implementation of the proposed management measures will ensure that the EPA's objective with respect to noise will be satisfied.
Visual Amenity	To ensure that visual amenity is considered and measures are adopted to reduce adverse visual impacts on the surrounding environment as low as reasonably practicable.	Significant landscape features in or adjacent to the amendment area include the: • Greenough River and its margins (regional significance); • Ocean foreshore reserve which is well represented in the area (local significance); • Large blow-out; and • Drainage line adjacent to Brand Highway. There are views over the amendment area to distant coastal dunes, the Greenough River and the Ocean. The higher one gets into the adjacent rural and future urban land to the east, the more extensive these views become.	Future development of the amendment area will result in the following visual impacts: • Vegetation loss • Landform modification • Creation of building and structures • Illumination	Existing dunal landform will be reduced in scale, re-shaped to final development levels (refer to Figure 4) and then stabilised in accordance with the Southgate Dunes Stabilisation Strategy as required by the State Agreement between Bayform and the State of Western Australia. The modified landform will consist of a broad north-south trending ridge over the current Southgate Dunes area, retain the existing low point just to the east of the current dunes and grade the land up to the Brand Highway. Discrete nodes of recreational development in the river and ocean foreshore reserves to concentrate community use at these nodes. Location of recreational nodes to be identified at the Structure Plan stage. Treatment of foreshore reserves to be detailed in Foreshore Management Plan to be prepared	Implementation of the proposed management measures will ensure that the EPA's objective with respect to visual amenity will be satisfied.

Environmental Factor	EPA Objectives	Existing Environment	Potential Impacts	Environmental Management Measures	Potential Outcomes
				by the developer at subdivision stage. Foreshore Management Plan to address retention of an area of bare dune in the northwest of the amendment area, retention and management of existing vegetation, rehabilitation of degraded areas of native vegetation and treatment of identified recreational nodes and facilities within the foreshore area. Areas of representative vegetation of the amendment area will be identified in the Structure Plan for retention as a part of the future development. The Structure Plan to identify a landscape buffer between Brand Highway and the future development.	
Aboriginal Culture and Heritage	To ensure that changes to the biophysical environment resulting from the amendment do not affect historical and cultural associations within the area and comply with the requirements of relevant heritage legislation.	Seven registered archaeological sites are present in the amendment area. Following archaeological investigations, an additional six newly discovered sites were discovered. All sites, with the exception of one, were considered to be of low significance. The exception was considered to be of moderate significance.	Some of the existing Aboriginal heritage sites are currently being impacted by natural processes (primarily erosion and deposition of sand) and human activity. There is some possibility that sub-surface material may be present in parts of the subject land but this cannot be determined from the field inspection undertaken. As a part of the dune stabilisation program (a requirement of the State Agreement), there is potential for some sites to be disturbed.	Where possible, identified Aboriginal heritage sites will be retained in public open space in the Structure Plan. Where disturbance is unavoidable, the developer will be required to submit a Section 18 application to the Department of Indigenous Affairs prior to the commencement of any activity that has the potential to disturb known sites. The developer will prepare an Aboriginal Heritage Protocol prior to undertaking any earth working of the subject land. The protocol will address the procedure for dealing with potential Aboriginal sites found during earth working/construction activities.	Stabilising Southgate Dunes, controlling human activities (e.g. off-road vehicles) and retention of sites in public open space will assist in the protection of existing sites. Some sites in the amendment area may be disturbed. Where disturbance is unavoidable, the developer will lodge a Section 18 application with the Department of Indigenous Affairs.
Recreation	To ensure that existing and planned recreational uses of the environment are not compromised.	The Greenough River and its associated foreshore reserve, the ocean and adjacent land (including Southgate Dunes) are suitable for a range of recreational pursuits. Common recreational pursuits include: • Water based sports (fishing, water skiing, swimming, rowing, wind surfing, boating); • Off-road driving; • Sand boarding; • Bush walking; • Bike riding; • Bird watching; and • Camping.	Re-zoning the subject land to facilitate development for urban and associated purposes has the potential to influence recreation in the following ways: • Increased demand for recreational resources and infrastructure requiring the upgrade of existing resources. • De-gazetting off-road vehicle area on Southgate Dunes to facilitate dune stabilisation. • Discouraging vehicles on beaches.	Management of recreational activities will largely be the responsibility of the local authority. The developer will be required to identify key open space requirements as well as provide a foreshore reserve in the Structure Plan. A Foreshore Management Plan for the coastal and river foreshore reserves will be prepared by the developer at subdivision stage and implemented at subdivision. The Foreshore Management Plan will detail infrastructure to be installed to fulfil future recreational needs of the area.	Future development of the subject land will result in a net benefit in terms of recreational opportunities along the coast as well as in future Public Open Space Off-road enthusiasts will be disadvantaged with the removal of a gazetted off-road vehicle use area. However, de-gazetting Southgate Dunes for off-road vehicles is a requirement of the State Agreement between the State of Western Australia and Bayform. It is also essential to allow for the successful stabilisation of Southgate Dunes. The provision of infrastructure (e.g. dual use pathways, ovals etc) in key locations will encourage recreational activities within the urban environment.

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1. INTRODUCTION

1.1 Purpose and Scope

This Environmental Review (ER) has been prepared in accordance with the Environmental Protection Authority's (EPA) decision to formally assess Amendment No.4 to the City of Geraldton-Greenough's Town Planning Scheme (TPS) No.1A for the Cape Burney area. The purpose of Amendment No.4 is to introduce zonings and reservations for the Cape Burney area to facilitate the development of the land for residential purposes and associated development, including commercial, tourism and community land uses and to reserve land adjacent to the coast.

The EPA has identified some environmental factors which are relevant to the scheme area and require consideration. Where a Scheme Amendment is subject to an assessment by the EPA, the responsible authority (City of Geraldton-Greenough) is required to prepare a report (referred to as an Environmental Review (ER)).

The format of this ER is based on that recommended by the EPA in its Instructions for this ER (Appendix 1). The EPA's ER Instructions set out the work required for the ER in relation to a number of key environmental factors considered relevant to the scheme and those likely to be deferred environmental factors. The ER is structured such that for each environmental factor considered relevant by the EPA, the EPA instructions are provided in terms of objectives and scope of work, followed by a description of the existing environment and relevant environmental policies, potential impacts of the amendment, proposed management strategies and subsequent environmental outcomes. The relevant environmental factors are listed below:

Biophysical Environment

- Vegetation Communities and Significant Flora (Declared Rare and Priority Flora) and Threatened Ecological Communities
- Specially Protected (Threatened) Fauna
- Coastal Landforms, Processes and Foreshore
- Watercourse – Greenough River

Pollution Management

- Water Quality
- Noise – Road Transport Noise

Social Surroundings

- Visual Amenity - Landscape
- Aboriginal Culture and Heritage
- Recreation

Deferred Environmental Factor

- Wastewater Treatment Plant

The information presented in the ER will assist the EPA to evaluate the impact of the amendment on the various environmental factors and provide independent environmental advice to Government. An additional function of the ER process is to articulate details of the proposed amendment and its future implications so that the EPA can obtain public comment on the possible environmental impacts of the Scheme Amendment. The ER outlines the environmental

management commitment which will form part of the environmental assessment and approval to cater for environmental protection and environmental management during the eventual development of Cape Burney.

1.2 Amendment Area

The amendment area can broadly be described as the land to the west of Brand Highway, north of Greenough River Road and to the south of suburban Geraldton and is located in the City of Geraldton-Greenough (Figure 1). It specifically includes those parcels of land listed in Table 2.

TABLE 2
LAND OWNERSHIP AND EXISTING ZONING/RESERVATION

Lot	Area (ha)	Current Owner	Current Zoning or Reservation in TPS No. 1A
1945	13.0258	Ramage	General Farming
5843	24.9074	Bayform Holdings Pty Ltd	General Farming; and Parks and Recreation
1268	22.9609	Bayform Holdings Pty Ltd	General Farming; and Dune Preservation
1	92.2898	Bayform Holdings Pty Ltd	Residential Development; General Farming; and Parks and Recreation
1925	35.2472	Bayform Holdings Pty Ltd	General Farming; Parks and Recreation; and Dune Preservation
2453	40.1145	Bayform Holdings Pty Ltd	Dune Preservation
4201	78.8428	Bayform Holdings Pty Ltd	Residential Development; and Parks and Recreation
6852	33.2364	Bayform Holdings Pty Ltd	Residential Development; and Parks and Recreation
708	8.4624	Bayform Holdings Pty Ltd	Residential; Commercial
3	2.7296	Bayform Holdings Pty Ltd	Commercial
4200	1.5403	Bayform Holdings Pty Ltd	Commercial; and No zone
VCL 11939	213.8984	Crown	Dune Preservation; and Parks and Recreation
VCL 12196	4.5627	Crown	Parks and Recreation

It should be noted that Bayform has entered into an agreement with the State of Western Australia for the exchange of Victoria Location 2584 (approximately 422ha located south of the amendment area) for Victoria Location 11939 (approximately 214ha commonly known as Southgate Dunes). The execution of this land exchange will not occur until Native Title Claims have been resolved.

1.3 Environmental Review Process

Where a planning scheme, or a scheme amendment, is considered likely to have a significant environmental impact by the EPA, the *Environmental Protection Act 1986* (Division 3 of Part IV) requires that it be subject to an assessment by the EPA. The EPA has determined that

Amendment No.4 to the TPS is being assessed because it raises significant environmental factors. The EPA requires the preparation of an ER to address the environmental issues relevant to the amendment, issued as Instructions by the EPA.

This ER has been structured in accordance with the EPA Instructions and describes the existing environmental characteristics of the area, the rezoning proposed under the Scheme, the potential environmental impacts of developments permitted under the Scheme, and proposed environmental management measures to be implemented as part of those developments.

This Review is available for public comment for 6 weeks from 5th Jan 2009 to 16th Feb 2009 concurrently with the draft TPS map and text. Advice on how to make a submission on this ER is presented at the front of the document.

Submissions on environmental matters received from government agencies, private organisations and individuals during that period will be considered by the City of Geraldton-Greenough, which will prepare a response that may include:

- Clarification of parts of the Review to resolve misunderstandings.
- Modification of the TPS as appropriate in response to environmental issues.
- Provision of additional information to support particular proposals.

The City of Geraldton-Greenough's response, together with the Review document and the TPS itself, will then be assessed by the EPA, which will recommend the Minister for the Environment under what conditions the TPS should be approved. The EPA's advice will be published and will be open to public appeal for two weeks. The Minister for the Environment will then consult with the Minister for Planning regarding the conditions of approval and any other relevant matters before the conditions are set.

Advice on how to prepare a submission on this ER is provided at the beginning of this report.

1.4 Supporting Information

There have been extensive background studies in a range of environmental issues for the Cape Burney area prior to the initiation of the TPS Amendment.

This Amendment is accompanied by a number of specialist reports prepared by consultants on behalf of the landowners. The accompanying specialist reports, available for public inspection with this Amendment, comprise:

- Environmental Review (this Report).
- Flora and Vegetation Assessment Report (ATA Environmental, 2006a).
- Vertebrate Fauna Assessment Report (ATA Environmental, 2006b).
- Cape Burney Estate Coastal Setback Study (M P Rogers and Associates, 2006).
- Cape Burney Estate, Greenough - Hydrological Investigation Report (JDA Consultant Hydrologists, 2006a).
- Acoustic Assessment Residential Development – Cape Burney Estate Development (Herring Storer Acoustics, 2006).
- Greenough River Estate Landscape Study (James, 2006).
- Report on Archaeological Investigation for Aboriginal Sites, Cape Burney Project (Quartermaine Consultants, 2006).
- Southgate Dunes Stabilisation Strategy (ATA Environmental, 2007).

In the event of any conflict between this ER and the reports listed above, the ER prevails.

In addition to the above, the following historical reports are available on request, as listed in Table 3.

TABLE 3
LIST OF REPORTS AVAILABLE ON REQUEST

Environmental	• Cape Burney Estate, Greenough – Calculation of 100 Year Flood Level Estimates for Rudds Gully (JDA Consultant Hydrologists, 2006b)
Coastal	• Geraldton-Greenough Coastal Strategy and Foreshore Management Plan (ATA Environmental, 2005) • Southgate Dunes Coastal Management Strategy (Alan Tingay and Associates 1998) • Southgate Dunes Coastal Engineering Study (M P Rogers and Associates, 1996)
Aboriginal Heritage	• An Ethnographic Heritage Survey of Lot 11939, Southgates, Greenough (Haydock, 2004) • Report on an Ethnographic Survey of the Southgate Dune Area (O'Connor, 2001)

1.5 Key Contacts During Assessment Process

1.5.1 City of Geraldton-Greenough

The City of Geraldton-Greenough (the City) is the primary contact during the assessment process that arises from its involvement in the environmental assessment process as the "Responsible Authority" under the terms of the *Environmental Protection Act 1986* (as amended). The primary contact is:

Mr Tony Brun
Chief Executive Officer
City of Geraldton-Greenough
PO Box 21
Geraldton WA 6531

Tel: (08) 9956 6601

1.5.2 Western Australian Planning Commission

The Western Australian Planning Commission (WAPC) is the co-ordinating authority for planning matters as the advisory authority to recommend to the Minister for Planning and Infrastructure whether the proposed Scheme Amendment should proceed. The WAPC's contact details are:

Western Australian Planning Commission
Albert Facey House
469-489 Wellington Street
Perth WA 6000

Tel: (08) 9264 7777

1.5.3 Environmental Protection Authority

The EPA is a statutory authority that provides amongst others, advice to the Minister of the Environment in relation to key environmental factors relating to development proposals and Scheme Amendments in Western Australia. The EPA places a high level of importance on public input into the environmental impact assessment process. To facilitate the EPA's consideration of possible environmental impacts associated with the Scheme Amendment and subsequent implementation of the proposed land uses, public input on environmental matters is sought throughout the advertising period of the scheme amendment.
The EPA's contact details are:

Environmental Protection Authority
Level 8, The Atrium
168 St Georges Terrace
Perth WA 6000

Tel: (08) 6364 6500
Fax: (08) 6467 5557

1.5.4 Department of Environment and Conservation

The Department of Environment and Conservation (DEC) provides administrative and technical support to the EPA in conducting environmental assessments. The primary contact is:

Mr Glen McLeod-Thorpe
Senior Environmental Officer
Planning and Infrastructure Assessment
Department of Environment and Conservation
Level 4, The Atrium
168 St Georges Terrace
Perth WA 6000

Tel: (08) 6467 5431
Fax: (08) 6467 5562

1.5.5 Bayform Holdings Pty Ltd

Bayform Holdings Pty Ltd is the landowner for the Lots affected by the Scheme Amendment. The primary contact is:

Mr Anthony van den Dries
Prestige Project Management Pty Ltd
Unit 3, 300 Rokeby Road
Subiaco WA 6008

Tel: (08) 9381 7522
Fax: (08) 9381 7566

2. PLANNING CONSIDERATIONS

2.1 Strategic Planning Considerations

2.1.1 Geraldton Region Plan 1999

The Geraldton Region Plan (which incorporates the Greater Geraldton Structure Plan) was adopted by the Western Australian Planning Commission (WAPC) in June 1999. The Plan and associated document provides a regional framework for guiding strategic planning and development decisions for the greater Geraldton Region. Geraldton is recognised as the focal point for commercial and administrative activity for the Mid-West Region. The Plan provides a framework for coordinating its development in this role. Its key objectives are to identify the extent and location of urban land, regional open space, future transport networks and infrastructure, future community infrastructure, service corridors and the location of regional activity nodes.

The majority of the amendment area is identified as 'Future Urban' in the Region Plan, with two areas identified as 'Future Tourism' and 'Potential Special and Rural Residential'. With regard to future residential areas, the Region Plan supports the preparation of local structure plans based on contemporary planning principles consistent with the Liveable Neighbourhoods Community Design Codes to coordinate district and regional development.

2.1.2 Geraldton Land Development Program 1998-2002

The Geraldton Land Development Program focuses on land development and major infrastructure issues for the majority of the Geraldton Region Plan area, extending from the Buller River in the north to Greenough River in the south and east to Moonyoonooka. The program includes the entire City of Geraldton, the most populous parts of the City of Geraldton-Greenough, and the southern portion of the Shire of Chapman Valley.

The Program projects populations in the Geraldton Region to increase from 31,000 in 1996 to 38,000 by 2001 and to 41,000 by 2011. It further highlights that the population of the City of Geraldton-Greenough will be affected in the short term by the construction of two steel production plants and associated downstream developments, which could see the population increase to 46,200 by 2011.

Short term indicators in the Program suggest that demand for additional housing could vary from 1,100 to 2,600 dwelling units over a five-year period, resulting in a potential upward swing in the local land development and housing industries. Average lot uptake for the five-year period from 1993 to 1998 indicates an underlying housing demand of 100 lots per year in the former City of Geraldton, and up to 250 lots in the former Shire of Greenough. The City of Geraldton and the Shire of Greenough amalgamated to become the City of Geraldton-Greenough on 1 July 2007.

The Program notes that there is potential for further short-term impacts with potential increases of up to 3,500 temporary residents, to assist with resource development projects being undertaken in the region. It further notes that major Government commitments for the significant upgrading of infrastructure in and around Geraldton will assist and, in some cases, enhance the forecast growth of Geraldton as the primary regional centre and activity node for the entire Mid-West Region.

Although the Land Development Program is now somewhat out of date, recent resource development projects coupled with major infrastructure projects have significantly increased the Region's commercial activity and population, and there have consequently been substantial increases in land take up since 2003, with demand reported to remain very high.

The Program recognises the future development proposed for the Cape Burney locality, both north and south of Greenough River Road. Further subdivision of the existing Cape Burney settlement is projected in the Program, as is the development of Rudds Gully, east of the Brand Highway, consistent with the current City of Geraldton-Greenough's TPS No. 1A zonings.

2.1.3 Batavia Coast Strategy

This Strategy was prepared in response to concerns over increased pressure on the coast and nearshore environment in the region and the acknowledgement that the Batavia Coast contributes significantly to the economic and environmental values of the Mid West Region. The purpose of this Strategy is to provide a framework for coastal planning and management at both the regional and local level.

The Strategy supports the extension of the Geraldton urban area to the north and south, as identified within the Greater Geraldton Structure Plan on the basis that the distinct coastal villages (such as Cape Burney) retain their identity as a feature of the new coastal development. The Strategy recommends that Drummond Cove and Cape Burney develop as coastal villages, providing an opportunity to ensure the coastal development of Geraldton is 'book ended' by defined commercial/community centres.

In addressing the marine environment at Cape Burney, the Strategy outlines a demand for boat launching facilities north and south of Cape and recommends that the current arrangements of informal boat launching be retained, but supports investigations for locations for upgraded facilities.

The Strategy nominates South Cape Burney as a site for minor recreational day use and highlights the need to restrict off-road recreational vehicle use within areas north and south of the Greenough River to assist with the dune stabilisation.

2.1.4 City of Geraldton – Shire of Greenough Public Open Space Study 2002

The Public Open Space (POS) Study outlined an oversupply of POS within residential areas of the former City of Geraldton and the former Shire of Greenough, based on the provision of 3.36ha of POS per 1,000 people.

The Study also identified an oversupply of POS in the Cape Burney/Greenough area, based on the current residential population, and highlights that the existing POS areas a concentrated around the existing residential area. The Study highlighted that the distribution of POS within Cape Burney areas should be improved upon subdivision of land to the north and south and the provision of POS areas based on 400m walkable catchments.

The Study identified a shortage of facilities in the existing areas of POS, which reduces the capacity of the reserves to perform a recreational function.

2.1.5 Geraldton – Greenough Coastal Strategy and Foreshore Management Plan

This document consolidated and updated the existing coastal management plans prepared for the City of Geraldton-Greenough and aims to guide the management of coastal foreshore areas and identify priorities for implementation.

The Management Plan identifies two precinct areas for the coastal foreshore abutting the subject land, being 'Southgate' and 'Greenough/Cape Burney'. Both precincts are identified as having a Conservation/Recreation management priority.

The Strategy recommends that access for recreational fishing and informal boat launching be retained within the 'Southgate' precinct and that consideration should be given to the installation of a protected district boat launching facility. The Plan further recommends that residential development of the adjacent land should involve the preparation of a detailed foreshore management plan addressing the management of potential impacts resulting from an increase in demand and recreational potential.

Within the 'Greenough/Cape Burney' precinct, the Strategy highlights the need for improved amenity and facilities around the existing car parking area.

2.2 Statutory Planning Considerations

2.2.1 City of Geraldton-Greenough Town Planning Scheme No. 1A

A number of lots are subject to the provisions and controls of the City of Geraldton-Greenough TPS No. 1A. There are a number of reserves and zones that cover the land under TPS No. 1A, and include:

Local Reserves

- Dune Preservation
- Parks and Recreation
- Public Use

Local Zones

- Residential
- Residential Development
- Resort Development
- Commercial
- General Farming

2.2.2 Statement of Planning Policy No. 3 – Urban Growth and Settlement 2006

The WAPC's 'Urban Growth and Settlement Planning Policy' seeks to guide planning for urban growth and new settlements throughout Western Australia. The Policy notes that a high proportion of the population of WA (over 90%) live in towns and cities throughout the State, reflecting the varying economic and social development drivers of the different regions.

The Policy promotes well planned and coherent settlement patterns through careful management of urban growth, and the delivery of social, economic and environmental objectives, noting that in the past 30 years, the State's population has almost doubled to around 2 million people, with an expected increase in the population to 2.9 million by 2031.

One of the key objectives of the Policy is to encourage development to build on existing communities with well established local and regional economic bases, in order to concentrate investment in the improvement of services and infrastructure, and to enhance the quality of life in those communities. It further notes that coastal developments need to be particularly carefully planned to ensure beaches, dunes, estuaries and coastal wetlands are protected, and urban development is located where it is feasible to provide essential infrastructure, employment and services.

As households are becoming smaller and more diverse, and with an aging in the population, there is a growing demand for smaller and more diverse housing. The Policy requires that new settlements and town site expansions provide for this, and be supported by a sound economic and employment opportunities, as well as to be efficiently serviced by local and regional infrastructure such as roads, water supply, sewerage, drainage, energy, local parks, schools, shops, recreational facilities and so forth.

2.2.3 Statement of Planning Policy No. 2.6 – State Coastal Planning Policy

The State Coastal Planning Policy provides broad direction on the planning and management of the WA coast. It was gazetted on 10 June 2003 and recently amended to incorporate specific provisions relating to the height of buildings along the beach, limiting these to five storeys in height, or eight where substantial community support can be demonstrated. Its objectives are "*to protect, conserve and enhance coastal values…., provide for public foreshore areas and access to these on the coast, ensure the identification of appropriate areas for the sustainable use of the coast for housing, tourism, recreation, ocean access, maritime industry, commercial and other activities; and ensure that the location of coastal facilities and development takes into account coastal processes…" (*Part 4).

3. TOWN PLANNING SCHEME NO. 1A AMENDMENT NO.4

3.1 Introduction

The identification of land for future urban development on the coast to the north of town (from Sunset Beach, Glenfield to Buller River) and south of town (from Tarcoola Beach/Wandina, Southgate Dunes to Cape Burney) recognises the demand for residential development in coastal locations and is also the result of constraints to Geraldton's growth eastwards, which is restricted by the Narngulu Industrial area and Moresby Ranges.

3.2 Development Zone

Amending City of Geraldton-Greenough's TPS No. 1A will go some way to fulfil demand for housing in the Geraldton region. Aside from residential development, a range of complementary land uses including schools, commercial and community nodes, public open space and tourism/residential/commercial precincts will be required to create a vibrant and attractive urban environment that is identifiably different from the existing patterns of development in the Greater Geraldton region. The future development will be a semi-autonomous district of Geraldton.

To allow development to proceed in a flexible and responsive manner, it is proposed that a 'Development' zone be created. This will require the introduction of a new zone into the City of Geraldton-Greenough TPS No. 1A to provide guidance to Council on the appropriate use and development of the land and provide statutory control over land use planning, subdivision and development.

The developer will be required to prepare and submit a Structure Plan for the entire landholding to the local authority and the WAPC for endorsement. Structure plans provide an indicative land use pattern and road network that will require further detailed planning to address specific matters of importance. The Structure Plan will be refined through the preparation of subdivision plans.

4. KEY ENVIRONMENTAL FACTORS

4.1 Introduction

The EPA, in its instructions for this ER, has defined relevant factors that it considers particularly important for its assessment of the proposed Amendment. Relevant environmental factors are defined as those which have the potential to have significant environmental impacts, and which the EPA may be required to provide advice to the Minister for the Environment.

The environmental implications of the Amendment are discussed in this section of the ER. For each factor, the EPA objective, a description of the relevant factor and analysis of the environmental implications associated with the Amendment is provided. This is followed by a description of how the Amendment will incorporate provisions for environmental management where appropriate, and in some instances a description of programs which will be required during the Scheme Amendment.

4.2 Vegetation Communities and Flora

4.2.1 Preliminary EPA Objective

To maintain the abundance, diversity, geographic distribution and productivity of flora at species and ecosystem levels through the avoidance or management of adverse impacts and improvement in knowledge.

Protect Declared Rare and Priority Flora consistent with the provisions of the Wildlife Conservation Act 1950 and the Environment Protection and Biodiversity Act 1999. Protect other flora of conservation significance.

4.2.2 Applicable Legislation, Criterion or Guidance

- EPA (2004a) Guidance Statement No. 51 – *Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia*
- *Environment Protection and Biodiversity Conservation Act 1999*
- *Wildlife Conservation Act 1950*
- Commonwealth of Australia (2001) *National Targets and Objectives for Biodiversity Conservation 2001-2005*
- Commonwealth of Australia (1996) *National Strategy for the Conservation of Australia's Biological Diversity*
- City of Geraldton-Greenough Town Planning Scheme No. 1A

4.2.3 EPA Scope of Work

TABLE 4
EPA SCOPE OF WORK REQUIRED FOR VEGETATION AND FLORA

CONTENT		SCOPE OF WORK
Factor	**Site specific factor**	**Work required for the environmental review**
Flora	Vegetation Communities and Flora	Identify and assess the values and significance of vegetation communities and flora within the Amendment area and immediate adjacent area and describe these values in a local, regional and State context. Describe and assess the potential direct and indirect impacts that may result from any use or development, allowed by the Amendment, on any significant vegetation communities and flora within the Amendment area and adjacent area. In the event that significant vegetation and flora is impacted, describe measures to be implemented, to ensure that the abundance, diversity, geographic distribution and productivity of significant vegetation and flora are maintained. Map and describe the vegetation and relate these mapped units to soil/landform types. The survey should address all relevant regional datasets, detail the site specific vegetation and flora attributes, and identify the conservation significant of the site taking into consideration the EPA's Position Statement No. 3 *Terrestrial Biological Surveys as an Element of Biodiversity Protection.* Discuss the potential direct and indirect impacts of the Amendment on the existing environment, in a local and regional context, including adjacent reserves. Consider cumulative impacts of habitat loss on terrestrial flora. Describe proposed management measures, including subdivision design, fire, weed, and dieback management, to minimise clearing or loss of vegetation. Detail how the management measures will be carried out, and to whose satisfaction the work will be done.

CONTENT		SCOPE OF WORK
Factor	**Site specific factor**	**Work required for the environmental review**
	Declared Rare and Priority Flora and other significant flora (including threatened ecological communities)	Identify species of Declared Rare and Priority Flora that may be directly or indirectly impacted by the Amendment. Identify other species or communities of significance that may be impacted by the Amendment and discuss the reason for their conservation significance. These species or communities may include undescribed taxa; new records for the region; species or taxa that are endemic to the region or at the limit of their range; or species confined to specific sites of limited occurrence in the region. Subject to the appropriate permits, retain voucher specimens for all significant species and lodge them with the WA Herbarium. The EPA's Guidance Statement No. 51 *Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia* is to be used. Flora survey work should be undertaken during the flowering season (including a spring survey). Describe management measures to prevent impacts on Declared Rare Flora, Priority Flora, and other significant flora and communities (including threatened ecological communities), and to whose satisfaction the work will be done. It is recommended that Appendix 3 of the EPA's Guidance No. 10 Level of assessment for proposals affecting natural areas within the System 6 Region and Swan Coastal Plain portion of the System 1 Region (EPA 2003) be used as a guide to determining the regional or local significant of the vegetation on the site.

4.2.4 Existing Environment

Within the amendment area approximately 200ha consists of bare dune, approximately 250ha consists of native vegetation and approximately 120ha consists of cleared grazing land adjacent to Brand Highway.

Flora and Vegetation Surveys

ATA Environmental (2006a) conducted a vegetation and flora survey on the subject land on 27 and 28 October 2005. This report is included as Appendix 1 in Volume II (Technical Appendices).

The survey was undertaken to determine if any of the significant species identified by the Department of Environment and Conservation (DEC) in a database search actually occur or are likely to occur on the site. This was based on sampling within a non-permanent quadrat of 10m x 10m dimension as well as a thorough site walkover to record all plant species present at the time of the survey. This methodology complies with the EPA's guidelines for flora surveys as outlined in Guidance Statement No. 51: *Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia* (EPA 2004a) and Position Statement No. 3: *Terrestrial Biological Surveys as an Element of Biodiversity Protection* (EPA 2002).

The subject land was traversed by vehicle wherever possible and on foot in areas of limited access. The major vegetation types were previously identified and delineated using a colour

aerial photograph in ATA Environmental's (2003) *Southgate Dune Estate Environmental Assessment Report*. The spring 2005 survey include verification of the previous vegetation mapping as well as more detailed data collection in accordance with EPA (2004a) *Guidance Statement No. 51*.

It was possible to cover the survey area comprehensively within the two days on site due to the uniformity and low species richness of the vegetation within.

Although there are marked differences in the appearance between some areas mapped as 'Ar', this is a direct result of the differences in condition between the areas, (i.e. an area mapped as being in 'Good' condition appears sparser to one that is in 'Very Good' condition).

Prior to conducting the field survey, a review of the following DEC databases was undertaken:

- *'Threatened (Declared Rare) Flora'* database; and
- '*Declared Rare and Priority Flora List'* which contain species that are Declared Rare (Conservation code R or X for those presumed to be extinct) poorly known (Conservation codes 1, 2 or 3) or require monitoring (Conservation Code 4).

Regional Vegetation Description

The subject land is located within the Irwin Botanical District of the Northern Sandplains Region, which is characterised by scrub heath on sandplains near the coast and *Acacia* scrub thickets further inland (Beard, 1990). More specifically according to mapping of the Geraldton area by Beard (1976), a large proportion of the subject land contains drift sand, the remainder consists of *Acacia rostellifera* open scrub (a23Sr, vegetation number 431).

Vegetation Types

The surveys of the coastal foreshore undertaken by ATA Environmental July 2003 and October 2005 revealed that the vegetation is dominated by Coastal Heath on the primary dunes and a Closed Heath dominated by *Acacia rostellifera* on the inland protected dunes and flats.

Ten vegetation types were described and mapped in the study area (Figure 2). The different types are reasonably uniform in their composition but local variations do occur. In addition, the vegetation types often grade into each other, forming a mosaic of vegetation types in some areas. Within the coastal dunes, the vegetation types can be grouped according to their location on foredunes, primary dunes and secondary dunes.

A general description of the vegetation types recorded in the study area is provided below.

Foredunes

TdSl *Tetragonia decumbens/Spinifex longifolius* Low Open Heathland/Grassland

This vegetation type typically occupies the most seaward permanent vegetation on the foredunes. The vegetation is low and has very few species due to the extremely exposed conditions and dynamic sand movement.

OaSl *Olearia axillaris* Shrubland over *Spinifex longifolius* Grassland

This vegetation type is often found behind the TdSl unit and comprises other coastal dune colonisers such as *Acanthocarpus preissii, Cakile maritima, Myoporum insulare, Scaevola crassifolia* and *Tetragonia decumbens*.

Primary Dunes

NbSlTd *Nitraria billardierei* Open Heath over *Spinifex longifolius/Tetragonia decumbens* Grassland/Low Open Heath

This unit occurs in a very small area and is restricted to the sheltered side of the tall primary dune in the northern region of the study area.

Secondary Dunes

ArOaSl *Acacia rostellifera/Olearia axillaris* Open Heath over *Spinifex longifolius* Grassland

This widespread unit occurs inland from the coast throughout the study area. *Acanthocarpus preissii* is common in the understorey. Other species occasionally found in this unit include *Rhagodia baccata, Myoporum insulare* and *Solanum symonii*.

ArOaSc *Acacia rostellifera/Olearia axillaris* Open Heath over *Scaevola crassifolia* Low Open Heath

This unit is similar to the ArOaSl unit described above but contains *Scaevola crassifolia* rather than *Spinifex longifolius*. This subtle variation generally indicates the area is prone to accumulating sand rather than the more stable ArOaSl unit.

Ar *Acacia rostellifera* Open to Closed Heath

This unit dominates the inland region of the study area. The unit lacks many of the other species typical of coastal dunes, which is an indication that the soil type is changing to loamy red soils of the inland areas rather than the white sandy coastal dune soils.

MhAr *Melaleuca huegelii/Acacia rostellifera* Closed Scrub

One small stand of *Melaleuca huegelii/Acacia rostellifera* occurs on the inland portion of the foreshore area at the northern boundary of the study area. The presence of *Melaleuca huegelii* suggests the presence of limestone in the soil although no limestone rock was observed on the surface.

T Tamarisk (*Tamarix aphylla*) Trees

Tamarisk trees have been planted within the foreshore area to provide shade and protection from the wind. Some Tamarisk plants have self-seeded within the native dune vegetation, however these are only minor occurrences and do not appear to pose a threat of becoming an invasive weed.

Regional Representation of Vegetation

The vegetation types TdSl, OaSl, and NbSlTd correspond most closely to the Griffin (1994) Floristic Community Type Group 20-20. This Community Type Group has been recorded on 101 sites on incipient foredunes and calcareous grey sands between Dongara and Mindarie.

The vegetation types ArOaSl, ArOaSc, Ar and MhAr correspond most closely to the Griffin (1994) Floristic Community Type Group 20-17. This Community Type Group has been recorded at 161 sites on plains and dunes, on well drained calcareous grey sand and limestones, between Geraldton and Trigg

Both of these Floristic Community Type Groups are well represented along the coast between Perth and Geraldton, and therefore not regionally significant.

The Tamarisk trees are planted non-natives, and are therefore not of concern in a regional context.

Vegetation Condition

The condition of the vegetation was assessed using the condition rating scale of Keighery published in Bush Forever (Government of WA, 2000) and ranges from Completely Degraded to Very Good (Figure 3). Keighery's condition rating scale ranges from Pristine (which the vegetation exhibits no visible signs of disturbance) to Completely Degraded (where the vegetation structure in no longer intact and without native plant species). A description of the vegetation condition ratings applicable to the survey area are outlined below.

Very Good (VG) Vegetation structure altered, obvious signs of disturbance. For example, disturbance to vegetation structure caused by repeated fires, the presence of some more aggressive weeds, dieback, logging and grazing.

Good (G) Vegetation structure significantly altered by very obvious signs of multiple disturbance. Retains basic vegetation structure or ability to regenerate. For example, disturbance to vegetation structure caused by very frequent fires, the presence of some very aggressive weeds at high density, partial clearing, dieback and grazing.

Degraded (D) Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching good condition without intensive management. For example disturbance to vegetation structure caused by very frequent fires, the presence of some very aggressive weeds at high density, partial clearing, dieback and grazing.

Completely Degraded (CD) The structure of this vegetation is no longer intact and the area is completely or almost completely without native species. These areas are often described "parkland cleared" with the flora comprising weed or crop species with isolated native trees or shrubs.

In general, the remnant vegetation is in Very Good condition, particularly the foredunes and more exposed faces of the primary dunes where the harsh conditions do not allow weed species to grow. The inland area of the study area has been totally cleared to accommodate rural land uses.

The areas in poorest condition are along unsealed tracks and adjacent to road verges where Capeweed and Wild Oats easily colonise. The inland *Acacia rostellifera* stands vary in condition with the aggressive Boxthorn (*Lycium ferocissimum*) weed prevalent in places.

Boxthorn is common in the more stable landforms throughout the study area. In some areas, Boxthorn is present in low numbers and may not spread rapidly if the native vegetation remains in very good condition. In other areas, the density of Boxthorn has already reached levels that require control.

Conservation Significance of Vegetation

A search of DEC's Threatened Ecological Community (TEC) database was conducted for the study area prior to undertaking the field assessment. Two TECs were listed as occurring in the geographical range of the subject land, Greenough River Flats- *Acacia rostellifera* low forest with scattered *Eucalyptus camaldulensis* on Greenough Alluvial Flats and Moresby Range – *Melaleuca megacephala* and *Hakea pycnoneura*. Neither of these TECs was identified within the study area.

According ATA Environmental (2005), all of the native vegetation remaining within the foreshore region the Geraldton – Greenough region is considered to have some conservation value. This is mostly due to the fact that a large proportion of the vegetation has already been cleared for development to the north and south of the study area. The conservation value also includes use for fauna habitat and an important function in stabilising the fragile dunes from coastal erosion and wind erosion.

The following vegetation types in the study area are considered to have local conservation significance:

- The *Melaleuca huegelii - Acacia rostellifera* (MhAr) Scrub at the northern end of the study area is the only area within the foreshore of the study area that contains this vegetation type. The tall, dense structure of the vegetation may provide habitat for a different range of fauna than the lower, more open vegetation elsewhere in the foreshore.

- The conservation status of the areas which are dominated by an *Acacia rostellifera* Open to Closed Heath has been assessed by the Department of Agriculture and Food (2006) as part of a study of the conservation status of vegetation types held in reserves. The study identified that the *Acacia rostellifera* vegetation type (a23Sr; vegetation type number 431) currently has 4,508ha or 74.6% of the pre-European extent remaining. However, only approximately 0.9% of its original extent is currently reserved in the conservation estate and it is therefore identified as poorly reserved.

Flora

A total of 67 species were recorded within the subject land during the July 2003 and October 2005 surveys. This included 32 native species and 35 introduced (weed) species. The dominant families were the Poaceae (Grass family – ten species; one native), Asteraceae (Daisy family - nine species; two native) and Chenopodiaceae (Saltbush family – nine native species).

A list of the flora recorded within the subject land during the surveys and a list of all plant species from each of the 10m x 10m quadrats is presented in Appendices 1 and 2 of Appendix 1, Volume II (Technical Appendices).

The very low number of native species reflects the generally low diversity of flora on Quindalup dunes, the large area of mobile sand and the impact of weeds particularly on the eastern side of the study area.

Conservation Significance of Flora

No species of Declared Rare or Priority Flora were recorded from the site during the October 2005 site visit. The significant flora identified in the DEC database searches would have been identifiable at the time of the survey.

No known range extensions, restricted subspecies, poorly reserved taxa or locally endemic/species with restricted distribution were identified from the October 2005 survey based on DEC database searches and Florabase.

DEC conservation officer Kathy Page was consulted on 27 September 2007 on the possibility of other significant vegetation or flora species in the area, and she was unable to think of any further species.

4.2.5 Potential Impacts

Bayform are in negotiations with the Western Australian State Government regarding a land exchange which will result in the transfer of approximately 400ha of good quality native vegetation (Victoria Location 2584 located south of Greenough River) into State ownership in return for approximately 214ha of land (Victoria Location 11939 known as the Southgate Dunes). Victoria Location 11939 is mostly devoid of native vegetation with a mobile sand dune progressively moving in a northeast direction.

Less than 20% (26,612ha) native vegetation in the former Shire of Greenough remains (Shire of Greenough, 2006). According to the Northern Agriculture Catchment Council (2006), 7,173ha of native vegetation are protected in reserves in the former Shire of Greenough. This represents approximately 27% of remaining native vegetation is protected in reserves. The outcome of the proposed land exchange will increase the area of native vegetation protected in the conservation estate within the former Shire of Greenough.

Re-zoning the subject land to 'Development' will facilitate future development of the subject land. Urban and associated development within the amendment area has the potential to impact directly on approximately 250ha of remnant vegetation through clearing.

No species of Declared Rare or Priority Flora and no TECs were recorded within the subject land, consequently there will be no impact on rare or priority flora or threatened ecological communities.

4.2.6 Proposed Management

Representative areas of native vegetation on the subject land will to be retained in Public Open Space will be identified in at the Structure Plan stage. The developer will prepare a Vegetation Management Plan at subdivision stage to the satisfaction of the local authority on advice from the DEC. As a minimum, the Management Plan will address the following:

- Aims and long term management objectives for the area;
- Description of the area, including size, location, topography and major features;
- Aboriginal and European history of the area; including prior land uses, ownership or other relevant data;
- Biodiversity and ecological values of the area, including links to other areas;
- Description of predevelopment flora and fauna – including flora and fauna that have been located in the area and identification of any threatened, endangered or priority species;
- Details of how the assessment was conducted, including details of any transects, monitoring points or sampling;
- Details of risk assessment for site including risk to flora and fauna from adjacent urban development – from people, litter, pets, road traffic, changes in hydrology, nutrients, pollutants etc;
- Proposed management strategies to protect flora and fauna; particularly any endangered, threatened or priority species;
- Proposed management strategies for the control of feral animals;

- Reference Legislation and Policy relevant to the Management Plan;
- Risks from fire, and to community from fire;
- Risks to community from biting insects, snakes and pathogens;
- Detailed management programs to address issues identified in risk assessments;
- Management and maintenance programs for weed control, fire control, and rehabilitation or restoration of bushland area;
- Description of monitoring programs to be conducted during and after development has occurred;
- How the local community will be included in the management of the area; and
- Responsibility for conducting and financing, monitoring, restoration management and education programs.

Use of native species of local provenance should be used in rehabilitation/landscaping works for areas of public open space.

No management measures are required for significant flora, as no Declared Rare Flora or Priority Flora were found during the October 2005 flora survey.

4.2.7 Potential Outcome

Subject to resolving native title issues and the subsequent execution of the land exchange agreement, there will be a net increase in the area of native vegetation protected in the conservation estate in the Greenough Region. Victoria Location 11939 which is approximately 214ha of land which contains approximately 70ha of native vegetation will be exchanged for approximately 400ha of good quality vegetation located south of the amendment area. This land south of the river will protect a continuous bushland reserve extending from the ocean inland to the Greenough River.

Representative areas of native vegetation on the subject land will be retained in Public Open Space in the Structure Plan including the area identified as locally significant (*Melaleuca huegelii/Acacia rostellifera* Closed Scrub).
No declared rare flora, priority flora or threatened ecological communities will be impacted by the proposed Scheme Amendment.

4.3 Specially Protected (Threatened) Fauna

4.3.1 EPA Objective

Protect Specially Protected (Threatened) Fauna and Priority Fauna, consistent with provisions of the Wildlife Conservation Act 1950 and the Commonwealth Environment Protection and Biodiversity Conservation (EPBC) Act 1999. Protect other fauna of conservation significance.

4.3.2 Applicable Legislation, Criterion or Guidance

- *Wildlife Conservation Act 1950*
- *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)
- EPA (2004b) Guidance No. 56 - *Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia*
- City of Geraldton-Greenough Town Planning Scheme No. 1A

4.3.3 EPA Scope of Work

TABLE 5
EPA SCOPE OF WORK REQUIRED FOR SPECIALLY PROTECTED (THREATENED) FAUNA

CONTENT		SCOPE OF WORK
Factor	**Site specific factor**	**Work required for the environmental review**
Fauna	**Specially Protected (Threatened Fauna)**	Undertake a suitable fauna survey to identify any Specially Protected (Threatened) Fauna and other significant fauna, which may utilise the proposed Amendment area or immediate adjacent areas and may be directly or indirectly impact by the Amendment. The EPA's Guidance Statement No. 56 *Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia* is to be used. Identify and assess the potential impacts (direct and indirect) on Specially Protected (Threatened) Fauna and other significant fauna as a result of the implementation of the proposed Amendment. Discuss the representation of habitat, in existing conservation reserves, suitable for any identified Specially Protected (Threatened) Fauna and other significant fauna that will be impacted by the proposal. Consider cumulative impacts of habitat loss on terrestrial fauna. Discuss what management measures are proposed to manage impacts.

4.3.4 Existing Environment

An eight-day fauna trapping program was conducted in habitat types representative of the study area between 1 and 10 November 2005. The survey was conducted under a licence issued by the DEC (# SF 5180). The methodology employed during this survey was reviewed by Wildlife Officers from the DEC Geraldton office prior to site investigations commencing. No modifications to the proposed methodology were suggested and the assessing officer indicated that the DEC was satisfied with the proposed survey effort, scope of works and timing.

The full report for the survey is included as Appendix 2 in Volume II (technical appendices) (ATA Environmental 2006b). The report includes appendices that list the species (including (Specially Protected (Threatened) Fauna) potentially occurring on-site and numbers of those species actually present.

Pre-Survey Desktop Investigation

Prior to the survey, a desktop search for the presence of rare fauna was undertaken for the subject land. This investigation encompassed a review of the following databases:

1. Western Australian Museum on-line database (*FaunaBase*) undertaken to develop a list of potential birds, reptiles, mammals and amphibians for the subject land. The search area was bounded by latitude 28^{o} 30' – 29^{o} 15'S, and longitude 114^{o} – 115^{o}E. Marine species (e.g. seals and whales) and predominantly marine and freshwater species (e.g. petrels, albatrosses, pelicans, cormorants, darters, sea turtles) presented in the search of *FaunaBase* along with obvious exotics, have been excluded from this analysis as the proposed development does not include a marine or freshwater habitat. This large search area was used as there were limited data in *FaunaBase* for the specific study area and the

habitats represented within the study area are similar to those in the quadrant described by the latitudes and longitudes selected.

2. DEC's Threatened and Priority Species database was undertaken to identify potential scheduled and threatened species in the region using the same coordinates used for *FaunaBase*.

3. The Commonwealth *Environment Protection and Biodiversity Conservation (EPBC) Act 1999* on-line database using the same coordinates used for *FaunaBase*.

These sources of information were used to create lists of species expected to occur within the subject land. As far as possible, expected species are those that are likely to utilise the subject land. Such lists often include species that have been recorded in the general region as vagrants or for which suitable habitat is absent on-site. Particularly amongst the birds, for example, vagrants can be recorded almost anywhere. Data from *FaunaBase* were supplemented with information from Other more general texts were also used to provide supplementary information including Tyler *et al.* (2000) for frogs; Storr *et al.* (1983, 1990, 1999, 2002) for reptiles; Johnstone and Storr (1998; 2004) and Storr and Johnstone (2003) for birds; and Strahan (2000) for mammals. In addition, a number of published and unpublished reports for fauna surveys on the northern Swan Coastal Plain and Geraldton Sandplains have been used to provide a regional context for the small vertebrate assemblages sampled in the study area.

Taxonomy and nomenclature for fauna species used in this report are mostly those used in *FaunaBase* which presumably follows Aplin and Smith (2001) for amphibians and reptiles, How, Cooper and Bannister, (2001) for mammals, and Johnstone and Storr (1998, 2004) for birds.

Fieldwork Methodology

Two broad habitat types are present in the study area. These are the Coastal Heath on the primary dunes (Habitat type I) and a Closed Heath dominated by *Acacia rostellifera* (Habitat type II) on the inland protected dunes and flats. Both of these habitat types range in habitat quality from very good to highly degraded.

A series of trapping arrays were set up within the different habitat types across the study area. The allocation of trapping effort reflected the relative abundance of each habitat type on the overall study area. Each trapping array consisted of one 150mm diameter stormwater pipe pit-trap (500mm deep), one 20L bucket pit-trap and two-pairs of funnel traps (4) located along a 10m drift fence (300mm high). Two Elliott traps were placed within 5m of the drift fence. Five trapping arrays were set up at each trapping site and each trapping site had three cage traps. Cage and Elliott traps were baited with a mixture of peanut butter, oats and sardines.

Sites 1-4 were established in remnant vegetation to the south of the study area. Sites 5-16 were established in the Closed Heath on the inland dunes and flats. Sites 17-20 were established in the Coastal Heath. Sites 1-8 and 17-20 were open for nine nights, and sites 9-16 were open for eight nights. In total, 7,396 trap-nights were employed during the survey period of 1-10 November 2005.

Avifauna Surveys

Systematic avifauna surveys were conducted from sunrise for a minimum of six person hours between 3-9 November and opportunistically throughout the whole survey period between 1-10 November 2005. The order of avifauna survey was rotated among sites to minimize activity period bias. Each habitat type was surveyed first at least three times from sunrise and three times early-mid morning. To enable a representative search of each habitat type,

randomly assigned transects that bisected the habitat types were searched. This involved two observers walking slowly 30-50m in parallel through the habitat and recording any birds that were seen or heard. All birds were identified by their call or direct observation. Additional avifauna surveys were conducted at dusk on four evenings (3-6 November) for approximately four person hours. These were designed to target bird species that may be more active in the early evenings than during the day or around sunrise.

Spotlighting Survey

Spot-lighting targets a particular suite of fauna that often do not readily get caught by other means, such as nocturnal reptiles and mammals (e.g. pythons, rabbits), and provides useful supplementary data to the trapping program. Large, predominantly nocturnal mammals (e.g. foxes, kangaroos, cats, etc) are also observed during these searches.

Spot-lighting was conducted on five evenings (3-7 November) from a slow moving vehicle (~5 km/hr) using a high powered hand-held spot-light with a diffuse red light cover. In addition, areas that could not be surveyed from the vehicle were walked using head torches (head-torching). Each survey lasted approximately 3-4 hours and included various sections of the study area and surrounding habitat. Access tracks that bisected the study area were used for spotlighting and each of the trapping sites were investigated at least once over the five-night survey period. These tracks provide relatively good access to each of the habitat types across the study area. Head torching was conducted around eight sites (9, 10, 13 - 17 and 19).

Coastal Heath and Closed Heath areas to the south of the study area were also investigated during the spotlighting surveys to provide a regional comparison. These areas were accessed by vehicle tracks that crossed the Greenough River mouth and ran parallel to the coastline or along the southern bank of the Greenough River. No head torching was conducted south of the Greenough River.

Bat Surveys

Night surveys of bat species active in the study area were undertaken using an Anabat II recorder during the spot-lighting surveys. The Anabat II recorder was set up and left vertically in fly ways within each habitat type for approximately 45 minutes. Surveys were conducted near five sites (8, 10, 14, 17 and 19).

Non-Systematic Searches

Hand searching using rakes, digging out holes and opportunistic sightings of reptiles, mammals and amphibians in the study areas were recorded. Non-systematic searching was conducted between sites 1-4, west of sites 10 and 12, north of site 6 and 7 and between 17 and 18, and 19 and 20.

Results

Twenty four species and 275 individual terrestrial vertebrates were trapped over the nine day period. An additional three species and 66 individuals were recorded as part of opportunistic searches.

Nocturnal Searches

Nocturnal searches indicated a high number of rabbits, feral cats and at least one fox are present in the study area. No bats were recorded or observed during any of the spotlighting assessments. Stubble Quails were regularly disturbed in the wheat fields adjacent to Brand

Highway during nocturnal searches. Two geckoes were recorded (*Diplodactylus granariensis* and *Strophurus spinigerus*) during the nocturnal searches.

In addition to the seven cats and single fox observed, multiple sets of tracks from both species were observed each morning indicating that these species were active throughout the subject land.

Avifauna

A total of 130 species could potentially be found in the general locality, however, not all of these species are expected to be observed, forage or nest in the general area. There are always going to be vagrants present in an area because of unusual weather (e.g. flooding or storms) or because of the nearby habitats (i.e. coastline, estuary). Of these 130 species, 27 species and 1,215 individuals were observed in the vicinity of the trapping sites. A number of bird species have been reported in the general region that were not recorded in *FaunaBase* for the search area. This is to be expected as species lists for the region are compiled over many years and many of the species listed have seasonal shifts in foraging and breeding sites and *FaunaBase* is a list of vouchered specimens only.

It should be noted that the Indian Ocean and associated coastline abuts the western edge of the subject land. The Greenough River Estuary is immediately south of the subject land. Birds that frequent the sea, beach and estuary occasionally fly over the study area but do not actively forage in this area. In addition, there are four ponds associated with the Water Corporation Waste Water Treatment Plant. These have not been surveyed as part of this assessment. Species presented in the search of *FaunaBase* and in other reports for the region have been included in the appendices. It is acknowledged that some of these species are unlikely to use the study area because of a lack of suitable habitat.

Reptiles

Twenty one species of reptiles were caught during the field survey.

Mammals

Larger mammal species (e.g. kangaroos and rabbits) are unlikely to be caught in pit, funnel, Elliott or cage traps, but their scratchings, burrows and scats provide evidence of their presence in an area. Spot-lighting at night is also a useful method of detecting the presence of many of these species. Three species of mammals were caught, House Mice (*Mus musculus*), feral cats (*Felis catus*) and an Echidna (*Tachyglossus aculeatus*). Numerous rabbits, a fox and many cats were sighted in the night searches.

Amphibians

No amphibians were recorded at Cape Burney.

Species of National Environmental Significance under the EPBC Act 1999

Numerous species of birds were identified as having National Environmental Significance under the *EPBC Act 1999* within the search grid co-ordinates. However, the vast majority of these are marine or coastal species that are likely to inhabit the marine environment to the west of the study area, or Greenough Estuary to the south and are unlikely to breed or forage in the subject land. These birds have not been included in this analysis. The only species of particular conservation interest under the *EPBC Act 1999* likely to be found or recorded in the subject land are the White Bellied Sea-Eagle (*Haliaeetus leucogaster*), Rainbow Bee-eater (*Merops ornatus*) and the Fork-tailed Swift (*Apus pacificus*). Based on the results of the survey, none of these

species is likely to rely on the subject land for survival. Therefore, it is unlikely that these species will be significantly affected by the Scheme Amendment.

Significant Fauna under the WA Wildlife Conservation Act 1950-1979

In Western Australia, all native fauna species are protected under the *WA Wildlife Conservation Act 1950-1979*. Fauna species that are considered rare, threatened with extinction or have a high conservation value are specially protected under the Act. In addition, some species of fauna are covered under the 1991 ANZECC convention, while certain birds are listed under the Japan and Australian Migratory Bird Agreement (JAMBA) and the China and Australian Migratory Bird Agreement (CAMBA).

Classification of rare and endangered fauna under the Wildlife Conservation (Specially Protected Fauna) Notice 1998 recognises four schedules of taxa. These are:

Schedule 1 – fauna which are rare or likely to become extinct and are declared to be fauna in need of special protection.

Schedule 2 – fauna which are presumed to be extinct and are declared to be fauna in need of special protection.

Schedule 3 – birds which are subject to an agreement between the governments of Australia and Japan relating to the protection of migratory birds and birds in danger of extinction which are declared to be fauna in need of special protection; and

Schedule 4 – fauna that are in need of special protection, otherwise than for the reasons mentioned in Schedule 1, 2 or 3.

In addition to the above classification, the DEC also classifies fauna under four different Priority codes:

Priority one – *Taxa with few, poorly known populations on threatened lands*:
Taxa which are known from few specimens or sight records from one of a few localities on lands not managed for conservation. The taxon needs urgent survey and evaluation of conservation status before consideration can be given to declaration as threatened species.

Priority two – *Taxa with few, poorly known populations on conservation lands, or taxa with several, poorly known populations not on conservation lands:*
Taxa which are known from few specimens or sight records from one or a few localities on lands no under immediate threat of habitat destruction or degradation. The taxon needs urgent survey and evaluation of conservation status before consideration can be given to declaration as threatened fauna.

Priority three – *Taxa with several, poorly known populations, some on conservation lands*:
Taxa which are known from few specimens or sight records from several localities, some of which are on lands not under immediate threat of habitat destruction or degradation. The taxon needs urgent survey and evaluation of conservation status before consideration can be given to declaration as threatened fauna.

Priority four – *Taxa in need of monitoring:*
Taxa which are considered to have been adequately surveyed or for which sufficient knowledge is available and which are considered not currently threatened or in need of special protection, but could if present circumstances change. These taxa are usually represented on conservation lands. Taxa which are declining significantly but are not yet threatened.

Species Listed as Threatened or Priority Species under WA Wildlife Conservation Act 1950 Potentially Occurring within the subject land

Threatened and Priority species listed under the *Wildlife Conservation Act* or DEC's Priority species database that may potentially occur near Cape Burney are listed in Table 6 and 7. Included are two Schedule 1 species, one Schedule 2 species, two Schedule 4 species and 2 two migratory species. Two species with a priority listing with DEC have also been predicted or recorded in the general area. The likelihood of species listed under government legislation or conservation programs being found near Cape Burney are discussed below.

TABLE 6
SIGNIFICANT SPECIES LISTED AS OCCURRING IN THE AREA BASED ON A SEARCH OF THE DEC AND DEH DATABASES

Species	Status under Wildlife Conservation Act	Status under Commonwealth *Environment Protection and Biodiversity Act*	Potential to be found in the study area
Shield-backed Trapdoor Spider *Idiosoma nigrum*	Schedule 1		*Unlikely* to be present in the study area due to unsuitable habitat.
Bothriembryon whitleyi	Schedule 2		Presumed extinct.
Aspidites ramsayi	Schedule 4		Unlikely to be present due to lack of recent sightings and abundance of feral cats.
Psacadonotus seriatus	Priority 1		No information available.
Western Brush Wallaby *Macropus irma*	Priority 4		*Recorded* in region but not within the study area.
White-bellied Sea Eagle *Haliaeetus leucogaster*		Migratory	*Unlikely* to rely on the study area for survival although regionally present.
Rainbow Bee-eater *Merops ornatus*		Migratory	*Recorded* during the survey.

TABLE 7
SIGNIFICANT SPECIES LISTED AS POTENTIALLY OCCURRING IN THE AREA BUT NOT LISTED ON A SEARCH OF THE DEC AND DEH DATABASES

Species	Status under Wildlife Conservation Act	Status under Commonwealth *Environment Protection and Biodiversity Act*	Potential to be found in the study area
Carnaby's Cockatoo *Calyptorhynchus latirostis*	Schedule 1	Endangered	*Unlikely* to be in the study area.
Peregrine Falcon *Falco peregrinus*	Schedule 4		*Recorded* in the region but not in the study area.
Carpet Python *Morelia spilota imbricata*	Schedule 4		*Unlikely* to be in the study area.
Fork-tailed Swift *Apus pacificus*		Migratory	Recorded in the region

NB: Marine species have been excluded from the Tables 4 and 5.

Significant Fauna Potentially Found in the Subject Land

The following is a brief description of the preferred habitat of species listed in Table 6 and 7 and ATA Environmental's assessment of the likelihood of these species being found within the study area.

Shield-backed Trapdoor Spider (*Idiosoma nigrum*) (Schedule 1 Species)

The Shield-backed Trapdoor spider is a winter runner (males) and disperser (juveniles). The genus *Idiosoma* is endemic to south-western Western Australia, with *I. nigrum* being found in the central wheatbelt area (Main, 1991). Although once widespread, *I. nigrum* is now restricted to a small area of Jam (*Acacia acuminata*) woodland, east of the northern part of the Darling Ranges to Murchison River, and then east to Paynes Find (Main, 1982). *Idiosoma nigrum* make its burrows in heavy clay soils in open York Gum (*Eucalyptus loxophleba*), Salmon Gum (*E. salmonophloia*), wheatbelt Wandoo (*E. capillosa*) woodland, with Jam (*A. acuminata*) forming a sparse understorey (Main, 1987, 1991, 1992). Some nests have also been found in granite soils (Main, 1992). A thin layer of permanent *Eucalyptus*, *Casuarina* and *Acacia* litter is required, within which the spiders forage (Main, 1987). If the litter layer is too thick, the young spiders cannot dig through to establish nests (Main, 1992). It is a long-lived species that is very susceptible to disturbance.

Given that much of the habitat is disturbed and has sandy soils, it is ATA Environmental's assessment that this species is unlikely to be found in the study area.

***Bothriembryon whitleyi* (Schedule 2 Species)**

This species of snail has historically be recorded from Geraldton, however, is now presumed extinct. The potential for this species to be found in the subject land is highly unlikely.

Woma Python (*Aspidites ramsayi*) (Schedule 4 species)

This species is found across central Australia into the southwestern edge of Queensland, and into northern South Australia. Other populations are known from the Pilbara coast, north to the Eighty-mile Beach area, and southwest Western Australia, from Cape Peron south and east to the eastern Goldfields. It occurs in the arid zones of Western Australia, favouring open myrtaceous heath on sandplains, and dunefields dominated by Spinifex. The various geographic populations of the Woma have long been recognised informally however are only described taxonomically as one species. Although listed as Schedule 4 only the southern populations from Shark Bay through the Wheatbelt, Goldfields and to the Nullarbor are considered threatened. The last confirmed sighting in the region was at Watheroo in 1989, but there have also been unconfirmed observations near Coorow within the last five years.

ATA Environmental's assessment is that given the lack of recent observations of Woma Pythons in the Geraldton area and the high abundance of feral cats it is unlikely that Woma Pythons would be present in the study area.

***Psacadonotus seriatus* (Priority 1 Species)**

This species of mantis is only known from Champion Bay near Geraldton. No other information is available on the species. The potential for this species to be found in the subject land is unlikely.

Western Brush Wallaby (*Macropus irma*) (Priority 4 Species)

This species was very common in the early days of settlement, however, its range has been seriously reduced and fragmented due to clearing for agriculture and there is a significant decline in abundance within most remaining habitat. It is now distributed across the south-west of WA from north of Kalbarri to Cape Arid. The optimum habitat is open forest or woodland, particularly favouring open, seasonally wet flats with low grasses and open scrubby thickets.

Although no Western Brush Wallabies were observed during the assessment, they are potentially found in the region, as some areas of habitat are dense and large enough to sustain a population. It is ATA Environmental's assessment that the proposed development at Cape Burney will not significantly impact on this species.

White-bellied Sea Eagle (*Haliaeetus leucogaster*) (Migratory Species)

This species is the second largest bird of prey found in Australia. White-bellied Sea-Eagles are a common sight in coastal and near coastal areas of Australia. Birds form permanent pairs that inhabit territories throughout the year. These eagles are normally seen perched high in a tree, or soaring over waterways and adjacent land. This eagle is seen along most of the Western Australian coastline, so it may occasionally be seen in vicinity of the study area.

Given the disturbed habitat, and lack of large trees that may be suitable for nesting or roosting, it is ATA Environmental's assessment that this species is unlikely to regularly utilise the area, however, it may be observed flying through the region. Therefore, it is ATA Environmental's assessment that the proposed development at Cape Burney will not significantly impact on this species.

Rainbow Bee-eater (*Merops ornatus*) (Migratory Species)

The Rainbow Bee-eater is a migratory bird that arrives in the south-west of WA in late September – early October and nests in a burrow usually dug in sandy soils. It is found in a wide variety of sandy habitats on the Swan Coastal Plain and Geraldton Sandplains. This species is listed as a Migratory species under the *EPBC Act 1999*.

ATA Environmental recorded 55 observations of Rainbow Bee-eaters (many of the same individuals) during the nine day site assessment. Many breeding burrows were also located within sandy substrate across the study area. Although, the birds were recorded breeding on site, ATA Environmental considers that any proposed land clearing will not have a significant impact on this species as there are many other suitable foraging and breeding sites for this species in the general vicinity.

Carnaby's Black-Cockatoo (*Calyptorhynchus latirostrsi*) (Schedule 1 Species)

This species inhabits the south-west of WA. Its preferred habitat is the woodland where it preferentially feeds on plants of the Proteaceae family. In winter, flocks can be found in heaths. It is possibly a seasonal visitor to heath vegetation to the south of Cape Burney, however, has not been recorded regularly in the Greenough region.

Given the extent of disturbed habitat, it is ATA Environmental's assessment that this species is unlikely to regularly utilise the area, however, it may occasionally be observed flying through the region. Therefore, it is ATA Environmental's assessment that the proposed development at Cape Burney will not significantly impact on this species.

Peregrine Falcon (*Falco peregrinus*) (Schedule 4 Species)

This species is uncommon, although widespread throughout much of Australia, excluding the extremely dry areas and has a wide and patchy distribution. It shows a habitat preference for areas near cliffs along coastlines, rivers and ranges and within woodlands along watercourses and around lakes.

ATA Environmental's assessment is that this species is possibly an infrequent visitor to the area but the loss of habitat is unlikely to have an impact on this species. Therefore, it is ATA Environmental's assessment that the proposed development at Cape Burney will not significantly impact on this species.

Carpet Python (*Morelia spilota imbricata*) (Schedule 4 Species)

The South-west Carpet Python is a large snake found across the south-west of WA, north to Geraldton and Yalgoo, and east to Kalgoorlie, Fraser Range and Eyre. They inhabit forest, heath, or wetland areas and shelter in hollow logs or in branches of large trees. Carpet Pythons are often found in colonies, particularly when breeding in spring. This species is widespread within the southwest, but is not in high density across its distribution.

ATA Environmental's assessment is that this species is unlikely to inhabit the study area as it is at the northern extent of its distribution and juveniles would be easily predated upon by feral cats, thereby reducing the chances of maintaining a viable population.

Fork-tailed Swift (*Apus pacificus*) (Migratory Species)

This species breeds in the northeast and mid-east Asia and winters in Australia and southern New Guinea. It is a visitor to most parts of WA, beginning to arrive in the Kimberley in late September, in the Pilbara and Eucla in November and in the southwest land division in mid-December, and leaving by late April. It is common in the Kimberley, uncommon to moderately common near northwest, west and southeast coasts and rare to scarce elsewhere. Usually flocks (up to 2,000) occur when changed weather conditions (e.g. storms and cyclones) occur. Fork-tail Swifts were recorded by HGM in 2000 in the surveys between Lancelin and Cervantes.

ATA Environmental considers that any proposed land clearing will not have a significant impact on this species as they area an aerial forager, don't usually land and there are many other suitable areas for this species in the general vicinity.

4.3.5 Potential Impacts

Of the species listed under Commonwealth and State Government legislation requiring special protection due to their vulnerability only the Rainbow Bee-eater was recorded during the survey conducted by ATA Environmental. ATA Environmental's assessment is that this species is unlikely to be significantly impacted upon by the proposed development of the subject land, as there are many other suitable foraging and breeding sites for this species in the general vicinity of the subject land.

No significant trees containing hollows suitable for breeding birds were recorded within the subject land and it is ATA Environmental's assessment that species of Black Cockatoo are unlikely to either forage or nest in the subject land.

Re-zoning the subject land to facilitate development will result in the clearing of fauna habitat. It is unlikely that the proposed development of the subject land will substantially modify, destroy or isolate an area of important habitat for any of these species, or seriously disrupt the

lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significantly proportion of the population of any of the listed fauna species.

None of the species listed as being recorded or predicted in the region are likely to be significantly impacted by clearing of native vegetation in the subject land.

4.3.6 Proposed Management

Representative areas of fauna habitat will be retained in Public Open Space. These areas will be identified at the Structure Plan stage and where possible, be retained in corridors to assist faunal movement. In order to manage the impacts between the proposed development and areas of native vegetation, a Vegetation Management Plan that protects fauna habitat values and addresses feral animal control will be prepared. Details of the Vegetation Management Plan have been provided in Section 4.2.6.

The land exchange will result in the transfer of approximately 400ha of very good quality fauna habitat into the conservation estate.

4.3.7 Potential Outcome

Implementing the land exchange will result in an increased area of habitat protected in the conservation estate. This transfer will ensure protection of very good quality vegetation and fauna habitat from the coast inland to Greenough River.

Representative areas of habitat will be identified and retained in Public Open Space at the Structure Plan stage.

4.4 Coastal Landforms, Processes and Foreshore

4.4.1 EPA Objective

To maintain the integrity of landscape and landforms by maintaining their integrity, ecological functions and environmental values.

4.4.2 Applicable Legislation, Criterion or Guidance

- Western Australian Planning Commission (2003a) Statement of Planning Policy No. 2 *Environment and Natural Resources Policy*
- *Planning and Development Act 2005*
- Western Australian Planning Commission (2003b) Statement of Planning Policy 2.6 *State Coastal Planning Policy*
- City of Geraldton-Greenough Town Planning Scheme No. 1A

4.4.3 EPA Scope of Work

TABLE 8
EPA SCOPE OF WORK REQUIRED FOR COASTAL LANDFORMS, PROCESSES AND FORESHORE

CONTENT		SCOPE OF WORK
Factor	**Site specific factor**	**Work required for the environmental review**
Coast	Coastal Landforms and Processes	Describe the coastal landforms that may be impacted by the Amendment (both directly and indirectly as a result of increased population) and their significance. Identify landforms and dunes potentially subject to coastal processes and coastline movements, taking into account the effects of predicted sea-level rise, and describe the impact the Amendment may have on these landforms. Describe management measures, including setbacks, to be implemented to reduce impacts on the coastal landforms. Assess coastal processes, including the contribution of the dune system to off-shore sediment movement and the nourishment of beaches outside the Amendment area. Assess the impact and document management provisions.
	Coastal Foreshore	The determination of appropriate setbacks and foreshore reserve to be based on shoreline movement data and other relevant factors such as adequate space for public amenity facilities and protection of foredune areas.

4.4.4 Existing Environment

The subject land lies within the northern section of the Perth basin within the coastal belt (Playford *et al*., 1976). The area is underlain and backed by Pleistocene Tamala limestone and comprises consolidated aeolian and marine sediments. More recent, Holocene aeolian derived sediments of calcareous sands have been deposited over the limestone, forming dunes which are part of the Quindalup Dune System.

The Quindalup Dune System contains a complex association of parabolic dunes, blowouts and deflation basins. Within the subject land, the beach is narrow with exposed limestone at many locations. The orientation of the dunes and ridges is influenced by the strong prevailing south to south-west winds.

The beach and dunes consist of deep calcareous sands predominantly composed of shell fragments (Safety Bay Sand). These sands are highly permeable and susceptible to wind erosion if devoid of native vegetation.

The Southgate Dune System is an area of bare mobile sand approximately 3km long and 1.2km at its widest point, extending along the coast immediately north from the Greenough River mouth (Alan Tingay and Associates, 1998). The dune system is both visually prominent in the landscape and forms a local landmark. However, there is no evidence to suggest any cultural significance of this feature. The dune system is migrating in a north-east direction due to the predominant winds and is a potential impediment to future development of land south of Geraldton. It has been previously recognised that that the dunes need to be stabilised to protect existing residential development and infrastructure (Alan Tingay and Associates, 1998).

M P Rogers and Associates (MRA), a specialist coastal engineering firm, have undertaken various coastal engineering investigations in 1996 and more recently in 2006. The information contained below has been adapted from these documents.

MRA's 1996 investigations involved the following work:

- Assessment of long-term beach stability from shoreline movement plans;
- Determination of a quantitative sediment budget for the amendment area;
- Assessment of coastal vulnerability and suitable set-backs at various coastal locations within the development; and
- Identification and assessment of the potential impacts on adjacent beaches of the stabilisation of the mobile Southgate Dune System.

MRA's 2006 investigation identified a suitable coastal setback in line with the State Coastal Planning Policy. A copy of this report is provided as Appendix 3 in Volume II (Technical Appendices).

A number of driving forces interact to drive coastal processes. These forces typically include wind regime, wave climate, tides and nearshore currents. Each of these is discussed below:

Wind Regime

The wind regime influences coastal processes through the generation of ocean waves and currents as well as feeding dune systems with wind blown beach sands. The Bureau of Meteorology has measured the wind speed and direction at Geraldton Airport for many decades. During winter, morning winds are predominantly from the north-east and afternoon winds usually blow from north-west to southerly directions. In summer, morning winds mainly blow from the east through to the south. During summer afternoons, the common wind directions are south-west and south. The overall pattern is that of moderate to strong winds with speeds often more than 40km/hr. The most frequent direction is the southern quadrant.

Wave Climate

The waters offshore near Geraldton experience high wave energy.

The main elements of the offshore wave climate are:

- Locally generated seas which are fetch limited by the extent of the sea breeze system. These waves are typically 0.5m to 1.5m high with periods of 3 to 6 seconds and are generally from the south-west to south.
- Seas generated locally by the passage of cold fronts during winter. The wave heights and periods vary markedly from storm to storm. Often wave heights exceed 4m and the wave periods reach 6 to 10 seconds. The direction from which the waves approach can range from west to south-west during the passage of the storm.
- Swell waves from distant storms in the Southern Indian Ocean continually reach the offshore area. These swell waves often exceed 2m and typical periods are between 8 and 16 seconds. These swell waves commonly approach from the south-west.
- Severe waves caused by dissipating tropical cyclones. These storms are infrequent at Geraldton however, when the do occur, the casus severe conditions for short periods.

The offshore waves are greatly affected by the various reefs and the gaps between the reefs as they travel toward the shore. The reefs and adjacent areas modify the waves.

Tides

The astronomical tides at Geraldton are predominantly diurnal with a typical range of 0.7m during spring tides and less than 0.5m during neap tides (Alan Tingay and Associates, 1998). Tidal statistics derived from the Australian National Tide Tables (Department of Defence, 1995) include the following:

- Highest Astronomical Tide (HAT) 1.3m above Chart Datum (CD)
- Mean High High Water (MHHW) 1m above CD
- Mean Sea Level (MSL) 0.6m above CD

Due to meteorological influences, the mean sea level at Geraldton rises 0.1m during winter and falls 0.1m during summer (Alan Tingay and Associates, 1998).

Significant storm surges occur during storm events associated with both winter cold fronts and cyclones due to barometric and wind effects. Storm surge in excess of 1m above the astronomical tide level can occur during extreme events (Port and Harbour Consultants, 1989). The highest water level recorded at Geraldton was 2.1m above CD or 1.5m above MSL in 1970 and was most likely associated with a tropical cyclone.

Given the limited tidal range, the level of the level of the sea would generally have a secondary effect on sand movement along the shoreline except during storm events when high water levels would enable waves to attack the rear of sandy beaches (Alan Tingay and Associates, 1998).

Nearshore Currents

A brief literature search conducted by MRA uncovered little data on the ocean currents near Geraldton. In the deeper water of the continental shelf, the warm Leeuwin current has been observed in various satellite images. However, no data on the nearshore currents around Geraldton were found.

The flooding of the Greenough River in March 1994 resulted in the discharge of turbid water into the nearshore coastal environment. This flooding event provided an ideal tracer with which to gauge nearshore currents, albeit for a short period. Generally, the river water plume extended from the beach to approximately 2km offshore in a northward ribbon. The plume turned westward at Separation Point and travelled to the seaward side of Point Moore Reefs before heading northward again. The observed track of plume did not travel along Greys Beach.

This sort of advective current could transport very fine sediments, especially when significant wave energy was present and provided a mechanism to agitate the bottom sediments.

Coastal Setback Investigations

The State Coastal Planning Policy (SCPP) provides guidance on the sitting of development on the Western Australian Coastline. Schedule One of the SCPP outlines the recommended criteria for use in determining the appropriate coastal setback to development. This setback should provide adequate protection from physical coastal processes for a 100 year planning horizon.

For the general case of development on an undeveloped sandy shoreline, the SCPP recommends using the following criteria to calculate the appropriate coastal setback:

- Severe Storm Erosion Allowance (S1) – This allowance accounts for acute short term erosion caused by a series of severe storms, with elevated water levels and an Average Recurrence Interval (ARI) of approximately 100 years. S1 is calculated using the SBEACH profile change model using three repeats of the severe storm experienced in

Perth in July 1996 to conservatively represent the 100 year ARI storm with respect to coastal erosion.

- The SCPP recommends taking the S1 factor as the total recession of the mean sea level contour as estimated using SBEACH and three repeats of the July 1996 storm. MRA does not believe that the recession of the mean sea level contour is the most critical factor when assessing safe development on the coast. The erosion behind the Horizontal Setback Datum (HSD) or coastal vegetation line is the more critical factor for safe development and is used in this assessment.

- Long-Term Shoreline Movement Allowance (S2) – This allowance accounts for chronic long-term trends caused by the local coastal dynamics. This needs to provide a buffer for the coming 100 years. Consequently, the prediction for the future chronic erosion setback allowance should be calculated as 100 times the assessed present long term rate of erosion, although allowance should also be made for other factors that may effect the future shoreline movement. A minimum allowance of 20m should be used where the rate of erosion or accretion is less than 0.2m/yr. If the long term rate of accretion is greater than 0.2m/yr no allowance is given, and S2 is taken as 0m.

- Future Climate Change Allowance (S3) – This allowance accounts for possible recession of the shoreline because of the anticipated sea level rise in the coming 100 years. The policy recommends allowing for a 0.38m rise in the general sea level and assumes that this may cause a 38m recession of the shoreline.

The SCPP provides several variations to the general case of development on a sandy coastline. One such variation is for rock shorelines, which are defined as *"a coast where the highest visible influence of sea action is in direct contact with lithified material"* (WAPC, 2003b). In this case, it is recommended that the development setback be determined following a geotechnical survey accounting for possible erosion over a 100 year period. In the absence of a geotechnical survey, a minimum setback of 50m is recommended.

The calculated setback distance is measured from the Horizontal Setback Datum (HSD). On a sandy coast, the HSD is taken as the seaward limit of coastal vegetation on a stable or accreting shoreline, or the toe of an erosion scarp in areas of erosion. On a rock shoreline, the HSD is set based on the normalised alignment of the landward limit of sea action.

The SCPP also considers factors such as public beach access and ecological values. MRA's investigations did not include consideration of these factors, but only the requirements to protect development from physical coastal processes.

Severe Storms

MRA used SBEACH, a profile change computer model, to determine an appropriate allowance for severe storm erosion events. SBEACH was used to simulate three repeats of the severe storm experienced in Fremantle in July 1996. Adjustments were made to ensure that the extreme conditions experienced at Fremantle correspond with those likely to be experienced at Cape Burney.

Sediment samples were taken by MRA from the waterline, the beach berm and the foredune, and a composite sample of the three was analysed to determine the representative grain size which was used in the SBEACH model.

The beach was divided into four sections based on exposure, aspect and characteristics of the beaches adjacent to the amendment area. SBEACH modelling indicated that the magnitude of

erosion that could be expected in each of the sectors during the prescribed storm ranged from 16m (where exposed limestone on the beach is present) to 32m (sandy beach).

Long-Term Shoreline Movement

Analysis of the shoreline movement over several decades provides an indication of the long term stability of the coast. Shoreline movement plans for the region were prepared from aerial photos covering a 59 year period (1942, 1975, 1988, 1992 and 2001). An assessment of the position and extent of advance or retreat of the coastline between these years was estimated at 200m intervals along the coast.

The shoreline movement assessment showed that the northern 1,200m of shoreline experienced significant erosion between 1942 and 1975, but has since experienced a moderate accretion trend. In 1956, the vegetation line was up to 120m east of the 1942 line. A severe storm is the probable cause for the destabilisation of the beach and dunes and subsequent erosion. The remainder of the shoreline has remained stable or has experienced a slight accretion trend. The rate of shoreline movement observed in this area is generally below 0.2m per annum.

MRA (1996) reported that the coastline south of Cape Burney was relatively stable during this period, most likely due to the presence of rock platforms which contribute to beach stability.

In calculating an S2 (shoreline movement) allowance, MRA also factored in potential errors and a safety net for the situation if Southgate Dunes are stabilised and the sand feed from the dunes to the beach is removed. MRA recommended S2 allowances ranged from 20m to 115m.

Climate Change

The Intergovernmental Panel on Climate Change has identified various scenarios for possible climate change and associated sea level rise over the coming 100 years. The SCPP recommends adopting a possible sea level rise in the coming 100 years of 0.38m. The impact of this seal level change on a sandy coast is difficult to predict. The SCPP recommends that an allowance of 100 times the sea level rise be made. Therefore, an allowance of 38m is needed for the Cape Burney shoreline, although this figure is likely to be conservative for the section of coastline that is stabilised by rock.

4.4.5 Potential Impacts

The gradual migration of Southgate Dunes in a northerly direction will ultimately encroach on to property and infrastructure. It is therefore a necessity to stabilise Southgate Dunes to protect existing property and infrastructure from the migrating dune. Urbanisation has been a successful approach to stabilising mobile dune systems. Bayform has entered into an agreement with the State of Western Australia that will result in the transfer of Lot 11939 into Bayform's ownership in exchange for Lot 2584 (currently owned by Bayform) into Crown ownership. This land exchange is also currently subject to two Native Title Claims. Subject to resolution of Native Title issues, Bayform, as a part of the land exchange agreement will be responsible for the stabilisation of Southgate Dunes. In order to facilitate future development of the subject land, it is necessary to re-sculpt Southgate Dunes to final development levels. The resulting landform will retain an element of the Southgate Dunes landform as depicted in Figure 4. Once final levels have been achieved, the site will be stabilised by spreading approximately 100mm of loamy soil across the site then seeded with cereal rye as detailed in with ATA Environmental's Southgate Dunes Stabilisation Strategy (Refer to Appendix 4, Volume II Technical Appendices). This approach is favoured over other methods due to the proposed end land use for the subject land.

When considering the impacts on beaches further north, it is necessary to consider sands sources (where the sand is coming from) and sand sinks (where sand is deposited). If there is a net loss of sediment being deposited into the beach zone, for example through the action of inland wind transport, then the shoreline will retreat unless sand is being supplied from another source. Conversely, if there is a net gain of sediment to the beach zone then the shoreline will advance resulting in beach ridge formation as sand is trapped by vegetation behind the beach.

MRA (1996) identified that in 1958 Southgate Dunes broke through the vegetated barrier between the mobile dune and the beach. Therefore, the beaches to the north (Tarcoola, Mahomets and Back Beaches) are likely to have received some sediment supply from Southgate Dunes since 1958. Prior to this point in time, Southgate Dune system would not have significantly contributed to the sediment supply of the northern beaches. Therefore, one could assume that pre-1958 coastal trends would reflect the situation where Southgate Dunes were not contributing to the littoral drift of sand to the beaches north of the amendment area. MRA (1996) identified that during the 1942 to 1956 period, some localised erosion occurred near the southern end of Tarcoola Beach, however, over the 14 year period both Mahomets and Tarcoola Beaches steadily accreted while the Back Beach remained relatively stable. MRA (1996) estimated that the beaches north of Southgate Dunes have generally been accreting at 40,000m^3 per year. MRA (1996) also estimated that Southgate Dunes have been contributing approximately 10,000m^3 of sand to the littoral drift each year, which represents only a small portion of the Southgate Dunes that contributes to the littoral drift. Stabilisation of the Southgate Dunes has the potential to remove the sand feed from the dunes. However, the available data makes it difficult to predict whether the beaches to the north would remain stable or erode slightly if the supply of sediment from Southgate Dunes were removed. To compensate for this uncertainty, MRA added a factor of 10m to the S2 component for the northern 1,000m of coastline to provide additional protection in the case of slight erosion.

4.4.6 Proposed Management

A foreshore reserve, consistent with MRA (2006) recommendations and taking into account recommendations of the Geraldton-Greenough Coastal Strategy and Foreshore Management Plan (ATA Environmental, 2005) will be identified for retention in public open space at the Structure Plan stage.

An essential requirement for coastal development is to provide a balance between protection of the environment and sustainable development of both recreational facilities within and immediately adjacent to the foreshore reserve. Detailed Foreshore Management Plans and Implementation Strategies will be developed for the foreshore reserves at subdivision stage and implementation at the subdivision stage to the satisfaction of the local authority on advice from the Department for Planning and Infrastructure. The following principles and components will apply to the development of the foreshore reserve and will be incorporated into the Foreshore Management Plans:

- Development of nodal access to concentrate beach use in selected areas;
- All access formalised by construction of roads, paths and car parks;
- Fenced dual use paths and pedestrian access ways;
- Incorporation of a highly scenic cycle route along edge of, or within, the foreshore reserve as part of a regional system;
- Structures such as pavilions, boardwalks adopted as public facilities which enhance beach access yet offer foreshore protection;
- Use of fencing and signage as integral methods of access control; and
- Coastal rehabilitation/stabilisation and revegetation undertaken for degraded areas.

Management works and improvements to the foreshore reserve and foreshore management will be initially the responsibility of the developer, but this responsibility will be transferred to the local authority.

Cross-sections, showing the proposed landform are shown in Figure 4. Upon completion of the land exchange, the landowner will commence earth works to final levels and subsequent dune stabilisation as required by the land exchange agreement. Urban development has been effective in stabilising mobile dune systems. However, in the short term, the developer will stabilise Southgate Dunes in accordance with the principles contained in the Southgate Dunes Stabilisation Strategy (Appendix 4, Volume II Technical Appendices). In simple terms, this approach involves earth-working to final development levels followed by the spreading of loamy soil over the site and seeding with sterile pasture grasses.

4.4.7 Potential Outcome

Major earthworks program will result in the modification of the existing landform. The modified landform will consist of a broad north-south trending ridge over the current Southgate Dunes area, retain the existing low point just to the east of the current dunes and grade the land up to the Brand Highway.

A foreshore reserve will be established and developed in accordance with a Foreshore Management Plan to ensure the integrity of the coastal environment is maintained and enhance and that prime regional beaches are able to accommodate a variety of recreational and community demands in a sustainable manner.

4.5 Greenough River Watercourse

4.5.1 EPA Objective

To maintain the integrity, ecological functions and environmental values of waterways.

4.5.2 Applicable Legislation, Criterion or Guidance

- Western Australian Planning Commission (2003a) Statement of Planning Policy No. 2 *Environment and Natural Resources Policy*
- *Planning and Development Act 2005*
- City of Geraldton-Greenough Town Planning Scheme No. 1A

4.5.3 EPA Scope of Work

TABLE 9
EPA SCOPE OF WORK REQUIRED FOR GREENOUGH RIVER WATERCOURSE

CONTENT		SCOPE OF WORK
Factor	**Site specific factor**	**Work required for the environmental review**
Watercourse	Greenough River	A buffer to be provided between development proposed within the Amendment area and the Greenough River consistent with the Department of Environment's report *Determining Foreshore Buffers* (Report No. RR 16).

4.5.4 Existing Environment

The following contains information from the hydrological investigation report prepared by JDA Consultant Hydrologists (2006a). The full report is included in Appendix 5 in Volume II of Technical Appendices.

The major watercourse near the subject land is the Greenough River, which runs along the southern boundary of the subject land. The Greenough River is a major river approximately 250km in length with a catchment area of approximately 19,500km^2 as measured to its downstream gauging station at Karlanew Peak.

The Greenough River starts approximately 240km north-east of Geraldton in the Yalgoo District and meanders in a southwest direction through the Perth Basin until the coastal sandplains where it is diverted north. The river mouth is located 10km south of Geraldton but is continuously displaced northward by prevailing winds and dune movements.

The Greenough River is an intermittently estuarine river as the mouth is blocked by a sandbar during the dry summer months but winter flows breach the sandbar allowing the river to exchange tidal waters with the ocean. The estuarine reach extends approximately 7km upstream of the river mouth (WRC, 2001), extending upstream of the subject land.

Historical Flooding

Historical flooding of the Greenough River is summarised in Table 10. Records indicate 11 flood events since 1888. Peak flow estimates are given to Karlanew Peak located approximately 25km upstream of the subject land.

With respect to Rudds Gully, the section which flows parallel to Brand Highway (Figure 5) has been a particular problem and the highway has had a number of closures caused by flooding due to either flow from the local catchment, or backwater from the Greenough River.

TABLE 10
HISTORICAL FLOODING EVENTS – GREENOUGH RIVER

Year	Estimated Peak Flow (m3/s) [1]	Approx ARI of Flood Event [2]
1888 (February)	1700	100
1927 (March)	not available	40
1934 (April)	not available	15
1953 (March)	750	35
1961 (June)	not available	15
1963 (May)	450	22
1970 (February)	300	13
1971 (March)	410	20
1988 (May)	320	14
1999 (May)	440	22
2006 (January)	660	30

1. Estimated peak flows via WAWA(1986) for 1888 – 1970 based on flood magnitudes derived from flood markings, anecdotal information, documented flood damage and newspaper articles
   Estimated peak flows from 1971 onwards (based on gauged data) provided via DoW (Rick Bretnall, pers comm)
2. Estimates ARI's based on DoW revised Greenough River 2006 flood study.
   1927, 1934, and 1961 event ARI's reproduced via WAWA (1986).

Greenough River Floodplain Mapping and Peak Flow Estimates

The Department of Water (DoW) has recently updated floodplain mapping and peak flow estimates for the Greenough River (Table 11).

This study has provided flow estimates at both Karlanew Peak and the mouth of the Greenough River adjacent to Cape Burney. Flow at the river mouth can be seen to be significantly less at the river mouth than at Karlanew Peak for large events, due to the impact of the Greenough River Flats located upstream of the subject land, which provide significant attenuation of flood flows.

DoW floodplain mapping based on these flows is shown in Figure 5. The 100 year flood levels for the Greenough River adjacent to the Subject land range from 1.0m AHD to 4.5m AHD at the upstream boundary at the confluence of Rudds Gully and the Greenough River.

The 100 year flood levels of the Greenough River provide a backwater along Rudds Gully.

TABLE 11
GREENOUGH RIVER PEAK FLOW ESTIMATES

Flood Event	Peak Flow Estimate At Karlanew Peak (m^3/s)	Peak Flow Estimates at Mouth of the Greenough River (m^3/s)
1 in 10 year	200	190
1 in 25 year	504	420
1 in 50 year	930	-
1 in 100 year	1620	800

Rudds Gully Peak Flow Estimates

Main Roads has previously analysed local flooding of Rudds Gully.

The analysis provides 5, 10, 20 and 50 year ARI flood levels for 2.5km of the watercourse which runs parallel to Brand Highway. The analysis also indicates existing areas of flooding of the highway for various ARI. The highway can be seen to flood based on local catchment flows from Rudds Gully for storm events as frequent as five year ARI (Figure 5).

For the lower reaches of Rudds Gully (within 1.5km of its confluence with Greenough River), Greenough River flood levels are higher than flood levels due to the local catchment response and therefore would govern any development levels in this area.

Foreshore Assessment

W.G. Martinick and Associates (1994) prepared the Greenough River Estuary Management Plan in 1994 for the then Shire of Greenough. The Management Plan covered the area from the Greenough River mouth to Devlin's Pool Road and included the riverbanks.

The lower section of the Greenough River (including the part of the Greenough River adjacent to the subject land) was beyond the scope of the Greenough River Foreshore Assessment subsequently conducted by the Water and Rivers Commission (WRC) (2001). The visual

assessment conducted by WRC collected information about the Greenough River foreshore and assigned a condition rating for foreshore health. Various parameters were assessed to determine foreshore condition and these included:

- Bank stability;
- Foreshore vegetation;
- Stream cover;
- Habitat diversity; and
- Verge vegetation.

The overall condition of the lower section of Greenough River was classified by WRC as 'Very Good' and requiring minimum maintenance.

Greenough River Road runs close to the Greenough River (less than 10m from the water edge in places) with the foreshore margins being reserved as Parks and Recreation. The foreshore reserve is particularly narrow due to the position of the road (Plate 1). On the northern side of Greenough River Road, the land is currently zoned 'Resort Development' which is outside of the amendment area.

In 2006, ATA Environmental conducted a site inspection of the foreshore area. In assessing the foreshore condition, ATA Environmental reviewed those parameters outlined above. A discussion of each parameter is provided below:

Bank Stability

The width of the Greenough River near the subject land varies from 40m to 200m wide. The banks are characterised by a gentle slope. The foreshore reserve is generally grassed, though it does contain isolated pockets of degraded native vegetation.

No significant areas of erosion or sediment deposition in the floodway or on lower banks were identified. However, some smaller areas (Plate 2) where pedestrian wear has occurred indicate the potential for localised erosion. Despite this, the overall riverbank is generally stable and not actively eroding.

Foreshore Vegetation

The vegetation of the Greenough River area is within Beard's (1976) Greenough System of the Irwin Botanical District of the South-western Botanical Province (W.G. Martinick and Associates, 1994).
The foreshore margins has generally been parkland cleared with small isolated pockets of degraded native vegetation present (Plates 3 and 4). Coastal heath (dominated by *Acacia rostellifera, Olearia axillaris, Scaevola crassifolia*) is present north of Greenough River Road and west of the rowing club (closer to the ocean).

The vegetation structure of the foreshore reserve is considered Completely Degraded to Degraded using the condition rating scale of Keighery published in Bush Forever (Government of WA, 2000). The native vegetation north of the river mouth and north of Greenough River Road is considered to be in Good condition. Keighery's condition rating scale ranges from Pristine (which the vegetation exhibits no visible signs of disturbance) to Completely Degraded (where the vegetation structure in no longer intact and without native plant species). A description of the Degraded and Completely Degraded vegetation condition ratings is outlined below.

Good
Vegetation structure altered and obvious signs of disturbance. For example, disturbance to vegetation structure caused by repeated fires, the presence of some more aggressive weeds, dieback, logging and grazing.

Degraded
Basic vegetation structure severely impacted by disturbance. Scope for regeneration, but not to a state approaching good condition without intensive management. For example, disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds, partial clearing, dieback and grazing.

Completely Degraded
The structure of the vegetation is no longer intact and the area is completely or almost completely without native species. These areas are often described as 'parkland cleared' with the flora composing weed or crop species with isolated native trees or shrubs.

Stream Cover

There is no shade cover over the Greenough River in the section south of the amendment area due to the absence of native vegetation and the width of the river.

Habitat Diversity

The lower section of the Greenough River provides an important drought refuge for waterbirds as it contains water year round. However, there is little habitat for terrestrial fauna species due to the absence of native vegetation along the northern banks of the portion of the Greenough River adjacent to the amendment area.

4.5.5 Potential Impacts

Activities that may individually or cumulatively influence environmental values of the Greenough River include:

- The application of nutrients and use of chemicals in the catchment associated with current and future land uses;
- Construction contributing erosion and the export of sediment;
- Inappropriate stormwater management;
- Introduction of weed and pest species; and
- Increased human activity along the Greenough River.

4.5.6 Proposed Management

The land immediately adjacent to the Greenough River does not form a part of the subject land. However, the existing narrow foreshore reserve will be maintained with Greenough River Road separating future development from the Greenough River. The existing foreshore reserve is generally degraded from ecological perspective, thereby providing opportunities for community use. A detailed foreshore management plan will be prepared at subdivision stage and implemented at subdivision stage. This management plan will detail proposed activities in the foreshore area and will include (but not limited to) strategies for:

- Community use and recreational opportunities;
- Rehabilitation and restoration of the foreshore area;
- Landscaping and installation of community facilities; and
- Stormwater management.

A Local Water Management Plan consistent with DoW and local authority requirements will be prepared at subdivision stage by the developer.

4.5.7 Potential Outcomes

The Amendment will not result in any change to the size of the existing Greenough River foreshore reserve.

The Greenough River foreshore reserve will be developed to maximise community use, and landscaped and rehabilitated in accordance with the objectives of the Geraldton-Greenough Coastal Strategy and Foreshore Management Plan.

4.6 Water Quality

4.6.1 EPA Objective

To ensure that the quality of water emissions do not adversely affect environment values or the health, welfare and amenity of people and land uses, and meets statutory requirements and acceptable standards.

4.6.2 Applicable Legislation, Criterion or Guidance

- Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand (2000a) *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*, National Water Quality Management Strategy, October 2000
- Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand (2000b) *Australian Guidelines for Water Quality Monitoring and Reporting*, National Water Quality Management Strategy, October 2000
- Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand (2000c) *Australian Guidelines for Urban Stormwater Management*, National Water Quality Management Strategy, 2000
- Department of Environment (2004) *Stormwater Management Manual for Western Australia*, February 2004
- Department of Environment and Swan River Trust (2005) *Decision Process for Stormwater Management in W.A.*

4.6.3 EPA Scope of Work

TABLE 12
EPA SCOPE OF WORK REQUIRED FOR WATER QUALITY

CONTENT		SCOPE OF WORK
Factor	**Site specific factor**	**Work required for the environmental review**
Water	Water Quality	Detail site drainage, modifications to drainage and potential for contamination. Assess the implications this may have on local surface, ground and marine water quality. Detail measures proposed to: ▪ Ensure the quality of surface, ground and marine water is maintained so that existing and potential uses, including ecosystem maintenance are protected; and ▪ Manage impacts. Describe management measures, including: ▪ Effluent disposal; and ▪ Drainage and nutrient management, To be implemented to reduce the quantity of drainage runoff from the site and to reduce impacts on water quality. Document how stormwater management will be implemented in accordance with the Department of Environment's Stormwater Management Manual.

4.6.4 Existing Environment

The following contains information from the hydrological investigation report prepared by JDA Consultant Hydrologists (2006a). The full report is included in Appendix 5 Volume II of Technical Appendices.

Surface Hydrology

Greenough River

The southern extent of the Amendment area lies close to a small portion of the Greenough River. The Greenough River is approximately 250km in length with a catchment area of approximately 1,950,000ha as measured to its downstream gauging station at Karlanew Peak. It starts approximately 240km northeast of Geraldton in the Yalgoo District and meanders in a southwest direction through the Perth Basin until the coastal sandplains where it is diverted north. The river mouth is located 10km south of Geraldton but is continuously displaced northward by prevailing winds and dune movements.

The Greenough River is an intermittently estuarine river as the mouth is blocked by a sandbar during the dry summer months but winter flows breach the sandbar. The winter breach allows the Greenough River to exchange tidal waters with the ocean. The estuarine reach extends approximately 7km upstream of the river mouth (WRC, 2001).

Rudds Gully

Rudds Gully, a minor tributary of the Greenough River, is located on the south-eastern edge of the subject land, bordering Brand Highway and is a perennial watercourse. Based on 1:100,000 topographic mapping, Rudds Gully is estimated to drain a catchment of approximately 19,500ha and is know to regularly flood Brand Highway south of the amendment area.

There are no known previous estimates of 100 year flood levels or flows for Rudds Gully. However based on extrapolation of rational method flow estimates, a preliminary 100 year flow estimate for Rudds Gully is approximately 210m3/s. Using Mannings formula, preliminary 100 year flood level estimates for Rudds Gully adjacent to the Study Area have been made based on cross sectional data provided by Main Roads and Manning 'n' roughness estimated by photo interpretation. Calculation details including cross sectional data and locations are contained in JDA (2006) which is provided in Appendix 5 of Volume II (Technical Appendices).

The 100 year flood level for Rudds Gully is estimated to be approximately 5m AHD adjacent to most of the Study Area, 0.5m higher than the Greenough River 100 year flood level.

Greenough River Water Quality

Based on 1993-2002 salinity monitoring data, the Greenough River is classified as moderately saline with an average salinity of 3,700mg/L (Department of Agriculture, 2005). Total nitrogen (TN) and total phosphorus (TP) levels are classified as moderate, defined as in the range 0.9-1.5mg/L for TN and 0.04-0.09mg/L for TP (WRC, 2003).

Sewer

The Greenough-on-Sea Wastewater Treatment Plant currently services the Cape Burney/Greenough River locality and is centrally located in the amendment area on land reserved as 'Public Purposes'. The Plant will be de-commissioned once the new waste water treatment plant at Narngulu Industrial area has been completed.

Regional Hydrogeology

The following description of hydrogeology is reproduced from Gozzard *et al* (1988), WAWA (1995), and WRC (2002a).

Tamala Limestone

Regionally, Tamala Limestone extends along the coast as far north as Bluff Point and up to 10km inland. The formation consists of limestone and sand, and along the Greenough Flats is often overlain by silty clay.

Groundwater salinity increases toward the coast and with depth. Bores and wells are shallow and pumped at low rates to avoid drawing saline water from below. Salinity usually exceeds 1,500mg/L with Hydroplan (1995) reporting the salinity at City of Geraldton POS irrigation bores located in this aquifer as ranging from 2,000mg/L to 7,000mg/L.

Dune sands along the coast may supply small quantities of freshwater from shallow wells or spears, but over pumping may draw in saline water from below.

Cattamarra Formation

The Cattamarra Formation consists of very course to very fine-grained sandstone with interbedded siltstone and shale, and seams of coal. Groundwater from the relatively thin sandstone of the Cattamarra Coal Measures is used for farm water supplies.

Regionally, groundwater salinity ranges from fresh (<1,000mg/L) in elevated areas of outcrop to saline (up to 6,000mg/L). In the Dongara sub-area of the Arrowsmith groundwater area (in which the subject land is located), groundwater salinity is reported by WAWA (1995) as mostly brackish.

Yarragadee Formation

The Yarragadee Formation does not exist within the subject land, however the Yarragadee Formation contains the most important groundwater resources in the region, and supplies Geraldton and Dongara occurring in the south east of the region and extends beneath the Tamala Limestone. The Formation consists of sand with minor shale.

Its aquifer extends from the Urella Fault (located approximately 25-30km to the east of Allanooka Water Reserve) to beneath the Indian Ocean in the west, and from near the Greenough River in the north where the base on the formation outcrops) to a groundwater divide near Hill River 130km south.

In the Allanooka Area, approximately 45km southeast of the subject land, the Formation contains a 100m thickness of freshwater, but near the coast, the groundwater in this formation is brackish or saline. Depth to water table in the Yarragadee in the Allanooka Area varies from 12m to 85m with an average approximately 50m below ground. Groundwater salinity in the Yarragadee Formation is reported to increase with depth

Superficial Groundwater Levels

No DoW bores are located within the subject land, the nearest bore being located approximately 3km east along Rudds Gully Road.

Based on the Arrowsmith Groundwater Management Plan (WAWA, 1995) regional groundwater contours show the 5mAHD contour located approximately 3km east of the subject land. As the regional groundwater flow direction is west toward the Indian Ocean, maximum recorded groundwater levels in the subject land are likely to be below 5mAHD.

As existing topography is typically greater than 10mAHD, separation between the groundwater table and the natural surface is likely to be greater than 5m over the majority of the subject land, ranging to over 35m in elevated areas.

Existing Water Supply Sources

The groundwater resources of the general area are limited, in terms of both high salinity and low yield. Fresh groundwater is generally not available along the coast and, with exception of Kalbarri, water is piped to all towns in the region.

The only source of fresh groundwater of regional significance is in the southeast where water from the Allanooka bore field is piped to Geraldton for its town water supply scheme. The Water Corporation is currently licensed to abstract approximately 12GL/year from the Allanooka scheme (WRC, 2002b).

Groundwater salinity data indicate that few farms in the area have potable supplies. Groundwater for stock is generally available, although there are a few areas where yields are very low of salinities too high for even stock.

Apart from the reticulated town water supplies, the only groundwater used for irrigation is for vegetable growing near Geraldton and near the Irwin River.

Constraints/Opportunities

Based on the proposed development and subject land hydrogeology, key constraints and opportunities are identified in Table 13.

TABLE 13
KEY HYDROLOGICAL CONSTRAINTS/OPPORTUNITIES

Category	Constraints/Opportunities
Groundwater	• Given the natural surface elevation, surface geology, and superficial groundwater elevation, the subject land appears to offer good opportunities for infiltration from stormwater both at local (soak well) and regional (basin) scale. • Depth to groundwater provides a constraint on the development of any permanent open water bodies. • Given the depth to groundwater, opportunity to limit fill requirements necessary to provide clearance above groundwater.
Surface Water	• Flow path for 100 year flood event for Greenough River required to be maintained along the southern boundary of the subject land. • Rudds Gully known to flood an area adjacent to Brand Highway. Flow path required to be maintained, however development provides an opportunity for the enhancement of this watercourse and alleviation of current flooding.
Water Supply	• For irrigation of POS, superficial groundwater as a source is likely to be low yielding and have high salinity (>1500mg/l). • Yarragadee groundwater is likely to be brackish or saline near the coast. • Greenough River classified as moderately saline, intermittently estuarine as winter flows breach the sandbar.

4.6.5 Potential Impacts

Adverse nutrient export and drainage impacts on the receiving watercourse (Greenough River) may occur.

Development in the vicinity of the Greenough River watercourse may result in temporarily interrupted or altered water balances, water quality and flow rates.

4.6.6 Proposed Management

Regional Flood Management

Regional flood management is achieved through recognition of existing flow paths through the subject land for upstream catchments, and provision of adequate widths to accommodate safe passage of the 100 year flood.

Greenough River

With respect to Greenough River, this will be achieved by development consistent with DoW floodplain mapping (Figure 5) and associated floodplain management strategy.

Specific details of DoW's floodplain management strategy are contained in Appendix 5 of Volume II (Technical Appendices). The strategy states for any proposed development located within the 100 year ARI floodplain, a minimum building floor level of 0.5m above the adjacent 100 year ARI flood level is recommended.

As shown on conceptual development sketches, the Greenough River floodplain is well contained within designated Foreshore Reserves.

Rudds Gully

For planning purposes, based on the preliminary 100 year flood level estimates for Rudds Gully, it is proposed that no filling of the buffer occur for areas where existing natural surface is less than 5.0mAHD, with building levels set 0.5m above the current 100 year flood level estimate. This level will be refined with outcomes of more detailed flood modelling of Rudds Gully in due course.

A landscaped buffer of 75m wide along the margins of Rudds Gully will be retained. No filling of the landscaped buffer to occur.

Objectives and Criteria for Urban Water Management

Key objectives and criteria for urban water management for the subject land were developed consistent with current DEC/DoW and City of Geraldton-Greenough stormwater management guidelines as shown in Table 14.

These are used in conjunction with the constraints and opportunities presented in Table 13 to provide the framework for the urban water management plan for the subject land.

Further discussion and copies of DEC/DoW and City of Geraldton-Greenough guidelines and stormwater management decision processes are contained in Appendix 5 of Volume II (Technical Appendices).

TABLE 14
KEY OBJECTIVES AND GENERAL CRITERIA FOR URBAN WATER MANAGEMENT

Category	Relevant Objectives	General Criteria
Groundwater Management	• Provide sufficient clearance above groundwater in developed areas to provide protection from flooding due to seasonal groundwater rise.	• Building floor levels shall be a minimum 1.2m above the average annual maximum groundwater level (AAMGL).
Regional Flood Management	• Provide 100 year flood protection to developed areas within the Study Area. • Ensure development within the Study Area does not adversely affect 100 year ARI flood levels or flood risk for existing developed areas.	• Flow path for existing watercourses to be maintained. • For any areas which will not infiltrate post development, attenuation of rainfall runoff rates to peak flow levels which presently discharge from the Study Area. • Any modifications to watercourses will be required not to increase existing design flood levels.

Category	Relevant Objectives	General Criteria
		• A minimum building floor levels of 0.5m above the adjacent 100 year ARI flood level is recommended.
Local Flood Management (Urban Stormwater)	• Provide flood protection for the local authority drainage system within the subject land to the appropriate level of service.	• Where possible, stormwater runoff within the development area will be infiltrated without any discharge from the site. • Stormwater will be retained using techniques such as soak wells, open based manholes, vegetated swales/basins, or shallow depressions. • Stormwater basins to be designed to manage up to the 1 in 100 year ARI event. • Basins must not impair recreational amenity and are limited to 25% of a POS area. • Maximum water depth for the 1 in 100 year event should not exceed 500mm, and not retain water for more than 48 hours. • Calculations to be consistent with Australian Rainfall and Runoff - A Guide to Flood Estimation (Institution of Engineers Australia, 2000).
Water Quality Management	• To maintain or improve the surface and groundwater quality within development areas relative to pre-development conditions.	• If any discharge of stormwater from the Study Area is required, preliminary water quality targets to be based on predevelopment monitoring data with reference to ANZECC (2000a). • Retain and restore natural drainage lines and valuable ecosystems such as natural channels, wetlands and riparian vegetation. • Minimise any potential pollutant input to surface water and groundwater by the use of source control techniques, infiltration, and WSUD BMPs.
Water Supply Management	• To maximise the reuse of stormwater. • To maintain the total water cycle balance within development areas relative to the pre-development conditions. • Consider all potential water sources in water supply planning.	• Maximise infiltration of stormwater for potential reuse. • Where possible maximise use of local water sources for POS irrigation.

Local Water Management Plan

A Local Water Management Plan will be prepared for the subject land as part of the subdivision process.

The proposed Local Water Management Plan for the subject land is consistent with water sensitive design practices and meets the key objectives and criteria as detailed in Table 14.

The Plan will consist of a series of pipes, swales, multiple use corridors and basins (predominately infiltration but possibly some compensation) to infiltrate (and where required attenuate) peak surface water flows, and provide water quality treatment for any discharge from

the site. Basins will be landscaped and located within POS areas and designated landscape buffers consistent with Shire requirements. Given soil types and depth to groundwater, the vast majority of stormwater generated from within the subject land will be infiltrated.

The stormwater drainage system will be designed using a major/minor approach. The minor drainage system is defined as the system of underground pipes, swales, kerbs, gutters etc. designed to carry runoff generated by low frequency ARI storms, typically less than five year ARI. The major drainage system is defined as the arrangement of roads, drainage reserves, compensation/infiltration basins and open space planned to provide safe passage of stormwater runoff from extreme events which exceeds the capacity of the minor system.

Stormwater runoff generated by the impervious areas of the road reserve will generally be collected in gully or side entry pits into a formal piped drainage system with flow to multiple use corridors/swales and/or detention/infiltration basins located in each catchment. Where possible, roof drainage and road drainage will be connected to soak wells to promote and maximise at-source infiltration. The use of bottomless manholes for infiltration of road drainage is supported by DoW and is proposed for the amendment area, subject to Shire approval. Basins will generally be designed to attenuate runoff for storm events up to 100 year ARI, with any basin outflows (in any areas where infiltration may not possible) designed not to exceed pre-development (existing) levels. Provision for overland flow paths within road reserves and Public Open Space to accommodate larger storm events will be provided at the subdivision stage.

The minimum building floor levels will comply with DoW and Shire requirements for 1.2m clearance above AAMGL, and a 0.5m clearance above the estimated 100 year ARI flood level.

Water quality management will be achieved through a treatment train approach including the application of source controls, stormwater detention, and maximising infiltration opportunities. As the vast majority of stormwater generated from the site will be infiltrated, application of non structural source controls will be used for water quality management including planning practices (POS locations and configuration, plantings), maintenance practices (street sweeping, stormwater system, POS areas), educational and participatory practices (capacity building programs, community education).

Groundwater Management

Separation between the groundwater table and the natural surface is likely to be greater than 5m over the majority of the development area, ranging to over 35m in elevated areas. To this end, any proposed permanent water bodies would be required to be lined.

There are unlikely to be any significant issues with respect to provision of adequate clearance above groundwater for the development.

Local Stormwater Management

Local management of stormwater generated by the development is proposed to be via infiltration.

Based on the indicative proposed natural surface cross sections shown in Figure 13 of Appendix 5 of Volume II (Technical Appendices), stormwater flow for the northern region of the subject land will generally be toward the coast.

Detailed stormwater modelling of regional stormwater infrastructure has yet to be undertaken however, basin sizings for urban development typically require in the order of 3-4% of

developable area (~20ha for the 570ha amendment area). The location and sizing of basins will be undertaken at Structure Plan and subdivision stages.

Water Quality

Water quality management for the subject land post-development will be through application of a treatment train approach including both structural non-structural source controls, with an emphasis on infiltration.

- Non-Structural Controls
  - Planning practices (POS locations and layouts, plantings)
  - Construction practices (use of native plantings)
  - Maintenance practices (street sweeping, stormwater system, POS areas)
  - Educational and participatory practices (capacity building programs, community education)

- Structural Controls
  - Retention and infiltration of frequent events where possible (soak wells, swales, bottomless manholes)
  - Creation of ephemeral retention/detention areas within community park/wetland buffers/POS areas
  - Application of Gross Pollutant Traps

The proposed WSUD measures for water quality considerations presented above will not result in an increased land take for drainage purposes above that required for detention/retention storage and flood conveyance purposes.

The Water Corporation's requirements will be complied with in servicing the amendment area with a reticulated sewerage service.

4.6.7 Potential Outcomes

Implementation of the management strategies outlined above will fulfil that the EPA's objective of ensuring that *the quality of water emissions do not adversely affect environment values or the health, welfare and enmity of people and land uses, and meets statutory requirements and acceptable standards.*

4.7 Noise

4.7.1 EPA Objective

To protect the amenity of the community from noise impacts associated with development or land use by ensuring that statutory requirements and acceptable standards are met.

To avoid unacceptable adverse impacts on the natural environment, including native fauna.

4.7.2 Applicable Legislation, Criterion or Guidance

- Environmental Protection Authority (1997) *Environmental Protection (Noise) Regulations 1997*: Regulation 13 "Construction sites"
- Department of Environmental Protection (2000) *Road and Rail Transport Noise* Draft Guidance No. 14 (Version 3)

- Western Australian Planning Commission (2005a) *Statement of Planning: Policy Road and Rail Transport Noise (Draft)*
- Western Australian Planning Commission (2005b) *Statement of Planning Policy Metropolitan Freight Network (Draft)*
- Australian Standard *AS2670/1990 Evaluation of human exposure to whole body vibration*

4.7.3 EPA Scope of Work

TABLE 15
EPA SCOPE OF WORK REQUIRED FOR ROAD TRANSPORT NOISE

CONTENT		SCOPE OF WORK
Factor	**Site specific factor**	**Work required for the environmental review**
Noise	Road Transport Noise	Noise levels from vehicles on Brand Highway at sensitive land uses within the Amendment area are to comply and be managed in accordance with the standards set out in the Western Australian Planning Commission's Draft Road and Rail Transport Noise Statement of Planning Policy. Identify how this factor will be appropriately addressed via development control mechanisms during the subdivision and development approvals processes.

4.7.4 Existing Environment

Herring Storer Acoustics (HSA) (2006) carried out a noise study for the proposed Cape Burney Estate residential development (study area). HSA's full report is included as Appendix 6 of Volume II (Technical Appendices).

The objectives of the study were to:

- Monitor exiting noise levels received within the study area from vehicles travelling along the Brand Highway.

- Determine by noise modelling the noise that would be received at residences within the development from vehicles travelling on the neighbouring road network.

- Assess the predicted noise levels for compliance with the appropriate criteria.

- If exceedances are predicted, investigate possible noise amelioration options for compliance with the appropriate criteria.

To determine the existing noise received within the subdivision, noise data logging was carried out at two locations. The locations of the loggers were:

Location 1 - Northern end of development (268905 N 6808991 E)
Location 2 - Middle of development (270354 N 6807090 E)
The results of the noise data logging are shown in Table 16.

TABLE 16
NOISE LOGGING DATA - $L_{10,18hour}$ and $L_{eq,16hour}$

DATE	PARAMETER					
	LOCATION 1			LOCATION 2		
	$L_{10,18hour}$	$L_{eq,8hour}$	$L_{eq,16hour}$	$L_{10,18hour}$	$L_{eq,8hour}$	$L_{eq,16hour}$
Monday 1 May 2006	67.2	58.3	65.2	62.9	55.7	60.0
Tuesday 2 May 2006	67.1	59.1	65.1	62.4	55.8	60.1
Wednesday 3 May 2006	67.2	59.3	65.3	62.7	56.7	60.5
Thursday 4 May 2006	67.5	58.9	64.9	63.0	56.0	59.6
Friday 5 May 2006	68.2	58.7	65.0	62.6	56.6	59.5
Average	67	59	65	63	56	60

* Used to calculate $L_{10,18hr}$
\# Measurements influenced by noise sources other than road traffic. Data excluded from calculations

The difference between the $L_{A10,\ 18hr}$ and the $L_{Aeq,\ 8hr}$ and between the $L_{A10,18hr}$ and the $L_{Aeq,16hr}$ is approximately 8 and 2dB(A) respectively.

The logger recorded statistical weighted sound pressure levels, of which the L_{A10}, L_{Aeq} and L_{A90} values are reported. These parameters are defined as:

L_{A10} The noise level exceeded for 10% of the time (in this instance, the noise level exceeded for six minutes in each one-hour period).

L_{Aeq} The equivalent continuous noise level for the one hour period (sometimes referred to as the average noise level).

L_{A90} The noise level exceeded for 90% of the time (in this instance, the noise level exceeded for 54 minutes in each one hour period).

The WAPC in May 2005 released a Draft Planning Policy for Road and Rail Transport Noise. The policy included measures relating to outdoor noise exposure criteria for noise-sensitive premises. The criteria stated in the draft policy are shown in Table 17.

TABLE 17
EXTERNAL NOISE EXPOSURE CRITERIA FOR NOISE-SENSITIVE LAND USES

TIME PERIOD	External Noise Exposure Level[1] Criteria (dB)		
	Exposure Level 1 (Target)	Exposure Level 2	Exposure Level 3
Day 6.00am – 10.00pm	Less than L_{Aeq} 55	L_{Aeq} 55-60	Above L_{Aeq} 60
Night 10.00pm – 6.00am	Less than L_{Aeq} 50	L_{Aeq} 50-55	Above L_{Aeq} 55
Additional criteria for railways	Less than L_{Amax} 75	L_{Amax} 75-80	Above L_{Amax} 80

Note [1] Noise levels is to be determined at a point 1m from the edge of the site or building façade that is the most exposed to traffic noise, and at a height of 1.5m from the ground level at that point. Noise assessments should generally reflect the impact of any future growth in road and rail traffic, based on a 20 year forecast period.

The Policy also described a series of Exposure Levels with Exposure Level 1 (Target) – a desirable target for residential and other noise-sensitive development, through to Exposure Level 3 where the level of outdoor noise exposure is not generally regarded as acceptable for conventional residential or other noise-sensitive development.

HSA recommended that for the subject land, adjacent to existing infrastructure, exposure level 2 is the appropriate external noise exposure level criteria.

Exposure Level 2

Exposure Level 2 refers to a level of outdoor noise exposure that would be acceptable for residential and other noise-sensitive development, subject to appropriate measures to ameliorate noise impact.

For road or rail infrastructure with a noise exposure level in this range, new noise sensitive development should be designed and constructed to comply with:

- *The 'target' Exposure Level 1 for required outdoor living areas; and*
- *The 'satisfactory' criteria under Australian Standard AS 2107:2000 "Acoustics – Recommended Design Sound Levels and Reverberation Times for Building Interiors", for indoor areas.*

Exposure Level 2 generally represents the maximum noise exposure for proposed new road and rail infrastructure and noise-sensitive development on land adjoining such infrastructure, but may not be practicable for many of the existing major road and rail corridors.

For residences located adjacent to the Brand Highway, the internal noise levels listed is AS 2107:2000 for a major road recommends the following internal L_{Aeq} noise levels which would be applicable during the night period as shown in Table 18.

TABLE 18
RECOMMENDED NIGHT PERIOD INTERNAL L_{Aeq} NOISE LEVELS

	SATISFACTORY	MAXIMUM
Sleeping Areas	30 dB(A)	40 dB(A)
Living Areas	35 dB(A)	45 dB(A)

Note: The draft WAPC planning policy recommends achieving internal noise level within sleeping and living areas of 30 and 35 dB(A) respectively.

For the proposed development within the subject land, HSA recommended that the following criteria be used:

External
Day Maximum L_{Aeq} of 60dB(A)
Night Maximum L_{Aeq} of 55dB(A)

Outdoor Living Areas
Maximum L_{Aeq} of 50dB(A)

Internal
Sleeping Areas 35dB(A)
Living Areas 40dB(A)

Acoustic Assessment

Traffic volumes and percentage heavy vehicles were based on information supplied by Riley Consulting. This and other information relevant to the calculations are shown below in Table 19.

TABLE 19
NOISE MODELLING INPUT DATA

PARAMETER	VALUE	
	CURRENT	2026
Traffic flows	7900	21936
Heavy Vehicles (%)	2.3	7.0
Speed Limit (Varies) (km/hr)	70,90,110	70,90,110
Road Surface	14mm Chip Seal	14mm Chip Seal
Façade Correction	+2.5dB(A)	+2.5dB(A)

Note: The future traffic flow numbers are preliminary and modelling may require upgrading when revised traffic flows have been determined.

To determine the requirements of any noise amelioration, acoustic modelling was carried out using the computer program 'SoundPlan'. Acoustic modelling was carried out for road traffic flows in the year 2026. To calibrate the model with the monitored noise levels, preliminary calculations using current traffic flows were also carried out.

It was also assumed that the difference between the $L_{A10,18hour}$ and $L_{Aeq,8hour}$, and the $L_{Aeq10,18hr}$ and $L_{Aeq,16\ hr}$ in the year 2026 is as for the current situation and therefore the difference previously determined from the monitored data can be applied in the year 2026.

From noise monitoring, the $L_{A10,18hour}$ noise received within the proposed development would currently range between around 63 and 67dB(A), with the $L_{Aeq,8hr}$ ranging from 56 to 59dB(A).

4.7.5 Potential Impacts

Noise received at residences located adjacent to the Brand Highway in the year 2026 could, depending on the set back from the Highway, exceed both the Main Roads Western Australia 'Noise Level Objectives' and objectives of the WAPC Draft Planning Policy for Road and Rail Transport Noise for exposure level 2.

4.7.6 Proposed Management

Noise received at residences is dependant on the distance from the road, however, to comply with the appropriate criteria for various speed limits, the buffer distances for various speed limits and road surfaces as listed in Table 20 are required.

TABLE 20
BUFFER DISTANCES

SPEED LIMIT (km/hr)	Road Surface / Buffer Distance (m)	
	Chip Seal	Dense Graded Asphalt
70	90	60
90	150	90
110	220	130

With the construction of a 1.8m high earth bund and/or barrier, the above distances could be reduced as listed in Table 21.

TABLE 21
BUFFER DISTANCES WITH 1,800mm HIGH BARRIER

SPEED LIMIT (km/hr)	Road Surface / Buffer Distance (m)	
	Chip Seal	Dense Graded Asphalt
70	50	40
90	80	50
110	120	90

Note: Distances are from edge of road reserve. Barrier located at edge of road reserve.

A landscaped buffer will be developed between the edge of the road reserve and the closest residence. This landscaped buffer would for the majority of the proposed development, provide a sufficient buffer with respect to traffic noise, particularly if the road surface was upgraded to dense graded asphalt.

Even with the inclusion of noise amelioration, it is recommended that the first row of residences adjacent to the Brand Highway be designed so internal noise levels during the night do not exceed an L_{Aeq} of 35dB(A) in a bedroom or 40dB(A) in a living space. Outdoor entertainment areas should be designed or located such that they comply with a L_{Aeq} noise level during the night period of 50dB(A). To achieve the required internal noise level, 'Quiet House' design is to be used for those residences located adjacent to the Brand Highway. Further information on 'Quiet House' design is contained in Appendix D of HSA's report.

For the first row of residences adjacent to the Brand Highway, it is also recommended that notification of vehicle noise be stated on the titles and that in these cases, the proponent satisfy the "Appropriate Authorities" that acceptable internal noise levels can be achieved. This may require the submission of an acoustical report prepared by a suitably qualified consultant.

4.7.7 Potential Outcomes

Implementation of the proposed management strategies outlined in Section 4.7.6 will ensure that the EPA's objective with respect to noise will be met.

4.8 Visual Amenity

4.8.1 EPA Objective

To ensure that visual amenity is considered and measures are adopted to reduce adverse visual impacts on the surrounding environment as low as reasonably practicable.

4.8.2 Applicable Legislation, Criterion or Guidance

- *Environmental Protection Act 1986*
- Western Australian Planning Commission (2003a). Statement of Planning Policy No. 2 *Environment and Natural Resources Policy*
- *Planning and Development Act 2005*
- Western Australian Planning Commission (2003b) Statement of Planning Policy 2.6 *State Coastal Planning Policy*
- City of Geraldton-Greenough Town Planning Scheme No. 1A

4.8.3 EPA Scope of Work

TABLE 22
EPA SCOPE OF WORK REQUIRED FOR VISUAL AMENITY

CONTENT		SCOPE OF WORK
Factor	**Site specific factor**	**Work required for the environmental review**
Visual Amenity	Landscape	Describe and assess landscape character and views of the Amendment area and adjacent area and describe how character and views may be affected by development within the Amendment area. Community values of the area should be considered as part of the landscape character assessment. Detail proposed measures to address these potential impacts on landscape character and affected views, including subdivision design. Provide details of potential impacts on visual character, including affected views from local vantage points, within the Amendment area, from the Amendment area, and to the Amendment area from outside the Amendment area. Detail proposed measures to mitigate visual impacts.

4.8.4 Existing Environment

Significant Landscape Features

As part of the ER reporting requirements, William James Landscape Architect undertook a comprehensive Visual Amenity investigation of the subject land. The complete report has been included as Appendix 7 of Volume II (Technical Appendices). The following is an abridged version of the report as it pertains to the subject land.

Significant landscape features in or adjacent to the subject land include the:

- Greenough River and its margins (regional significance);
- Ocean foreshore reserve which is well represented in the area (local significance);
- Large blow-out; and
- Drainage line adjacent to Brand Highway.

Land Use

Traditional rural land uses are giving way to urbanisation and to recreational activities associated with centres of population.

There is a small settlement and caravan park near the mouth of the Greenough River, a more recent small residential subdivision a little way further to the east and a resort on the elbow of the Greenough River where it tends to the south.

To the east, adjacent to Brand Highway, is a strip of cleared grazing land, while the land to the east of Brand Highway is a mix of future residential and rural.

North and north east of the subject land the dominant land use is residential.

Wilderness Values

Areas of high wilderness value "represent the environment in its most natural state, provide a resource bank and may provide the backdrop and sense of remoteness for other more used areas" (Cleary, 2005). This definition could be applied to the more natural, secluded and undisturbed land within the Greenough River Foreshore Reserve and the Ocean Foreshore Reserve.

Visual Aesthetic Significance

Visual aesthetic significance attaches to outstanding landscape features within the context of the particular Character Units. They are features that through the presence of highly distinctive geological features, landforms, vegetation patterns or cultural elements, are set apart from the "background" landscape. Natural water bodies, unless severely degraded, are nearly always of visual aesthetic significance. Within the subject land, the following features are deemed significant:

- The undisturbed portion of foreshore of the Greenough River and the river mouth;
- The ocean foreshore;
- The large blow out; and
- The drainage line and associated vegetation adjacent to the Brand Highway.

Views

Views provide the opportunity to become acquainted with a place or landscape from a distance and to put place and landscape into a broader context.

There are views over the subject land to distant coastal dunes, the Greenough River and the Ocean. The higher one gets into the adjacent rural and future urban land to the east, the more extensive and significant these views become. There are views over the subject land from the River Walk Trail towards the north.

Landscape Character

Landscape character is the nature or identity of the landscape and is a combination of the natural and cultural elements and their processes (O'Brian and Ramsay, 1991). These elements and processes change from place to place and so too does the landscape character. A major purpose of landscape planning and management should be to maintain the diversity in landscape character existing between different places by protecting the unique qualities inherent in a place (Cleary, 1991).

The Landscape Character Types of Western Australia were mapped and defined by the Department of Conservation and Land Management (CALM) in 1994 in their publication *Reading the Remote – Landscape Characters of Western Australia*. This mapping places the site within the Wheatbelt Plateau Landscape Character Type, Geraldton Plain Sub Type.

The western fringe of the Geraldton Plain Sub Type, of which the site is a part, is characterised by *"a system of windswept coastal dunes….sending long fingers of white sand and parallel ridges of dunes to encroach the level to undulating plains beyond. In many areas along the coast, the dunes feature quite prominently in the landscape, reaching up to 200m. Large dunal blowouts, such as at Southgate to the north of the Greenough River and other areas of bright mobile sand, display their susceptibility to erosion due to the constant buffeting of this coast by strong winds."*

Six subdivisions of the general Character Type were identified. These are referred to as Landscape Character Type Units and are:

- Bare dunes;
- Vegetated dunes;
- Cleared grazing land;
- Settlement;
- River foreshore; and
- Ocean foreshore.

The landscape character types are described in terms of their natural and land use characteristics:

Bare Dunes

The bare dunes comprise the northern third of the site, covering approximately 200ha. They range in height from just above sea level to 40m – the highest point. The slopes range from almost flat to gradients exceeding 30%. The high reflectivity of the bare white sand, the elevation, and the steep slopes combine to make the bare dunes the site's most significant landform.

The bare dunes are actively moving north east with the prevailing southerly winds, resulting in the steeper slopes occurring on the eastern – leeward – side. In some places the bare sand dunes extend to the beach and are only separated from the ocean by a narrow flat bare sand margin. The eastern edge of the bare dune is marked by a distinct line separating the coastal vegetation from the advancing wind-blown sand.

The bare dunes are criss-crossed with short-lived tyre marks from recreational off-road vehicles – short-lived because they are soon removed by the wind. Because of the constant change in landform, the exact shape of the dunes is difficult to map. It appears that the highest point is not as shown on the elevation map but further to the north-west as indicated in Plates 5 and 6.

Vegetated Dunes

These dunes retain a reasonably complete vegetation cover (Plate 7). They cover approximately 250ha an area broken into distinct segments, separated by bare dunes, settlement and agricultural clearing. The condition, structure and floral composition of the vegetation vary over the character type but are generally low to medium height shrubland dominated by the bright green *Acacia rostellifera*. The smaller grey *Olearia axillaris* is common closer to the beach. There are occasional specimens of *Melaleuca huegelii*, growing in the more protected sites. These specimens may reach 4m to 5m in height.

The vegetated dunes are generally not as steep or as high as the bare dunes and the vegetation is in some places dense enough to cover the sand beneath and in others quite thin so that the underlying sand is evident. Towards the eastern cleared land, the ground vegetation has been overtaken by introduced pasture species.

Cleared Grazing Land

The cleared grazing land occurs in the eastern portion of the site adjacent to the Brand Highway. It covers a total of approximately 120ha. In the agricultural clearing, coastal heath and shrubland has been replaced with pasture grasses and the shelter belt planting (Plates 8 and 9). There are small pockets of retained vegetation.

The gently undulating dunes of the grazing land, like the bare and vegetated dunes, run generally parallel to the coast. The landscape is very open and windswept with the major visual interest being in views beyond the cleared land. A vegetated drainage line runs along the eastern edge of the cleared grazed land into the Greenough River.

Settlement

There are three distinct settlements and settlement types in the subject land. There is a recent residential subdivision of contemporary design (Plate 10), a caravan park and camping area, an associated strip of holiday cottages (Plate 11) and a lodge style resort. These three settlements are characterised by landscape elements that set them apart from other 'natural' landscapes. These elements include roads, car parks and footpaths, street lights, signs, buildings – both domestic and for tourist accommodation – fences, ornamental and amenity planting, mown grass, street furniture and retail outlets. These elements have been laid over the natural landscape so that although no indications of the pre-settlement landscape character remains, the dominant character is now altered.

Greenough River Foreshore

The Greenough River cuts a sinuous path through the sand dunes in the last few kilometres before it reaches the ocean. The resulting riverine landscapes are distinctly different from other landscapes of the study area - the edge between the river and the land being the distinctive feature. There is considerable variety within this character type – some areas further south of the amendment area are relatively steep and covered in native vegetation while others are flat and bare of native vegetation (Plate 12) except for a few rushes hanging on at the edge between a car park and the river. The river itself is such a dominant landscape element that it unites all these diverse landscapes into the one identifiable character type.

Ocean Foreshore

The ocean foreshore shares with the river foreshore the pervading presence of adjacent water. This is, however, the only similarity. The two landscapes are very different in several significant respects. The ocean waters are far more dynamic than the river waters; the landform of the ocean foreshore is steeper in places, and actively eroding; the vegetation is much sparser and more stunted; the beach is far more exposed to winds than the river. The landscape is altogether harsher and more dynamic.

Change is a constant on the beach; the eroding sand cliffs change suddenly during storms and then slowly return to former shapes; footprints that were present in the morning are gone in the afternoon; the strand line changes with the tides; and the tides themselves are constantly changing the width and shape of the beach and what is exposed or covered at the shoreline.

Distinctive features of this foreshore are the exposed limestone shelf (Plate 13) and the small isolated hillocks with intermediate blowouts resulting from active erosion of the foredune (Plate 14). Exposure to salt-laden winds prunes the grey-green vegetation with the landform being strongly expressed.

The foredune contains the view to the east for much of the length of the beach. It is only at the northern end that views are afforded back into the bare dunes beyond.

Sensitivity to Viewing

Consideration of character, significance, wilderness value and views define the physical resource. The term landscape suggests an interaction between observers (people) and observed (the environment). "Landscape is not synonymous with environment; it is the environment

perceived, especially visually perceived" (Appleton, 1980).

Determining landscape *value* requires a consideration of how the physical resource is viewed. This is known as "viewer sensitivity", determined by identifying viewing locations and classifying existing and potential observers.

The Visual Management System (VMS) provides a consistent and rigorous method for establishing the significance of viewing locations. This involves identifying viewing locations and types of observers and from this data defining three levels of sensitivity – high, moderate and low.

The final step in considering viewing opportunities is to identify distance zones.

Viewing Locations

The subject land is seen from the following travel routes and locations:

- Brand Highway, north, adjacent and south;
- Greenough River Road to the coast from Brand Highway;
- Greenough River and adjacent foreshores;
- River mouth car park;
- Ocean foreshore;
- Walk trails and lookouts; and
- Rural land and future urban land to the east of Brand Highway.

Types of Viewers

An assessment of the type and number of existing and potential viewers places viewers into the following groups:

- Residents;
- Travellers;
- Tourists;
- Sightseers;
- Commuters;
- Transport drivers;
- Farmers;
- Cyclists;
- Walkers; and
- Anglers.

Sensitivity Levelling

Sensitivity levelling as set out in the VMS classifies all travel routes and use areas into Levels of Public Sensitivity.

Level 1 High
Level 2 Moderate
Level 3 Low
Level 4 Very low

These Sensitivity Levels are based upon public perceptions of landscape and the criteria listed in Table 23.

TABLE 23
PUBLIC SENSITIVITY LEVEL: TRAVEL ROUTE AND USE AREA CLASSIFICATION

Classification	Type of Use - Existing or Formally Proposed		Settlement
	Non-recreation use Roads	**Recreation and tourism**	
Level 1 High Sensitivity	National & State Highways. Links between cities and major towns	Designated tourist roads. Major recreation sites recognised formally or informally at a national or state level, including walking tracks and lookouts. Primary access to these recreation sites or multiple level 2 use areas. Travel routes or sites through or adjacent to scenic or historic areas with recognised or assessed values of national or state significance.	Places with recognised or assessed scenic or historical values of national or state importance
Level 2 Moderate Sensitivity	Main link roads between towns and highways .	Important but undesignated tourist and recreation roads. Recreation sites of regional importance, including walking tracks and lookouts. Primary access to these recreation sites or multiple level 3 use areas. Travel routes or sites through or adjacent to scenic or historic areas with recognised or assessed values of regional significance.	Places developed to capitalise on views or attractions.
Level 3 Low Sensitivity	Minor link roads	Local recreation	Residential areas other than Level 1 or 2.
Level 4 Very Low Sensitivity	Roads receiving local non-recreational traffic		Industrial areas.

Based on criteria used in the Visual Management System (Williamson and Calder, 1979)

Sensitivity of Viewing Locations

- Brand Highway - Level 1
- Residential areas, Greenough River Road, walking trails and lookouts, foreshore reserves - Level 2
- Other roads – Level 3

Distance

Distance refers to the distance between the observed landscape and observation points and routes. For assessment purposes, distance has been divided into six zones:

- Foreground 0.3km
- Close middle ground 0.3–1km
- Middle ground 1–3km
- Distant middle ground 3–6km
- Background 6km–15km
- Distant background >15km

Visibility

Visibility was tested digitally and by direct field observation. ArcView software was used to establish "seen area" on the basis of landform (it does not account for vegetation). Examples of the digital seen area mapping are provided in the Greenough River Estate Landscape Study Report enclosed in Appendix 7 of Volume II (Technical Appendices). The subject land was field surveyed for views from all potential viewing locations.

The subject land is visible from the east, south and north. There are glimpses from the west but these views are less extensive and significant than from the other quarters.

Landscape Policies and Community Perceptions

Western Australian Planning Commission
There is no specific WAPC policy document dealing with the site. General policies are established by the State Coastal Planning Policy (Statement of Planning Policy No. 2.6.).

Register of the National Estate
Greenough River Estate has no sites on the National Estate Register.

Western Australian Heritage Commission
Greenough River Estate has no sites on the Register of the Western Australian Heritage Commission.

State Agreement
Bayform Holdings Pty Ltd, the project developer, has entered an agreement with the State Government, which binds them, among other things; to stabilise the Greenough River Estate dune blow-out and the blow-out located south of the Greenough River.

Community perception and values
Local community perceptions and values have not been tested and it is likely that there is a variety of views relating to the landscape values of the study area. Values common to similar communities would suggest that the ocean and river foreshore are highly valued. However, it is unclear the value placed by locals on the mobile dune. The mobile dune is a prominent landmark and has been used for recreational off-road driving.

Project Objectives
Based on the statements contained in the planning documents cited above and on generally accepted community perceptions of the significance of landscape and scenery, project specific objectives have been developed and these relate to:

1. Landscape character;
2. Visual aesthetic significance;
3. Wilderness quality; and
4. Views

Landscape Character

Opportunities:
Landscape character is the means of identifying one landscape from another. It bestows a distinctive sense of place and is the most influential factor in an individual's experience of a landscape.

Constraints:
Development may alter the character to such an extent that the character changes from one type to another. Careful planning and design is needed to maintain an experience of the existing character.

Project Management Objectives:

- Changes to natural land use character should be such that a sufficient representation of that character type is maintained in order that the character type is recognised.

- Priority for protection should be given to land use character types or areas:
  - That have high levels of naturalness;
  - That are uncommon in the region; or
  - Are close to locations with high sensitivity levels (i.e. Level 1 and 2).

- In foreshore character areas, the character within high sensitivity viewing areas (for example Level 1 and 2) should be maintained. This means that change should not be recognised from these areas and routes regardless of distance. In general, to achieve this, development should be unseen in distance zones less than middle ground (1-3km) and very low impact in greater distance zones. Exceptions to these standards include:
  - Low impact recreation facilities, which may be seen in the foreground; and
  - Changes that are evident in the short term.

- In cases of land-use "succession", where the land use character changes to a more developed type, the more developed areas should include, as far as possible, pre-change characteristics of the area. As a guide the following objectives should be applied to developed areas:
  - In vegetated and bare dune character areas, essential elements of the dunal landform should be maintained in areas viewed from Level 1 and 2 areas and routes.
  - Revegetation of earth-worked areas should be of a similar character to the regional coastal vegetation – short to medium changes are excepted.
  - In cleared grazing land, there are few constraints to development but changes to land use should be screened from Level 1 and 2 areas and routes.
  - In settlement areas, there are few constraints to land use changes. Significant cultural and historical features should be conserved and protected.

Visual Aesthetic Significance

Opportunities:
Areas of visual aesthetic significance are the most distinctive features of an area and in themselves worthy of protection. They are the features that provide most visual reward. Within the subject land, some areas of high visual aesthetic significance coincide with areas of high conservation value – the Greenough River and Ocean foreshore areas. This provides opportunities for conservation of both ecological and visual aesthetic values and for the restoration of values in degraded areas.

Constraints:
They are the most vulnerable to changes that reduce their significance. Apart from the foreshores, the other element of high visual aesthetic significance is the mobile dune – it is unlikely that this significance can be protected.

Project Management Objectives:

- Protect areas of high visual aesthetic significance; and
- Seek to restore former values in areas of former high visual aesthetic significance now reduced to moderate significance.

Wilderness Value

Opportunities:
Areas of high wilderness value offer opportunities for low impact access and nature based experience. Foreshore areas with a high degree of naturalness offer opportunities for such experience.

Constraints:
Structures, vehicle access and sophisticated facilities detract from the potential wilderness experience. Residential development is incompatible with the experience of wilderness values.

Project Management Objectives:

- Maintain and enhance areas of high wilderness value.

Views

Opportunities:
Views provide the opportunity to become acquainted with a place or landscape from a distance and to put place and landscape into a broader context.

Constraints:
A "good" view is not necessarily one with high scenic value but is one that allows a high degree of visual access. This visual access may be to undesirable developments and land use changes.

Project Management Objectives:

- Views over and through Southgate to the ocean and the river should be maintained and enhanced.

4.8.5 Potential Impacts

Physical impacts

The combined effect of the land use changes arising from the proposed re-zoning will result in the following impacts:

Vegetation loss:

- On steeper vegetated dunes
- Roads and service corridors
- Individual building sites

Landform changes:

- Bare mobile dune will be regraded and reduced significantly in height
- Steeper vegetated dunes will be regraded and reduced in height
- Cut and fill to roads and individual lots

Buildings and structures:

- Residential, community recreation and commercial
- Beach and riverine structures – boardwalks, lookouts, steps, shelters, gazebos
- Fences, signs, lights, roads, car parks
- Traffic intersections on Brand Highway

Illumination:

- There will be a night-time "glow" from street lights over the new residential and commercial areas.

Areas and Locations Visually Affected by Development

Seen area mapping and field surveys identified the areas and locations visually affected by the anticipated land use changes and physical impacts.

The distance of the viewer from the object of the view affects the experience generally as follows:

- 0-300m (foreground): Large structures are dominant unless screened from view. All detail and colour is discernible. Loud sounds are readily heard and individual lights and illuminated elements will be clearly visible.

- 300m-1km (close middle ground): Large structures form the major element of the view. Detail and colour is less than distinct. Individual lights and illuminated elements are clearly visible.

- 1-3km (middle ground): Variables such as atmospheric conditions and the speed and focus of viewer become critical to the viewing experience. Individual large structures are minor elements of the view. Detail and colour are difficult to make out. The pattern of lighting and illuminated elements will be apparent.

- 3-6km (distant middle ground): Visibility is strongly affected by atmospheric conditions, light levels and the speed and focus of the viewer. Individual complex elements are

difficult to discern. Individual simple large shapes are discernible but very minor elements of the view. Lighting is apparent through a general illumination.

- 6-15km (background): Less than ideal viewing conditions will severely limit views. High contrast in form and/or colour is necessary to discern individual elements. Lighting will be general night "glow".

- >15km (distant background): Atmospheric conditions are critical to visibility. Individual large structures not discernible unless highly contrasting in form and colour. Lighting experienced a night "glow".

Table 24 describes the visible changes that will be experienced at various locations in the vicinity of the subject land.

TABLE 24
TYPICAL VIEWS IN EACH DISTANCE ZONE

Distance Zone	Location	Description of expected visual changes
0-300m	Brand Highway; Greenough River Road; Residential land to the north and north east; future residential land and rural land to the east.	Views of rural (cleared grazing) land, bare dunes and vegetated dunes will change to views of settlement. Traffic intersections on Brand Highway – with traffic lights in the long term. A shopping centre will be visible on the corner of Greenough River Road and Brand Highway.
	Beach car park	Views of vegetated dunes to the north will change to views of settlement.
	Greenough River Walk Trail	Views of rural (cleared grazing) land, bare dunes and vegetated dunes will change to views of settlement.
	Ocean foreshore	From the northwest, views of bare dunes to the south east will change to views of settlement. From other locations, structures and landscape works on the foreshore reserve will be visible.
	River foreshore	From the western portion of the foreshore, views of vegetated dunes to the north will change to views of settlement and the character of the existing settlement will change.
	Ocean	Views of bare dunes and vegetated dunes will change to views of settlement.
	River	Views of vegetated dunes will change to views of settlement.
300m-1km	Brand Highway (north); residential land to the north	Views of bare dunes will change to views of settlement.

Distance Zone	Location	Description of expected visual changes
	Brand Highway (south)	Views of rural (cleared grazing) land will change to views of settlement.
	Rural land to the east.	Rural (cleared grazing) land will change to views of settlement.
	Beach	From the south, views of bare dunes and vegetated dunes will change to views of settlement. From the north, views of the bare dunes will change to views of settlement.
	Ocean	Views of bare dunes and vegetated dunes will change to views of settlement.
	River	Views of vegetated dunes will change to views of settlement.
3-6km	Not visible from the ground. May be visible from tall buildings in the City of Geraldton	
6-15km	Not visible	

Impact on Existing Visual Aesthetic Values

The impact of the proposed changes on the existing visual aesthetic values is described below:

Landscape Character

The character of the bare dunes and vegetated dunes and cleared grazing land will change from "natural and "rural" respectively to settlement. This change in character will be discernible wherever it is visible regardless of distance zone. It will be more apparent from the east and north than from the south or west. This change is an inevitable result of land use "succession" and the planning and design should protect the most valuable characteristics – in this case; typical dunal landforms and significant vegetation.

The character of the river and ocean foreshores will remain the same although there will be natural resource based recreational structures and treatments within these areas.

Views

Views from the north east and east over the site to the ocean will be made more accessible by a general reduction in the height of the major landforms. However, this may not be long-term, as trees associated with residential development may eventually restrict view access. Additional views will be opened up to the ocean and river through the new road system.

Visual Aesthetic Significance

Landscape elements associated with visual aesthetic significance are the ocean and river foreshore and the major blowout. The values on the foreshores will not be affected but visual aesthetic values relating to the major blowout will be lost.

Wilderness Values

Wilderness values are associated with the least disturbed areas of the Greenough River and ocean foreshore. As these are to be protected, wilderness values will not be affected.

Evaluation of Impacts

Evaluation is the assessment of impacts of development on visual aesthetic values – do they satisfy management aims and objectives? Table 25 undertakes an evaluation of impacts of development against objectives.

TABLE 25
ASSESSMENT OF IMPACTS OF DEVELOPMENT

Project Management Objectives	Evaluation of impacts against objectives	Degree of conformity to objective
LANDSCAPE CHARACTER		
Changes to natural land use character should be such that a sufficient representation of that character type be maintained in order that the character type is recognised.	Careful planning and design will ensure that this is achieved in all but the bare dunes character type. Particularly important is the retention of a dunal landform in regrading the site.	Moderate
Priority for protection should be given to land use character types or areas that: - have high levels of naturalness that are uncommon in the region; or - are close to locations with high sensitivity levels (i.e. Level 1 and 2)	The river and ocean foreshore have a high level of naturalness – they will be protected. There is another major blow-out close by to the south of the Greenough River. All Character Types are close to Level 1 and Level 2 sensitivity locations. There will be significant change to all but the river and ocean foreshore types.	Moderate
In foreshore character areas, the character within high sensitivity viewing areas (for example Level 1 and 2) should be maintained. This means that change should not be recognised from these areas and routes regardless of distance. As a guide, to achieve this, development should be unseen in distance zones less than middle ground (1-3km) and very low impact in greater distance zones. Exceptions to these standards include: - low impact recreation facilities, which may be seen in the foreground; - changes that are evident in the short term.	This will be achieved by the protection of the foreshore areas within Foreshore Reserves and by the preparation and implementation of Foreshore Management Plans to standards set by relevant authorities.	High
In cases of land-use "succession", where the land use character changes to a more developed type, the more developed areas		Moderate

Project Management Objectives	Evaluation of impacts against objectives	Degree of conformity to objective
should include, as far as possible, pre-change characteristics of the area. As a guide the following objectives should be applied to developed areas: - In vegetated and bare dune character areas, essential elements of the dunal landform should be maintained in areas viewed from Level 1 and 2 areas and routes. - Revegetation of earth-worked areas should be of a similar character to the regional coastal vegetation. - In cleared grazing land, there are few constraints to development but changes to land use should be screened from Level 1 and 2 areas and routes. - In settlement areas, there are a few constraints to land use changes. Significant cultural and historical features should be conserved and protected.	This will be achieved for the vegetated dunes but not for the bare dunes. This will be achieved by planting vegetation of a similar character as the existing in public open spaces. Dense screening along much of the Brand Highway edge will achieve this. This will be achieved in the detail design process.	
VISUAL AESTHETIC SIGNIFICANCE		
Protect areas of high visual aesthetic significance.	River and ocean foreshore will be protected. The major blow-out will not be protected.	Moderate
Seek to restore former values in areas of former high visual aesthetic significance now reduced to moderate significance.	Degraded river and foreshore areas will be restored.	High
WILDERNESS VALUE		
Maintain and enhance areas of high wilderness value.	This is met by the protection of the river and ocean foreshores within reserves and the preparation of Foreshore Management Plans.	High
VIEWS		
Views over and through Southgate to the ocean and the river should be maintained and enhanced.	This will be achieved by the reduction in height of the dunal landform and by the introduction of more east-west roads.	High

The visual aesthetic objectives are satisfactorily met by the proposed structure plan and by the mandatory preparation of Foreshore Management Plans for the ocean and river foreshores. The most significant non-conformity is the major change to the bare dunes character type and the consequent loss of the high visual aesthetic significance attached to these dunes. The retention of these values and the development of a residential subdivision – and indeed the long term protection of significant assets such as the Brand Highway and existing residential development – are essentially incompatible objectives.

4.8.6 Proposed Management

The application of the following principles will ensure that visual aesthetic values are protected in the proposed development:

- Retain dunal landform in the regrading of the site (refer to Figure 4). Retain significant representations of existing indigenous vegetation.

- Create small, discrete (separate) nodes of recreational development in the river and ocean foreshore reserves. Retain significant stretches of 'natural' landscape between nodes.

- Retain an area of bare dune in the wide portion of the foreshore reserve in the northwest of the site.

- Screen all development from Brand Highway with adequate planting buffers of mixed shrubs and trees. This will avoid the creation of an apparent strip development running south along the Brand Highway from Geraldton.

- Maintain existing vegetation in the Greenough River and ocean foreshore reserves and repair degraded areas.

- Develop designs and design guidelines for signs, planting, fencing and hard landscape elements to ensure consistency and responsiveness to the local character of the subject land.

4.8.7 Potential Outcomes

Implementation of the proposed management strategies will ensure that the EPA's objective for visual amenity is achieved.

4.9 Aboriginal Heritage

4.9.1 EPA Objective

To ensure changes to the biophysical environment resulting from the proposal do not affect historical and cultural associations within the area and comply with the requirements of relevant heritage legislation.

4.9.2 Applicable Legislation, Criterion or Guidance

- *Aboriginal Heritage Act 1972*
- *Native Title Act 1993*
- *Aboriginal and Torres Strait Islander Heritage Protection Act 1984*
- Environmental Protection Authority (2004c). *Assessment of Aboriginal Heritage* Final Guidance No. 41

4.9.3 EPA Scope of Work

TABLE 26
EPA SCOPE OF WORK REQUIRED FOR ABORIGINAL CULTURE AND HERITAGE

CONTENT		SCOPE OF WORK
Factor	**Site specific factor**	**Work required for the environmental review**
Heritage	Aboriginal Culture and Heritage	Identify Aboriginal cultural and heritage sites of significance through archaeological and ethnographic surveys of the Amendment area and through consultation with local Aboriginal groups and the Department of Indigenous Affairs.
		Consult with the relevant Aboriginal people of the area to determine potential impacts on the proposal on cultural associations with the Amendment area.
		Detail proposed measures to manage potential impacts.

4.9.4 Existing Environment

As a part of the ER report requirements, Quartermaine Consultants undertook an archaeological investigation of the subject land. The complete report has been included as Appendix 8 of Volume II (Technical Appendices). An ethnographic survey of the subject land was undertaken by Philip Haydock (2004) for the Department of Planning and Infrastructure. Preceding the 2004 ethnographic survey of Lot 11939, an ethnographic survey of the Southgate Dunes System and the adjacent land was completed for Landrow Ltd by R O'Connor (2001).

The following information has been taken from these reports as it pertains to the subject land.

Background to Survey

An archaeological investigation for Aboriginal heritage significance of the subject land was undertaken in February 2006. This work was undertaken by Gary Quartermaine, with the assistance of Vanessa Macri, archaeologist and Simon Macri, field assistant (Quartermaine Consulting, 2006).

The objective was to conduct an archaeological investigation to facilitate planning of the proposed seismic programme. The two aspects of the investigation were:

1. The assembly of data from previous work in the region, including information from the Heritage and Culture Division, Department of Indigenous Affairs (DIA) Aboriginal site files, previous survey reports, maps and environmental information.

2. A field programme to sample the subject land and the location of any archaeological sites within the subject land.

The 2004 ethnographic survey was conducted on Lot 11939 with the Naaguja claimant group, as a work clearance, on behalf of the Yamatji Land and Sea Council (Haydock, 2004). The 2001 ethnographic survey was undertaken in consultation with representatives of the Mullewa Wadjari native title claimant group.

Site Definitions

Sites of significance to Aboriginal people (ethnographic sites) include mythological, ceremonial and burial sites as well as named places and other known places, such as water sources. Archaeological sites contain physical evidence of past Aboriginal occupation. Sometimes the two types (ethnographic and archaeological) overlap.

Aboriginal material culture is largely based on non-durable materials; such as wood, bark, fibre and skins; that have a limited life in the archaeological record. Stone tools, conversely, remain as often the only evidence of prehistoric activity. Bone; either as a tool, as refuse, or as a burial; falls somewhere between these extremes. Lofgren (1975:7) describes spears, spear-throwers and clubs for men, and digging sticks, wooden carrying dishes and grindstones for women, as the basic implements of Aboriginal life. Therefore, stone artefact sites reflect only one aspect of Aboriginal material culture that utilised a wide range of materials from the natural environment.

For the purpose of this investigation, an archaeological site is defined as "any place containing traces of past human activity" (Fagan 1980:7). This is manifested in a number of different site components that may occur singularly or with one or more of the others to form an archaeological site. The most common of these are surface artefact scatters, quarries, art sites, stone arrangements, rock shelters with evidence of occupation, grinding patches, shell middens, burials and marked trees.

The above definition of archaeological sites is a scientific definition. However, registered Aboriginal sites may not meet the scientific criteria on all occasions. The assessment as to whether such sites are covered by the provisions of the WA *Aboriginal Heritage Act*, 1972, Section 5, is made for the Minister for Indigenous Affairs by the Aboriginal Cultural Material Committee. Such assessment is usually undertaken as part of a Section 18 application for site disturbance.

An Aboriginal archaeological site is mentioned in the WA *Aboriginal Heritage Act*, 1972, in Section 5 (c), which reads:

> *"Any place which, in the opinion of the Committee is, or was, associated with the Aboriginal people and which is of historical, anthropological, archaeological or ethnographical interest and should be preserved because of its importance and significance to the cultural heritage of the state."*

In order to address the state legislation and in the absence of any guidance from DIA despite several enquiries over the past twenty years, an artefact scatter is recorded as a site by this consultant if it contains a concentration of artefacts in contextual association, three or more with a density of at least 1/100m^2. Areas of solitary artefacts, called Isolated Finds, are presently recorded but not registered as Aboriginal sites. This was not always the case in the past and some previously registered sites contain only a solitary artefact, in keeping with the broad scientific definition.

Local Archaeological Research

A significant number of heritage surveys have been carried out near the subject land as well as the wider region. The majority of these studies however have been the result of mitigative work prior to development activities. Several surveys and research projects have been completed on, or near, the present subject land (Corsini 2002; Harris 1998; Murphy 1998; Pickering 1982; Quartermaine 1992, 2003; Schwede and von Bamberger 1996; and Veth and Quartermaine 1984).

A heritage study of the Geraldton area was undertaken by Schwede and von Bamberger (1996). The study covered an area of 200km^2 and approximately 15% of this area was surveyed. As a result of this study, they made the following conclusions:

- All new sites were adjacent to or within one kilometre of water;
- Large and extensive sites were usually located in higher areas such as deflation of yellow sand ridges which overlie the coastal limestone;
- Extensive sites were generally found along the coastal belt in association with adjacent offshore reefs;
- Continuous artefact scatters were adjacent to major river systems;
- Raw materials utilised were mostly quartz, quartzite, cherts and granitic rock obtained from local sources; and
- All sites have flake; fragment and core components and large sites have grinding material.

Murphy (1998) conducted an investigation for archaeological sites in the Landrow Landholdings at Greenough. The subject land was larger than just the subject land. This survey resulted in the discovery of four registered sites and three newly discovered sites located to the north of the subject land. Several other archaeological sites were discovered in the area to the south of Greenough River near the coastline.

Corsini (2002) reported on the recovery of human skeletal remains from a site near Greenough River.

Veth and Quartermaine (1984) recorded a nine sites along a 42km survey transect for the Geraldton lateral gas pipeline route.

Other surveys have been for the Dampier to Perth gas pipeline (Pickering, 1982), the Geraldton to Perth optic fibre cable route (Quartermaine 1992), the Geraldton Southern Transport Corridor (Harris 1998), and a bridge at Walkaway (Quartermaine 2003).

The majority of previously recorded sites in the region are artefact scatters, though some burials have also been recorded in the wider region. Most of these sites are clustered around the Irwin River and its neighbouring swamps, as this river system would have been one of the few reliable water sources in the region.

Most of the artefact scatters that have been recorded in the region are representative of small, ephemeral camp sites. The assemblages of these sites are dominated by quartz and silcrete, although a variety of other lithic materials were also utilised.

The clustering of archaeological sites around the Chapman, Greenough and Irwin Rivers and the neighbouring swamps demonstrates the importance of water in site location. The relatively large number of burials along the Irwin River also suggests that Aboriginal groups had major campsites along the banks of the river. In the region surrounding the Greenough River, it was common for burials to have taken place in the immediate area where a person died, hence their association with large occupation sites.

An understanding of the overall pattern of site distribution in the region enabled a survey strategy to be developed which targets those areas of highest site potential, given that 100% coverage of the seismic subject land is impractical due to difficulty of access and vegetation cover.

Potential Archaeological Site Locations

Based on the findings of survey work in the region, and the local environment, it was considered that most of the subject land is of relatively low archaeological site potential.

Surface artefact scatters, shell middens and burial sites are by far the most common archaeological site type on the coastal plain in this area. Other site types are in very low numbers, often as low as one example, with some sites containing multiple components.

Previously recorded sites in the region reflect a distribution that indicates where site survey work has been undertaken as well as the location of sites on the margins of rivers, lakes and swamps. While surface artefact scatters are the dominant recorded site type, quartz is the dominant lithic material used in the manufacture of stone tools. Other materials used include fossiliferous chert, dolerite, silcrete, mylonite, calcrete and granite plus the addition of glass and pottery in historic times.

From the limited available information, a general overview of the archaeological site distribution patterns for the area is as follows:

- Small, low density, surface stone artefact scatters are the most numerous archaeological site type found in the region.
- Larger sites are most likely to occur near bodies of permanent water.
- Quartz is the dominant lithic material used for the manufacture of while silcrete, dolerite, quartzite and chert are also found. Flakes and chips form the major class of artefact types in the recorded artefact assemblages.
- River, lake and swamp margins, and areas of de-vegetated sand are the main areas where artefact scatters have been recorded.
- Burials and middens may be present in coastal sand dunes while burials may be present at other locations.
- Engravings are sometimes found on granite, dolerite and limestone boulders and outcrops.
- Scarred trees have been recorded in various parts of the south-west.
- Stone structures that have been used as ceremonial centres, markers, animal traps or hides may occur.
- Quarry sites may be present at suitable lithic outcrops or ochre sources.
- Caves and rock shelters often contain evidence of past human occupation.

Archival Research

The WA *Aboriginal Heritage Act 1972* (as amended), is administered by the Department of Indigenous Affairs' Division of Heritage and Culture. The DIA maintains a Register in the form of a computerised database of reported Aboriginal sites. Each registered Aboriginal site is designated by a numerical site id, site type (e.g. engravings, ceremonial, artefacts, etc), site name and its position is recorded by the Map Grid of Australia 1994 (MGA94) coordinates related to the Geocentric Datum of Australia 1994 (GDA94), as well as Longitude and Latitude.

Although the grid references are given in MGA94/GDA94 coordinates, many sites were recorded in the period when imperial grid references were used with a three figure grid references (within a one square mile location). Since their recording, the grid references have been changed to the metric system on AGD84, with three figure grid references (within a one square kilometre location), then to AGD84, positioned in the centre of the one kilometre square, and finally to GDA94.

Given that there was likely to be some errors in any imperial recordings, the transfer to the present system may have resulted in further errors in site location coordinates over the various stages. Therefore, field verification is required to determine the correct site location for any sites near the subject land if there is insufficient information in the individual sites files to establish the actual location of the site.

As a result of previous surveys and independent research, it was established that 17 Aboriginal sites have been registered with the DIA within a 5km radius of the subject land. Sixteen of these sites are archaeological sites or contain archaeological material. Seven of these sites are within the subject land.

Obligations under the Act

The WA *Aboriginal Heritage Act l972* makes provision

> *"for the preservation on behalf of the community of places and objects customarily used by or traditional to the original inhabitants of Australia or their descendants, or associated therewith, and for other purpose incidental thereto."*

An archaeological survey is aimed at identifying the effects of proposed disturbance of the physical environment on historic and pre-historic Aboriginal sites. In recognition of the significance of this area to living Aboriginal people, consultations with Aboriginal people identified as having an interest in the area were conducted. This is reported upon separately.

The consultant is obliged to submit site documentation on appropriate forms for lodgement and submission to the DIA for any newly recorded Aboriginal sites.

Survey Strategy

The survey design involved the following stages of operation.

i. Background research - this involved familiarisation with DIA site files, survey reports, plus maps and environmental information for the area to be surveyed. Previously recorded Aboriginal sites, registered with the DIA, are listed in Appendix 2 of this Volume.

ii. Survey strategy - this consisted of a systematic and predictive sample survey of the designated subject land. The field survey was completed using 1:100,000 and 1:250,000 topographic maps of the area and plans of the subject land.

iia. Preliminary reconnaissance - This stage was necessary to refine a proposed survey strategy. It involved a general survey of the subject land to investigate ground surface visibility, accessibility, features in the landscape, and any areas where permanent or semi-permanent water would be available.

iib. Sample strategy - The subject land was accessed by 4WD vehicle during the course of the survey. Pedestrian transects were performed at regular intervals and potential archaeological site locations. The various tracks and access roads were used as baselines from which meandering pedestrian transects were conducted. These were positioned so that at least 25% of the subject land was surveyed. Particular attention was given to sand deflations.

Initially, the survey strategy implemented consisted of systematic pedestrian transects, but became more opportunistic and purposive due to numerous restraints. Pedestrian traverses were

undertaken where visibility was higher and where sites were expected to occur such as sandy exposures.

iii. Recording of the sites - a site recording form, compiled prior to fieldwork using information from previous research, was used in the field. This enabled a standardised set of data to be obtained from each site in an efficient manner. Categories under which site data will be recorded are as follows:

(a) Site description - type, linear dimensions, components, stratification potential and features;

(b) Environmental setting - geomorphic zone and location, vegetation, soil, drainage and proximity to water, surface visibility and disturbance;

(c) Artefact assemblage - numbers, density, types, lithic materials, artefact dimensions and retouch. A controlled sample of artefacts was recorded in the field, where time and site size allowed. However, most sites were subject to preliminary recording of basic features; and

(d) Site location plan and photo.

Significance Assessment

Site significance, in this report, is based on recognising that a body of archaeological data can answer regional research questions, as well as those concerning a particular site's attributes. Sites can be classified on the basis of uniqueness/representativeness, and capacity to provide further scientific information, particularly potential stratified deposits (Raab and Klinger, 1977). For example, unique sites are more significant than common sites, and sites with stratified deposits are more significant than unstratified sites. Significance is a relative quality, changing as more sites are recorded, questions are answered or new directions in research arise. Research questions that sites in the Greenough area may address include:

- The antiquity of colonisation of the coastal zone;
- Social and technological changes, if any, that occurred in the mid-Holocene;
- Specific patterns in the occupation of this zone; and
- Dating of industrial sequences in this region.

Results

Desktop research indicated that there were seven registered archaeological sites on the subject land (Appendix 2 of this Volume). As a result of field investigations, six newly discovered archaeological sites were located on the subject land (Appendix 3 of this Volume) along with the seven registered sites.

It was considered that any major archaeological sites would have been located given the size, environment and disturbed nature of the survey area. Disturbance was from natural processes and agriculture.

Conditions of the site discovery were reasonable. Surface visibility varied due to surface vegetation and ground disturbance, which covered much of the subject land.

The seven registered site locations were inspected and grid references and the present condition of the sites were recorded. The sites were located using site file descriptions and directions as well as GPS grid references. Details of the registered and newly identified sites are provided in Appendices 3 and 4.

The Aboriginal people consulted as a part of the 2001 ethnographic survey gave their support for the development of the subject land. Similarly, the Naaguja heritage survey team gave conditional support for the proposed development on Lot 11939.

Both ethnographic surveys identified concerns by representatives about the potential to disrupt existing and unknown archaeological sites.

4.9.5 Potential Impacts

Re-zoning the subject land to 'Development' zone will facilitate future development of the land for urban and associated purposes. In developing land, there is potential for the disturbance of known and unknown heritage sites.

Existing sites are mainly being impacted by natural processes (primarily the erosion and deposition of sand). Other disturbance factors include recreational off-road vehicles and the construction of firebreaks is impacting on some of the identified sites.

All of the identified sites are considered to be of low archaeological significance with the exception of site DIA ID 1063, which is considered to be of moderate archaeological significance.

4.9.6 Proposed Management

Where possible, activities should be directed to avoid disturbance to known archaeological sites. For example, some sites may be retained in public open space. However, where disturbance is unavoidable, permission to use the land where archaeological sites are present is required under Section 18 of the Western Australian *Aboriginal Heritage Act 1972*, prior to any disturbance occurs. Permission to disturb the identified sites on the subject land will be made prior to the implementation of the proposed earth working program.

In order to address Aboriginal heritage issues appropriately, the developer will be responsible for the preparation of an Aboriginal Heritage Protocol in consultation with local Aboriginal representatives to the satisfaction of the DIA and the local authority. The protocol will outline the procedure for dealing with potential Aboriginal sites found during construction works. Specifically the protocol will address:

- The requirement for work to stop in the immediate are should a potential site be identified;
- The reporting requirements from the site supervisor to the project manager;
- The requirement to contact a qualified archaeologist to determine the appropriate course of action based on the level of significance;
- The procedure to be followed if skeletal remains are found; and
- The requirement for recording each incident.

It is the developer's responsibility to take adequate measures to inform any project personnel of this protocol and any other relevant information.

4.9.7 Potential Outcomes

Development of the subject land has the potential to disturb known and unknown heritage sites. These sites have been identified as generally of low significance. The developer will be comply with the *Aboriginal Heritage Act 1972*, and lodged a Section 18 application for the disturbance of these sites.

Stabilising Southgate Dunes, controlling human activities (e.g. off-road vehicles) and retention of sites in public open space will assist in the protection of existing sites.

4.10 Recreation

4.10.1 EPA Objective

To ensure that existing and planned recreational uses of the environment are not compromised.

4.10.2 Applicable Legislation, Criterion or Guidance

- *Control of Vehicles (Off-Road Areas) Act 1978*

4.10.3 EPA Scope of Work

TABLE 27
EPA SCOPE OF WORK REQUIRED FOR RECREATION

CONTENT		SCOPE OF WORK
Factor	**Site specific factor**	**Work required for the environmental review**
Recreation		Assess the potential impacts of the proposed development within the Amendment area on the recreation values of the beach and foreshore areas. Describe proposed measures for managing these impacts.

4.10.4 Existing Environment

Cape Burney and its surrounds are a popular tourist destination and it is expected that tourism will continue to grow in the region. At present, the Greenough River and its associated foreshore reserve, the ocean and adjacent land (including Southgate Dunes) are suitable for a range of recreational pursuits. Common recreational pursuits near the subject land include:

- Water based sports (fishing, water skiing, swimming, rowing, wind surfing, boating);
- Off-road driving;
- Sand boarding
- Bush walking;
- Bike riding;
- Bird watching; and
- Camping.

The following has been adapted from the Greenough River Estuary Management Plan prepared by W.G. Martinick and Associates (1994):

Water Based Sports

The ocean and beach is used for fishing, surfing, swimming, sunbathing and windsurfing. Access to the ocean is facilitated by the road to the river mouth and a track further north which is accessible from Brand Highway. This track is currently located on privately owned land. At present, people launch boats into the ocean at the River mouth and further north in the amendment area (accessed via the track from Brand Highway).

Powerboats are permitted on the Greenough River with the exception of the two designated water ski areas when these are being used by the Western Australian Water Skiing Association (Inc.) and/or the Geraldton Water Ski Club. An eight knot speed restriction is in place for powerboats on the Greenough River. Boating pursuits on the ocean are a popular pursuit, however there are no proper boat launching facilities adjacent to the subject land.

Two designated water ski areas exist on the Greenough River, these are:

- Area adjacent to Pelican Point; and
- Devlin's Pool.

Both areas have been set aside for use by the Western Australian Water Ski Association (Inc.) and are under the control of the Geraldton Water Ski Club. Use is not permitted for non-members.

The Greenough River Rowing Club has a facility along the banks of the Greenough River south of the amendment area. Holidaymakers also use the river for canoeing and kayaking.

Fishing is popular along the coastline and in the Greenough River due to the relative abundance of fish. Fishing is primarily restricted to rod and hand lines and bag and size limits apply.

Some people use the river for swimming; however, its suitability for swimming is dependent on water quality. However, the ocean remains the more popular option for swimming.

The Cape Burney region is known to be a windy area, making the region suitable for windsurfing. At times, the Greenough River is used for windsurfing, however due to the topographical conditions and prevailing breezes restrict the suitability of the River for windsurfing to when conditions are favourable.

Land Based Recreation

Southgate Dunes are used frequently by off-road enthusiasts. The large, soft dunes provide challenging conditions for drivers and are also popular with sand boarders. This area is gazetted under the *Control of Vehicles (Off-Road Areas) Act 1978.* However, with future development of Southgate Dunes, the City of Geraldton-Greenough has indicated a preference for the staged downgrading of areas for off-road vehicles in the area north of Greenough River. The beach is also a popular off-road vehicle area and frequently accessed by fisherman.

The Greenough River Nature Walk Trail is located south of the amendment area. This walk trail was extended in 1999 with funding from Trailswest. It is a 17km circular nature trail caters for walkers and mountain bike riders. The trail is a valued recreational facility offering scenic views of the Greenough River and the ocean, opportunity to view native plants and a range of fauna species. The trail traverses through the portion of the Greenough River foreshore reserve.

The Greenough River is an important drought refuge for birds due to the presence of permanent water in the lower section. The large number of birds, particularly in late summer, adds considerably to the aesthetic value of the area and appealing to bird enthusiasts.

Camping is permitted at the caravan park located closer to the Greenough River mouth. Barbecue facilities are provided on the northern side of the Greenough River close to the mouth of Greenough River. Camping outside of designated areas is prohibited although it does occur along coastal side of the Greenough River south of the amendment area.

4.10.5 Potential Impacts

Re-zoning the subject land to Development zone will facilitate future development for urban and associated purposes. Development has the potential to alter existing recreational opportunities as well as result in an increase in demand for recreational facilities and infrastructure. If insufficient opportunities are provided, or if recreational activities are not managed appropriately, there may be increased pressures on the natural environment. In some cases, existing recreational pursuits (such as off-road driving) are not complementary with dune stabilisation and the ultimate land use of the subject land.

Off-road enthusiasts will be disadvantaged with the removal of a gazetted off-road vehicle use area. Continued off-road driving on Southgate Dunes will compromise efforts to stabilise the dune system (which is a requirement of the State Agreement between Bayform and the State of Western Australia).

The proposed development will result in the creation of new recreational opportunities through the provision of new facilities such as active recreation areas (e.g. ovals) and a tourist marine development. Beach access by vehicles will generally be discouraged, however the existing track to the beach in the northern area used for boat launching will be retained with the provision of boat launching facilities on the coast at this location.

4.10.6 Proposed Management

Management of recreational activities will largely be the responsibility of the local authority. The developer will be required to identify key open space requirements and a foreshore reserve in the preparation of a Structure Plan. A Foreshore Management Plan detailing the treatment of the foreshore area and outline appropriate activities in the foreshore area will be prepared during the subdivision process by the developer to the satisfaction of the local authority on advice from the Department for Planning and Infrastructure. Details of the Foreshore Management Plan have been provided in Section 4.4.6.

Furthermore, as a part of the development, the developer will be responsible for the design and installation of recreational facilities on the subject land to the satisfaction of the local authority. The existing track to the beach in the northern portion of the amendment area will be retained and boat launching facilities located on the beach where the community currently launches its boats.

4.10.7 Potential Outcomes

Future development of the subject land will result in a net benefit in terms of recreational opportunities. Off-road enthusiasts will be most disadvantaged. However, the provision of infrastructure (e.g. dual use pathways, ovals etc) in key locations will facilitate recreational activities.

Most existing recreational uses of the natural environmental on and adjacent to the subject land will not be compromised by future development. However, the main recreational pursuit that will be affected by future development of the subject land is off-road driving. Subject to the execution of the land exchange agreement, Bayform will be required to stabilise Southgate Dunes. For successful stabilisation of this mobile dune system and protection of existing infrastructure, it will be required that off-road vehicle use be removed.

5. DEFERRED ENVIRONMENTAL FACTORS

5.1 Wastewater Treatment Plant

5.1.1 EPA Objective

To ensure that emissions do not adversely affect environment values or the health, welfare and amenity of people and land uses by meeting statutory requirements and acceptable standards.

5.1.2 Applicable Legislation, Criterion or Guidance

- Western Australian Planning Commission (2003a) Statement of Planning Policy No. 2 *Environment and Natural Resources Policy*
- Western Australian Planning Commission (1997) Statement of Planning Policy No. 4.1 *State Industrial Buffer Policy*
- Western Australian Planning Commission (2004) Draft Statement of Planning Policy No. 4.1 *State Industrial Buffer Policy*
- Environmental Protection Authority (2004d). *Separation Distances between Industrial and Sensitive Areas.* Draft Guidance Statement No. 3
- City of Geraldton-Greenough Town Planning Scheme No. 1A

5.1.3 EPA Scope of Work

Sometimes the EPA will identify environmental factors that it considers relevant to the scheme but which are likely to be best addressed at a later level of planning. These factors are considered significant enough to warrant attention as part of the environmental review of this scheme, to the extent that the Responsible Authority should show how these factors could be addressed at a later level of planning. These factors are called “deferred environmental factors".

The Water Corporation’s Greenough-on-Sea Wastewater Treatment Plan (WWTP) has been identified as a deferred factor identified for this Amendment.

5.1.4 Existing Environment

The Greenough-on-Sea WWTP services the Cape Burney/Greenough River locality and is centrally located in the amendment area. The land that the Plant is situated on is zoned ‘Public Purposes’ under the current City of Geraldton-Greenough TPS No. 1A. This land is not included in the EPA’s ER instructions.

The Plant was constructed in 1980, in response to the rapid growth of the Greenough area and environmental concerns regarding the proximity of the urban development and the subsequently impacts on the quality of the Greenough River.

The Water Corporation are constructing a new facility in the Narngulu Industrial area, which will ultimately serve the subject land. However, the de-commissioning of the Greenough-on-Sea WWTP is subject to the establishment of the new Plant at Narngulu. The new WWTP is located outside of the subject land and is expected to be completed by the end of 2007.

5.1.5 Potential Impacts

The Greenough-on-Sea WWTP, while operational will emit odours that will have an impact on amenity of surrounding land users. Therefore, it is important to identify and retain an adequate buffer that separate odour-sensitive land uses (e.g. residential areas) with the odour-source.

Upon completion of the new waste water treatment plant in the Narngulu Industrial area, the Greenough-on-Sea WWTP will be de-commissioned. The timeframe for the de-commissioning the Greenough-on-Sea WWTP is not known.

Land use for the Greenough-on-Sea WWTP site has not yet been determined.

5.1.6 Proposed Management

Land use for the area occupied by the Greenough-on-Sea WWTP has not yet been determined and is not included in the EPA's Instructions for the preparation of this ER. While the Plant remains operational, an odour buffer will be required with only compatible land uses allowed within the buffer area. Once the Plant has been de-commissioned, the land occupied by the buffer will become available for future development.

Further planning for this site will be addressed at the Structure Plan stage.

6. ENVIRONMENTAL MANAGEMENT COMMITMENTS

In accordance with Section 86 of the *Planning and Development Act 2005*, the proponent will incorporate the environmental conditions imposed by the Minister for the Environment into the City of Geraldton-Greenough TPS No. 1A. Following is a draft set of environmental conditions that may be incorporated into the Scheme.

6.1 Environmental Management Plans

Prior to final subdivision approval, the developer shall prepare the following environmental management plans:

- **Vegetation Management Plan**

  The Vegetation Management Plan will include:
  - Aims and long term management objectives for the area;
  - Description of the area, including size, location, topography and major features;
  - Aboriginal and European history of the area; including prior land uses, ownership or other relevant data;
  - Biodiversity and ecological values of the area, including links to other areas;
  - Description of predevelopment flora and fauna – including flora and fauna that have been located in the area and identification of any threatened, endangered or priority species;
  - Details of how the assessment was conducted, including details of any transects, monitoring points or sampling;
  - Details of risk assessment for site including risk to flora and fauna from adjacent urban development – from people, litter, pets, road traffic, changes in hydrology, nutrients, pollutants etc;
  - Proposed management strategies to protect flora and fauna; particularly any endangered, threatened or priority species;
  - Proposed management strategies for the control of feral animals;
  - Reference Legislation and Policy relevant to the Management Plan;
  - Risks from fire, and to community from fire;
  - Risks to community from biting insects, snakes and pathogens;
  - Detailed management programs to address issues identified in risk assessments;
  - Management and maintenance programs for weed control, fire control, and rehabilitation or restoration of bushland area;
  - Description of monitoring programs to be conducted during and after development has occurred;
  - How the local community will be included in the management of the area; and
  - Responsibility for conducting and financing, monitoring, restoration management and education programs.

- **Foreshore Management Plan**

  The Foreshore Management Plan will consider the following:
  - Pedestrian access;
  - Carparking requirements
  - Requirement for cycle route along edge of, or within, the foreshore reserve as part of a regional system;
  - Structures such as pavilions, boardwalks adopted as public facilities;
  - Use of fencing and signage;
  - Protection of existing vegetation; and
  - Coastal rehabilitation/stabilisation and revegetation undertaken for degraded areas.

- **Local Water Management Plan**

  The Local Water Management Plan will consider the following:
  - Non-Structural Controls
    - Planning practices (POS locations and layouts, plantings)
    - Construction practices (use of native plantings)
    - Maintenance practices (street sweeping, stormwater system, POS areas)
    - Educational and participatory practices (capacity building programs, community education)

  - Structural Controls
    - Retention and infiltration of frequent events where possible (soak wells, swales, bottomless manholes)
    - Creation of ephemeral retention/detention areas within community park/wetland buffers/POS areas
    - Application of Gross Pollutant Traps

The above environmental conditions shall be prepared and implemented in accordance with provisions of the Plans, to the requirement of the Local Authority on advice from the Department of Environment and Conservation (Vegetation Management Plan), Department of Planning and Infrastructure (Foreshore Management Plan) and Department of Water (Local Water Management Plan).

TABLE 28
SUMMARY OF PROPOSED MANAGEMENT MEASURES

Environmental Factor	Objective	Environmental Management Measures	Timing (Phase)	Whose Requirements
Vegetation Communities and Significant Flora	Maintain the abundance, diversity, geographic distribution and productivity of flora at species and ecosystem levels through the avoidance or management of adverse impacts and improvement in knowledge. Protect Declared Rare and Priority Flora consistent with the provisions of the *Wildlife Conservation Act 1950*, and the *Environment Protection and Biodiversity Conservation Act 1999*. Protect other flora of conservation significance.	Vegetation Management Plan will be prepared for vegetation to be retained in the future development of the subject land.	Plan preparation at Subdivision stage.	Local authority
Specially Protected (Threatened Fauna)	Protect specially protected (threatened) fauna and priority fauna, consistent with the provisions of the *Wildlife Conservation Act 1950* and the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*. Protect other fauna of conservation significance.	Vegetation Management Plan will be prepared for vegetation to be retained in the future development of the subject land and will include strategies for the management of fauna habitat and feral animal control.	Plan preparation at Subdivision stage.	As above
Coastal Landforms, Processes and Foreshore	To maintain the integrity of landscape and landforms by maintaining their ecological functions and environmental values.	Prepare Foreshore Management Plans for coastal foreshore reserve to identify measures to preserve the natural environment of the area, while accommodating the local and regional recreational	Plan preparation at Subdivision stage.	As above

Environmental Factor	Objective	Environmental Management Measures	Timing (Phase)	Whose Requirements
		demands. Southgate Dunes Stabilisation Strategy to be implemented.	 Implementation will commence upon completion of land exchange agreement.	 Responsible authority on advice from DEC.
Greenough River Watercourse	To maintain the integrity, ecological functions and environmental values of watercourses.	Prepare Foreshore Management Plans for river foreshore reserve. Prepare a Local Water Management Plan to identify measures to preserve the natural environment.	Plan preparation at Subdivision stage. Plan preparation at Subdivision stage.	Local authority DoW and local authority.
Water Quality	To ensure that the quality of water emissions do not adversely affect environment values or the health, welfare and amenity of people and land uses by meeting statutory requirements and acceptable standards.	Prepare a Local Water Management Plan to identify measures to preserve the natural environment.	Plan preparation at Subdivision stage.	DoW and local authority.
Noise	To protect the amenity of the community from noise impacts associated with the development or land use by ensuring that statutory requirements and acceptable standards are met.	A landscaped buffer located west of the Brand Highway will be retained. An earth bund will be incorporated into sections of the buffer if road surface is not upgraded. Quiet house design to be included in the first row of residence located adjacent to Brand Highway.	Buffer to be identified at Structure Plan stage. To Design guidelines to be prepared at subdivision stage.	Responsible authority on advice from local authority. Local authority.
Visual amenity	To ensure that visual amenity is considered and measures are adopted to reduce adverse visual impacts on the surrounding environment as low as reasonably practicable.	Treatment of foreshore reserves to be detailed in Foreshore Management Plan for coastal and river foreshore areas. Existing landform to be reduced in scale in	Plan preparation at subdivision stage. Implementation will	Local authority. Responsible authority on

Environmental Factor	Objective	Environmental Management Measures	Timing (Phase)	Whose Requirements
		accordance with conceptual cross-sections. Dunes to be stabilised in accordance with Southgate Dunes Stabilisation Strategy.	commence upon completion of land exchange agreement.	advice from DEC.
Aboriginal Culture and Heritage	To ensure that changes to the biophysical environment resulting from the amendment do not affect historical and cultural associations within the area and comply with the requirements of relevant heritage legislation.	Where possible, recognised sites will be retained in Public Open Space. If disturbance is unavoidable, a section 18 application will be lodged with the DIA. Aboriginal heritage protocol to be prepared by the developer prior to undertaking any earth working of the subject land.	Structure Plan stage. Prior to earthworks commencing. Prior to earthworks commencing.	Local authority and DIA. DIA. DIA.
Recreation	To ensure that existing and planned recreational uses of the environment are not compromised.	Provision of open space to meet recreational needs. Foreshore Management Plan for coastal and river foreshore areas to identify infrastructure to be installed to fulfil recreational needs of the area.	Structure Plan and subdivision stages. Plan preparation at subdivision stage.	Local authority. Local authority.

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PLATES

Plate 1: Foreshore area showing Greenough River Road in the background

Plate 2: Localised bank erosion along Greenough River

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Plate 3: Existing foreshore reserve

Plate 4: Existing foreshore reserve looking west towards ocean and rowing club

Plate 5: Bare dunes from beach to north west (Photo by W James)

Plate 6: Mobile dunes encroaching onto vegetated dunes at the northern end of the site (Photo W James)

Plate 7: View over vegetated dunes to bare dunes from the Greenough River Walk Trail (Photo W James)

Plate 8: Cleared grazing land viewed over drainage line from Brand Highway (Photo by W James)

Plate 9: Grazing land viewed from rural land to the east of Brand Highway (Photo by W James)

Plate 10: Contemporary subdivision (Photo by W James)

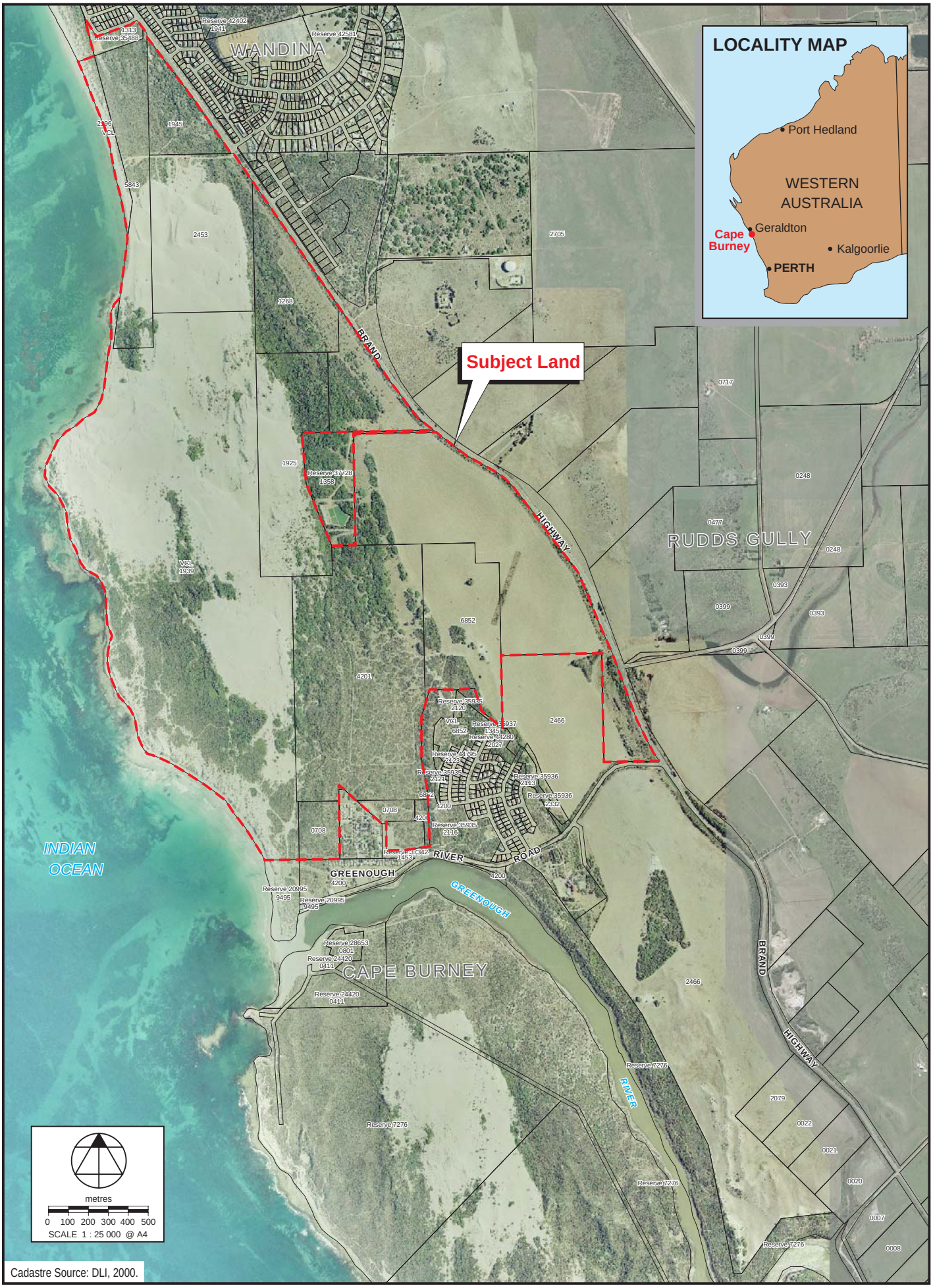
Plate 11: Holiday style cottages south of Caravan Park (Photo by W James)

Plate 12: Greenough River foreshore near river mouth (Photo by W James)

Plate 13: Exposed limestone shelf (Photo by W James)

Plate 14: Eroding foredunes – hillock and blowouts (Photo by W James)

FIGURES



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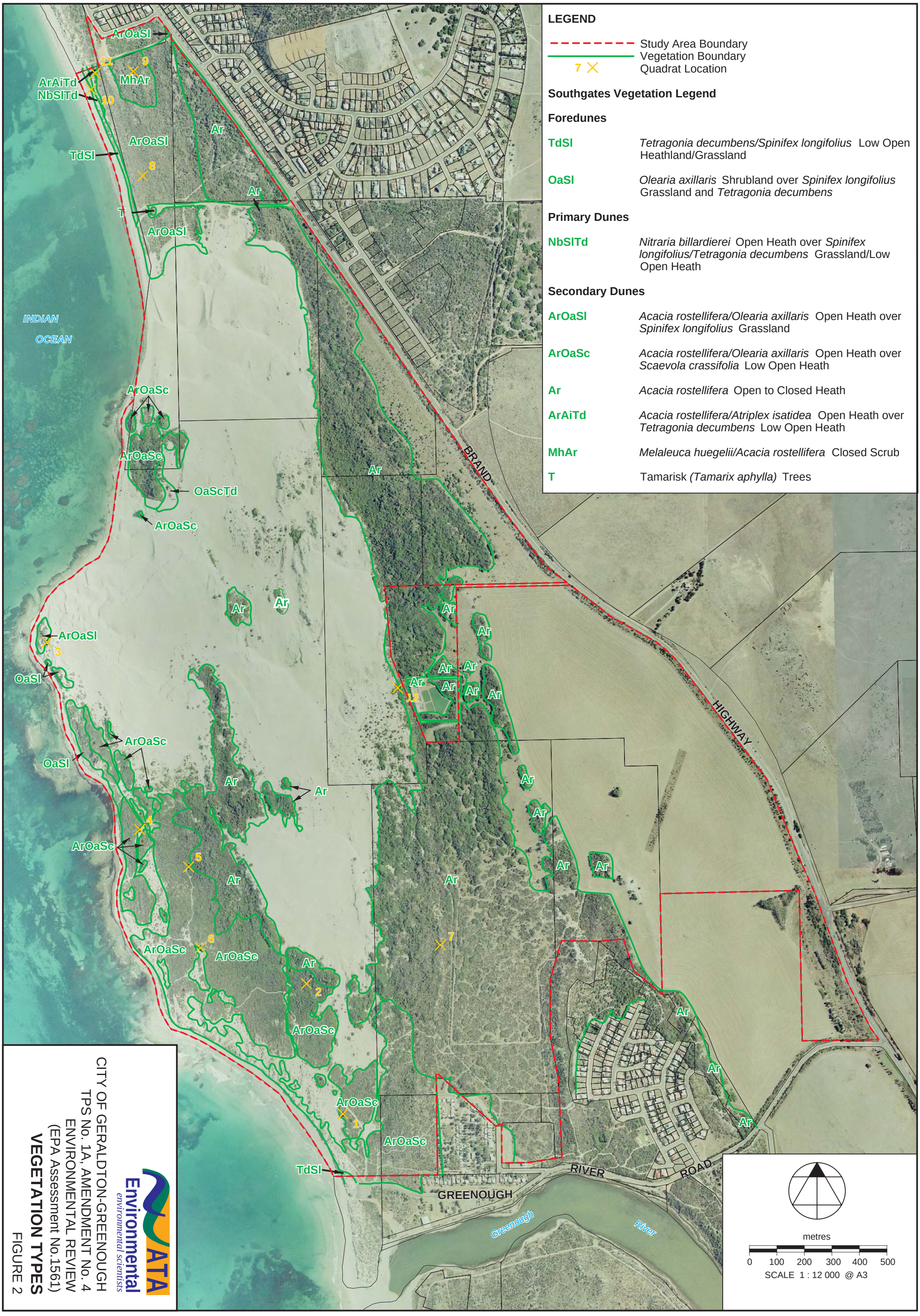
CITY OF GERALDTON-GREENOUGH TPS No. 1A AMENDMENT No. 4
ENVIRONMENTAL REVIEW (EPA Assessment No.1561)

LOCATION

FIGURE 1

BHO-2005-001/REPT/26_067/26_067f02.dgn DATUM: MGA50 DRAWN: TE/EDS/GLM 3-7-08 CHECKED: PZ/AT 3-7-08 PRINTED: Thu 03 Jul 08



LEGEND

Study Area Boundary
Vegetation Boundary
7 Quadrat Location

Southgates Vegetation Legend

Foredunes

TdSl *Tetragonia decumbens/Spinifex longifolius* Low Open Heathland/Grassland

OaSl *Olearia axillaris* Shrubland over *Spinifex longifolius* Grassland and *Tetragonia decumbens*

Primary Dunes

NbSlTd *Nitraria billardierei* Open Heath over *Spinifex longifolius/Tetragonia decumbens* Grassland/Low Open Heath

Secondary Dunes

ArOaSl *Acacia rostellifera/Olearia axillaris* Open Heath over *Spinifex longifolius* Grassland

ArOaSc *Acacia rostellifera/Olearia axillaris* Open Heath over *Scaevola crassifolia* Low Open Heath

Ar *Acacia rostellifera* Open to Closed Heath

ArAiTd *Acacia rostellifera/Atriplex isatidea* Open Heath over *Tetragonia decumbens* Low Open Heath

MhAr *Melaleuca huegelii/Acacia rostellifera* Closed Scrub

T Tamarisk *(Tamarix aphylla)* Trees

metres
0 100 200 300 400 500
SCALE 1 : 12 000 @ A3

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CITY OF GERALDTON-GREENOUGH
TPS No. 1A, AMENDMENT No. 4
ENVIRONMENTAL REVIEW
(EPA Assessment No.1561)

VEGETATION TYPES

FIGURE 2

LEGEND

Study Area Boundary
Vegetation Condition Boundary

VEGETATION CONDITION (SOURCE: BUSH FOREVER Govt. of W.A., 2000)

Pristine (Not applicable)
Pristine or nearly so, no obvious signs of disturbance.

Excellent (Not applicable)
Vegetation structure intact, disturbance affecting individual species and weeds are non aggressive species.

Very Good VG
Vegetation structure altered, obvious signs of disturbance. For example, disturbance to vegetation structure caused by repeated fires, the presence of some more aggressive weeds, dieback, logging and grazing.

Good G
Vegetation structure significantly altered by very obvious signs of multiple disturbance. Retains basic vegetation structure or ability to regenerate it. For example, disturbance to vegetation structure caused by very frequent fires, the presence of some very aggressive weeds at high density, partial clearing, dieback and grazing.

Degraded D
Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching good condition without intensive management. For example, disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds, partial clearing, dieback and grazing.

Completely Degraded (Not applicable)
The structure of the vegetation is no longer intact and the areas is completely or almost completely without native species. These areas are often described as 'parkland cleared' with the flora composing weed or crop species with isolated native trees or shrubs.

INDIAN OCEAN
BRAND HIGHWAY
GREENOUGH RIVER ROAD
Greenough River

metres
0 100 200 300 400 500
SCALE 1 : 12 000

CITY OF GERALDTON-GREENOUGH
TPS No. 1A, AMENDMENT No. 4
ENVIRONMENTAL REVIEW
(EPA Assessment No.1561)
VEGETATION CONDITION
FIGURE 3

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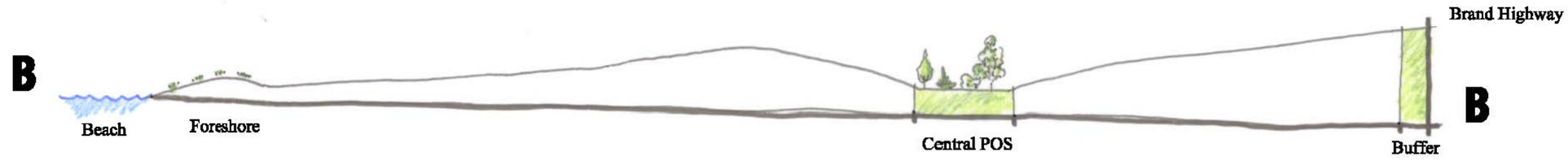
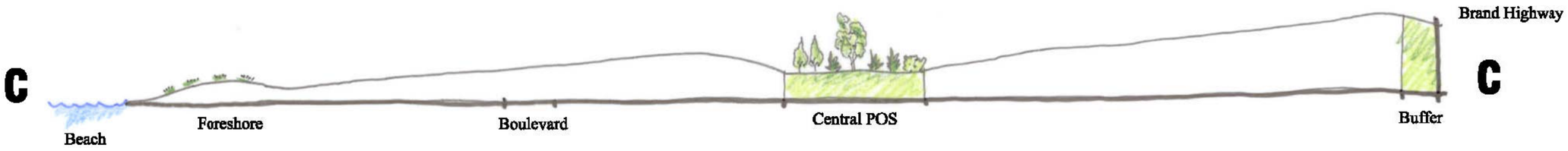
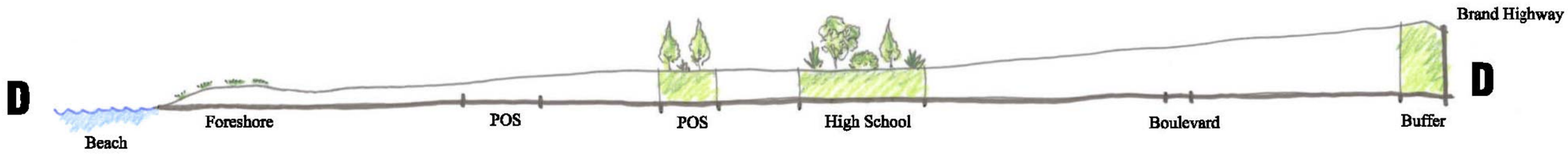
CHAPPELL LAMBERT EVERETT







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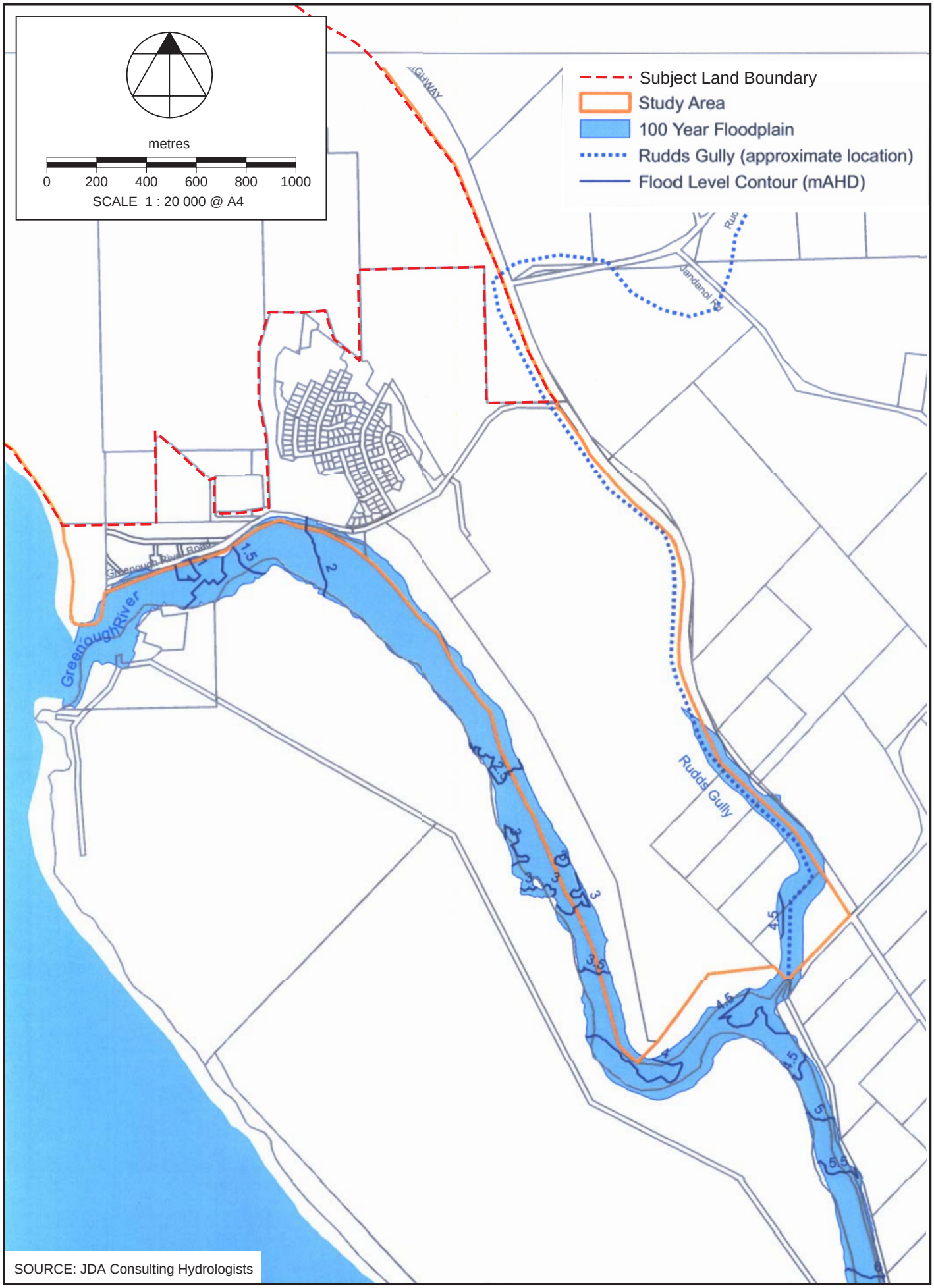
CITY OF GERALDTON-GREENOUGH TPS No. 1A AMENDMENT No. 4
ENVIRONMENTAL REVIEW (EPA Assessment No. 1561)

GREENOUGH RIVER ESTATE CONCEPTUAL SECTIONS

FIGURE 4

Vertical scale - 4x exaggeration
SOURCE: CLE (2088-66A), 22-02-07



SOURCE: JDA Consulting Hydrologists

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CITY OF GERALDTON-GREENOUGH TPS No. 1A AMENDMENT No. 4
ENVIRONMENTAL REVIEW (EPA Assessment No.1561)

GREENOUGH RIVER FLOODPLAIN MAPPING

FIGURE 5

APPENDICES

APPENDIX 1

EPA ENVIRONMENTAL REVIEW INSTRUCTIONS

ENVIRONMENTAL ASSESSMENT OF PLANNING SCHEMES AND THEIR AMENDMENTS

Shire of Greenough Town Planning Scheme No. 1A

Amendment No. 4

(Assessment No. 1561)

ENVIRONMENTAL REVIEW INSTRUCTIONS

1. Introduction

The *Environmental Protection Act 1986* (the Act) sets out that where a planning scheme, or an amendment to a scheme, is judged to have a significant environmental impact it will be subject to an assessment by the Environmental Protection Authority (EPA) under Section 48A of the Act. These schemes/amendments are being assessed because they raise significant environmental factors.

Where a scheme/amendment is subject to an assessment by the EPA, the responsible authority is required to produce an Environmental Review addressing the environmental factors relevant to the scheme/amendment. The EPA issues instructions for the scope and content of the Environmental Review. Below are the instructions for the above scheme/amendment.

The Environmental Review is then made publicly available with the scheme/amendment document to enable members of the public and relevant agencies to comment on the possible environmental impacts of the scheme/amendment. Additional information on the purpose and functions of environmental assessment of a scheme/amendment is given in Attachment 1.

The scheme that is the subject of this assessment is called Shire of Greenough Town Planning Scheme No. 1A. A map showing the location of the amendment is shown as Attachment 2.

2. Instructions

2.1 Status of the instructions

The EPA, in its formulation of the instructions, endeavours to come to an agreement with the Responsible Authority and any other involved agency about the scope and content of the

Environmental Review document. The EPA Service Unit provides services and facilities for the EPA. In many cases the EPA Service Unit will act for the EPA.

Other parties may also have a view about the contents of the instructions. To accommodate this additional input the instructions are subject to appeal to the Minister for the Environment.

Where an appeal is lodged and upheld the Chairman of the EPA will issue the final instructions, consistent with the appeal decision. Where no appeals are received or all appeals are dismissed, this document is the final instructions for the preparation of the Environmental Review.

2.2 General information

The fundamental requirements of the Environmental Review document are to:

a) describe the state of the environment affected by the scheme, indicating at least the scheme area and its immediate surroundings;

b) describe the purpose of any zoning or reservation;

c) identify those environmental factors which should be considered in relation not only to the scheme being assessed but also to later levels of planning, such as subdivision and development;

d) identify those environmental factors which require alternative procedures or processes to address any requirements for on-going long-term management;

e) for those environmental factors not relevant to the scheme being assessed, describe the process (approvals and the like) necessary to address those factors later, including likely referral to the EPA; and

f) for those factors relevant to the scheme being assessed, describe the extent to which the environment could be protected from both direct and indirect impacts, including:
   - identifying the portions of the environment of highest conservation value and describing how the scheme plans to protect them;
   - listing those land-uses that will be permitted without further environmental approval being required under proposed zoning;
   - predicting the potential environmental impacts of these land uses;
   - describing the scheme provisions which will allow management of those impacts to ensure the environment is protected to an acceptable level in the best manner possible; and
   - identifying potential conflicts of land uses having environmental implications and how the environmental impacts are to be managed.

The Environmental Review document should consist of sections that deal with the above requirements. The recommended format for the Environmental Review document is enclosed as Attachment 3.

An important aspect of the environmental impact assessment process is the review by the public. The EPA wants to receive public input into the possible environmental impacts of

this scheme and its implementation. To facilitate adequate public input, the Environmental Review should be made available as widely as possible and at a reasonable cost.

2.3 Environmental factors relevant to this scheme and deferred environmental factors

The EPA, following consideration of the factors related to the scheme, is likely to identify some key factors which need to be given special attention and which should form the principal basis of the EPA assessment report to the Minister for the Environment. These key factors are termed the "environmental factors relevant to the scheme".

The EPA has also identified other environmental factors which it considers to be relevant to the scheme but are likely to be best addressed at a later level of planning. These factors are considered to be significant enough to warrant attention as part of the environmental review of this scheme to the extent that the Responsible Authority should show how these factors could be addressed at a later level of planning. These factors are called "deferred environmental factors".

The EPA, in consultation with the Responsible Authority and the relevant agencies, has identified a list of factors likely to be found to be the "environmental factors relevant to the scheme" and those likely to be found to be "deferred environmental factors". This list is provided to assist with the preparation of the Environmental Review document, but during the course of the preparation of the document other factors may be found also to be relevant, and they should be included in the detailed discussion.

A copy of the form used to identify the environmental factors (the "filtering form") is included as Attachment 4.

2.4 General scope of the Environmental Review - Limit of the Environmental Review

The scheme/scheme amendment has been initiated to:

- rezone the subject land (Lots 1945, 5843, 1268, 1, 1925, 2453, 4201, 6852, 708, 3, 4200 and Victoria Locations 11939 and 12196) within the Shire of Greenough Town Planning Scheme No. 1A from numerous Local Scheme Reserves ('Dune Preservation', 'Parks and Recreation' and 'Public Use') and zones ('Residential', 'Residential Development', 'Resort Development', 'Commercial' and 'General Farming') to 'Development' to facilitate the development of the land for urban and associated development., including residential, commercial, tourism and community land uses.

2.5 Environmental factors relevant to the scheme

The EPA has identified some environmental factors which are relevant to the scheme area and should be addressed in the Environmental Review document. These factors are listed over (see Table 1).

Table 1: Environmental factors relevant to the scheme

CONTENT		SCOPE OF WORK
Factors	**Site specific factor**	**Work required for the environmental review**
BIOPHYSICAL		
Flora	Vegetation communities and flora	*How will any native vegetation and flora of conservation significance likely to be impacted by the Amendment, be protected?* • Identify and assess the values and significance of vegetation communities and flora within the Amendment area and immediate adjacent area and describe these values in a local, regional and State context. • Describe and assess the potential direct and indirect impacts that may result from any use or development, allowed by the Amendment, on any significant vegetation communities and flora within the Amendment area and adjacent area. • In the event that significant vegetation and flora is impacted, describe measures to be implemented, to ensure that the abundance, diversity, geographic distribution and productivity of significant vegetation and flora is maintained. The EPA's Guidance Statement No. 51 *Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia* is to be used. Baseline studies by appropriately trained and experienced persons under appropriate seasonal conditions to identify the diversity, distribution and condition of the existing flora species and vegetation communities that may be directly or indirectly impacted by the Amendment. The detail and timing of the baseline studies will be dependent upon the vegetation community type. Liaison with relevant CALM officers is recommended. In cases where a vegetation community's floristic composition is distinctive, more detailed information is required. Map and describe the vegetation and relate these mapped units to soil/ landform types. The survey should address all relevant regional datasets, detail the site specific vegetation and flora attributes, and identify the conservation significance of the site taking into consideration the EPA's Position Statement No. 3 *Terrestrial Biological Surveys as an Element of Biodiversity Protection*. Discuss the potential direct and indirect impacts of the Amendment on the existing environment, in a local and regional context, including adjacent reserves. Consider cumulative impacts of habitat loss on terrestrial flora. Describe proposed management measures, including subdivision design, fire, weed, and dieback management, to minimise clearing or loss of vegetation. Detail how the management measures will be carried out, and to whose satisfaction this work will be done.

CONTENT		SCOPE OF WORK
Factors	**Site specific factor**	**Work required for the environmental review**
	Declared Rare and Priority Flora and other significant flora and communities (including threatened ecological communities)	Identify species of Declared Rare and Priority Flora that may be directly or indirectly impacted by the Amendment. Identify other species or communities of significance that may be impacted by the Amendment and discuss the reason for their conservation significance. These species or communities may include undescribed taxa; new records for the region; species or taxa that are endemic to the region or at the limit of their range; or species confined to specific sites of limited occurrence in the region. Subject to the appropriate permits, retain voucher specimens for all significant species and lodge them with the WA Herbarium. The EPA's Guidance Statement No. 51 *Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia* is to be used. Flora survey work should be undertaken during the flowering season (including a spring survey). Describe management measures to prevent impacts on Declared Rare Flora, Priority Flora, and other significant flora and communities (including threatened ecological communities), and to whose satisfaction the work will be done. It is recommended that Appendix 3 of the EPA's *Guidance No 10 Level of assessment for proposals affecting natural areas within the System 6 Region and Swan Coastal Plain portion of the System 1 Region* (EPA 2003) be used as guide to determining the regional or local significance of the vegetation on the site.
Fauna	Specially Protected (Threatened fauna)	Undertake a suitable fauna survey to identify any Specially Protected (Threatened) Fauna and other significant fauna, which may utilise the proposed Amendment area or immediate adjacent areas and may be directly or indirectly impacted by the Amendment. The EPA's Guidance Statement No. 56 *Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia* is to be used. Identify and assess the potential impacts (direct and indirect) on Specially Protected (Threatened) Fauna and other significant fauna as a result of the implementation of the proposed Amendment. Discuss the representation of habitat, in existing conservation reserves, suitable for any identified Specially Protected (Threatened) Fauna and other significant fauna that will be impacted by the proposal. Consider cumulative impacts of habitat loss on terrestrial fauna. Discuss what management measures are proposed to manage impacts.

CONTENT		SCOPE OF WORK
Factors	**Site specific factor**	**Work required for the environmental review**
Coast	Coastal landforms and processes.	*How will development permitted by the proposed Amendment impact on coastal processes?* Describe the coastal landforms that may be impacted by the Amendment (both directly and indirectly as a result of increased population) and their significance. Identify landforms and dunes potentially subject to coastal processes and coastline movements, taking into account the effects of predicted sea-level rise, and describe the impact the Amendment may have on these landforms. Describe management measures, including setbacks, to be implemented to reduce impacts on the coastal landforms. Assess coastal processes, including the contribution of the dune system to off-shore sediment movement and the nourishment of beaches outside the Amendment area. Assess the impact and document management provisions.
	Foreshore	The determination of appropriate setbacks and foreshore reserve to be based on shoreline movement data and other relevant factors such as adequate space for public amenity facilities and protection of foredune areas.
Watercourse	Greenough River	A buffer to be provided between development proposed within the Amendment area and the Greenough River consistent with the Department of Environment's report Determining Foreshore Buffers (Report No. RR 16).
POLLUTION MANAGEMENT		
Water	Water quality	Detail site drainage, modifications to drainage and potential for contamination. Assess the implications this may have on local surface, ground and marine water quality. Detail measures proposed to: • ensure the quality of surface, ground and marine water is maintained so that existing and potential uses, including ecosystem maintenance are protected; and • manage impacts. Describe management measures, including: • effluent disposal; and • drainage and nutrient management, to be implemented to reduce the quantity of drainage runoff from the site and to reduce impacts on water quality. Document how stormwater management will be implemented in accordance with the Department of Environment's Stormwater Management Manual.

CONTENT		SCOPE OF WORK
Factors	**Site specific factor**	**Work required for the environmental review**
Noise	Road Transport Noise	Noise levels from vehicles on Brand Highway at sensitive landuses within the Amendment area are to comply and be managed in accordance with the standards set out in the Western Australian Planning Commission's Draft Road and Rail Transport Noise Statement of Planning Policy. Identify how this factor will be appropriately addressed via development control mechanisms during the subdivision and development approvals processes.
SOCIAL SURROUNDINGS		
Visual amenity	Landscape	Describe and assess landscape character and views of the Amendment area and adjacent area and describe how character and views may be affected by development within the Amendment area. Community values of the area should be considered as part of the landscape character assessment. Detail proposed measures to address these potential impacts on landscape character and affected views, including subdivision design. Provide details of potential impacts on visual character, including affected views from local vantage points, within the Amendment area, from the Amendment area, and to the Amendment area from outside the Amendment area. Detail proposed measures to mitigate visual impacts.
Heritage	Aboriginal culture and heritage	Identify Aboriginal cultural and heritage sites of significance through archaeological and ethnographic surveys of the project area and through consultation with local Aboriginal groups and the Department of Aboriginal Affairs. Consult with the relevant Aboriginal people of the area to determine potential impacts of the proposal on cultural associations with the project area. Detail proposed measures to manage potential impacts.
Recreation		Assess the potential impacts of the proposed development within the Amendment area on the recreation values of the beach and foreshore areas. Describe proposed measures for managing these impacts.

2.6 Deferred environmental factors

- Wastewater Treatment Plant

Other environmental factors

For context, the Environmental Review should also provide at least a summary discussion of all environmental aspects of the scheme area. For environmental factors not required to be addressed in detail (i.e. factors not listed in the table above, such as topography), the Environmental Review should provide an outline description and indication of the extent of environmental management.

During the environmental review process, should it appear that significant environmental impacts may be associated with any of these other factors, then the EPA Service Unit should be approached for advice on the work to address the factor.

Attachment 1

Information on the purposes and functions of the environmental assessment of schemes and their amendments

Purpose of the environmental assessment

The purpose of an environmental assessment is to ensure that the scheme takes proper account of the relevant environmental factors. To do this the EPA reports to the Minister for the Environment on the environmental factors relevant to the scheme, recommends environmental conditions under which the scheme may operate and provides other recommendations as it sees fit.

Functions of an Environmental Review

The primary function of the Environmental Review is to provide information about the environmental factors related to the proposed scheme to the EPA to enable it to evaluate the significant effects on the environment of the scheme and provide independent environmental advice to Government.

An additional function of the document is to clearly communicate details of the proposed scheme and its future implications to the public so that the EPA can obtain informed public comment on relevant environmental factors and their areas. Effective public information and involvement is an essential part of environmental impact assessment.

These instructions are issued to assist in identifying matters that should be addressed within the Environmental Review document. However, other relevant matters may arise during the preparation of the environmental review document and these should also be included.

The Environmental Review document will be made publicly available during the advertised period for the scheme and submissions from other agencies and the public will be sought. The Responsible Authority is required to forward submissions relating to the Environmental Review to the EPA and respond to the EPA on environmental factors or conditions and procedures which may apply should the proposal be implemented that are raised in those submissions. Based on the information in the Environmental Review document, the response to submissions and its own investigations the EPA will then report to the Minister for the Environment.

Please note:

Statements of fact, conclusions or theories used to justify arguments should be substantiated and supported by technical work undertaken to prepare the Environmental Review. In addition, statements of fact, conclusions and arguments should be based on information that has a high degree of scientific certainty. Where these are not met the EPA will provide advice consistent with the precautionary principle.

Attachment 2

Location of Scheme/amendment

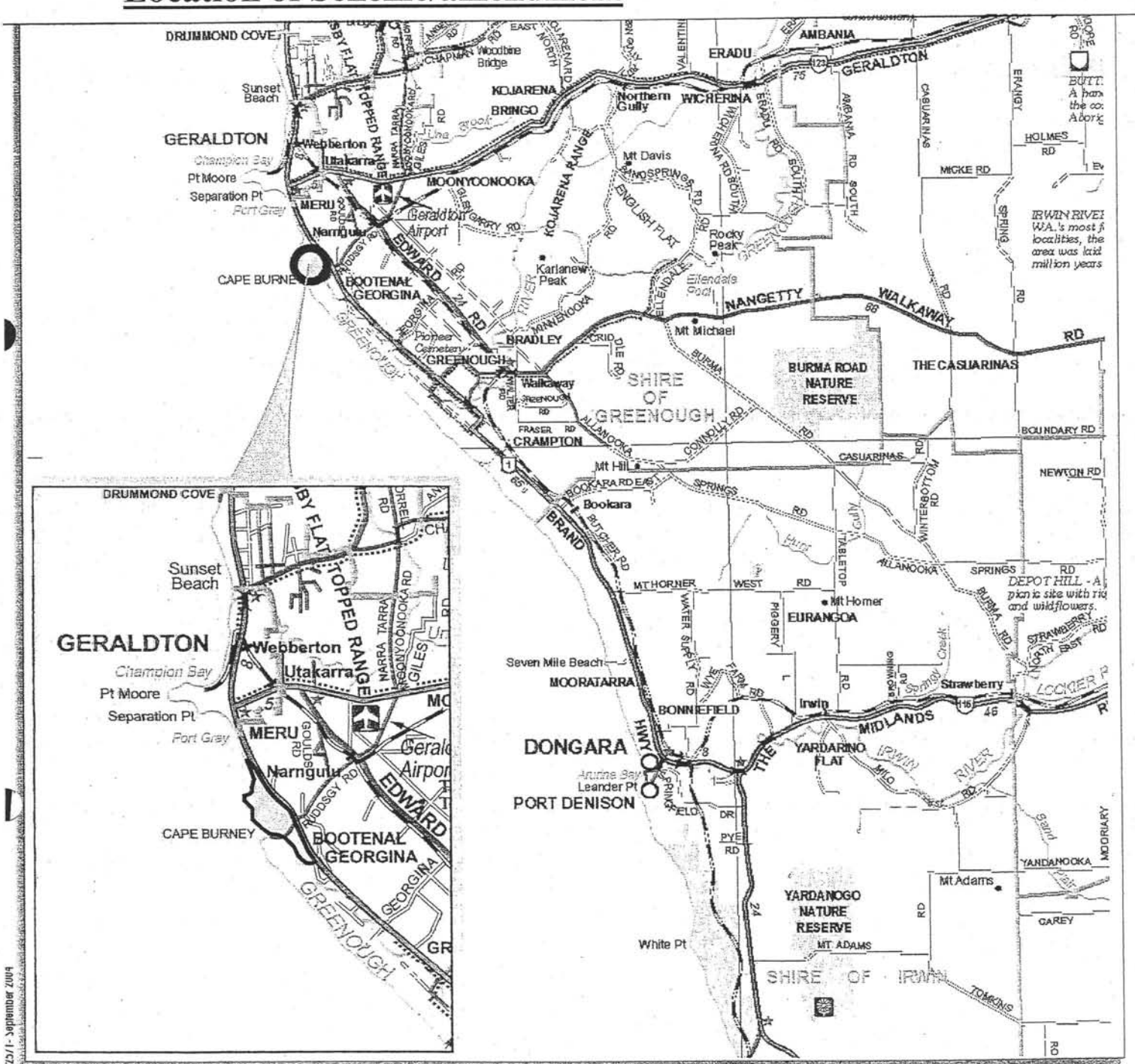

Figure 1

LOCATION PLAN

Cape Burney Estate
Brand Highway, Geraldton

Subject Land

Source: Street Smart- Touring Maps

koltasz smith
DEVELOPMENT CONSULTANTS
TOWNPLANNERS • PROJECT MANAGERS

PERTH Tel: (08) 94862222 Email: perth@ksap.com.au

Attachment 3

Environmental Review Document Structure

The legislation requires that the Environmental Review Document be part of the amendment documentation. For our purposes it would be useful for it to be a separate volume, perhaps an appendix to the amendment document.

The following structure is suggested:

1. How to make a submission

- Include a standard sheet to guide the reader how to make a submission.

2. Introduction

- Clarify who is the Responsible Authority.
- Provide a paragraph or two to explain the background to the Environmental Review document and the process to date (see recent examples of Environmental Reviews) eg the Environmental Review Document is prepared in accordance with S48A of the *Environmental Protection Act* 1986; and, the Environmental Review Document should be read in conjunction with the amendment document.
- Refer the reader to a process flow chart, eg from the *Planning for People* document, which could be Appendix A1.

3. Summary of Amendment

- Should include a brief description of scheme / amendment and its purpose.
- Cross reference to the amendment document, particularly the scheme text / provisions, wherever possible.
- Include a clear location map and any other figures to describe the amendment.

4. Environmental Factors Relevant to the Scheme

These factors will be specified by the EPA in the final instructions. Each factor should be addressed using the following format:

4.1 Environmental factor: eg wetlands

- Provide background on the current state of the environment.
- Discuss any polices relevant to the environmental factor.

4.2 Preliminary EPA objective / proposed alternative objective

- The EPA objectives for each environmental factor will be provided to the Responsible Authority following the issuing of the final instructions.

4.3 Potential impacts

- This section should outline the potential impacts that could result from the implementation of the scheme / amendment.

4.4 Proposed management

- How the scheme / amendment, provisions or zoning pattern address the impacts on environment.
- How scheme provisions will be implemented and how subsequent planning stages will address the impacts on the environment.

4.5 Proposed outcome

- Given the proposed management, can the EPA objective be met?
- On evaluation of the above (4.1 to 4.4), if it appears the EPA objective cannot be met this section provides the opportunity to offer an alternative objective and justify why the EPA should accept the alternative objective.

5. Deferred Environmental Factors (if applicable)

- These will have been identified in the instructions
- Alternatively, the document may argue why an environmental factor relevant to the scheme, as determined by the EPA, is considered to be a deferred factor.
- This section should largely follow the same format as Section 4 above.

6. Summary of scheme provisions

- This Section should reiterate the proposed management of the environmental factors (from Section 4).

7. References

8. Glossary (if necessary)

Appendices

A1 Flow chart of process

A2 Instructions and objectives

A3 Other information

Attachment 4

Department of Environmental Protection

Thursday March 31 2005 12:14 PM

Record of Section 48 referrals received

Records details: CRN 212997 **Date of Letter** 29/03/2005 **Date Referred :** 30/03/2005 **Date More Info:**

Referral details: **Proposal:** Shire of Greenough TPS 1A Amendment 4 (Cape Burney Estate) - Various amendments

TITLE AND LOCATION CORRECT GMT (Initial)

Location : Lot 1945 Brand Highway to Ocean Ridge

Locality : Shire of Greenough

Environmental Factors : Refer attached documentation (Decision to Assess or Not Assess Form 2) in support of recommendation based on criteria for the determination of the need for and level of environmental impact assessment in Western Australia.

Responsible Authority :

Company : Shire of Greenough
Contact Person : ATTENTION: Mr Simon Lancaster
Address : PO Box 21
Suburb : GERALDTON
State : WA **Post code :** 6531
Phone : 9921 0500 **Fax :** 9921 8570

Other Parties :

Local Government Authority : Shire of Greenough

Decision Making Authorities : Minister for Planning, WAPC, DIA, CALM

Involved Agencies : Ministry for Planning, DoE

CC:

Signatures

Evaluation Division

Assessment officer(s): Marie Ward, GLEN McLEOD-THORPE

Project Officer(s) : ..... **Date :** 12.4.05

..... **Date :** .....

A/ **Manager :** Marie Ward **Date :** 12/4/05

Other divisional input (Where applicable)

Manager /Director: ..... **Date :** .....

Branch / Division : .....

Manager / Director : ..... **Date :** .....

Branch / Division : .....

Other Infromation :

Assessment Number: 1561 **Date:** 13/04/05

Checked by: AB

INFORMATION FOR USE IN DETERMINING LEVEL OF ASSESSMENT FOR SCHEMES AND SCHEME AMENDMENTS UNDER SECTION 48A

Summary	Yes	No	N/A
Does the scheme/amendment impact any biophysical factors?	☑	☐	
Does the scheme/amendment impact any pollution management factors?	☐	☑	
Does the scheme/amendment impact any social surroundings factors?	☑	☐	
Does the scheme/amendment conform to existing policies, guidelines and criteria for EIA?	☐	☐	☑
Is further information required to determine level of assessment?	☐	☑	

Has the Regional Office of the DoE been consulted? ☐ ☑ NOT AT THIS STAGE.

RECOMMENDED LEVEL OF ASSESSMENT:

DoE Correspondence	☐
EPA Referral – More Information Requested	☐
Level 1 Assessment - Not assessed, no advice given	☐
Level 2 Assessment - Not assessed, non-binding advice given	☐
Level 3 Assessment - Assessed, Environmental Review Required	☑
Incapable of Being Made Environmentally Acceptable	☐

Summary For Inclusion In Report To Chairman:

ENVIRONMENTAL FACTORS:

- TERRESTRIAL FLORA & FAUNA
- COASTAL PROCESSES
- MARINE FLORA & FAUNA
- VISUAL AMENITY
- WATERCOURSES

POTENTIALLY SIGNIFICANT EFFECTS:

ADVERSE IMPACTS ON THE ABOVE ENVIRONMENTAL FACTORS.

MANAGEMENT:

TO BE EXAMINED AS PART OF THE ENVIRONMENTAL REVIEW PROCESS.

ENVIRONMENTAL SIGNIFICANCE	LOW	MEDIUM	HIGH

ENVIRONMENTAL MATTERS			COMMENTS AND POSSIBLE IMPACTS
SECTION A: BIOPHYSICAL			
1. Does the scheme/amendment impact on areas of highest conservation value?	YES	NO	
(If 'Yes' tick the appropriate box below; if 'No' then proceed to 2.)			
The area covered by the scheme/amendment involves or is adjacent to:	Incl.	Adj	
• Land covered by recommendations for protection in the System 'Red Book' report;	☐	☐	
• Land vested in NPNCA for the purpose of:			
– conservation of flora and fauna;	☐	☐	
– National Park; or	☐	☐	
– Conservation Park.	☐	☐	
• Other areas recommended for reservation by CALM and endorsed by Govt. for inclusion in CALM's Estate;	☐	☐	
• Land reserved as "Parks and Recreation" under the MRS;	☐	☐	
• Areas managed for multiple use where conservation is one defined use;	☐	☐	
• Areas with rare vegetation communities or assemblages not adequately represented in secure conservation areas (eg Bushplan, TOPRPC);	☐	☐	UNKNOWN AT THIS STAGE - TO BE ADDRESSED THROUGH ENVIRONMENTAL REVIEW.
• Land known to contain declared rare flora and fauna;	☐	☐	
• Land containing areas thought to be the habitat of Specially Protected (Threatened) Fauna;	☐	☐	
• Areas known or suspected to contain karst landforms;	☐	☐	
• Land listed as World heritage; or	☐	☐	
• Land listed by the Australian Heritage Commission.	☐	☐	
Will the scheme/scheme amendment allow for any land clearing and, if so, does Commissioner for Soil and Land Conservation approval need to be obtained?	YES	NO	

ENVIRONMENTAL MATTERS		COMMENTS AND POSSIBLE IMPACTS
2. Does the area covered by the scheme/amendment include any water resources of highest conservation value? (If 'Yes' proceed to 2.1 below; if 'No' proceed to Section B, page 7)	YES / NO (NO circled)	

2.1 Wetlands, Watercourses & Rivers

The area covered by the scheme/amendment involves a wetland, watercourse or river:	Incl	Adj	Drain into
• nominated for protection in the Environmental Protection (Swan Coastal Plain Lakes) Policy 1992;	☐	☐	☐
• nominated for protection in the draft EPP for Lakes and Swamps of the South West Agricultural Zone;	☐	☐	☐
• recommended for protection in the Systems 'Red Book' reports;	☐	☐	☐
• on land vested in the National Parks and Nature Conservation Authority for the purpose of Conservation of Flora and Fauna, National Park or Conservation Park, or areas recommended, and endorsed by Government, for inclusion in CALM estate for conservation purposes;	☐	☐	☐
• in areas reserved as "Parks and Recreation" under the Metropolitan Regional Scheme;	☐	☐	☐
• in areas with rare vegetation communities considered by the EPA not adequately represented in secure conservation areas, or rare flora and fauna and their habitats, eg those areas identified in Perth's Bushplan;	☐	☐	☐
• recognised by international agreements because of their importance primarily for waterbirds and their habitats.	☐	☐	☐

UNKNOWN AT THIS STAGE.

Conservation category (if known) _____

Further information: GREENOUGH RIVER

ENVIRONMENTAL MATTERS				COMMENTS AND POSSIBLE IMPACTS
2.2 Estuaries and Inlets				
The area covered by the scheme/amendment involves:	Incl	Adj	Drain into	
• an estuary or inlet.	☐	☐	☐	
Name of estuary or inlet: _____				

2.3 Coastline and Near-shore Marine areas.			
The area covered by the scheme/amendment involves a coastline or near-shore marine area:	Incl.	Adj	
• recommended for protection in the Systems 'Red Books' reports;	☐	☐	
• with mangroves present;	☐	☐	
• identified by CALM for inclusion on the List of Wetlands of International Importance (RAMSAR);	☐	☐	
• recommended by CALM for inclusion in its estate for conservation purposes;	☐	☐	
• reserved for "Parks and Recreation" under the Metropolitan Region Scheme;	☐	☐	
• with rare vegetation communities considered by the EPA not adequately represented in secure conservation reserves, or rare flora and fauna and their habitats ;	☐	☐	– UNKNOWN AT THIS STAGE
• where recreational usage is high, such as beaches in the metropolitan region.	☑	☐	
Further information: _____			

ENVIRONMENTAL MATTERS		COMMENTS AND POSSIBLE IMPACTS
2.5 Public Water Source Areas - Groundwater or Surface Water		
The area covered by the scheme/amendment involves:	Yes	
• a proposed or existing groundwater source area:	☐	
◦ Priority 1 UWPCA;	☐	
◦ Priority 2 UWPCA;	☐	
◦ Priority 3 UWPCA.	☐	
either		
◦ Jandakot Mound, or	☐	
◦ Gnangara Mound	☐	
• a proposed UWPCA groundwater source area:	☐	
◦ Priority 1;	☐	
◦ Priority 2;	☐	
◦ Priority 3;		
• Water and Rivers Commission gazetted groundwater areas outside the Perth metropolitan area;	☐	
◦ Priority 1;	☐	
◦ Priority 2;	☐	
◦ Priority 3;		
• any surface catchments where water is collected for public water supply purposes.	☐	
Indicate priority (if known) _____		

2.6 Catchments (Surface and Ground Water) With Special Requirements		
The area covered by the scheme/amendment involves:	Yes	
• Lake Clifton;	☐	
• Swan Coastal Plain Catchment of the Peel-Harvey Estuary;	☐	
• Swan and Canning Rivers and Ellen Brook;	☐	
• Lake Forrestdale;	☐	
• Thomsons Lake;	☐	
• Other: _____		

ENVIRONMENTAL MATTERS	COMMENTS AND POSSIBLE IMPACTS

SECTION B:

POLLUTION MANAGEMENT

1. Would the scheme/amendment allow for a land-use which will or could discharge a pollutant? YES / NO

(If 'Yes' indicate the appropriate category(s) by ticking the boxes and give a brief description of industry/land-use; if 'No' proceed to question 2 below)

Type of pollutant:	Yes
• Gases	☐
• Noise	☐
• Dust	☐
• Odour	☐
• Other (specify): _____	☐

2. Would the scheme allow for a land-use which requires a buffer? YES / NO

(If 'Yes' give a brief description of land-use; if 'No' proceed to question 3 below)

What is the distance to the nearest residence? _____

What is the recommended buffer distance? _____

3. Would the scheme allow for a residential area to encroach into an existing buffer area? YES / NO

(If 'Yes' give a brief description below; if 'No' proceed to question 4 on page 8)

What is the industry involved? _____

ENVIRONMENTAL MATTERS		COMMENTS AND POSSIBLE IMPACTS
4. Has the site been the subject of a past land-use which could contaminate the soil or groundwater?	YES NO	
(If 'Yes' indicate the appropriate category(s) by ticking the boxes; if 'No' proceed to question 5 below)		
4.1 Does the existing or past land-use include one of the following industries?		
acid/alkali plant	☐	
agricultural/horticultural activities	☐	
airport	☐	
asbestos production/disposal	☐	
chemicals manufacture & formulation	☐	
defence works	☐	
drum re-conditioning works	☐	
dry cleaning establishment	☐	
electrical manufacturing	☐	
electroplating & heat treatment	☐	
engine works	☐	
explosives industry	☐	
gas works	☐	
iron & steel works	☐	
landfill sites	☐	
metal treatment	☐	
mining & extractive industries	☐	
oil production/storage	☐	
paint formulation/manufacture	☐	
pesticide manufacture/formulation	☐	
pharmaceutical manufacture/formulation	☐	
power stations	☐	
railway yards	☐	
scrap yards	☐	
service stations	☐	
sheep and cattle dips	☐	
smelting and refining	☐	
tanning and associated trades	☐	
waste storage and treatment	☐	
wood preservation	☐	
other _____		

ENVIRONMENTAL MATTERS	COMMENTS AND POSSIBLE IMPACTS
5. Is the site on land which requires offsite disposal of drainage waters? YES / NO ie. Does the land have a high water table or is the soil predominantly clay? (If 'Yes' give a brief description of the land; if 'No' proceed to question 6 below)	

6. Would the scheme/amendment allow for the dredging of rivers and/or marine environments? YES / NO (NO circled) (If 'Yes' indicate the appropriate category by ticking the boxes and give a brief description of the extent of the project; if 'No' proceed to question 7 below) • developmental dredging ☐ • disposal of dredge material within a river system ☐ • other _____ ☐	

7. Would the scheme/amendment allow for a land-use change that is inconsistent with the Kwinana EPP for Atmospheric Wastes? YES / NO (NO circled) (If 'Yes' give a brief description of the change in land-use; if 'No' proceed to question 8 below)	

8. Would the scheme/amendment allow a land-use which requires special management? YES / NO (YES circled) (If 'Yes' indicate the appropriate category by ticking the boxes and give a brief description; if 'No' proceed to question 9 below) The land-use is one of the following: Yes • Horticulture ☐ • Heavy Industry ☐ • Marina ☑ • Aquaculture ☐ • Industry requiring licensing under Part V of the Environmental Protection Act ☐ • Other _____ ☐	PART OF PROPOSAL IS A MARINE DEVELOPMENT.

ENVIRONMENTAL MATTERS	COMMENTS AND POSSIBLE IMPACTS
SECTION C: **SOCIAL SURROUNDINGS** 1. Does the scheme/amendment raise any issues known to be of concern or controversy to the community? YES / NO (If 'Yes' indicate the appropriate category by ticking the boxes and give a brief description of the concern; if 'No' proceed to question 2 below) Is the concern to the public related to: • an issue of environmental significance ☑ • another issue: _____ ☐ Give details (eg known public interest groups; environmental issue(s) of concern): Further information: _____	COASTAL DEVELOPMENT.
2. Would the scheme/amendment pose any threat to public safety or is it a generator of risk? YES / NO (If 'Yes' please indicate by ticking the appropriate box; if 'No' proceed to question 3 below) Is the threat to public safety the result of: • a new industry being located near an existing residential area; or ☐ • a new residential area being located near an existing industry? ☐ Further information: _____	
3. Would the scheme/amendment impact any areas known to have cultural significance? YES / NO Please indicate: • Aboriginal culture and heritage ☐ • Non-indigenous heritage ☐ Further information: _____	

LIST OF ENVIRONMENTAL FACTORS ON WHICH EPA HAS A POLICY/POSITION.

Biophysical

Terrestrial Flora
- Vegetation communities
  - vegetation community types 3b and 20b
- Declared Rare and Priority Flora

Terrestrial Fauna
- Terrestrial Fauna
- Subterranean Fauna
  - stygofauna
- Specially Protected (Threatened) Fauna

Marine Flora
- Marine Flora
  - seagrass
  - mangroves
  - macro-algae
- Declared Rare and Priority Flora

Marine Fauna
- Marine Fauna
  - coral reefs
- Specially Protected (Threatened) Fauna
  - turtles
  - dugongs

Wetlands
- Wetlands
  - lakes
- Watercourses
  - rivers
  - ephemeral streams
- Estuaries
- Underground wetlands
  - cave pools
- Groundwater
  - unconfined aquifers

Coast
- Dunes
- Foreshore (beach)
- Seabed
  - banks
- Sea level

Land
- Soil
- Landform
  - karst

Pollution Management

Air
- Odour
- Particulates / Dust
- Gases
  - SO2
  - NOx
- Greenhouse gases
- Haze
- Smog

Water
- Groundwater quality
  - nutrients
  - pesticides
- Surface water quality
  - salinity
  - sewage
- Marine water and sediment quality

Land
- Soil contamination
  - solid waste

Non-chemical Emissions
- Noise
- Vibration
- Radiation
  - EMR
- Light

Social Surroundings

Social
- Public safety
  - risk and hazard
  - road traffic

Aesthetic
- Visual amenity

Cultural
- Aboriginal culture and heritage
- Non-indigenous heritage

Economic

APPENDIX 2

DIA REGISTERED ABORIGINAL HERITAGE SITES

APPENDIX 2
DIA REGISTERED ABORIGINAL HERITAGE SITES

Site ID	DIA Site File Information	Present Condition	Discussion
DIA ID 1063 (S02850) Greenough River Midden (GDA 269079.6806349)	This site was originally registered in 1992 as an ethnographic site with ceremonial and camp components that included a shell midden and artefact scatter. It was situated at the south end of a mobile dune. The archaeological site was further recorded in 1997 as being situated in a dune system. Site dimensions were 1,500m x 250m. Artefacts were made from quartz, silicified mudstone and glass. Artefact types noted were hammer stones, choppers, flakes and flake fragments. The area was still being used by local Aboriginal people as an occasional camp site. A sample excavation revealed sub-surface material. The site also contained various shell species including cockle, baler, whelk and oyster. Some of the shells had been modified by drilling. Some ochre was also observed.	The sparse shell scatter was located at the following area – AMG 269000-269250E/6805250-6806050N. The dimensions of the site appeared to be smaller than previously recorded at approximately 800m x 250m and no stone artefacts were relocated.	The site area has been altered over time by the erosion and deposition of sand in the large mobile dune system. This has the effect of covering and uncovering material. This process is likely to continue because of the site location. The site is considered to be of moderate archaeological significance due to its large size and components. The shell midden and artefact scatter is similar stylistically and technologically to others recorded in the general area. The relationship of this site to the other sites in the vicinity is considered to be of significance.
DIA ID 1064 (S02851) Southgate Dune GDA 268638.6806651	This site was originally registered as an artefact scatter in 1992. It is registered as being 200-300m north of DIA ID 1063. Site dimensions were 100m x 100m. It is located on the south-west flank of a large sandhill that is gradually moving northwards. It is probably associated with DIA ID 1063. Artefacts were made from river pebbles and silicified sandstone and	Further north of DIA id 1063, a small shell midden and artefact scatter (100m x 100m) was located containing a silicified sandstone chopper and utilised river pebble, along with whelks, turbans and oyster shell. The dimensions and contents of this site match those recorded for site DIA ID 1064, however it was located approx 150-200m SE of recorded location. The present	The site area has been altered over time by the erosion and deposition of sand in the large mobile dune system. This has the effect of covering and uncovering material. This process is likely to continue because of the site location. The site is considered to be of low archaeological significance due to its size and components. The shell midden is similar to others recorded in the

Site ID	DIA Site File Information	Present Condition	Discussion
	included a shaped hammer stone and an adze.	location is at AMG 269320.6806250.	general area. The relationship of this site to the other sites in the vicinity is considered to be of significance.
DIA ID 4669 (S02280) Greenough Mouth GDA 268638.6807651	This site was originally registered as an artefact scatter and shell midden in 1978. The site is 2.2km due north of the Greenough River mouth along the coast. Site dimensions were 2,000m x 300m. It is situated in a large blow-out between very large sandhills and the coast – a wave cut platform. The site appears to be a series of largely re-deposited middens containing quantities of turban, abalone, limpet and other shells. Artefacts were scarce. Storm beach deposits were also present and probably mixed with the midden material. Some burnt limestone clusters were also present. Artefact material recorded in 1997 included dolerite, quartz, rose quartz, black siliceous material, and possible ochre pieces. Artefact types recorded were flakes, grindstones and debitage.	The site is located in an expansive, flat and exposed area surrounded by large dune systems. This site is a massive, sparse shell scatter comprised of whelks, turbans and oyster shells and extending between 1.5 and 2km (N/S) and 250-300m (E/W). The shell scatter was located at the following area – AMG 268650-269100/6806500-6807450.	The site area has been altered over time by the erosion and deposition of sand in the large mobile dune system. This has the effect of covering and uncovering material. This process is likely to continue because of the site location. The site is considered to be of moderate archaeological significance due to its large size and components. The shell midden and artefact scatter is similar stylistically and technologically to others recorded in the general area. The relationship of this site to the other sites in the vicinity is considered to be of significance.
DIA ID 5287 (S01009) South Gates Burial Site GDA 268738.6808451	This site was registered in 1980 as a burial and artefact scatter. It was situated at the foot of a large sand dune several hundred metres from the coast within Victoria location 1945 and immediately north of Victoria location 2453. The burial is a single burial on the surface of a deflated sand plateau adjacent to an eroding sand	The heavily vegetated area to the south of the access road to the beach was accessed and investigated, as was the north-eastern extent of the dune system (to the east of the sand mine). According to the co-ordinates provided for DIA ID 5287, the site may be in this area, but after an extensive inspection of the area, the site was not located. It is most likely to be under the ever	The site area has been altered over time by the erosion and deposition of sand in the large mobile dune system. This has the effect of covering and uncovering material. This process is likely to continue because of the site location. The site is considered to be of low archaeological significance due to its size and components. The skeletal material has been removed and reburied

Site ID	DIA Site File Information	Present Condition	Discussion
	dune. It had been exposed for some time. The bones were collected and reburied at a later date at a location chosen by the Aboriginal representatives. It is believed to have been a 40 years plus Aboriginal male possibly of great antiquity. The artefact scatter measured 50m x 50m and contained dozens of artefacts made from quartz, yellow chert, silicified limestone, shell and metal. Artefact types noted included a backed piece, a tula adze slug, a pebble manuport and flakes.	encroaching sand dune.	elsewhere. The artefact scatter is similar stylistically and technologically to others recorded in the general area. The relationship of this site to the other sites in the vicinity is considered to be of significance. However, the site is considered to be presently under the leading edge of the mobile sand dune.
DIA ID 17957 Sga-1 GDA 268388.6806900	This site was originally registered as an artefact scatter and shell midden in 1997. Site dimensions were 12m x 4m containing 12 artefacts. It was eroding out of the base of a primary coastal dune associated with Southgate Dunes. The site consists of a diffuse scatter of quartz artefacts and largely intact turban shells. A dark humic soil horizon is present above the shell lens. Artefact types included a core, flake fragments and debitage.	This site was relocated at previously recorded co-ordinates AMG 268250E 6806750N, situated along a series of eroded dunes facing east away from the coastal winds. This site was found to extend further than previously recorded, at 100m (N/S) x 10m (E/W) as opposed to 12m x 4m. Along with a moderate-sparse midden of whelks, turbans, abalone and oyster were a possible small hammerstone and rough chopper made of silicified limestone.	The site area has been altered over time by the erosion and deposition of sand in the large mobile dune system. This has the effect of covering and uncovering material. This process is likely to continue because of the site location. The site is considered to be of low archaeological significance due to its size and components. The shell midden and artefact scatter is similar stylistically and technologically to others recorded in the general area. The relationship of this site to the other sites in the vicinity is considered to be of significance.
DIA ID 17962 Sgs-1 GDA 268538.6806550	This site was originally registered as a shell scatter in 1997. It is within eroding dune systems facing the coast and in close proximity to offshore rock platforms that are readily accessible from the beach. The shell scatter consisted mainly of turban shells (*T. haliotis*).	This site was relocated at AMG 268310.6806175 and consisted of a moderate-dense shell scatter of whelks and perforated turbans, and measuring 80m (N/S) x 4m (E/W).	The site area has been altered over time by the erosion and deposition of sand in the large mobile dune system. This has the effect of covering and uncovering material. This process is likely to continue because of the site location. The site is considered to be of low archaeological

Site ID	DIA Site File Information	Present Condition	Discussion
			significance due to its size and components. The shell midden is similar to others recorded in the general area. The relationship of this site to the other sites in the vicinity is considered to be of significance.
DIA ID 17963 Sgs-2 GDA 268638.6806150	DIA site file information: This site was originally registered as a shell scatter in 1997. The site file description is the same as for DIA id 17962.	This site was relocated at AMG 268370.6806000, and consisted primarily of perforated turban shells and some whelks. This site extended 40m (N/S) x 5m (E/W). Some of the turbans from this site had recently been incorporated into a modern sculpture featuring shells, stone and beer bottles. These two sites Sgs 1 and 2 are located proximate to each other and adjacent to rock platforms on the beach that act as natural fish traps. This area is still a popular local fishing spot today.	The site area has been altered over time by the erosion and deposition of sand in the large mobile dune system. This has the effect of covering and uncovering material. This process is likely to continue because of the site location. The site is considered to be of low archaeological significance due to its size and components. The shell midden is similar to others recorded in the general area. The relationship of this site to the other sites in the vicinity is considered to be of significance.

APPENDIX 3

NEWLY DISCOVERED ABORIGINAL HERITAGE SITES

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Site ID	Description	Discussion
Cape Burney 1 S1 AMG 268999.6806385	This site is a shell midden and artefact scatter. It is located in a small, vegetated valley within the coastal dune system about 300m from the ocean. It is situated at an area of dense acacia thicket within a dip between several large, steep, eroding sand dunes. The area within the acacia thicket was impenetrable but the shell scatter continues around the margins with the artefacts concentrated in the north-east section. Site dimensions are 120m x 120m. The site contained moderate quantities of whelks, a few abalone shells, several quartz flakes (two with retouch), a retouched rose quartz flake, a crystal quartz fragment and other stone pieces such as mudstone and silicified sandstone. Artefact numbers were estimated at approximately 20 pieces. The area has been severely disturbed by recreational 4WD vehicle activity and is subject to ongoing natural processes of erosion and deposition of sand.	The site area has been altered over time by the erosion and deposition of sand in the large mobile dune system. This has the effect of covering and uncovering material. This process is likely to continue because of the site location. The site is considered to be of low archaeological significance due to its size and components. The shell midden and artefact scatter is similar stylistically and technologically to others recorded in the general area. The relationship of this site to the other sites in the vicinity is considered to be of significance. This midden site meets several of the criteria to be classified as of human origin. The shells are mainly of a single species and are of an edible size. Stone artefacts are present within the shell midden and no marine debris is present. From the analysis of the data, these observations are made: - Flakes are the predominant artefact type. - Quartz was the main raw material type used at the site. - The site has some potential for the presence of a stratified deposit. - Whelks are the main shell species and are present in large numbers. - The shells are of an edible size.
Cape Burney S2 AMG 268549.6806537	This site is a shell midden. It is located in a large, flat, exposed area surrounded on the NE/E sides by steep sand dunes, on the SW by acacia scrub and coastal heath, and on the NW by an eroded dune system. This natural depression in the landscape contained an expansive and fairly dense shell midden, also containing emu egg shell and the sun-bleached bones of several relatively large animals (possibly just natural deposition). The land here rose slightly towards the east, giving a good view of the coast and rock platforms, approximately 300m away. Site dimensions are 100m x 80m. The site contained moderate to dense quantities of whelks, turban shells, and oyster shells. No artefacts were noted.	The site area has been altered over time by the erosion and deposition of sand in the large mobile dune system. This has the effect of covering and uncovering material. This process is likely to continue because of the site location. The site is considered to be of low archaeological significance due to its size and components. The shell midden is similar to others recorded in the general area. The relationship of this site to the other sites in the vicinity is considered to be of significance. This midden site meets several of the criteria to be classified as of human origin. The shells are of an edible species and are of an edible size. No marine debris is present.

Site ID	Description	Discussion
	The area has been severely disturbed by recreational 4WD vehicle activity and is subject to ongoing natural processes of erosion and deposition of sand.	From the analysis of the data, these observations are made: - The site has limited potential for the presence of a stratified deposit. - Whelks, oysters and turban shells are the main shell species. - The shells are of an edible size.
Cape Burney S3 AMG 268750.6807850	This site is a shell midden and artefact scatter. It is located in a series of small, discrete depressions in the landscape, surrounded on all sides by large dunes, but being fairly exposed and protected themselves. This is approximately 300m from the coast. A small, dense shell midden was located within one of these areas where the sand is darker and slightly compacted. Site dimensions are 50mx 50m. This site contained oyster, abalone, whelk and perforated turban shells, along with one possible silicified limestone hammerstone. A larger, similar area was located to the N/NW, but was found to contain no artifactual material. The area has been severely disturbed by recreational 4WD vehicle activity and is subject to ongoing natural processes of erosion and deposition of sand.	The site area has been altered over time by the erosion and deposition of sand in the large mobile dune system. This has the effect of covering and uncovering material. This process is likely to continue because of the site location. The site is considered to be of low archaeological significance due to its size and components. The shell midden and artefact scatter is similar stylistically and technologically to others recorded in the general area. The relationship of this site to the other sites in the vicinity is considered to be of significance. This midden site meets several of the criteria to be classified as of human origin. The shells are mainly of a single species and are of an edible size. One stone artefact is present within the shell midden and no marine debris is present. From the analysis of the data, these observations are made: - A hammerstone is the only artefact type. - Silicified limestone was the material type used at the site. - The site has limited potential for the presence of a stratified deposit. - Whelks, oysters, abalone and turban shells are the main shell species. - The shells are of an edible size.
Cape Burney S4 AMG 269660.6807520	This site is an artefact scatter. This site was situated on the opposite side of the fence to the parking area on the verge of Brand Highway, just after the turning for the sewerage plant on a partially overgrown firebreak located along the eastern perimeter. It is located at AMG 269660E6807520N near an area of unploughed, natural vegetation located between the Brand Highway and the northern extent of the sand dunes.	This site is of low archaeological significance due size of the scatter, its proximity to other sites and the low potential for a stratified deposit. The artefact scatter is similar stylistically and technologically to others of similar type recorded in the general area. The relationship of this site to the other sites in the vicinity is considered to be of significance. From the analysis of the data, these observations are made:

Site ID	Description	Discussion
	Site dimensions are 60m x 7m. The site was comprised of several worked glass artefacts, a possible ceramic core and a piece of quartz. Artefact numbers were estimated at approximately 15 pieces. Artefact types included two scrapers, a finely serrated blade and three retouched pieces. The area has been severely disturbed by the firebreak and track.	- Retouched pieces are the predominant artefact type. - Glass was the main raw material type used at the site. - The site has limited potential for the presence of a stratified deposit. - No grinding material was present.
Cape Burney S5 AMG 268550.6805950	This site is a shell midden. It is located on a slight rise approximately 100m east of the beach and enabled an unimpeded view of the rock platforms. Site dimensions are 30mx 40m. This site was a moderate-sparse shell scatter comprising of mainly whelks, perforated turbans and oyster shells. No lithic material was located at this site. The area has been moderately disturbed vehicle tracks and is subject to ongoing natural processes of erosion and deposition of sand.	The site area has been altered over time by the erosion and deposition of sand in the large mobile dune system. This has the effect of covering and uncovering material. This process is likely to continue because of the site location. The site is considered to be of low archaeological significance due to its size and components. The shell midden is similar to others recorded in the general area. The relationship of this site to the other sites in the vicinity is considered to be of significance. This midden site meets several of the criteria to be classified as of human origin. The shells are of an edible species and are of an edible size. No marine debris is present. From the analysis of the data, these observations are made: - The site has limited potential for the presence of a stratified deposit. - Whelks, oysters and turban shells are the main shell species. - The shells are of an edible size.
Cape Burney S6 AMG 268835E 6806360	This site is a shell midden and artefact scatter. It is located in a small, densely vegetated valley surrounded on all sides by impenetrable scrub and so its exact extent is unknown. The site was located within 30m of a well established tree line, possibly suggesting a creek line, but access was impossible. Site dimensions are 15m x 25m. This site was a moderate shell scatter comprising of mainly whelks and oyster shells. A possible silicified sandstone hammerstone was also located here. This site is likely to be an extension of DIA ID 4669, and should probably be recorded as such. The area is relatively undisturbed but is subject to ongoing natural	The site area has been altered over time by the erosion and deposition of sand in the large mobile dune system. This has the effect of covering and uncovering material. This process is likely to continue because of the site location. The site is considered to be of low archaeological significance due to its size and components. The shell midden and artefact scatter is similar stylistically and technologically to others recorded in the general area. The relationship of this site to the other sites in the vicinity is considered to be of significance. This midden site meets several of the criteria to be classified as of human origin. The shells are mainly of a single species and are of an edible size. One stone artefact is present within the shell midden and no marine debris

Site ID	Description	Discussion
	processes of erosion and deposition of sand.	is present. From the analysis of the data, these observations are made: - A hammerstone is the only artefact type. - Silicified sandstone was the material type used at the site. - The site has limited potential for the presence of a stratified deposit. - Whelks and oysters shells are the main shell species. - The shells are of an edible size.