

# GOLDEN BAY

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## MINISTERIAL IMPLEMENTATION STATEMENT NO. 297 COMPLIANCE ASSESSMENT REPORT YEAR 2017

Prepared for: Peet Golden Bay Pty Ltd/Department of Communities

Report Date: 30 August 2018

Version: 2

Report No. 2018-393

The logo for PGV Environmental is located in the bottom right corner of the page. It features the letters 'pgv' in a large, bold, white sans-serif font. To the right of 'pgv', the word 'ENVIRONMENTAL' is written in a smaller, all-caps, white sans-serif font. The background of the bottom half of the page is a vibrant orange with a subtle, wavy pattern of thin white lines.

**pgv** ENVIRONMENTAL

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# **1 INTRODUCTION**

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## **1.1 Background**

The proposal to develop Part Lot 12 and Reserve 34664, Golden Bay for urban development was referred to the Environmental Protection Authority (EPA) under the *Environmental Protection Act 1986* (EP Act) in 1992 by H & B Developments. The EPA set the level of assessment as a Public Environmental Review (PER) (Assessment No. 604). The Minister for the Environment approved the proposal through Ministerial Statement 297 subject to environmental conditions in January 1993 (Attachment A).

Ministerial Statement 297 gave environmental approval subject to conditions to develop the landholding then known as Part Lot 12 and Reserve 34664, Golden Bay.

The Minister for the Environment confirmed on 30 July 1997 that the project had been substantially commenced, and as a result the environmental approval remains valid.

The Department of Environmental Protection (now the Department of Water and Environmental Regulation (DWER)) recognised the change in ownership to the Department of Housing and Works (now known as the Department of Communities (DoC)) and issued an Audit Table detailing the status of the Environmental Conditions and Commitments on 3 April 2001 (Attachment B).

The landholding is now referred to as Lot 2 Warnbro Sound Avenue and Lot 3 Dampier Drive, Golden Bay.

## **1.2 Golden Bay Project Description**

Golden Bay is located on the coast, approximately 62km south of the Perth Central Business District and 20km south of The City of Rockingham (Figure 1).

The landholding covers an area of approximately 161 hectares (ha) and is situated west of Mandurah Road (Figure 2). Lot 2 has approximately 800m of coastal frontage and the foreshore reserve covers an area of 10.61ha with vegetation that is largely in Excellent condition. Lot 3 has a Landscape Protection Area that conserves the parabolic dunal formation associated with Mandurah Hill, the highest point in the region.

The key environmental elements of the Golden Bay Proposal as described in the PER were listed as:

- Foreshore Reserve designation;
- Foreshore Reserve management;
- Landscape protection;
- Southern Brown Bandicoot Protection; and
- Protection of the heritage site.

## **1.3 Proponent**

Peet Golden Bay Pty Ltd (Peet) and the Housing Authority (now DoC) formed a co-ownership in November 2014. The change in Proponent was endorsed by the OEPA (now DWER) on 1 August 2016.

## **1.4 Environmental Approval to Implement the Project**

The proposal to develop the site was assessed through a Section 38 Public Environmental Review (PER) assessment process under the WA *Environmental Protection Act 1986* (EP Act). The project was approved through Ministerial Statement 297 in January 1993 (Appendix 1).

The Minister for the Environment confirmed on 30 July 1997 that the project had been substantially commenced.

## **1.5 Scope of the Report**

Condition 8 of MS297 states the following:

### *8. Compliance Auditing*

*In order to ensure that environmental conditions and commitments are met, an audit system is required.*

*8-1 The Proponent shall prepare periodic 'Progress and Compliance Reports' to help verify the environmental performance of this project, in consultation with the Environmental Protection Authority.*

### *Procedure*

*The Environmental Protection Authority is responsible for verifying compliance with the conditions contained in this statement, with the exception of conditions stating that the proponent shall meet the requirements of the Minister for the Environment or any other government agency.*

*If the Environmental Protection Authority, other government agency or proponent is in dispute concerning compliance with the conditions contained in this statement, that dispute will be determined by the Minister for the Environment.*

The reporting requirements set out in the Audit Table indicated that the first compliance report was due before clearing activities commenced and the second one year after the clearing had commenced. Thereafter the submission of compliance reports was as required by the OEPA.

The OEPA advised in correspondence dated 8 April 2016 (Appendix 2) that a CAR was required to be submitted by 30 August 2016 and annually thereafter and to report on the period of the previous calendar year.

This is the sixth Compliance Assessment Report (CAR), the previous CARs were submitted on the following dates:

- 20 May 2010;
- 30 May 2011;
- 30 May 2012;
- 30 August 2016 (Report Period Year 2015); and
- 30 August 2017 (Report Period Year 2016).

This CAR has been prepared in accordance with the OEPA *Guidelines for Preparing a Compliance Assessment Report, August 2012*. This report is based on the Proponent's assessment of compliance with the conditions in accordance with the MS297 and MS297 Audit Table. This CAR covers the period between January 2017 to December 2017.

## **2 CURRENT STATUS OF PROJECT IMPLEMENTATION**

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### **2.1 Golden Bay Project**

Peet is delivering the urban development project on behalf of the landowners in accordance with the approved Comprehensive Development Plan (Figure 2) will deliver the following:

- Residential Lots;
- Commercial Precinct;
- Primary and Secondary Schools;
- Local Public Open Space (recreational and drainage functions);
- Landscape protection area; and
- A Foreshore Reserve.

### **2.2 Current Project Activities**

Development construction has progressed over Lot 2 both east and west of Warnbro Sound Avenue and has also commenced on Lot 3 Dampier Drive (Figure 3). The following tasks have been undertaken to date:

- Lot 3 (2 stages of earthworks complete to December 2017);
- 16 stages of development have been completed to December 2017;
- The Foreshore Reserve adjacent to Lot 2 has been surveyed and demarcated with flagging tape;
- The Southern Brown Bandicoots are being managed on the site and within the foreshore reserve;
- The wetlands within the foreshore reserve have been monitored annually;
- Rehabilitation works have commenced in the southern portion of the foreshore reserve adjacent to the existing Golden Bay; and
- The landscape protection area on Lot 3 has been fenced off on the eastern perimeter.

### **3        INSTANCES OF POTENTIAL NON-COMPLIANCE AND PREVENTATIVE ACTIONS UNDERTAKEN**

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In accordance with Condition 8-1 of MS 297, all instances of potential non-compliance with the conditions of MS 297 that are identified during the reporting period are to be reported in the annual CAR, and corrective and preventative actions taken are to be described. The status of all conditions is presented in Table 1 and Appendix 3.

There were no non-compliance issues during this reporting period.

## **4 PUBLIC AVAILABILITY OF REPORT**

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This CAR will be made publicly available within one month of being submitted to the OEPA. A copy of the most recent CAR will be placed on the Proponent's website until the subsequent annual CAR is placed on the website.

The website URL is [www.peet.com.au/GoldenBay](http://www.peet.com.au/GoldenBay)

## **5 COMPLIANCE**

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### **5.1 Compliance Assessment Method**

An audit of the Golden Bay project was conducted in June/July 2018 to facilitate the assessment of compliance against MS 297 and the implementation of actions to meet environmental conditions. The audit was conducted by Belinda Heath of PGV Environmental.

The compliance status terminology to define the level of compliance used during the audit follows the EPA *Post Assessment Guideline for Preparing an Audit Table* and is listed below:

- C = Compliant;
- CLD = Completed;
- NC = Non – compliant
- NR = Not Required at this stage;
- IP = In Process may only be used by the proponent in circumstances outlined in Section 2.8 of the guideline

The information reviewed and the evidence obtained during this audit has been presented within the Compliance Assessment Audit Table (Appendix 3), along with additional information gathered during a desktop study/investigation.

### **5.2 Statement of Compliance**

The Statement of Compliance and the Compliance Assessment Audit Table are attached at Appendix 3.

### **5.3 Summary Audit Table**

Details on compliance with the MS297 conditions and management plans are presented below in a summary audit table (Table 1). The detailed Compliance Assessment Audit Table is provided in Appendix 3.

**Table 1: Summary Audit Table Status**

<b>Audit Code</b>	<b>Requirement</b>	<b>Status</b>	<b>Comment</b>
297:M1-1	Fulfil the commitments	CLD	All commitments have been fulfilled
297:M2-1	Adhere to the Proposal	C	
297:M2-2	Seek approval for modifications to the Proposal	C	No modifications sought
297:M3-1	Provide a foreshore reserve for conservation and recreation which: <ul style="list-style-type: none"> <li>1. Protects the Peelhurst Wetlands and the Southern Brown Bandicoot (<i>Isoodon obesulus</i>) population; and</li> <li>2. Includes landscape and recreation values at least equivalent to the area affected by this proposal which is within System 6 Recommendation M107 Area.</li> </ul>	CLD	4 June 1993
297:M3--2	Transfer to public ownership the proposed foreshore reserve as required by M3-1.	CLD	4 June 1993
297:M4-1	Liaise with the Department of Planning and Urban Development and the CoR to incorporate planning measures which recognise and protect the landscape value of the parabolic ridge on the eastern edge of Golden Bay.	CLD	5 April 1994
297:M5-1:1	Establish the regional implications of disturbing the population of the Southern Brown Bandicoot ( <i>Isoodon obesulus</i> ) at Golden Bay.	CLD	6 February 1996
297:M5-1:2	Initiate management of the population of the Southern Brown Bandicoot ( <i>Isoodon obesulus</i> )	CLD	Submitted 20 May 2010
297:M5-2:1	Carry out the ongoing management of the population of the Southern Brown Bandicoot ( <i>Isoodon obesulus</i> ) at Golden Bay as proposed in M5-1.	C	All stages of development have included a relocation program prior to any clearing activity.
297:M5-2:2	Carry out the ongoing management of the population of the Southern Brown Bandicoot ( <i>Isoodon obesulus</i> ) at Golden Bay as proposed in M5-1.	NR	Post development management
297:M6-1	Seek approval for transfer of ownership, control or management of this project.	C	Proponents are DoC and Peet Golden Bay Pty Ltd
297:M7-1	Seek approval to extend approval to implement proposal.	CLD	Minister for Environment confirmed project has commenced on 30 July 1997
297:M8	Prepare a periodic 'Progress and Compliance Report' to help verify the environmental performance of this project.	C	OEPA has requested (Appendix 2) that from August 2016 compliance reports are to be submitted annually by 30

			August for the previous calendar year.
297:P1	Provide in exchange for the development of the currently proposed System 6 Area M107, additional Regional and Public Open Space adjacent the Coastal Reserve as shown in the Structure Plan, in excess to that which would normally be required by DPUD.	CLD	26 October 1995 Not Audited (duplicated by condition M3-1) – Audit Branch
297:P2	Prepare a Management plan for the coastal reserve at Golden Bay.	CLD	Golden Bay Foreshore Management Plan approved by the OEPA on 30 March 2012 (on advice from DoP and CoR) An addendum to the FMP to address the interface between the development and foreshore reserve was submitted and approved by the OEPA on 29 September 2016
297:P3	Include the historic aboriginal camping site within the proposed Public Open Space for the development.	CLD	13 December 1995
297:P4	Protect against Bushfire	CLD	Fire Management Plan for the Golden Bay Structure Plan Area was approved by the City of Rockingham in March 2012.
297:P5	Provide reticulated sewerage and stormwater drainage designated to infiltrate stormwater into the soil within the development site.	CLD	A Local Water Management Strategy (LWMS) has been prepared for the Structure Plan Area and approved by the Department of Water and the City of Rockingham. Urban Water Management Plans are being prepared in accordance with the

			LWMS for each stage of subdivision.
297:P6	Liaise with CALM regarding the presence of bandicoots at Golden Bay and examine feasibility of relocating bandicoots if required by CALM.	CLD	13 December 1995

## 5.4 Compliance with Management Plans

Commitment 2 of the Ministerial Statement required that a management plan be prepared for the foreshore reserve on advice from the Department of Planning and the City of Rockingham.

The Golden Bay Foreshore Management Plan was prepared in consultation with the Department of Planning and the City of Rockingham and approved by the OEPA on 30 March 2012 (Appendix 3).

An addendum to the FMP to address the interface between the development and foreshore reserve was submitted and approved by the OEPA on 29 September 2016 (Appendix 8).

The FMP provides for the management and conservation of the Peelhurst Wetlands, Southern Brown Bandicoot, TEC 19a (Sedgeland in Holocene Dune Swales) and the Indigenous Heritage site located within the approved Foreshore Reserve. In addition, the FMP details the proposed infrastructure, recreational activities and relevant management strategies as proposed in the Public Environmental Review.

Implementation of the FMP has commenced and a status update on the management actions are provided in Appendix 4.

### 5.4.1 TEC19a Photo Point Monitoring

The condition of the TEC19a (*Sedgeland in Holocene Dune Swales*) has been recorded annually through photo point monitoring survey conducted in late September/October. The survey records the overall condition of the TEC and provides a basis to determine if the TEC is improving/degrading over time.

The photo point monitoring survey results are provided in Appendix 5.

**Plate 1: TEC19a (Sedgeland in Holocene Dune Swales)**



#### **5.4.2 Southern Brown Bandicoot Monitoring**

The local population of Southern Brown Bandicoots within the foreshore reserve have been monitored in autumn and spring each year since 2012. The monitoring reports for 2017 are provided at Appendix 6.

Based on the results of this trapping program, there appears to have been a reduction in the population of Southern Brown Bandicoots in the Foreshore Reserve. The likely causes of this reduction are a reduced area of native vegetation as a result of a fire which occurred in the foreshore reserve on 1 January 2016 and an increase in the number of foxes and cats in the area.

Peet are working with the City of Rockingham on implementing a fox and feral cat control program in the area in Year 2018.

**Plate 2: Southern Brown Bandicoot (photo source G. Thomson Terrestrial Ecosystems)**



#### **5.4.3 Groundwater Levels Monitoring**

The groundwater levels in the foreshore reserve are monitored each month. The levels for the period July 2012 to October 2017 are provided at Appendix 7.

**Plate 3: Groundwater Monitoring Bore**



#### **5.4.4 Landscape Protection Management Plan**

Development on the northern end of Lot 3 Dampier Drive commenced in 2017.

The Landscape Protection Area has been fenced along the north east to protect it from construction activity.

Rehabilitation works will commence as per the Landscape Protection Area Management Plan as part of subdivisional works.

## 6 REFERENCES

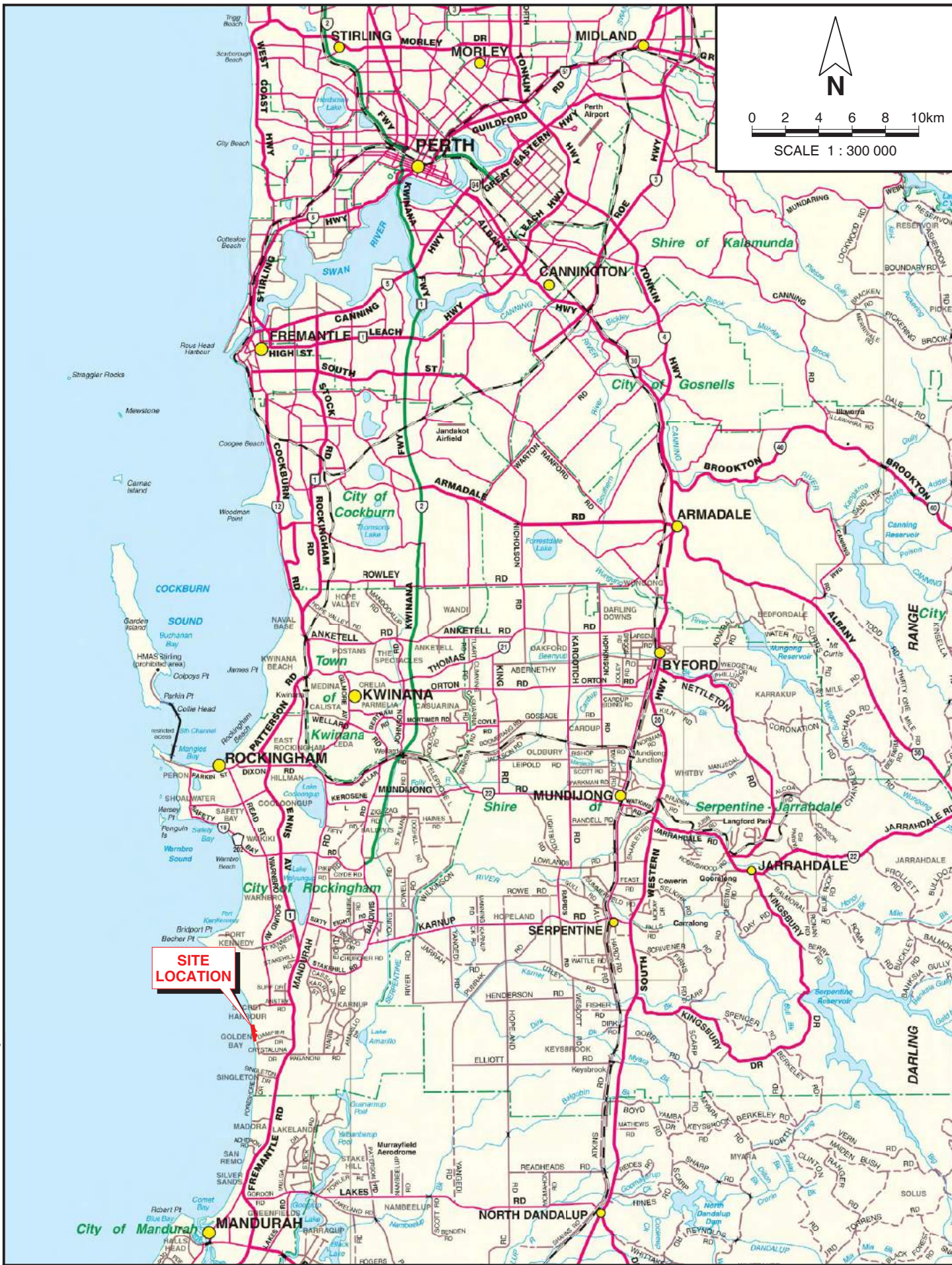
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Environmental Protection Authority (EPA) (2012) *Post Assessment Guideline No. 3 for Preparing a Compliance Assessment Report* Perth Western Australia.

Office of the Environmental Protection Authority (2012). *Post Assessment Guideline for Preparing an Audit Table*. Office of the Environmental Protection Authority, Government of Western Australia. August 2012

Office of the Environmental Protection Authority (2010c). *Post Assessment Guideline for making information publicly available*. Office of the Environmental Protection Authority, Government of Western Australia. August 2012

# FIGURES



**SITE  
LOCATION**



Department of Housing  
OUT USE OF COASTAL ZONE  
GOLDEN BAY

Drawn: B. Heath

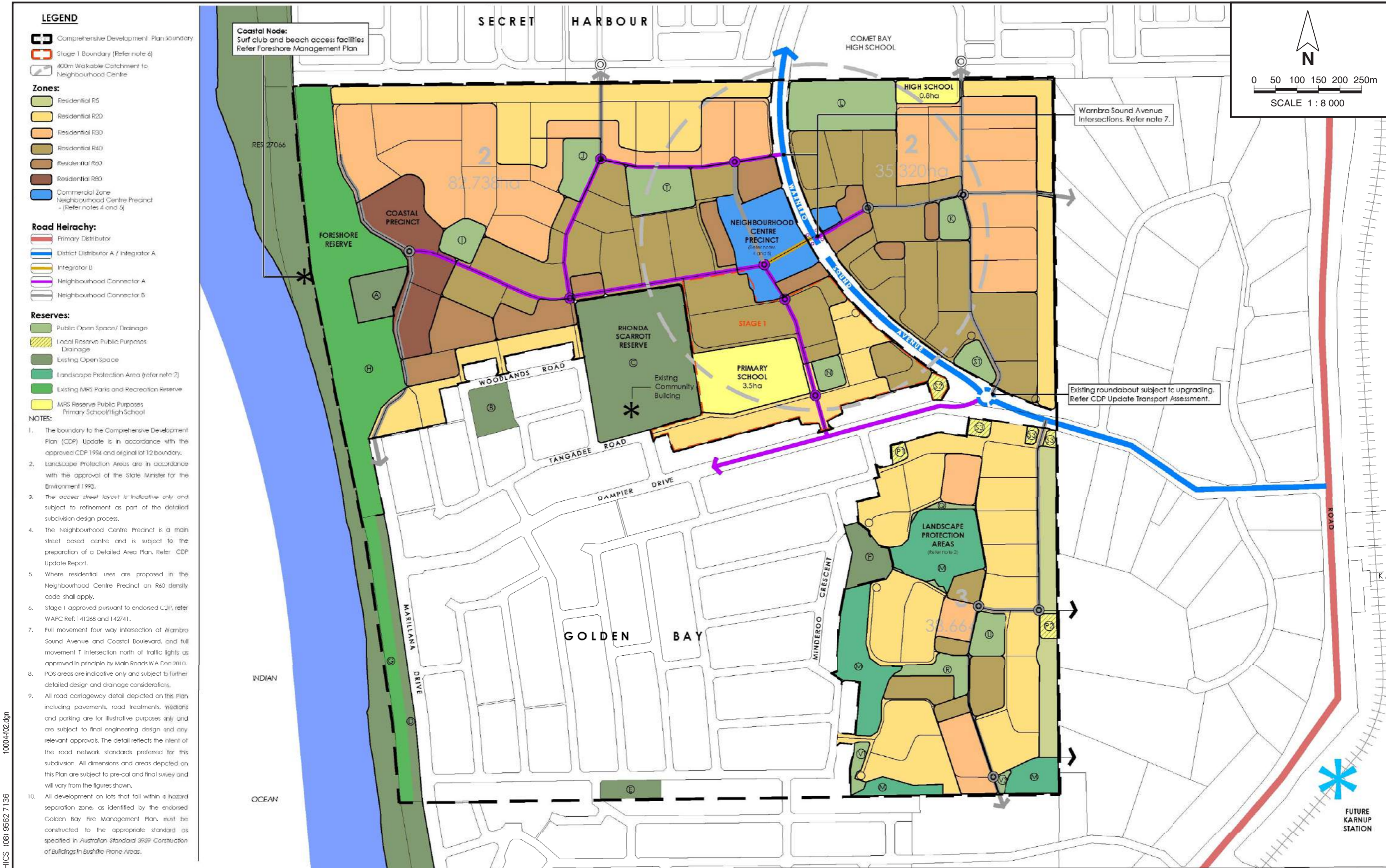
Date: 10 Aug 2011

Job: 10004

Revision: A

## REGIONAL LOCATION

**Figure 1**



10004-102.dgn

PINPOINT CARTOGRAPHICS (08) 9562 7136



SOURCE: Chappell Lambert Everett, Plan No. 2187-29U-01, 28-02-2011.



Drawn: B. Heath  
Date: 10 Aug 2011  
Job: 10004  
Revision: A

Department of Housing  
FOUT USAP OOA UOUUT OP VAUOUUUV  
GOLDEN BAY

## COMPREHENSIVE DEVELOPMENT PLAN

Figure 2

**APPENDIX 1**  
**MINISTERIAL STATEMENT 297**



WESTERN AUSTRALIA  
MINISTER FOR THE ENVIRONMENT

Ass # 604  
Bull # 648  
State # 297

**STATEMENT THAT A PROPOSAL MAY BE IMPLEMENTED  
(PURSUANT TO THE PROVISIONS OF THE  
ENVIRONMENTAL PROTECTION ACT 1986)**

**URBAN DEVELOPMENT OF PART LOT 12 & RESERVE 34664 (AFFECTING PART OF  
SYSTEM SIX RECOMMENDATION M107), GOLDEN BAY (604)**

**H & B DEVELOPMENTS PTY LTD**

This proposal may be implemented subject to the following conditions:

**1 Proponent Commitments**

The proponent has made a number of environmental management commitments in order to protect the environment.

- 1-1 In implementing the proposal, the proponent shall fulfil the commitments (which are not inconsistent with the conditions or procedures contained in this statement) made in the Consultative Environmental Review and included in Environmental Protection Authority Bulletin 648. (A copy of the commitments is attached.)

**2 Implementation**

Changes to the proposal which are not substantial may be carried out with the approval of the Minister for the Environment.

- 2-1 Subject to these conditions, the manner of detailed implementation of the proposal shall conform in substance with that set out in any designs, specifications, plans or other technical material submitted by the proponent to the Environmental Protection Authority with the proposal. Where, in the course of that detailed implementation, the proponent seeks to change those designs, specifications, plans or other technical material in any way that the Minister for the Environment determines on the advice of the Environmental Protection Authority, is not substantial, those changes may be effected.

**3 Foreshore Reserve**

- 3-1 The proponent shall provide a foreshore reserve for conservation and recreation which:

- 1 protects the Peelhurst wetlands and the Southern Brown Bandicoot (*Isodon obesulus*) population; and
- 2 includes landscape and recreation values at least equivalent to the area affected by this proposal which is within System 6 Recommendation M107 Area.

- 3-2 Prior to the lifting of Urban Deferment, the proponent shall identify the foreshore reserve as required by condition 3-1, and at subdivision the proponent shall transfer to public ownership the proposed foreshore reserve, to the requirements of the Minister for the Environment on advice of the Environmental Protection Authority.

Published on  
12 JAN 1993

**4 Landscape Protection**

The landscape value of the parabolic dune ridge on the eastern edge of Golden Bay should be recognised.

- 4-1 Prior to subdivision approval, the proponent shall liaise with the Department of Planning and Urban Development and the City of Rockingham to incorporate planning measures which recognise and protect the landscape value of the parabolic dune ridge on the eastern edge of Golden Bay, to the requirements of the Minister for the Environment and the Minister for Planning on advice of the Department of Planning and Urban Development, the City of Rockingham and the Environmental Protection Authority.

**5 Southern Brown Bandicoot (*Isoodon obesulus*)**

The population of the Southern Brown Bandicoot (*Isoodon obesulus*) at Golden Bay requires special consideration.

- 5-1 Prior to the commencement of development and in consultation with the Department of Conservation and Land Management, the proponent shall establish the regional implications of disturbing the population of the Southern Brown Bandicoot (*Isoodon obesulus*) at Golden Bay and shall initiate management of the population, to the requirements of the Minister for the Environment on advice of the Department of Conservation and Land Management.
- 5-2 The proponent shall carry out the on-going management of the population of the Southern Brown Bandicoot (*Isoodon obesulus*) at Golden Bay to the requirements of the Department of Conservation and Land Management.

**6 Proponent**

These conditions legally apply to the nominated proponent.

- 6-1 No transfer of ownership, control or management of the project which would give rise to a need for the replacement of the proponent shall take place until the Minister for the Environment has advised the proponent that approval has been given for the nomination of a replacement proponent. Any request for the exercise of that power of the Minister shall be accompanied by a copy of this statement endorsed with an undertaking by the proposed replacement proponent to carry out the project in accordance with the conditions and procedures set out in the statement.

**7 Time Limit on Approval**

The environmental approval for the proposal is limited.

- 7-1 If the proponent has not substantially commenced the project within five years of the date of this statement, then the approval to implement the proposal as granted in this statement shall lapse and be void. The Minister for the Environment shall determine any question as to whether the project has been substantially commenced. Any application to extend the period of five years referred to in this condition shall be made before the expiration of that period, to the Minister for the Environment by way of a request for a change in the condition under Section 46 of the Environmental Protection Act. (On expiration of the five year period, further consideration of the proposal can only occur following a new referral to the Environmental Protection Authority.)

**8 Compliance Auditing**

In order to ensure that environmental conditions and commitments are met, an audit system is required.

- 8-1 The proponent shall prepare periodic "Progress and Compliance Reports", to help verify the environmental performance of this project, in consultation with the Environmental Protection Authority.

### **Procedure**

The Environmental Protection Authority is responsible for verifying compliance with the conditions contained in this statement, with the exception of conditions stating that the proponent shall meet the requirements of either the Minister for the Environment or any other government agency.

If the Environmental Protection Authority, other government agency or proponent is in dispute concerning compliance with the conditions contained in this statement, that dispute will be determined by the Minister for the Environment.

Jim McGinty, MLA  
MINISTER FOR THE ENVIRONMENT

12 JAN 1993

## **PROPONENT'S COMMITMENTS**

**URBAN DEVELOPMENT OF PART LOT 12 & RESERVE 34664  
(AFFECTING PART OF SYSTEM SIX RECOMMENDATION M107)  
GOLDEN BAY (604)**

**H & B DEVELOPMENTS PTY LTD**

**The proponent has made the following environmental commitments:**

## CONSOLIDATED LIST OF COMMITMENTS FOR GOLDEN BAY

1. The proponent will provide, in exchange for the development of the currently proposed System 6 Area M107, additional Regional and Public Open Space adjacent to the Coastal Reserve as shown in the Structure Plan, in excess to that which would normally be required by DPUD. This will be done to the satisfaction of the EPA, DPUD and the Local Authority at the rezoning stage.
2. The proponent will prepare a Management Plan for the Coastal Reserve at Golden Bay prior to development commencing. This will be done to the satisfaction of DPUD and the Local Authority.
3. The proponent will include an historic aboriginal camping site within the proposed Public Open Space for the development. This will be done to the satisfaction of the Local Authority.
4. The proponent will continue to provide and maintain a network of firebreaks and access tracks to protect against bushfire until the Local Authority takes on this responsibility. This will be done to the satisfaction of the Local Authority.
5. The proponent will provide reticulated sewerage and will design the development so that stormwater drainage is disposed of on site. This will be done during the installation of services within the development to the satisfaction of DPUD and the Local Authority.
6. The proponent will liaise with CALM regarding the presence of bandicoots at Golden Bay and if required by CALM will examine the feasibility of relocating the bandicoots to an appropriate location elsewhere. This will be done prior to any disturbance of the vegetation at Golden Bay and will be done to the satisfaction of both CALM and the EPA.

## **APPENDIX 2**

# **OEPA CORRESPONDENCE**



Government of **Western Australia**  
Office of the **Environmental Protection Authority**



Mr Alex Horsburgh  
Senior Project Manager  
Department of Housing  
169 Hay Street  
**EAST PERTH WA 6175**

Our Ref: 16-006294  
Enquiries: Rowan Inglis, 6145 0849  
Email: [rowan.inglis@epa.wa.gov.au](mailto:rowan.inglis@epa.wa.gov.au)

3RD HAY ST.

Dear Mr Horsburgh

**MINISTERIAL STATEMENT 297 – URBAN DEVELOPMENT OF PART LOT 12 & RESERVE 34664, GOLDEN BAY – ANNUAL COMPLIANCE ASSESSMENT REPORT REQUIRED**

Ministerial Statement 297 places conditions on the implementation of the proposal above. Condition 8-1 of Statement 297 requires preparation and submission of a Compliance report.

The Office of the Environmental Protection Authority (OEPA) advises the Department of Housing that a Compliance Report reporting on the period of the previous calendar year (January to December 2015) is required to be submitted by **30 August 2016** and annually thereafter to demonstrate compliance with Statement 297.

The CAR must be developed in accordance with the following:

- Post Assessment Guideline for Preparing a Compliance Assessment Report
- Post Assessment Guideline for Preparing an Audit Table

These documents are available on the OEPA website [www.epa.wa.gov.au](http://www.epa.wa.gov.au)

If you have any queries regarding this matter, or wish to align the submission of the Compliance Report with reporting submitted to other government agencies, please contact Rowan Inglis on 6145 0849.

Yours sincerely

**Mr Ian Munro**  
MANAGER COMPLIANCE BRANCH

31 March 2016



# Reserve Enquiry Detail (5100LJ)

Screen Friendly Print Page

Reserve Name	34664	Legal Area (ha)	1.2757
Type		Status	Current
Notes		Current Purpose	PUBLIC RECREATION
File Number	3915/62		

Class	C	Responsible Agency	DEPARTMENT FOR PLANNING AND INFRASTRUCTURE	Date of Last Change	23/10/1995
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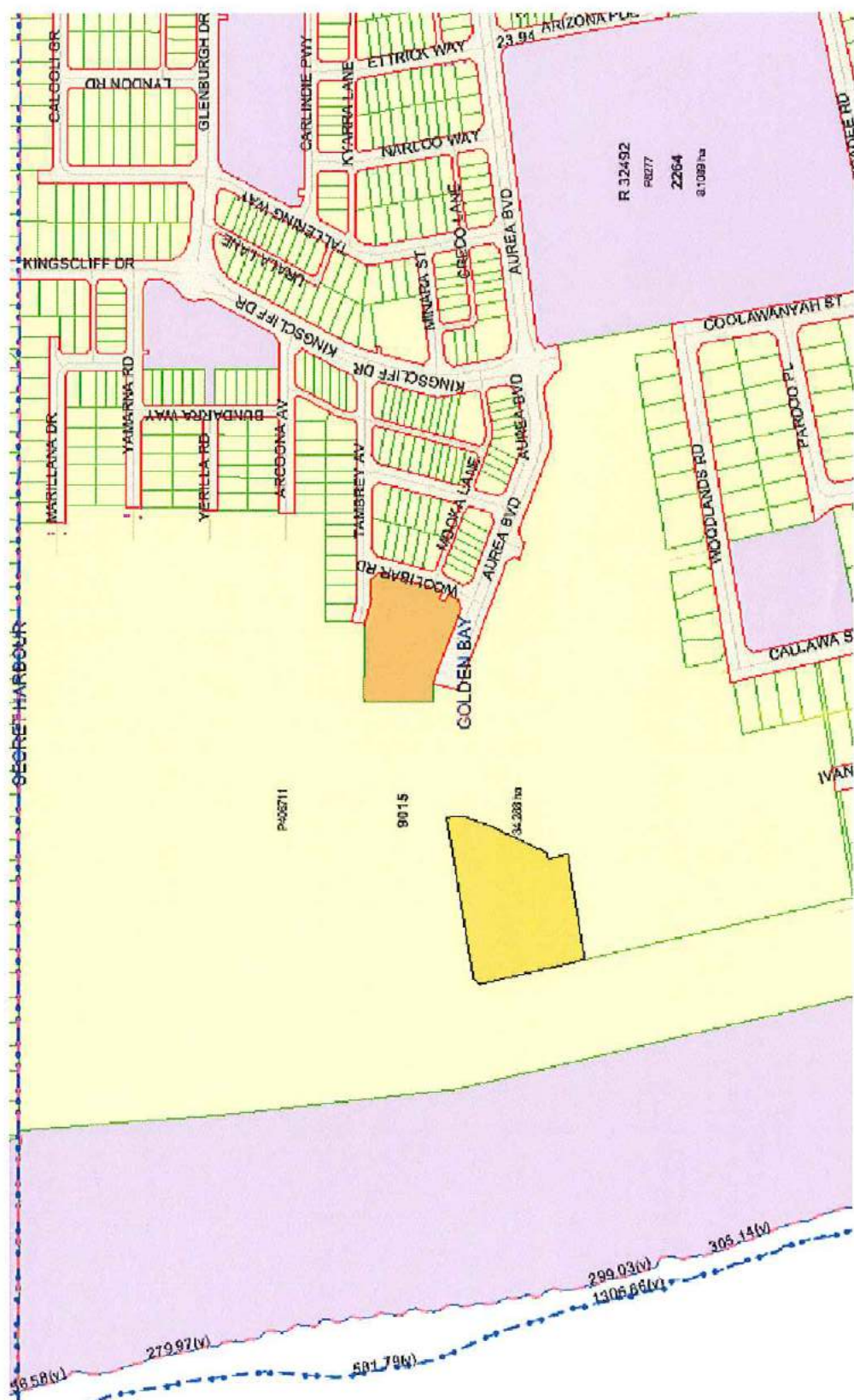
Management Orders	Document	Land Use	Local Government Authority
THE CITY OF ROCKINGHAM	PUBLIC RECREATION	ROCKINGHAM, CITY OF	

Add Item	CLT Number	Parcel Identifier	Street Address	Suburb	File Number	PIN	Area (sqm)	Map Viewer
<input type="checkbox"/>	LR3067-211	Lot 2486 On Diagram 28721			3915/1962	368857	12757.0	

Reserve Number 34664

Previous Certificates of Title	Historic Crown Allotments
LR3053-222	COCKBURN SOUND Location 2486

Gaz Page/Document	Date	Type	Text
4852	17/10/1995	Current Area	1.2757
4852	17/10/1995	Public Plan	BG33 (2) 7.13
2593	12/08/1977	Current Vesting	VEST SHIRE OF ROCKINGHAM
1841	17/06/1977	Formerly	FORMERLY PTN COCKBURN SOUND 16 LOT 246-D:28721
1841	17/06/1977	Original Gazettal and page	ORIGINAL GAZETTE
	17/06/1977	Class	C
	17/06/1977	Current Purpose	PUBLIC RECREATION
	17/06/1977	Correspondence File Number	3915/62
	17/06/1977	Historical Area	2.4306
	17/06/1977	Location	COCKBURN SOUND,2486



**APPENDIX 3**

**STATEMENT OF COMPLIANCE AND**

**AUDIT TABLE**

## Statement of Compliance

### 1. Proposal and Proponent Details

Proposal Title	Urban Development of Part Lot 12 and Reserve 34664
Statement Number	Enter the Ministerial Statement Number
Proponent Name	Peet Golden Bay Pty Ltd and Department of Communities
Proponent's Australian Company Number (where relevant)	94 600325 175 56 167 671 885

### 2. Statement of Compliance Details

Reporting Period	1/01/17 to 31/12/17
------------------	---------------------

Implementation phase(s) during reporting period (please tick ✓ relevant phase(s))					
Pre-construction		Construction	✓	Operation	✓
				Decommissioning	

Audit Table for Statement addressed in this Statement of Compliance is provided at Attachment:	3
<p>An audit table for the Statement addressed in this Statement of Compliance must be provided as Attachment 2 to this Statement of Compliance. The audit table must be prepared and maintained in accordance with the Department of Water and Environmental Regulation (DWER) <i>Post Assessment Guideline for Preparing an Audit Table</i>, as amended from time to time. The 'Status Column' of the audit table must accurately describe the compliance status of each implementation condition and/or procedure for the reporting period of this Statement of Compliance. The terms that may be used by the proponent in the 'Status Column' of the audit table are limited to the Compliance Status Terms listed and defined in Table 1 of Attachment 1.</p>	

Were all implementation conditions and/or procedures of the Statement complied with within the reporting period? (please tick ✓ the appropriate box)	
No (please proceed to Section 3)	Yes (please proceed to Section 4) ✓

Each page (including Attachment 2) must be initialed by the person who signs Section 4 of this Statement of Compliance.  
INITIALS: CR

*CR*

**3. Details of Non-compliance(s) and/or Potential Non-compliance(s)**

The information required Section 3 must be provided for each non-compliance or potential non-compliance identified during the reporting period covered by this Statement of Compliance.

**Non-compliance/potential non-compliance 3-1**

Which implementation condition or procedure was non-compliant or potentially non-compliant?
Was the implementation condition or procedure non-compliant or potentially non-compliant?
On what date(s) did the non-compliance or potential non-compliance occur (if applicable)?

Was this non-compliance or potential non-compliance reported to the Chief Executive Officer, DWER?	
<input type="checkbox"/> Yes <input type="checkbox"/> Reported to DWER verbally      Date _____ <input type="checkbox"/> Reported to DWER in writing      Date _____	<input type="checkbox"/> No

What are the details of the non-compliance or potential non-compliance and where relevant, the extent of and impacts associated with the non-compliance or potential non-compliance?
What is the precise location where the non-compliance or potential non-compliance occurred (if applicable)? (please provide this information as a map or GIS co-ordinates)
What was the cause(s) of the non-compliance or potential non-compliance?
What remedial and/or corrective action(s), if any, were taken or are proposed to be taken in response to the non-compliance or potential non-compliance?
What measures, if any, were in place to prevent the non-compliance or potential non-compliance before it occurred? What, if any, amendments have been made to those measures to prevent re-occurrence?
Please provide information/documentation collected and recorded in relation to this implementation condition or procedure: <ul style="list-style-type: none"> <li>• in the reporting period addressed in this Statement of Compliance; and</li> <li>• as outlined in the approved Compliance Assessment Plan for the Statement addressed in this Statement of Compliance.</li> </ul> (the above information may be provided as an attachment to this Statement of Compliance)

*For additional non-compliance or potential non-compliance, please duplicate this page as required.*

Each page (including Attachment 2) must be initialed by the person who signs Section 4 of this Statement of Compliance.

INITIALS: CR

**4. Proponent Declaration**

I, Craig Raynor (Senior Development Manager)

declare that I am authorised on behalf of Peet Golden Bay Pty Ltd

(being the person responsible for the proposal) to submit this form and that the information contained in this form is true and not misleading.

Signature:  .....

Date: 30/8/18

Please note that:

- it is an offence under section 112 of the *Environmental Protection Act 1986* for a person to give or cause to be given information that to his knowledge is false or misleading in a material particular; and
- the Chief Executive Officer of the DWER has powers under section 47(2) of the *Environmental Protection Act 1986* to require reports and information about implementation of the proposal to which the statement relates and compliance with the implementation conditions.

**5. Submission of Statement of Compliance**

One hard copy and one electronic copy (preferably PDF on CD or thumb drive) of the Statement of Compliance are required to be submitted to the Chief Executive Officer, DWER, marked to the attention of Manager, Compliance (Ministerial Statements).

Please note, the DWER has adopted a procedure of providing written acknowledgment of receipt of all Statements of Compliance submitted by the proponent, however, the DWER does not approve Statements of Compliance.

**6. Contact Information**

Queries regarding Statements of Compliance, or other issues of compliance relevant to a Statement may be directed to Compliance (Ministerial Statements), DWER:

**Manager, Compliance (Ministerial Statements)**

**Department of Water and Environmental Regulation**

Postal Address: Locked Bag 33  
Cloisters Square  
PERTH WA 6850

Phone: (08) 6364 7000

Email: [compliance@dwer.wa.gov.au](mailto:compliance@dwer.wa.gov.au)

**7. Post Assessment Guidelines and Forms**

Post assessment documents can be found at [www.epa.wa.gov.au](http://www.epa.wa.gov.au)

Each page (including Attachment 2) must be initialed by the person who signs Section 4 of this Statement of Compliance.  
INITIALS: CR

## ATTACHMENT 1

Table 1 Compliance Status Terms

Compliance Status Terms	Abbrev	Definition	Notes
Compliant	C	Implementation of the proposal has been carried out in accordance with the requirements of the audit element.	This term applies to audit elements with: <ul style="list-style-type: none"> <li>ongoing requirements that have been met during the reporting period; and</li> <li>requirements with a finite period of application that have been met during the reporting period, but whose status has not yet been classified as 'completed'.</li> </ul>
Completed	CLD	A requirement with a finite period of application has been satisfactorily completed.	This term may only be used where: <ul style="list-style-type: none"> <li>audit elements have a finite period of application (e.g. construction activities, development of a document);</li> <li>the action has been satisfactorily completed; and</li> <li>the DWER has provided written acceptance of 'completed' status for the audit element.</li> </ul>
Not required at this stage	NR	The requirements of the audit element were not triggered during the reporting period.	This should be consistent with the 'Phase' column of the audit table.
Potentially Non-compliant	PNC	Possible or likely failure to meet the requirements of the audit element.	This term may apply where during the reporting period the proponent has identified a potential non-compliance and has not yet finalized its investigations to determine whether non-compliance has occurred.
Non-compliant	NC	Implementation of the proposal has not been carried out in accordance with the requirements of the audit element.	This term applies where the requirements of the audit element are not "complete" have not been met during the reporting period.
In Process	IP	Where an audit element requires a management or monitoring plan be submitted to the DWER or another government agency for approval, that submission has been made and no further information or changes have been requested by the DWER or the other government agency and assessment by the DWER or other government agency for approval is still pending.	<p><b>The term 'In Process' may not be used for any purpose other than that stated in the Definition Column.</b></p> <p>The term 'In Process' may not be used to describe the compliance status of an implementation condition and/or procedure that requires implementation throughout the life of the project (e.g. implementation of a management plan).</p>

Each page (including Attachment 2) must be initiated by the person who signs Section 4 of this Statement of Compliance.

INITIALS: CR

## Urban Development of Part Lot 12 and Reserve 34664, Golden Bay (Assessment 604, Statement 297)

### Ministerial Statement 297 Audit Table

Note:

Phases that apply in this table = Pre-Construction, Construction, Operation, Decommissioning, Overall (several phases)

This audit table is a summary and timetable of conditions and commitments applying to this project. Refer to the Minister's Statement for full detail/precise wording of individual elements.

Code prefixes: M=Minister's condition; P=Proponent's commitment; A=Audit specification; N=Procedure.

Abbreviations: CAR=Compliance Assessment Report; LPA=Landscape Protection Area; FMP-Foreshore Management Plan; CEO=Chief Executive Officer of OEPA; Minister for Env=Minister for the Environment; OEPA=Office of the Environmental Protection Authority; CoR - City of Rockingham; DoT - Department of Transport; CALM Conservation and Land Management (now known as Department of Parks and Wildlife); DPUD = Department of Planning and Urban Development (now Department of Planning)

Compliance Status: C=Compliant, CLD=Completed, NC=Non-compliant, NR=Not Required at this stage. Please note the terms NA=Not Audited and VR=Verification Required are only for OEPA use. IP=In Process may only be used by the proponent in circumstances outlined in Section 2.8 of the *Post Assessment Guideline for Preparing an Audit Table*.

Audit Code	Subject	Requirement	How	Evidence	Phase	To requirements of On advice from	Timeframe	Status	Comment
297: M1-1	Commitments	Fulfil the commitments	As per attachment to the Minister's statement.	CAR	Overall	EPA DPaW		C	
297: M2-1	The Proposal	Adhere to the Proposal	In accordance with any designs, specifications, plans or other technical material submitted by the Proponent to the OEPA.	CAR	Overall	EPA DPaW	Throughout life of the project	C	No changes proposed
297: M2-2	The Proposal	Seek approval for modifications to the Proposal	Submit a written request to the Minister for Env. Detailing changes to designs, specifications, plans or other technical material.	Correspondence to OEPA	Overall	Minister for Env. EPA	Throughout life of the project	C	No changes proposed
297: MB-1	Foreshore Reserve	Provide a foreshore reserve for conservation and recreation which: 3. Protects the Peelhurst Wetlands and the Southern Brown Bandicoot ( <i>Isodon obesulus</i> ) population; and 4. Includes landscape and recreation values at least equivalent to the area affected by this proposal which is within System 6 Recommendation M107 Area.	Make a submission to the Minister for Env. For approval on advice of the EPA.	Submission to the Minister for Env.	Pre development	Minister for Env. EPA	Prior to lifting of 'Urban Deferred'	CLD	4 June 1993
297: MB-2	Foreshore Reserve	Transfer to public ownership the proposed foreshore reserve as required by MB-1.	Make a submission to the Minister for Env. On advice of the Department of Conservation and Land Management	Submission to the Minister for Env.	Pre development	Minister for Env. EPA	Prior to lifting of 'Urban Deferred'	CLD	4 June 1993
297: M4-1	Landscape Protection	Liaise with the Department of Planning and Urban Development and the CoR to incorporate planning measures which recognise and protect the landscape value of the parabolic ridge on the eastern edge of Golden Bay.	Make a submission to the Minister for Env. And the Minister for Planning for approval on advice of the DPUD, CoR, EPA	Submission to the Minister for Env. And Minister for Planning	Pre development	Minister for Env Minister for Planning DPUD CoR EPA.	Before or as a condition of subdivision	CLD	5 April 1994

Audit Code	Subject	Requirement	How	Evidence	Phase	To requirements of On advice from	Timeframe	Status	Comment
297: M5-1:1	Southern Brown Bandicoot	Establish the regional implications of disturbing the population of the Southern Brown Bandicoot (Isodon obesulus) at Golden Bay.	Make a submission to the Minister for Env. On advice of the Department of Conservation and Land Management	Correspondence with Minister for Env.	Pre development	Minister for Env CALM	Prior to any clearing/construct ion activities commencing	CLD	6 February 1996
297: M5-1:2	Southern Brown Bandicoot	Initiate management of the population of the Southern Brown Bandicoot (Isodon obesulus)		Report on this in the first report required under M8	Pre development	Minister for Env CALM	Prior to any clearing/construct ion activities commencing	CLD	CAR Submitted 20 May 2010
297: M5-2:1	Southern Brown Bandicoot	Carry out the ongoing management of the population of the Southern Brown Bandicoot (Isodon obesulus) at Golden Bay as proposed in M5-1.	Agreement with CALM	Report on this under M8	Development	CALM	Ongoing	C	All stages of development have included a relocation program prior to any clearing activity.
297: M5-2:2	Southern Brown Bandicoot	Carry out the ongoing management of the Southern Brown Bandicoot (Isodon obesulus) at Golden Bay as proposed in M5-1.	Agreement with CALM	Report on this under M8	Post Development	CALM	Ongoing	NR	
297: M6-1	Project Ownership, management, control	Seek approval for transfer of ownership, control or management of this project.	Letter to the Minister for Env. Together with the new proponent's endorsement of the Ministerial Statement	Letter and statement endorsed by the replacement proponent	overall	Minister for Env. EPA	Before transfer of ownership	C	DoC and Peet Golden Bay Pty Ltd were recognised by the OEPA as joint Proponents 1 August 2016.
297: M7-1	Time limit on approval	Seek approval to extend approval to implement proposal.	Application to be made before the end of five years (from the publish date of the Minister's statement)	Letter application	Overall	Minister for Env. EPA	Before 12 January 1998 if project has not commenced substantially	CLD	
297: M8	Compliance auditing	Prepare a periodic 'Progress and Compliance Report' to help verify the environmental performance of this project.	The report (CAR) should be an update on the project giving evidence of how compliance has been achieved. It should list each condition and commitment to be reported on showing for each: its code no. Form the audit table; what action it requires; what has been done to meet the condition or commitment including any problems that may have arisen and what the proponent has done to address them; how compliance can be verified.	CAR providing evidence of compliance for each relevant audit element in the audit table.	Overall	EPA	First report before clearing activities commence, second report one year after clearing has commenced, then as required by the OEPA.	C	OEPA has requested (Appendix 2) that from August 2016 compliance reports are to be submitted annually in August for the previous calendar year.
297: P1	Foreshore Reserve	Provide in exchange for the development of the currently proposed System 6 Area M107, additional Regional and Public Open Space adjacent the Coastal Reserve as shown in the Structure Plan, in excess to that which would normally be required by DPUD.	Duplicated by M3-1		Predevelopment	EPA, DPUD CoR	At the rezoning stage	CLD	26 October 1995 Not Audited (duplicated by condition M3-1) – Audit Branch
297: P2	Management Plan	Prepare a Management plan for the coastal reserve at Golden Bay.	In a submission to the local authority, Minister for Planning and EPA.	Management Plan for foreshore reserve to be submitted	Predevelopment	EPA, Minister for planning, local authority, DEP	before clearing/construct ion activities commence	CLD	Golden Bay Foreshore Management Plan approved by the OEPA on 30 March 2012 (on advice from DoP and CoR).

Audit Code	Subject	Requirement	How	Evidence	Phase	To requirements of On advice from	Timeframe	Status	Comment
									An addendum to the RMP to address the interface between the development and foreshore reserve was submitted and approved by the OEPA on 29 September 2016.
297: P3	Historic Site	Include the historic aboriginal camping site within the proposed Public Open Space for the development.	Present a submission to the local authority		Predevelopment	EPA Local Authority	before clearing/construct ion activities commence	C.D	13 December 1995
297: P4	Fire	Protect against Bushfire	By providing and maintaining a network of firebreaks and access tracks until the local authority takes on this responsibility	Report on this under M8	overall	EPA DEP	until the local authority takes on this responsibility	C.D	Fire Management Plan for the Golden Bay Structure Plan Area has been approved by the City of Rockingham in March 2012.
297: P5	Reticulated sewerage and stormwater drainage:	Provide reticulated sewerage and stormwater drainage designated to infiltrate stormwater into the soil within the development site.	To the satisfaction of Minister for planning and local authority	Report on this under M8	Development	EPA Minister for Planning Local Authority	During provision of services within the development	C.D	A Local Water Management Strategy (LWMS) has been prepared for the Structure Plan Area and approved by the Department of Water and the City of Rockingham. Urban Water Management Plans will be prepared in accordance with the LWMS for each stage of subdivision.
297: P6	Bandicoots	Liaise with CALM regarding the presence of bandicoots at Golden Bay and examine feasibility of relocating bandicoots if required by CALM.	Duplicated by M5			EPA CALM	Prior to any disturbance of the vegetation at Golden Bay	C.D	13 December 1995

**APPENDIX 4**

**FORSHORE MANAGEMENT PLAN**  
**MANAGEMENT ACTION TABLE**

## FORESHORE MANAGEMENT PLAN

### MANAGEMENT COMMITMENTS AND RESPONSIBILITIES

Compliance Status: C = Compliant, CLD = Completed, NC = Non – compliant, NR = Not Required at this stage.

Task	Responsibility	Timeframe FMP Stages	Priority	Status
Locate roads, access tracks and DUPs, and the Coastal node along existing routes where possible, or realign them to move through areas of disturbed vegetation	Developer	Stage 4	2	C
Erect temporary fencing between the Foreshore Reserve vegetation and proposed development	Developer	Stage 2	1	C
Survey and peg the Foreshore Reserve area to ensure this is protected from potential impacts of subdivision development	Developer	Stage 2	1	CLD
Replace temporary fencing in appropriate areas with a permanent barrier once earthworks have been completed, to prevent unauthorised access to areas of native vegetation (embedded limestone and native vegetation can be used for this purpose)	Developer	Stage 3	3	NR
Erect interpretative signage on access paths near the TEC to inform DUP users of the conservation value of the vegetation	Developer	Stage 4	3	NR
Maintain grassed parkland area, toilets and showers, access paths, DUPs and fences.	Developer (2 years post- construction)	Stage 3-5	3	NR

	then City of Rockingham			
Transfer of proposed Foreshore Reserve to public ownership (to the City of Rockingham)	Developer	Post Stage 5	3	NR
Machinery and vehicles will use the cleared, degraded areas for access, and must be clean on entry to the site.	Developer	Stage 2-5	2	NR
Vegetation clearing will be undertaken in weather conditions that are conducive to effective dust control.	Developer	Stage 2-5	1	NR
Wind-fencing will be used as required in conjunction with water sprays and tankers to control and limit excessive dust from earthworks operations and roads.	Developer	Stage 2-5	2	NR
The size of soil stockpiles will be limited and water or stabilising agents used to control dust.	Developer	Stage 2-5	2	NR
Soil stabilisation methods will be used to reduce the risks associated with wind erosion through the use of mulches, dust suppression agents or by revegetation as appropriate.	Developer	Stage 2-5	2	NR
Work will be planned to ensure construction or stabilisation follows demolition wherever possible.	Developer	Stage 2-5	2	NR
Dust suppression equipment and/or agents will be regularly inspected and maintained as required to prevent unacceptable dust emissions.	Developer	Stage 2-5	2	NR
Regular inspections of adjacent roads will be undertaken for dust creating materials.	Developer	Stage 2-5	2	NR

Excessive build-up of mud, debris or any other deleterious matter deposited on any road used for access to or egress from the project site will be removed.	Developer	Stage 2-5	2	NR
Construction staff will be made aware of issues relevant to dust control and will be familiar with the requirements prescribed in this management plan.	Developer	Stage 2-5	2	NR
Revegetate areas not likely to be impacted during construction as indicated in Figure 5	Developer	Stage 1	1	NR
Apply brush to large dune “blowout” area	Developer	Stage 1-3	1	NR
Revegetate areas impacted during construction with species consistent with City of Rockingham’s <i>Coastal Rehabilitation Policy</i> (CoR, 2002a)	Developer	Stage 2-5	2-3	NR
Implement a monitoring program using visual inspections and photographs to monitor the progress of revegetation plans.	Developer (2 years post- construction) then City of Rockingham	Stage 1-5  Monitoring will be undertaken on a six-monthly basis, reviewed annually	3	NR
Replace failed plants if coverage is not adequately achieved.	Developer (2 years post- construction) then City of Rockingham	As required, on a yearly basis post-construction	3	NR
Carry out a visual inspection onsite to determine the success of weed control applied as determined in above task, and establish a weed control program for the following two years.	Developer	Stage 2-5	2	NR

		Six monthly following initial weed management		
Carry out the weed control program devised in the above task. Potentially regular spot-spraying or removal by hand, done periodically over several years.	Developer (2 years post- construction) then City of Rockingham	Stage 2-5 Pre-, during and post-construction	3	NR
Erect a dog-proof fence between the residential subdivision and the Foreshore Reserve to protect Bandicoots within the conservation areas from domestic pets and feral animals.	Developer	Stage 2 During Construction	2	NR
Construct fauna access underpasses beneath paths intersecting known Bandicoot habitat vegetation.	Developer	Stage 3	2	NR
Ensure site crew are aware of the 24hr Wildcare Helpline number to call ((08) 9474 9055) in the case of wildlife being encountered during clearing of construction.	Developer	Stage 2-5	2	C
Erect signage indicating the conservation status of the Bandicoot nearby to their known habitat areas.	Developer	Stage 4	3	NR
Educate landowners on the effect of domestic animals on native fauna, such as by erecting signs addressing responsible pet ownership and protection of habitat for Bandicoot. Signs should also include information on the general biology of Bandicoots.	Developer (2 years post- construction) then City of Rockingham	Stage 3-5	2	NR
Consider seeking community consent for the trapping of cats (particularly after Bandicoot breeding) within conservation areas in the Foreshore Reserve	Developer (2 years post- construction)	Ongoing	3	NR

	then City of Rockingham			
Conserve and rehabilitate any good quality, dense wetland habitat which is planned for protection and provides protection for Bandicoots. The addition of further vegetation and cover (such as hollow logs) may assist with the survival of Bandicoot within protected areas at the Golden Bay site. (Such management actions should continue in parallel with the population monitoring.)	Developer (2 years post- construction) then City of Rockingham	Ongoing	1	C  TEC19a Photo Point Monitoring Survey
Undertake an annual bandicoot trapping survey of seven nights in spring and autumn each year within the Foreshore Reserve (targeting conservation areas with known Bandicoot habitat).	Developer	Stage 2-5 During construction and for a period of 2 years post-construction.	1	C  Bandicoot Monitoring Survey
Continue to rehabilitate areas degraded as a result of construction and implement weed control.	Developer (2 years post- construction) then City of Rockingham	Ongoing	3	NR
Removal of debris from bandicoot underpasses to prevent blockages.	Developer (2 years post- construction) then City of Rockingham	Ongoing (monthly)	3	NR
Remove all rubbish from conservation areas.	Developer (2 years post- construction) then City of Rockingham	Ongoing (monthly)	3	NR

Have regard to the Aboriginal Heritage site reserve boundary and erect signage to indicate the significance of the site.	Developer	Stage 1-5 Construction	2	C
Ensure adequate provision of emergency vehicle access through the Foreshore Reserve.	Developer	Ongoing	2	C
Provide suitable drainage infrastructure such as soakwells for hardstand areas (e.g. Car parks)	Developer	Stage 2-5 Construction	2	NR
Provision of passive surveillance such as lighting within the Foreshore Reserve.	Developer	Stage 2-5 Construction	2	NR

**APPENDIX 5**

**TEC19A PHOTO POINT MONITORING  
SURVEY**

# GOLDEN BAY FORESHORE RESERVE

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## 2017 VEGETATION PHOTO POINT MONITORING REPORT

Prepared for: Peet Golden Bay Pty Ltd and Department of Communities

Report Date: 30 August 2018

Version: 1

Report No. 2018-394



**pgv**  
ENVIRONMENTAL

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**Figures**

Figure 1: Site Location

Figure 2: TEC19a Locations

**Appendices**

Appendix 1: Vegetation Photo Point Monitoring Proforma

Appendix 2: Site Photos

Appendix 3: Groundwater Levels in Wetland Bores

# 1 INTRODUCTION

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## 1.1 Background

The urban development of Lots 2 and 3, Golden Bay was subject to a Public Environmental Review (EPA Assessment 604) and was approved in Ministerial Statement 297 in January 1993 (Appendix A). Ministerial Statement 297 contains three conditions relevant to the Foreshore Reserve at Golden Bay as follows:

*Condition 3-1 The proponent shall provide a foreshore reserve for the conservation and recreation which:*

*1 Protects the Peelhurst wetlands and the Southern Brown Bandicoot (Isoodon obesulus) population; and*

*2 Includes landscape and recreation values at least equivalent to this proposal which is within System 6 Recommendation M106 Area.*

*Commitment P-2 The proponent will prepare a Management Plan for the Coastal Reserve at Golden Bay prior to development commencing. This will be done to the satisfaction of the DPUD [now Department of Planning, Lands and Heritage] and the Local Authority.*

## 1.2 Location

The Golden Bay Foreshore Reserve (the study area) is situated 50km south of Perth and 16km south of the Rockingham Town Centre, within the City of Rockingham (Figure 1). The site is bounded by Secret Harbour to the north, the developing residential area on Lots 2 Warnbro Sound Avenue to the east and the existing Golden Bay Township to the south.

### 1.2.1 Foreshore Reserve Description

The Foreshore Reserve covers an area of approximately 10.61ha, is 800m in length and incorporates the beach, foredune and near-coastal dune systems. The width of the reserve from the back of the beach to its eastern extent ranges between approximately 400m (centre), 200m (southern end) and 250m (northern end). The western boundary of the reserve is marked by the high-water mark, the northern and southern boundaries in line with the northern and southern Lot 2 property boundaries and the eastern boundary marks the western limit of urban zoning. The extent of the reserve is shown in Figure 3.

### 1.2.2 Foreshore Reserve Ecological Values

The Foreshore Reserve contains wetlands that belong to the Peelhurst suite of wetlands. These wetlands form in low lying depressions within the Quindalup Dunes which have intercepted the water table and are typically small, seasonally inundated sumplands or seasonally wet damplands. The Golden Bay wetlands have been listed as Conservation Category in the *Geomorphic Wetlands of the Swan Coastal Plain* database.

The Threatened Ecological Community (TEC) 19a *Sedgelands in Holocene Dune Swales* is located in all the wetlands in the Foreshore Reserve at Golden Bay. This TEC is listed as “Critically Endangered” under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* and is also recognised as a TEC at State level.

The vegetation in the Foreshore Reserve supports a population of Southern Brown Bandicoot (*Isoodon fusciventer*). Bandicoots have been identified as a species of state significance and are listed as a Priority 5 species by the Department of Biodiversity, Conservation and Attractions (DBCA).

An indigenous heritage site (DIA 2519) is located in the southern end of the Foreshore Reserve.

### **1.3 Report Purpose**

A Foreshore Management Plan (FMP) was prepared for the study area by the developers of Lot 2 Warnbro Sound Ave (Peet Golden Bay Pty Ltd and Department of Housing now Department of Communities) and approved on 30 March 2012. An addendum to the FMP to address the interface between the development and foreshore reserve was submitted and approved by the OEPA on 29 September 2016.

The FMP contained a commitment to monitor the health of the vegetation in the wetlands using permanent photo points.

The initial photo point monitoring assessment was conducted in October 2012. This report documents the methods and results of the annual photo point monitoring undertaken in the Golden Bay Foreshore Reserve over the period from 2012 to 2017.

The objectives of the photo point monitoring report are to:

- Provide a qualitative assessment of the condition of the TEC19a vegetation in the wetlands;
- Assess any requirement for weeding;
- Assess any requirement for grazing control; and
- Determine if any erosion control is required.

## 2 EXISTING ENVIRONMENT

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### 2.1 Topography

The topography of the Foreshore Reserve ranges from 1 to 10m AHD. The dunes closest to the coast are part of a recent parallel dune ridge system with dune crests up to 5-6m AHD. The eastern half of the Foreshore Reserve contains a low linear flat swale at an elevation of 1-2m AHD with some taller dunes up to 10m AHD.

### 2.2 Wetlands

The eastern half of the Foreshore Reserve contains a number of small wetlands within the flat swale directly behind the frontal dunes. The wetlands are described as sumplands and contain shallow freshwater above-ground in spring during an average rainfall season. The wetlands are rated as Conservation Category wetlands.

### 2.3 Vegetation

The Foreshore Reserve was subject to a bushfire on 1 January 2016. The fire was reported as being ignited by fireworks/boat flares. The area of the Foreshore Reserve impacted by the fire was estimated to be approximately 7ha. The northern section was burnt in patches and the eastern part of the central section was largely burnt.

The area burnt by the January 2016 bushfire is being monitored in accordance with the FRP to assess the progress of regeneration. The monitoring will determine whether any supplementary planting will be required to assist regeneration and whether any weed control needs to be undertaken during the recovery period. The Post Fire Vegetation Monitoring Survey results are provided in Appendix 8 of the Golden Bay Compliance Report 2017.

#### 2.3.1 Vegetation Types

A variety of coastal Quindalup vegetation types occur in the Foreshore Reserve as listed below:

##### Western Half

- *Spinifex hirsutus* Grassland: Located on the foredune with *Spinifex longifolius*, *Tetragonia decumbens* and *Cakile maritima* present on the seaward facing slopes and *Ficinia nodosa* and *Carpobrotus virescens* frequent near the crest and leeward sides.
- *Olearia axillaris* Shrubland: Located immediately behind the foredune and forms a wide band parallel to the coast, containing *Cassutha* sp., *Pelargonium capitatum* and *Trachyandra divaricata*. It grades into the *Spyridium globulosum* Open Heath.
- *Spyridium globulosum* Open Heath: Located on the lower dunes and containing *Acacia cyclops*, *Hibbertia cuneiformis*, *Alyxia buxifolia*, *Pelargonium capitatum* and the creeper *Hardenbergia comptoniana*.

##### Eastern Half

- *Acacia rostellifera*/*Spyridium globulosum* Closed Shrub: An intermediate unit located in the central part of the site.

- *Juncus kraussii* Sedgeland: Located within the eastern low linear flat swale in the wetland areas, containing *Baumea juncea*, *Centella asiatica*, *Ficinia nodosa*, *Dampiera alata* and *Lepidosperma gladiatum*. Mature Paperbark trees (*Melaleuca raphiophylla* and *Melaleuca cuticularis*) also occur in the wetlands. The 2016 fire caused a multitude of *M. raphiophylla* seedlings to germinate from one mature tree in one of the wetlands in the reserve.
- *Spyridium globulosum* Closed Heath: Making up the majority of the transitional vegetation on slightly higher ground within the swale, it contains similar species to the *Spyridium globulosum* Open Heath on the low dunes and additionally a dense ground coverage of the Sword Sedge *Lepidosperma gladiatum*.

The *Juncus kraussii* Sedgeland vegetation type generally describes the vegetation in the wetlands.

### **2.3.2 Vegetation Condition**

The vegetation in most of the Foreshore Reserve was rated as mostly being in Excellent condition with only a few tracks through it. Some wetland areas had previously been impacted by off road vehicles. These tracks have been closed off to allow for natural regeneration of the wetlands.

A weed survey of the Foreshore Reserve conducted by PGV Environmental in May 2015, identified the most prevalent introduced species in the area as Rose Pelargonium (*Pelargonium capitatum*) and False Onion Weed (*Trachyandra divaricata*). Both species were more common on the western part of the Foreshore Reserve on sand dunes than in the eastern swales. Hares Tail Grass (*Lagurus ovatus*) and Geraldton Carnation Weed (*Euphorbia terracina*) were also present in parts of the Foreshore Reserve.

The wetlands on the site contained few weeds.

## **2.4 Native Fauna**

The Foreshore Reserve at Golden Bay contains a population of Southern Brown Bandicoots (*Isodon fusciventer*). The size and health of the Bandicoot population has been monitored by the developers for 5 years. The number of Bandicoots surveyed in the foreshore reserve was reduced in 2016 most likely due to the fire event and predation.

The Foreshore Reserve contains an itinerant population of Western Grey Kangaroos (*Macropus fuliginosus*) that moves within the foreshore reserves north and south of Golden Bay. The presence of kangaroos may impact on the vegetation in the Foreshore Reserve, especially as the native vegetation in the adjoining urban area is removed.

The condition of the wetland vegetation may be impacted by kangaroos moving through or resting in the dense sedgelands. Management of the kangaroo population is not limited to Golden Bay as they range up and down the coastal corridor. A global approach across multiple land managers may be required if the number of kangaroos needs to be managed.

## **2.5 Pest Fauna**

The Foreshore Reserve contains a large number of rabbits as evidenced by the amount of rabbit droppings, diggings and a burrow. Foxes and feral cats are known to occur in the Foreshore Reserve. Fox and cat trapping was undertaken post the 2016 fire event.

### 3 MONITORING RESULTS

#### 3.1 Photo Point Monitoring

Photo point monitoring was undertaken on 23 September 2017 at the eight monitoring sites established in the wetland vegetation in 2012 (Plate 1). Sites 5 and 7 have been combined into one site due to their proximity (4m apart).

Four photos (east, north, west, south) were taken from the permanent photo points which are marked with a metal dropper and flagging tape. The location of markers is recorded in eastings and northings as shown in Table 1 and shown in Plate 1.

**Table 1: Photo Point Locations.**

Site	Eastings	Northings
1	382545	6411987
2	382527	6412049
3	382544	6412057
4	382501	6412185
5	382469	6412279
6	382507	6412293
8	382458	6412346

#### 3.2 Condition Assessment Method

The condition of the vegetation in the wetland areas was assessed using key indicators to facilitate comparison between the results from different years. A number of indicators were considered in the condition assessment, each of which were allocated a score using a three-point scoring system of 1 to 3 (Table 2). Relevant comments on condition indicators were also recorded as supplementary information. The scoring system will enable broad comparison over time between results, however, due to the subjective nature of the method, the scores are indicative only.

The nature of many of the indicators for the condition assessment is such that they will not change over the short term, for example surface water and fire history. The attributes most likely to change over time include weed invasion, grazing and flattening.

A standard proforma is used to document the condition assessment to ensure consistency across the subsequent monitoring events. The proforma is provided at Appendix 1.

**Table 2: Condition Indicators**

Indicator	Rating	Measure
Grazing	1	Severe/heavy
	2	moderate (limited but evident)

	3	nil very low
Clearing	1	30% +cleared
	2	10-30% cleared
	3	<10% cleared
Weeds	1	30% +cover
	2	1-30% cover
	3	<10% cover
Erosion	1	severe impacting >30% of site
	2	moderate (limited but evident)
	3	nil very low (minimal impact)
Fire History	1	<10 years
	2	10 to 20 years
	3	>20 years
Surface Water	1	Damp at Surface
	2	<10cm
	3	>10cm



**Plate 1: Photo Point Locations**

### 3.3 Condition Assessment Results

The results of the qualitative condition assessment for each monitoring point are provided in Table 3. The condition assessment photos are shown in Appendix 2.

Five of the seven monitoring sites had surface water greater than 10cm deep. Site 1 had an approximate water depth of 40cm. Site 3 and 6 were damp at the surface but did not contain any above ground water. The groundwater levels in the ground water monitoring bore WB01 in the foreshore wetlands showed maximum levels of around 1.2m AHD in October 2017 (Appendix 3). This is higher than all preceding years (2013-2016). Ground Water monitoring bore WB02 was not measured in October 2017.

There was an increase in the number of kangaroo trails and resting places through the wetlands as the sedges and the vegetation surrounding the wetlands has recovered and provides shelter. Site 1 had a similar number of tracks as the previous year. There was evidence of grazing on the sedges in Sites 2, 4, 5, 6, and 8.

Weed invasion has not changed significantly since 2012.

Erosion rating has not changed significantly since 2012.

Site 3 is a wetland that has had a 4WD track through it for many years and, as such, started with a low condition score and high rating for clearing. Site 3 had evidence of additional clearing either during or post fire which is now recovering.



**Plate 2: Site 3 Area regeneration after cleared for fire management purposes**

**Table 3: Condition Assessment (2017)**

Condition Attribute	Site	1	2	3	4	5	6	8
<b>Grazing/flattening by rabbits or kangaroos</b>	2017	1	2	2	2	2	2	3
	2016	2	3	3	3	3	3	3
	2015	2	2	2	2	2	3	3
	2012	1	2	3	3	3	3	2
<b>Clearing</b>	2017	3	3	1	3	3	2	3
	2016	3	3	1	2	2	2	2
	2015	3	3	1	3	3	2	3
	2012	3	3	1	3	3	1	2
<b>Weed Invasion</b>	2017	3	2	2	3	3	2	3
	2016	3	3	2	2	2	2	2
	2015	3	3	2	3	2	2	3
	2012	3	3	2	3	3	2	2
<b>Erosion</b>	2017	3	3	2	3	3	3	3
	2016	3	3	1	3	3	3	3
	2015	3	3	2	3	3	3	3
	2012	3	3	1	3	3	2	2
<b>Fire History</b>	2017	2	1	1	1	1	1	1
	2016	2	1	1	1	1	1	1
	2015	2	2	2	2	2	1	2
	2012	2	2	2	2	2	2	2
<b>Surface Water</b>	2017	3	2	1	3	3	1	2
	2016	2	1	1	1	1	1	1
	2015	1	1	1	1	1	1	1
	2012	2	1	1	1	2	1	2

### **3.4 Photo Point Monitoring Results**

The full set of photos for each site year 2017 is provided in Appendix 2.

#### **3.4.1 Site 1**

Comparison of photos from 2015, 2016 and 2017 showed that there was similar damage by kangaroos passing through and/or sleeping in the wetland at Site 1. There was approximately 40cm of standing water in the wetland.

**Plate 3: Year 2015**



**Plate 4: Year 2016**



**Plate 5: Year 2017**



### 3.4.2 Site 2

Comparison of photos from 2015, 2016 and 2017 shows the site is recovering from the fire. The sedges in the wetland have regrown to approximately 50cm in height. The surrounding vegetation is also regenerating. The wetland was damper than previous years with standing water to 10cm.

**Plate 6: Year 2015**



**Plate 7: Year 2016**



**Plate 8: Year 2017**



### 3.4.3 Site 3

Comparison of photos from 2015, 2016 and 2017 shows the recovery of the vegetation after the fire.

**Plate 9: Year 2015**



**Plate 10: Year 2016**



**Plate 11: Year 2017**



#### **3.4.4 Site 4**

Comparison of photos from 2015, 2016 and 2017 show the vegetation within the wetland has recovered completely from the fire event. The sedges in the wetland have regenerated and were approximately 40-50cm in height. The wetland had approximately 20cm of surface water on the day of the survey. The level of surface water was greater than in previous years. There was evidence of increase of kangaroos passing through the wetland.

**Plate 12: Year 2015**



**Plate 13: Year 2016**



**Plate 14: Year 2017**



### 3.4.5 Site 5

Comparison of photos from 2015, 2016 and 2017 shows the impact of the fire on the wetland and good regrowth in year 2017. There was approximately 20cm of surface water across the wetland which was more than previous years.

**Plate 15: Year 2015**



**Plate 16: Year 2016**



**Plate 17: Year 2017**



### 3.4.6 Site 6

Comparison of photos from 2015, 2016 and 2017 shows good vegetation recovery across the wetland and surrounding areas.

**Plate 18: Year 2015**



**Plate 19: Year 2016**



**Plate 20: Year 2017**



### 3.4.7 Site 8

Comparison of photos from 2015, 2016 and 2017 shows good regeneration of vegetation across the wetland. There was less than 10cm of standing water in parts of the wetland.

**Plate 21: Year 2015**



**Plate 22: Year 2016**



**Plate 23: Year 2017**



## 4 CONCLUSIONS

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The photo monitoring of vegetation in the wetlands of the Golden Bay Foreshore Reserve shows the vegetation regeneration after the impact of the fire on 1 January 2016. The sedges in the wetlands have regrown and there is significant regeneration in the surrounding vegetation.

There has been little change in the condition of the wetland in site 1 which wasn't impacted by the fire.

The impact of the fire in increasing weeds in the fire-affected areas is being monitored and, if required, weed control will be implemented. Currently, monitoring has not detected an increase in weed density or species richness after the fire. With the rapid recovery of the native vegetation the status of weeds in the wetlands is unlikely to change.

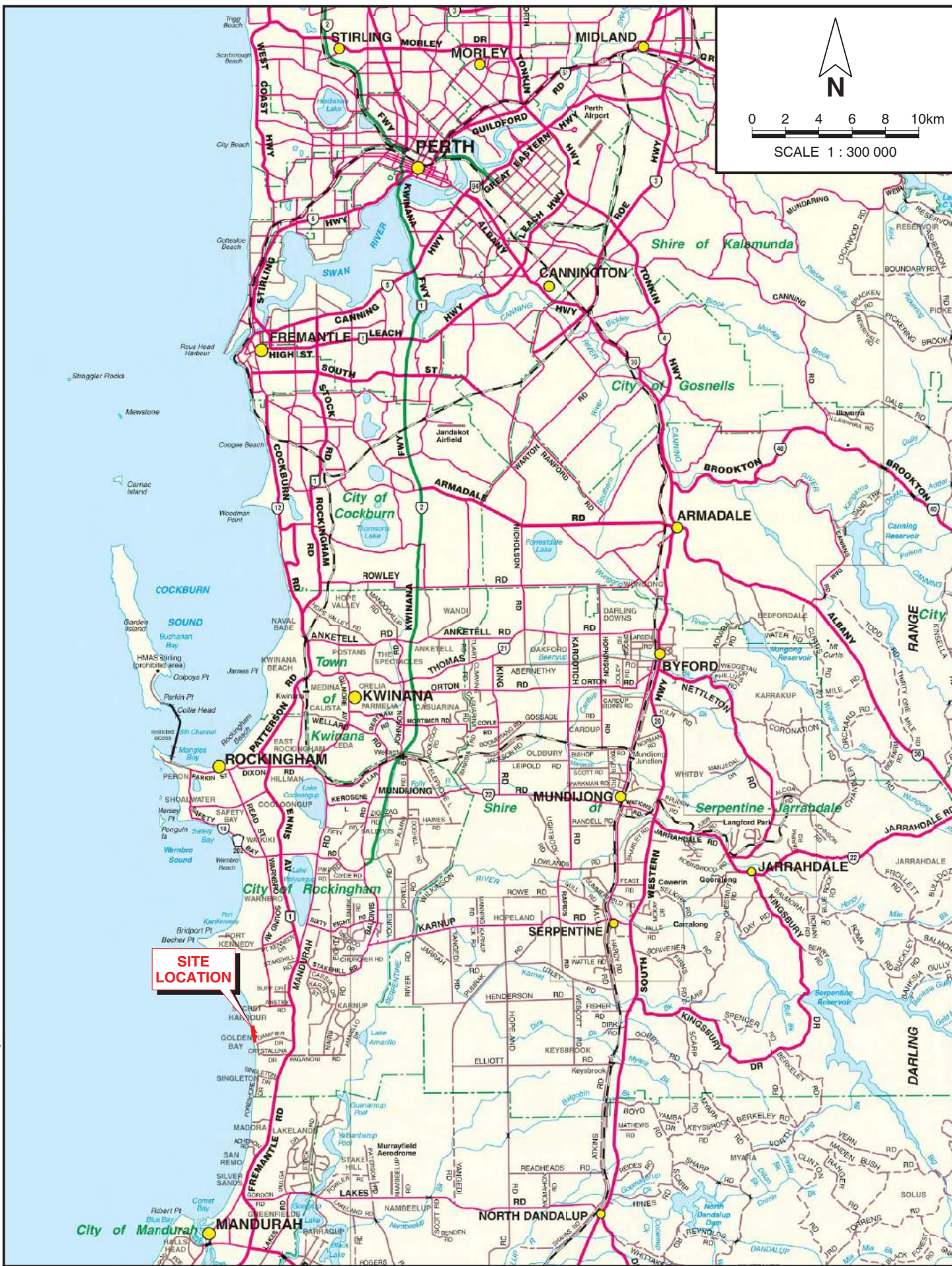
There is continued evidence of kangaroos passing through the wetlands and some evidence of grazing on the new sedges. The impact of kangaroos on the vegetation will be monitored further. If the impact is considered to be having long-term adverse effects, a programme to remove the kangaroos from the Foreshore Reserve will need to be investigated. Any kangaroo management in the Foreshore Reserve, however, will need to be a collaborative effort between all developers in the area, the City of Rockingham and the Department of Biodiversity, Conservation and Attractions.

## 5 REFERENCES

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PGV Environmental (2011) *Lots 2 and 3 Warnbro Sound Avenue Golden Bay Foreshore Management Plan*. Prepared for the Department of Housing. Report No. 2011-13 V6.

# FIGURES





**APPENDIX 1**

**SITE ASSESSMENT PROFORMA**

Site No.	Recorder (s)		Date	
GPS Point	Easting		Northing	
Fencing: fully/partial/not fenced	Current Land Use			
Monitoring Photos No. (taken from Stake)	East	South	West	North
Position of Marker in TEC				
Attribute of Site	Score	Comments		
Grazing				
1 = severe/heavy				
2= moderate (limited but evident)				
3=nil very low				
Clearing				
1 = 30% + cleared				
2 = 10-30% cleared				
3 = <10% cleared				
Weed Invasion				
1 = 30% + cover				
2 = 1--30%				
3 = <10%				
Erosion				
1 = severe impacting >30% of site				
2= moderate (limited but evident)				
3=nil very low (minimal impact)				
Fire History				
1 = <20 years				
2 = 20-50 years				
3 = > 50 years				
Surface Water				
1 = Damp at surface (no standing water)				
2 = < 10cm				
3 = >10cm				

# **APPENDIX 2**

## **SITE PHOTOS**

## Site Photos 2017 – Taken from permanent marker in each of the wetlands

### Site 1

382545 m E

6411987 m S

-32 25 22.93

115 45 2.08

Plate 1: Looking East



Plate 2: Looking south



Plate 3: Looking west



Plate 4: Looking north



**Site 2**

**382527 m E**

**6412049 m N**

**32 25 21.10**

**115 45 1.90**

**Plate 5: Looking East**



**Plate 6: Looking south**



**Plate 7 Looking west**



**Plate 8: Looking north**



**Site 3**

**382544 m E**

**6412057 m S**

**32 25 20.61**

**115 45 2.79**

**Plate 9: Looking East**



**Plate 10: Looking south**



**Plate 11: Looking west**



**Plate 12: Looking north**



**Site 4**

**382501 m E**

**6412185 m S**

**32 25 16.6**

**115 45 1.03**

**Plate 13: Looking East**



**Plate 14: Looking south**



**Plate 15 Looking west**



**Plate 16: Looking north**



**Site 5 and 7 combined**

**382469 m E**

**6412279 m S**

**32 25 13.6**

**115 44 59.78**

**Plate 17: Looking East**



**Plate 18: Looking south**



**Plate 19: Looking west**



**Plate 20: Looking north**



**Site 6 -**

**382507 m E**

**6412293 m S**

**32 25 12.93**

**115 45 1.5**

**Plate 21: Looking East**



**Plate 22: Looking south**



**Plate 23 Looking west**



**Plate 24: Looking north**



**Site 8**

**382458.00 m E**

**6412346.00 m S**

**Plate 29: Looking East**



**Plate 30: Looking south**



**Plate 31: Looking west**



**Plate 32: Looking north**



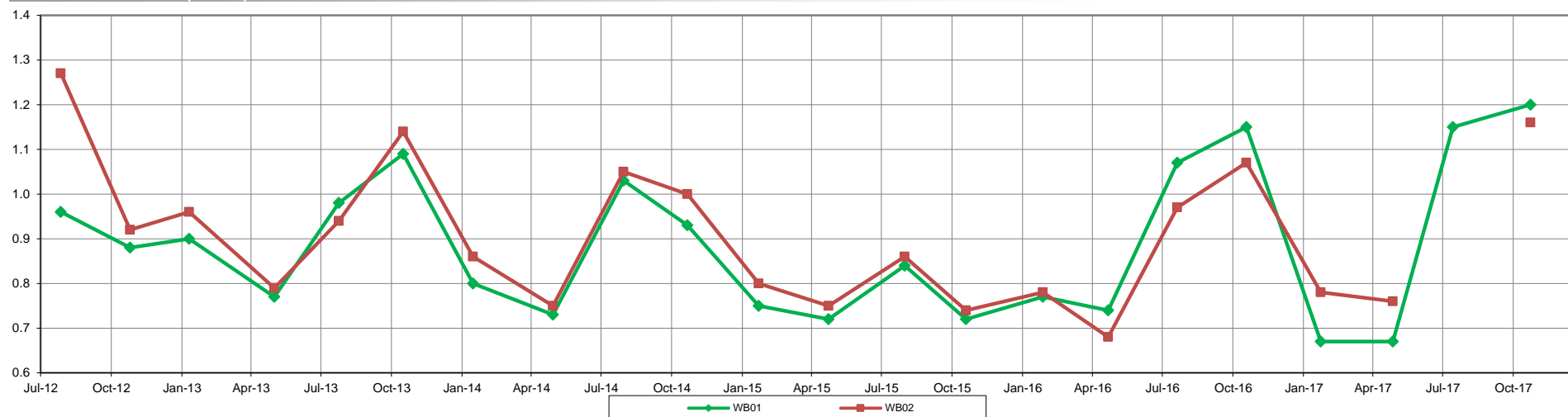
**APPENDIX 3**

**GROUNDWATER LEVELS IN  
WETLAND BORES**

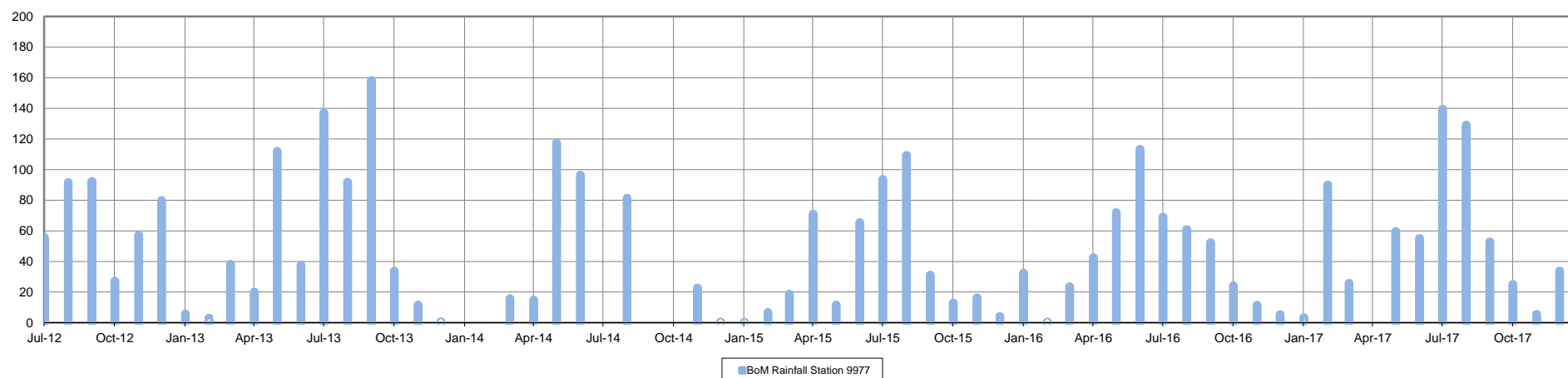
## Wetland Bores - Groundwater Levels

2017

### Groundwater Levels (mAHD)



### Rainfall (mm)



Job No. J6464

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PEET / Dept of Housing  
Golden Bay Groundwater Monitoring  
**Figure 1: Groundwater Levels in Wetland Bores**

## **APPENDIX 6**

### **SOUTHERN BROWN BANDICOOT MONITORING SURVEY REPORTS**

# **Southern Brown Bandicoot Monitoring Golden Bay Autumn 2017**



Version 1. April 2017

Prepared for:

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Front Cover: Southern Brown Bandicoot tracks in the sand

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# 1 INTRODUCTION

Peet Ltd, on behalf of the Peet Ltd and the Department of Housing, requested a follow up monitoring survey of the Southern Brown Bandicoot (*Isoodon obesulus fusciventer*) population in the Foreshore Reserve adjacent to Lot 2, Warnbro Sound Ave, Golden Bay (i.e. 'project area'). This follows on from an initial survey in spring 2012 and monitoring surveys in autumn and winter/spring of 2013, 2014, 2015 and 2016. Southern Brown Bandicoot monitoring is a requirement under the Ministerial Statement 150 and compliance reports are provided to the Office of the Environmental Protection Authority on an annual basis.

The Foreshore Reserve includes the fore dune and swale, and the hinterland vegetation inland for about 400m from the ocean (Figure 1). The Foreshore Reserve includes a Conservation Category Wetland and a Threatened Ecological Community (TEC) that supported dense vegetation before it was burnt. The project area was extensively burnt in January 2016 and the only continuous unburnt habitat remains at the southern end of the foreshore reserve. There are patches of unburnt habitat spread throughout the burnt area, however, none of these are substantial enough to maintain resident Southern Brown Bandicoots. Vegetation clearing is now within 10m of the Foreshore Reserve in the central and northern sections.

There is a sand track that runs the length of the Reserve east of the fore dune and along the fence line, with numerous tracks running at right angles to the beach in the southern section. Closer to the beach is a sand track used by walkers that runs parallel to the beach. In July 2013, a firebreak was cleared near the eastern boundary of the Foreshore Reserve, but this has now mostly disappeared and is part of the cleared area.

Peet in conjunction with the Department of Housing, is clearing the vegetation and developing residential lots to the east of the Foreshore Reserve. Past monitoring indicated that Southern Brown Bandicoots in the Foreshore Reserve were moving freely between the remaining areas to be cleared and the Foreshore Reserve. The majority of the vegetation clearing was completed in July 2016 and only a small patch of habitat remains in the south-west corner (Figure 1).

## 1.1 Scope of this Southern Brown Bandicoot survey for long-term monitoring

The Foreshore Reserve will remain public open space and the developer has made a commitment to monitor the health of the Southern Brown Bandicoot population on a twice yearly basis during the construction and development stages (PGV Environmental 2011).

Coffey Environments recorded eight Southern Brown Bandicoots in the Reserve during its survey in mid-February 2010 (PGV Environmental 2011). It was reported that Southern Brown Bandicoots preferred scrubby, often swampy vegetation with a dense understorey of cover up to one metre high. The TEC and wetland areas within the Foreshore Reserve were considered suitable habitat to sustain a bandicoot population in the long-term (PGV Environmental 2011).

A Southern Brown Bandicoot relocation program has been undertaken for each stage of development prior to vegetation clearing from Lot 2, Warnbro Sound Ave and Lot 3, Dampier Drive as required under Ministerial Statement 150. This program was implemented to minimise the impact of vegetation clearing on bandicoots residing in these lots. All bandicoots caught prior to the last vegetation clearing program in July 2016 were relocated out of the area as there would have been insufficient habitat remaining to sustain this population given the area that had been burnt in January 2016.

The results of nine previous monitoring surveys are shown in Table 1. This report provides the outcomes of the tenth monitoring survey of Southern Brown Bandicoots in the Foreshore Reserve.

**Table 1. Number of Southern Brown Bandicoots in the previous monitoring programs**

	Spring 2012	Winter 2013	Spring 2013	Winter 2014	Spring 2014	Autumn 2015	Spring 2015	Autumn 2016	Spring 2016
# of indiv. captured	31	30	28	39	48	53	36	26	12
# of males	13	10	7	12	10	16	14	8	3
# of females	15	20	21	27	25	34	22	18	3
# of juveniles	3	-	-	1	12	3	6	-	6

## 2 BIOLOGY AND ECOLOGY OF SOUTHERN BROWN BANDICOOTS

The Southern Brown Bandicoot (*I. obesulus*) is a medium-sized, ground-dwelling marsupial that belongs to the Peramelidae family (Van Dyck and Strahan 2008). Populations of Southern Brown Bandicoots occur widely throughout southern Australia (Rees and Paull 2000, Van Dyck and Strahan 2008).

*Isoodon obesulus fusciventer* is the Western Australian subspecies and it was listed as a Schedule 1 species (Fauna that is rare or likely to become extinct) under the Western Australian *Wildlife Conservation Act 1950* until 1998. An increase in the population, which was attributed to the implementation of fox baiting throughout the state, meant that in 1998 the Southern Brown Bandicoot was removed from the threatened species list. The Southern Brown Bandicoot is now listed as a Priority 4 species ('Taxa in need of monitoring') on the Department of Parks and Wildlife's (DPaWs) Priority Fauna List.

Southern Brown Bandicoots are found in the wetter sections of the south-west of Western Australia, mostly along the Swan Coastal Plain from the Moore River to Walpole and the Fitzgerald River area. Populations of Southern Brown Bandicoots are found in a variety of habitats in this region, and appear to be able to survive a level of habitat destruction and live in close proximity to urban and industrial developments. The Southern Brown Bandicoot prefers habitats with a dense shrub understorey up to one metre high, but they are found in a variety of habitats including Banksia, Eucalypt and Melaleuca woodlands, but most often in close proximity to a wetland where the vegetation is often more dense (Stoddard and Braithwaite 1979, Ramalho et al. 2013). In areas of thick undergrowth, Southern Brown Bandicoots are able to establish runways that are difficult to detect beneath the interlocking vegetation (Craven 1981). They are vulnerable to cat, fox and dog predation and are occasionally seen dead on the roads in urban environments, with the result that they are increasingly under threat due to the clearing of bushland leading to habitat fragmentation, bushland degradation and predation by introduced predators including foxes, cats and dogs (Friend 1991).

The Southern Brown Bandicoot is both nocturnal and diurnal, but are mostly active during the day early in the morning or late afternoon (Van Dyck and Strahan 2008). Individuals are mostly solitary, but with overlapping home ranges. The home range size of Southern Brown Bandicoots decreases with increasing population size (Broughton and Dickman 1991). The smallest home range estimates of 2.1ha for males and 1.4ha for females were recorded for a high density population (1.3 – 1.4 animals ha<sup>-1</sup>) on Franklin Island, South Australia (Copley et al. 1990). The largest home range estimates of 5.3ha for males and 2.3ha for females and were calculated for a low density population (0.07 – 0.2 animals ha<sup>-1</sup>) in Tasmania (Heinsohn 1966). A recent study of Southern Brown Bandicoots in the Perth metropolitan area found that the animals' increased their home range size and grazed in more open habitats in areas when predator control was implemented, compared to areas where there was no predator control (Gardner 2004).

Southern Brown Bandicoots are omnivorous, feeding on invertebrates (including earthworms, beetles and larvae), underground fungi, subterranean plant material, and occasionally small vertebrates such as lizards (Broughton and Dickman 1991). Southern Brown Bandicoots build a nest consisting of a heap of ground litter over a shallow depression providing an internal chamber with loose regions at both ends for entry and exit. The dense vegetation probably protects the nest from extremes in temperature and wind, rain and predators.

Heinsohn (1966) reported Southern Brown Bandicoots reach sexual maturity at five to six months of age when they weigh approximately 600g. As males produce sperm throughout the year, it is the reproductive activity of the female that determines the beginning and length of the breeding season (Heinsohn 1966). Breeding peaks in spring (Thomas 1987, Mallick et al. 1998) and females have a gestation period of 12 to 13 days and litters of one to six young are produced, although litters of two to four are most common. Two or three litters may be reared during a single breeding season, although this is dependent upon the availability of food resources (Friend 1991, Mallick et al. 1998) and rainfall (Barnes and Gemmell 1984).

Studies have reported the sex ratio of Southern Brown Bandicoot populations to be from 1.7 males to one female to 0.33 males to one female (Craven 1981, Thomas 1987, Mallick et al. 1998). The lifespan of the Southern Brown Bandicoot in the wild is estimated to be two to three years (Craven 1981).

### 3 METHODOLOGY

Sixty-eight baited wire cage traps were set in locations shown in Figure 1 (Appendix A). Cage traps were baited with a peanut butter sandwich and were set for five nights between 2-7 April 2017. Traps were located in the vegetated areas that were likely to support Southern Brown Bandicoots. The layout of traps was similar to spring 2016, but different to earlier surveys due to the fire in January 2016 and vegetation clearing in July 2016. Traps were baited when they were opened, when they had no bait and on every other day if they had bait. All traps had a hessian cover and were placed under vegetation. Traps were cleared from first light each morning. Staff in the Department of Parks and Wildlife (DPaW) requested that tissue samples were taken from caught bandicoots, which was done and the tissue samples will be given to DPaW at a later date.

Trapping was conducted under License SF010966. All Southern Brown Bandicoots that had not previously been caught had a microchip inserted on the dorsal surface near the shoulder blades. Captured bandicoots were identified and released near their site of capture.

#### 3.1 Data analysis

Trap success rate was determined by dividing the trapping effort by the number of bandicoots caught per trap-night. There were 68 cage traps targeting Southern Brown Bandicoots and the trapping effort was 340 trap nights. Trapping data are compared with previous survey data.

#### 3.2 Signs

As recommended in the winter 2014 monitoring report (Terrestrial Ecosystems 2014) signs (Plate 1) were prepared by Peet and placed on each track leading into the survey area. These signs were designed to reduce the number of people and dogs interfering with traps and captured bandicoots.



Plate 1. Sign placed near the end of an access track

## 4 RESULTS AND DISCUSSION

### 4.1 Survey monitoring

The Southern Brown Bandicoot trapping results are shown in Table 2. Fifteen individual bandicoots were caught with five adult females, nine adult males and one juvenile (<200g) male. Three of the females were carrying pouch young. Including non-target captures the trapping success was 13.5% and for bandicoots only it was 10.8%.

Nine of the 15 bandicoots caught during this survey were new to the monitoring program. This is a high percentage particularly as 11 of 12 captures in spring 2016 were also new to the area. This shows that there is a very high turnover of animals in the area and the population is relying on juvenile recruitment to maintain the low density of bandicoots in the area.

In most cases, once a Southern Brown Bandicoot had been caught it was caught multiple times during the survey, indicating it had become accustomed to the bait and is not afraid of the traps.

In addition to the Southern Brown Bandicoots, rats (*Rattus rattus*), bobtails (*Tiliqua rugosa*), house mice (*Mus musculus*) and a Western blue-tongued lizard (*Tiliqua occipitalis*) were caught in the traps.

Based on an assessment of the tracks in the area, there is at least once fox active in the coastal dunes and project area and multiple cats. Removal of cats and foxes from the area would significantly improve the chances of the Southern Brown Bandicoot population remaining viable while the burnt bushland rehabilitates.

The rabbit population is more abundant than in spring 2016, with new tracks present everyday. Without control programs to manage numbers the rabbit population is expected to increase as the new vegetation emerges in the foreshore during winter. Maintaining a low rabbit population in the short-term may be beneficial in taking the predation pressure off the Southern Brown Bandicoots (Pedler et al. 2016).

Kangaroos were seen on multiple occasions, and move through the burnt and unburnt areas. They are also seen feeding in the nearby residential areas. The movement of kangaroos into the residential area may be due to a lack of sufficient foraging areas.

#### *Impacts on the trapping program*

Trap baits taken by House Mice (*M. musculus*), rats (*R. rattus*) and bobtails reduced the number of Southern Brown Bandicoots caught as these animals take the bait and cause traps to be closed stopping the capture of bandicoots. This is an unavoidable aspect of using bait that attracts multiple species. All non-native species were euthanased.

There was limited disturbance by residents, and none that would have significantly impacted on the results of this survey.

#### *Status of the population*

The total number of Southern Brown Bandicoots caught during this monitoring program (15) was slightly more than spring 2016 (12), but substantially less than during autumn 2016 (26), spring 2015 (36) and autumn 2015 (56 bandicoots; see Table 1). This low number was expected after the low captures in spring 2016 and the January 2016 fire. Until the vegetation in the burnt area has regenerated resident Southern Brown Bandicoots will be subject to increased predation by cats and foxes.

As a result of the limited available habitat, any bandicoots that remain in the foreshore reserve will be concentrated into one small area until the vegetation in the burnt area can re-establish. As all of the traps were also confined to this same area Terrestrial Ecosystems are confident that most of the bandicoots were caught.

Three females had pouched young which is promising for the establishment of a bandicoot population, however, the high turnover of animals and high number of new animals indicates that the population is not stable. Mortality

of young is high, and surveys in the past three years have indicated that only a small proportion of juveniles in the size range of 100-300g survive to adulthood.

Undertaking a management program for foxes and cats in cooperation with the City of Rockingham for the coastal dune system is critical to maintaining a viable population of Southern Brown Bandicoots in the Foreshore Reserve. This program should be discussed with the City of Rockingham and implemented during winter 2017 while the vegetation is recovering from the January 2016 fire.

#### *Western Grey Kangaroos*

There are about 11 Western Grey Kangaroos in the Foreshore Reserve and surrounds. With the growth on new vegetation after the fire it is likely that this population will increase by 25-30% each year. If Peet or the City of Rockingham wanted these kangaroos relocated, then now is the time for this to happen as their habitat has been significantly reduced. These kangaroos are particularly wary, as they have almost certainly been chased by people and local dogs, so any removal program will be difficult. However, a relocation program involving darting and sedating each kangaroo is probably the most effective option.

#### *Rabbits*

The population of rabbits in the Foreshore reserve and the adjacent beach dunes is increasing and is likely to continue to increase as the vegetation regrows. Rabbits move along and through the vegetation on the coastal dunes, but the higher density populations are in the remnant native vegetation like the Foreshore Reserve. A recent paper by Pedler et al. (2016) demonstrated the importance of rabbit control in maintaining populations of native mammals. Rabbits are likely to significantly impact on the regenerating native vegetation, by eating the emerging vegetation. If a rabbit control program was envisaged by Peet or the City of Rockingham, then this autumn and winter 2017 would be a good time. The use of the biological control agent - rabbit hemorrhagic disease virus (RHDV) and fumigating and closing warrens can most effectively be done when the regenerated vegetation is in an early stage and there is good access to most of the area.

## **4.2 Conclusion**

Based on the results of this trapping program, there has been a significant reduction in the population of Southern Brown Bandicoots in the Foreshore Reserve since early 2016, however, the population is similar to spring 2016. This is likely to be the result of reduced habitat availability after the January 2016 fire, the relocation of bandicoots prior to the July 2016 vegetation clearing program, and increased predation pressure from cats and foxes. The capture data also indicates that there is a high turnover of individuals which indicates the population is under stress and not stable. Although in low density, the small remaining population of Southern Brown Bandicoots should be sufficient to recolonise the area as the vegetation regrows post-fire presuming that predation pressures are maintained at low levels. If predation pressures are not managed the population could be removed quickly.

Given the reduced quantity of native vegetation, it is very important that feral predators remain at a very low level until the bandicoot population has recovered. It is therefore recommended that a fox and cat management program is repeated in 2017 to allow any young bandicoots a chance of survival during 2017. This program should be discussed with the City of Rockingham to see if they will financially contribute to a broader program across the coastal dune system. Consideration should also be given to a rabbit reduction program, as this will assist the regeneration of vegetation and also reduce competition for foraging opportunities for bandicoots.

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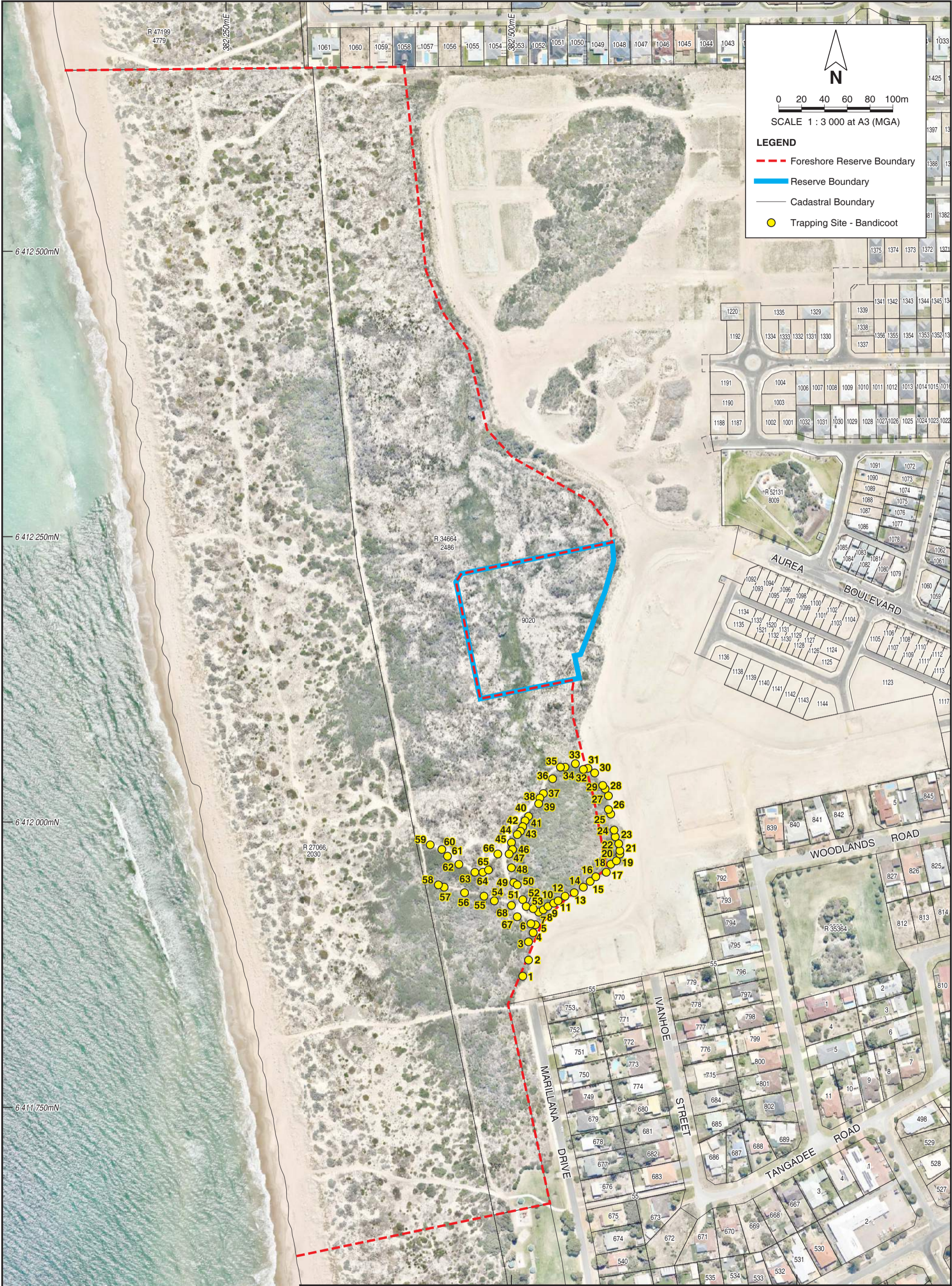
**Table 2. Southern Brown Bandicoot trapping results**

							Trapping days and trap number					
Sex	Mass	HL	HW	Pes	Testes	Chip No	03-04-17	04-04-17	05-04-17	06-04-17	07-04-17	No. times caught
m	1100	79	35	63	23	6B35490					1	1
f	590	71	30	25		6B3C3B8	1		1		1	3
m	980	80	42	58	35	6B3CE74				1		1
f	720	67	31	53		6E1E2E5					1	1
m	660	68	28	49	23	6E20137	1	1	1	1	1	5
m	1300	80	3	63	30	6E21B2C				1	1	2
m	760	80	38	62	30	6E21F96	1	1	1	1		4
m	1250	85	36	55	30	6E22596		1	1		1	3
f	720	68	37	51		6E22B20	1	1	1	1	1	5
m	1080	75	36	61	28	6E22CF6			1			1
m	540	63	30	53	23	6E2304C			1			1
f	540	64	30	53		6E2364A	1	1				2
f	400	65	29	51		6E2491B		1		1	1	3
m	120	49	24	42	8	6E252D7		1		1		2
m	990	73	36	61	30	6E2536A		1	1	1		2

### Appendix A. Trapping site locations (GDA94; Zone 50)

Site	Easting	Northing
1	382510	6411865
2	382515	6411879
3	382515	6411895
4	382519	6411903
5	382521	6411910
6	382517	6411911
7	382524	6411921
8	382528	6411923
9	382532	6411926
10	382537	6411929
11	382541	6411931
12	382547	6411935
13	382555	6411938
14	382563	6411943
15	382569	6411948
16	382574	6411952
17	382583	6411956
18	382587	6411963
19	382592	6411966
20	382595	6411972
21	382595	6411975
22	382594	6411981
23	382591	6411987
24	382590	6411993
25	382587	6412007
26	382585	6412011
27	382585	6412023
28	382582	6412029
29	382580	6412032
30	382573	6412043
31	382567	6412047
32	382563	6412046
33	382556	6412051
34	382547	6412048

Site	Easting	Northing
35	382543	6412048
36	382528	6412025
37	382525	6412021
38	382524	6412016
39	382515	6412005
40	382512	6412001
42	382510	6411996
43	382508	6411992
44	382505	6411989
45	382500	6411982
46	382501	6411976
47	382498	6411972
48	382500	6411960
49	382502	6411947
50	382505	6411945
51	382510	6411932
52	382513	6411926
53	382519	6411924
54	382485	6411931
55	382476	6411935
56	382459	6411938
57	382441	6411943
58	382436	6411945
59	382429	6411980
60	382439	6411976
61	382444	6411970
62	382454	6411963
63	382468	6411956
64	382475	6411956
65	382480	6411958
66	382488	6411972
67	382505	6411917
68	382500	6411927



CADASTRAL SOURCE: Landgate, April 2017.  
AERIAL PHOTOGRPAH SOURCE: NearMap, flown February 2017.



**TERRESTRIAL  
ECOSYSTEMS**

Drawn: S. Thompson

Date: 20 Apr 2017

Peet Ltd and Department of Housing  
BANDICOOT MONITORING  
GOLDEN BAY - AUTUMN 2017

**TRAPPING SITES**

**Figure 1**

Job: 2017-0013

# **Southern Brown Bandicoot Monitoring Golden Bay Spring 2017**



Version 1. October 2017

Prepared for:

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Front Cover: Regeneration of the burnt vegetation in the Foreshore Reserve

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# 1 INTRODUCTION

Peet Ltd, on behalf of the Peet Ltd and the Department of Housing, requested a follow up monitoring survey of the Southern Brown Bandicoot (*Isoodon obesulus fusciventer*) population in the Foreshore Reserve adjacent to Lot 2, Warnbro Sound Ave, Golden Bay (i.e. 'project area'). This follows on from an initial survey in spring 2012 and monitoring surveys in autumn and winter/spring of 2013, 2014, 2015, 2016 and autumn 2017. Southern Brown Bandicoot monitoring is a requirement under the Ministerial Statement 150 and compliance reports are provided to the Office of the Environmental Protection Authority on an annual basis.

The Foreshore Reserve includes the fore dune and swale, and the hinterland vegetation inland for about 400m from the ocean (Figure 1). The Foreshore Reserve includes a Conservation Category Wetland and a Threatened Ecological Community (TEC) that supported dense vegetation before it was burnt. The project area was extensively burnt in January 2016 and the only continuous unburnt habitat remains at the southern end of the foreshore reserve. There are patches of unburnt habitat spread throughout the burnt area, which are in the process of regenerating. Some of the regeneration is substantial enough to maintain resident Southern Brown Bandicoots but most is still growing. The regrowth in the burnt area has benefitted from winter rains. Vegetation clearing is now along the edge of the Foreshore Reserve in the central and southern sections.

There is a sand track that runs the length of the Reserve east of the fore dune and along the fence line, with numerous tracks running at right angles to the beach in the southern section. Closer to the beach is a sand track used by walkers that runs parallel to the beach. In July 2013, a firebreak was cleared near the eastern boundary of the Foreshore Reserve, but this has now mostly disappeared and is part of the cleared area.

## 1.1 Scope of this Southern Brown Bandicoot survey for long-term monitoring

The Foreshore Reserve will remain public open space and the developer has made a commitment to monitor the health of the Southern Brown Bandicoot population on a twice yearly basis during the construction and development stages (PGV Environmental 2011).

Coffey Environments recorded eight Southern Brown Bandicoots in the Reserve during its survey in mid-February 2010 (PGV Environmental 2011). It was reported that Southern Brown Bandicoots preferred scrubby, often swampy vegetation with a dense understorey of cover up to one metre high. The TEC and wetland areas within the Foreshore Reserve were considered suitable habitat to sustain a bandicoot population in the long-term (PGV Environmental 2011).

A Southern Brown Bandicoot relocation program has been undertaken for each stage of development prior to vegetation clearing from Lot 2, Warnbro Sound Ave and Lot 3, Dampier Drive as required under Ministerial Statement 150. This program was implemented to minimise the impact of vegetation clearing on bandicoots residing in these lots. All bandicoots caught prior to the last vegetation clearing program in July 2016 were relocated out of the area as there would have been insufficient habitat remaining to sustain this population given the area that had been burnt in January 2016.

The results of 10 previous monitoring surveys are shown in Table 1. This report provides the outcomes of the eleventh monitoring survey of Southern Brown Bandicoots in the Foreshore Reserve.

**Table 1. Number of Southern Brown Bandicoots in the previous monitoring programs**

	Spring 2012	Winter 2013	Spring 2013	Winter 2014	Spring 2014	Autumn 2015	Spring 2015	Autumn 2016	Spring 2016	Autumn 2017
# of indiv. captured	31	30	28	39	48	53	36	26	12	15
# of males	13	10	7	12	10	16	14	8	3	9
# of females	15	20	21	27	25	34	22	18	3	5
# of juveniles	3	-	-	1	12	3	6	-	6	1

## 2 BIOLOGY AND ECOLOGY OF SOUTHERN BROWN BANDICOOTS

The Southern Brown Bandicoot (*I. obesulus*) is a medium-sized, ground-dwelling marsupial that belongs to the Peramelidae family (Van Dyck and Strahan 2008). Populations of Southern Brown Bandicoots occur widely throughout southern Australia (Rees and Paull 2000, Van Dyck and Strahan 2008).

*Isoodon obesulus fusciventer* is the Western Australian subspecies and it was listed as a Schedule 1 species (Fauna that is rare or likely to become extinct) under the Western Australian *Wildlife Conservation Act 1950* until 1998. An increase in the population, which was attributed to the implementation of fox baiting throughout the state, meant that in 1998 the Southern Brown Bandicoot was removed from the threatened species list. The Southern Brown Bandicoot is now listed as a Priority 4 species ('Taxa in need of monitoring') on the Department of Biodiversity, Conservation and Attractions' (DBCAs) Priority Fauna List.

Southern Brown Bandicoots are found in the wetter sections of the south-west of Western Australia, mostly along the Swan Coastal Plain from the Moore River to Walpole and the Fitzgerald River area. Populations of Southern Brown Bandicoots are found in a variety of habitats in this region, and appear to be able to survive a level of habitat destruction and live in close proximity to urban and industrial developments. The Southern Brown Bandicoot prefers habitats with a dense shrub understorey up to one metre high, but they are found in a variety of habitats including Banksia, Eucalypt and Melaleuca woodlands, but most often in close proximity to a wetland where the vegetation is often more dense (Stoddard and Braithwaite 1979, Ramalho et al. 2013). In areas of thick undergrowth, Southern Brown Bandicoots are able to establish runways that are difficult to detect beneath the interlocking vegetation (Craven 1981). They are vulnerable to cat, fox and dog predation and are occasionally seen dead on the roads in urban environments, with the result that they are increasingly under threat due to the clearing of bushland leading to habitat fragmentation, bushland degradation and predation by introduced predators including foxes, cats and dogs (Friend 1991).

The Southern Brown Bandicoot is both nocturnal and diurnal, but are mostly active during the day early in the morning or late afternoon (Van Dyck and Strahan 2008). Individuals are mostly solitary, but with overlapping home ranges. The home range size of Southern Brown Bandicoots decreases with increasing population size (Broughton and Dickman 1991). The smallest home range estimates of 2.1ha for males and 1.4ha for females were recorded for a high density population (1.3 – 1.4 animals ha<sup>-1</sup>) on Franklin Island, South Australia (Copley et al. 1990). The largest home range estimates of 5.3ha for males and 2.3ha for females and were calculated for a low density population (0.07 – 0.2 animals ha<sup>-1</sup>) in Tasmania (Heinsohn 1966). A recent study of Southern Brown Bandicoots in the Perth metropolitan area found that the animals' increased their home range size and grazed in more open habitats in areas when predator control was implemented, compared to areas where there was no predator control (Gardner 2004).

Southern Brown Bandicoots are omnivorous, feeding on invertebrates (including earthworms, beetles and larvae), underground fungi, subterranean plant material, and occasionally small vertebrates such as lizards (Broughton and Dickman 1991). Southern Brown Bandicoots build a nest consisting of a heap of ground litter over a shallow depression providing an internal chamber with loose regions at both ends for entry and exit. The dense vegetation probably protects the nest from extremes in temperature and wind, rain and predators.

Heinsohn (1966) reported Southern Brown Bandicoots reach sexual maturity at five to six months of age when they weigh approximately 600g. As males produce sperm throughout the year, it is the reproductive activity of the female that determines the beginning and length of the breeding season (Heinsohn 1966). Breeding peaks in spring (Thomas 1987, Mallick et al. 1998) and females have a gestation period of 12 to 13 days and litters of one to six young are produced, although litters of two to four are most common. Two or three litters may be reared during a single breeding season, although this is dependent upon the availability of food resources (Friend 1991, Mallick et al. 1998) and rainfall (Barnes and Gemmell 1984).

Studies have reported the sex ratio of Southern Brown Bandicoot populations to be from 1.7 males to one female to 0.33 males to one female (Craven 1981, Thomas 1987, Mallick et al. 1998). The lifespan of the Southern Brown Bandicoot in the wild is estimated to be two to three years (Craven 1981).

### 3 METHODOLOGY

Sixty-eight baited wire cage traps were set in locations shown in Figure 1 (Appendix A). Cage traps were baited with a peanut butter sandwich and were set for five nights between 28 September and 3 October 2017. Traps were located in the vegetated areas that were likely to support Southern Brown Bandicoots. The layout of traps was similar to that in spring 2016 and autumn 2017, but different to earlier surveys due to the fire in January 2016 and vegetation clearing before July 2016. Traps were baited when they were opened, when they had no bait and on every other day if they had bait. All traps had a hessian cover and were placed under vegetation. Traps were cleared from first light each morning. Staff in the Department of Biodiversity, Conservation and Attractions (DBCA) requested that tissue samples were taken from caught bandicoots, which was done and the tissue samples will be given to DBCA at a later date.

Trapping was conducted under License 11-000925-1. All Southern Brown Bandicoots that had not previously been caught had a microchip inserted on the dorsal surface near the shoulder blades. Captured bandicoots were identified and released near their site of capture.

#### 3.1 Data analysis

Trap success rate was determined by dividing the trapping effort by the number of bandicoots caught per trap-night. There were 68 cage traps targeting Southern Brown Bandicoots and the trapping effort was 340 trap nights. Trapping data are compared with previous survey data.

#### 3.2 Signs

As recommended in the winter 2014 monitoring report (Terrestrial Ecosystems 2014) signs (Plate 1) were prepared by Peet and placed on each track leading into the survey area. These signs were designed to reduce the number of people and dogs interfering with traps and captured bandicoots.



Plate 1. Sign placed near the end of an access track

## 4 RESULTS AND DISCUSSION

### 4.1 Survey monitoring

The Southern Brown Bandicoot trapping results are shown in Table 2. Fifteen individual bandicoots were caught with five adult females, nine adult males and one juvenile (<200g) male. All of the females were carrying pouch young. Including non-target captures the trapping success was 15.3% and for bandicoots only it was 9.1%, which is similar to last years rates of 13.5% and 10.8% respectively.

Only four of the 15 bandicoots caught during this survey were caught in the autumn 2017 monitoring program. This is a particularly disappointing result, as 12 of the 15 bandicoots caught in the autumn survey had been previously caught. This shows that there is a very high turnover of animals in the area and the population is relying on recruitment to maintain the low density of bandicoots in the area. It is hoped that many of the pouch young survive this spring and enter the population as breeding adults.

Six of the 15 bandicoots were caught once and the remainder on two or more occasions. In addition to the Southern Brown Bandicoots, four rats (*Rattus rattus*), 17 bobtails (*Tiliqua rugosa*) and five house mice (*Mus musculus*) were caught in the traps.

We recorded no fox tracks but observed cat tracks on most days (Plate 2). These feral cats would be predated on young Southern Brown Bandicoots and other small vertebrate fauna in the Reserve.



Plate 2. Feral cat tracks along the edge of the sand dune

We indicated in the spring of 2016 and the autumn of 2017 that the rabbit population was on the increase. Without an active management program, the rabbit population is expected to increase as the new vegetation becomes established and provides a significantly greater area of vegetation cover. Maintaining a low rabbit population in the short-term may be beneficial in taking the predation pressure off the Southern Brown Bandicoots (Pedler et al. 2016).

Kangaroos were not seen during the survey, but their tracks were observed on most days.

#### *Status of the population*

The total number of Southern Brown Bandicoots caught during this monitoring program (15), is the same as autumn 2017 and slightly more than spring 2016 (12), but substantially less than during autumn 2016 (26), spring 2015 (36) and autumn 2015 (56 bandicoots; see Table 1). This low number was expected after the burning of a substantial quantity of the bushland in January 2016, however, we had expected an increase as the adjacent vegetation was regenerating.

All five females had pouched young which is promising for the establishment of a bandicoot population, however, the high turnover of individuals and high number of new animals indicates that the population is not stable. Mortality of young has been very high, and surveys in the past three years have indicated that only a small proportion of juveniles in the size range of 100-300g survive to adulthood. If the population is to return to pre-fire levels, then a significant increase should be expected in the autumn 2018 survey, as the bandicoots will be able to live in some of the adjacent regrowth by then.

Undertaking a management program for rabbits, foxes and cats in cooperation with the City of Rockingham for the coastal dune system is critical to maintaining a viable population of Southern Brown Bandicoots in the Foreshore Reserve. This program should be discussed with the City of Rockingham and implemented during winter/spring of 2018. It is more effective to target foxes during the breeding season than after young are mobile in late spring and early summer. Fox trapping in late spring and summer results in captures of young foxes and leaves the adult foxes. Vixens also teach their offspring to avoid traps. Cat control is most effective in late autumn and early winter when food resources are limited. *Western Grey Kangaroos*

We saw no Western Grey Kangaroos in the Foreshore Reserve and surrounds, however, based on the numbers seen in the autumn survey and number of fresh tracks each morning it could be anticipated there are 15-20 individuals living in the area. This population will increase by 25-30% each year.

#### *Rabbits*

The population of rabbits in the Foreshore Reserve and the adjacent beach dunes has increased and will continue to increase as the vegetation regrows (see diggings in Plate 3). Rabbits move along and through the vegetation on the coastal dunes, but the higher density populations are in the remnant native vegetation like the Foreshore Reserve. A recent paper by Pedler et al. (2016) demonstrated the importance of rabbit control in maintaining populations of native mammals.

Rabbits are likely to significantly impact on the regenerating native vegetation, by eating the emerging vegetation. If a rabbit control program was planned by Peet or the City of Rockingham, then autumn of 2018 would be a good time. The use of the biological control agent (i.e. rabbit hemorrhagic disease virus - RHDV), is very effective, particular when the majority of rabbits are still confined to the dense unburnt vegetation on the southern end of the Reserve. Rabbit control should be undertaken in spring or autumn to coincide with the optimum delivery period for RHDV (i.e. maximum abundance of dispersal vectors). Use of Pindone to control rabbits should be avoided in all areas which contain Western Grey Kangaroos and Southern Brown Bandicoots, as it is a non-discriminating bait and will impact on the native species.



**Plate 3. Rabbit diggings along one of the sand tracks**

## **4.2 Conclusion**

Based on the results of this trapping program, there has been a significant reduction in the population of Southern Brown Bandicoots in the Foreshore Reserve since early 2016, however, the population is similar to that recorded in the spring 2016 and autumn 2017 monitoring programs. This is likely to be the result of reduced habitat availability after the January 2016 fire, the relocation of bandicoots prior to the July 2016 vegetation clearing program, and increased predation pressure from cats and foxes in 2016 and 2017. The capture data also indicates that there is a very high turnover of individuals which indicates the population is under stress and not stable. Although in low density, the small remaining population of Southern Brown Bandicoots should be sufficient to recolonise the entire Foreshore Reserve as the vegetation regrows. If predation pressures are not managed the population could be removed quickly.

Given the reduced quantity of native vegetation, it is very important that feral predators remain at a very low level until the bandicoot population has recovered. It is therefore recommended that a fox and cat management program is implemented and the rabbit hemorrhagic disease virus (RHDV K5) is released to reduce the current abundance of rabbits in autumn of 2018. This program should be coordinated with the City of Rockingham.

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**Table 2. Southern Brown Bandicoot trapping results**

						Trapping days and number of trapped individuals					
Sex	Mass (g)	HL (mm)	HW (mm)	Pes (mm)	Chip N°	29/09/2017	30/09/2017	1/10/2017	2/10/2017	3/10/2017	Grand Total
M	980	75	34	64	0006B3CE74				1		1
F	720	75	30	63	0006B3D38E				1		1
M	1820	92	40	72	0006B3DA6C		1	1	1	1	4
M	1250	83	36	66	0006B3E664		1		1	1	3
M	1240	86	37	56	0006E21B2C	1	1				2
M	1110	79	37	71	0006E21F96	1	1			1	3
M	110	53	27	42	0006E24A16					1	1
M	990	87	36	70	0006E2536A	1					1
F	720	76	31	61	000783BFC5			1			1
F	470	68	27	51	00079D5624		1		1		2
M	670	79	30	60	00079D575C				1	1	2
F	610	72	30	59	00079D58F7			1			1
F	620	73	32	54	0007ABBD1F	1		1	1	1	4
M	800	81	31	67	0007AC2A59		1	1		1	3
M	970	82	34	64	0007AFEB1D				1	1	2



CADASTRAL SOURCE: Landgate, April 2017.  
AERIAL PHOTOGRPAH SOURCE: NearMap, flown August 2017.



**TERRESTRIAL  
ECOSYSTEMS**

Drawn: G. Thompson

Date: 16 Oct 2017

Peet Ltd and Department of Housing  
BANDICOOT TRAPPING SITES  
GOLDEN BAY - SPRING 2017

**TRAPPING SITES**

**Figure 1**

Job: 2017-0042

### Appendix A. Trapping site locations (GDA94; Zone 50)

Site	Easting	Northing
1	382550	6412046
2	382542	6412042
3	382539	6412040
4	382536	6412038
5	382533	6412033
6	382530	6412027
7	382527	6412023
8	382525	6412019
9	382521	6412012
10	382518	6412009
11	382515	6412005
12	382506	6411998
13	382511	6412000
14	382507	6411992
15	382505	6411989
16	382500	6411985
17	382499	6411977
18	382498	6411971
19	382498	6411960
20	382502	6411950
21	382508	6411942
22	382511	6411935
23	382513	6411932
24	382497	6411916
25	382488	6411922
26	382480	6411923
27	382468	6411931
28	382456	6411932
29	382446	6411935
30	382438	6411936
31	382427	6411940
32	382423	6411973
33	382429	6411970
34	382437	6411965

Site	Easting	Northing
35	382446	6411959
36	382457	6411951
37	382474	6411953
38	382478	6411959
39	382482	6411963
40	382516	6411921
42	382526	6411924
43	382536	6411930
44	382544	6411938
45	382555	6411939
46	382512	6411926
47	382562	6411942
48	382570	6411949
49	382576	6411954
50	382583	6411956
51	382586	6411960
52	382590	6411961
53	382590	6411965
54	382589	6411967
55	382590	6411973
56	382589	6411978
57	382589	6411987
58	382584	6411994
59	382582	6412002
60	382579	6412007
61	382577	6412012
62	382575	6412018
63	382574	6412025
64	382571	6412029
65	382569	6412033
66	382565	6412036
67	382560	6412039
68	382555	6412043

22 August 2017

Craig Raynor  
Senior Development Manager  
Peet Ltd  
Level 10, 200 St Georges Terrace  
PERTH WA 6000

**Re: Trapping and relocation program targeting Southern Brown Bandicoots in the Peet Golden Bay project area – Stage 5**

Dear Craig

In accordance with your request, Terrestrial Ecosystems undertook a trapping and relocation program for Southern Brown Bandicoots and other fauna in Stage 5 at Golden Bay.

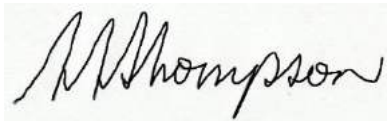
The trapping program commenced on Monday 14 August 2017 and it was implemented so that each area was trapped for between two and four days immediately before the area was cleared. The trapping program concluded on 22 August 2017 when most to the area had been cleared. Twenty five baited cage traps were used and successively moved throughout the project area and cleared within four hours of sunrise.

The weather was cool and it rained on some of the trapping days.

Five Southern Brown Bandicoot were caught and relocated in accordance with the licence 11-000925-1 that was issued by the Department of Parks and Wildlife (now Department of Biodiversity, Conservation and Attractions). Multiple Black Rats (*Rattus rattus*) and House mice (*Mus musculus*) were caught. Both of these rodents are introduced species, so they were humanely euthanased.

Please do not hesitate in contacting the undersigned (0407 385 239), if you require any further information regarding this proposal.

Yours sincerely



Dr Scott Thompson  
Partner and Principal Zoologist

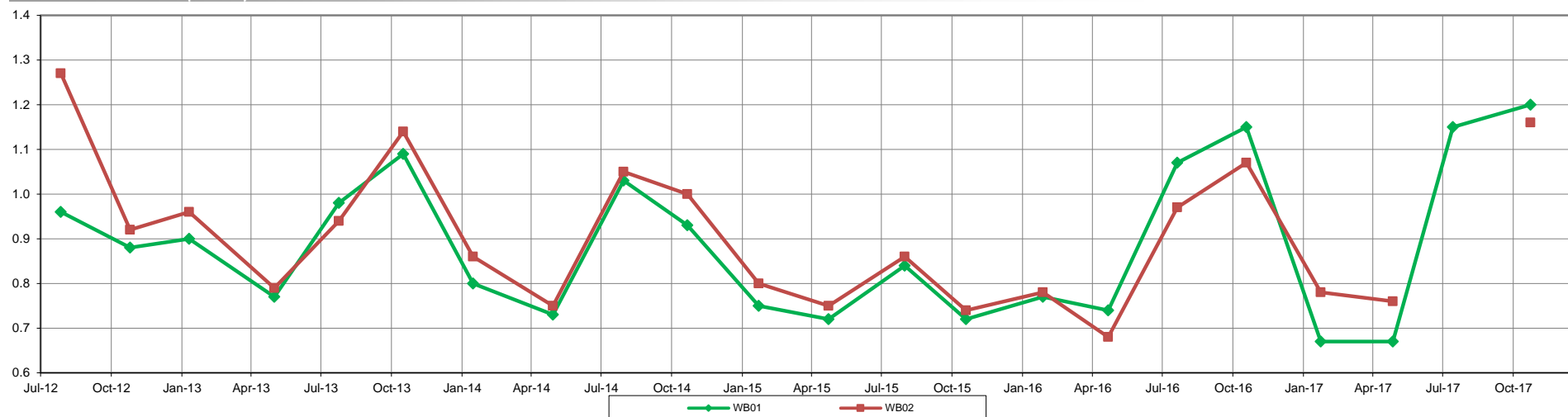
**APPENDIX 7**

**FORESHORE RESERVE  
GROUNDWATER LEVELS**

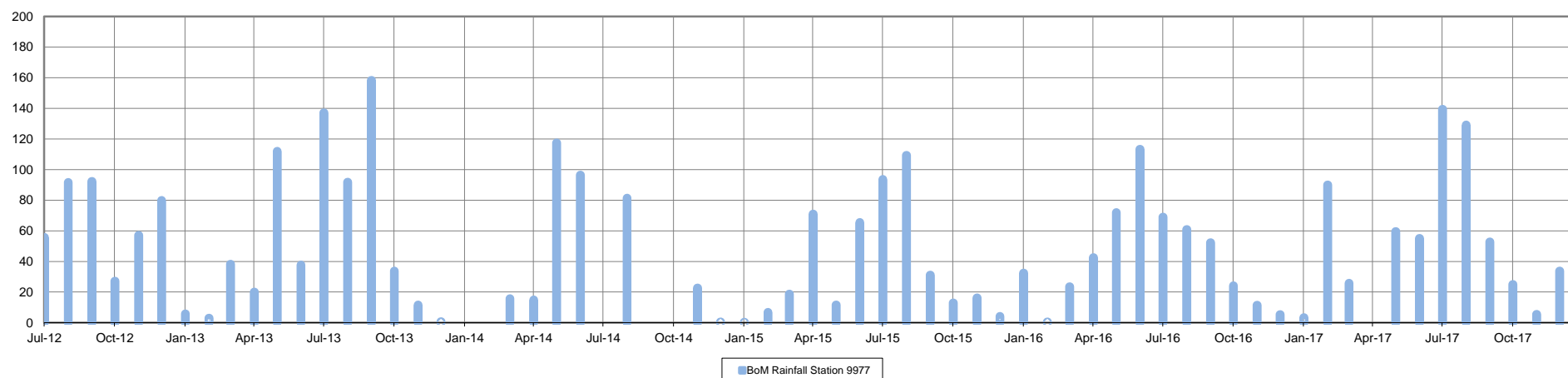
## Wetland Bores - Groundwater Levels

2017

### Groundwater Levels (mAHD)



### Rainfall (mm)



Job No. J6464

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PEET / Dept of Housing  
Golden Bay Groundwater Monitoring  
**Figure 1: Groundwater Levels in Wetland Bores**

**APPENDIX 8**

**POST FIRE BASELINE VEGETATION  
MONITORING REPORT**

# LOT 2 WARNBRO SOUND AVENUE, GOLDEN BAY FORESHORE RESERVE

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## POST-FIRE VEGETATION MONITORING SURVEY

Prepared for: The Housing Authority and Peet Golden Bay Pty Ltd

Report Date: 12 January 2018

Version: 1

Report No. 2017-352



**pgv**  
ENVIRONMENTAL

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- Figure 1: Site Location
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## **Appendices**

- Appendix 1 Monitoring Plot Data
- Appendix 2: Species List

# **1 INTRODUCTION**

---

## **1.1 Background**

The Housing Authority and Peet Golden Bay Pty Ltd are developing Lot 2 Warnbro Sound Avenue and Lot 3 Dampier Drive, Golden Bay for residential purposes. The development abuts a Foreshore Reserve, established under Condition 3 of Ministerial Statement 297 which is the environmental approval for the development.

A Foreshore Management Plan (FMP) has been prepared by the developers for the Foreshore Reserve and was approved by the Environmental Protection Authority (EPA) on 30 March 2012. Subsequent to the approval of the FMP a Foreshore Rehabilitation Plan (FRP) has been prepared to outline the rehabilitation and weed management requirements to be implemented within the Foreshore Reserve.

The Foreshore Reserve was subject to a bushfire on 1 January 2016. The fire was reported as being ignited by fireworks/boat flares. The area of the Foreshore Reserve impacted by the fire was estimated to be approximately 7ha (Appendix 1). The northern section was burnt in patches and the eastern part of the central section was largely burnt out (Plates 1 and 2).

The area burnt by the 1 January bushfire is required by the FRP to be monitored to assess the progress of regeneration. The monitoring will determine whether any supplementary planting will be required to assist regeneration and whether any weed control needs to be undertaken during the recovery period.

This report presents the results of the monitoring survey undertaken in October 2017.

## **1.2 Site Location**

The Golden Bay Foreshore Reserve is located approximately 50km south of Perth and 16km south of Rockingham Town Centre, within the City of Rockingham (Figure 1). The site is bound by Secret Harbour to the north, the Lot 2 Golden Bay development to the east, the existing Golden Bay Township to the south and the high water mark of the Indian Ocean to the west.

The Foreshore Reserve covers an area of approximately 10.61ha and is around 800m in length from north to south and ranges between approximately 150m to 300m wide.

## **1.3 Objectives**

The objectives of the post-fire vegetation monitoring report are to:

- Monitor permanent plots set up in the Baseline Survey;
- Measure current species regeneration;
- Assess post-fire recovery mechanisms for each species;
- Assess any requirement for weeding during the post-fire recovery period; and
- Report on progress towards meeting regeneration criteria.

## 2 EXISTING ENVIRONMENT

---

### 2.1 Topography

The topography of the Foreshore Reserve ranges from 1 to 10m AHD. The dunes closest to the coast are part of a recent parallel dune ridge system with dune crests up to 5-6m AHD. The eastern half of the Foreshore Reserve contains a low linear flat swale at an elevation of 1-2m AHD with some taller dunes up to 10m AHD.

The 1 January fire was largely contained to the eastern half of the Foreshore Reserve.

### 2.2 Wetlands

The eastern half of the Foreshore Reserve contains a number of small wetlands within the flat swale directly behind the frontal dunes. The wetlands are described as Sumplands and contain shallow freshwater above-ground in spring during an average rainfall season. The wetlands are rated as Conservation Category wetlands.

The 1 January fire burnt more than half the area of wetlands in the Foreshore Reserve.

### 2.3 Vegetation

#### 2.3.1 Vegetation Types

A variety of coastal Quindalup vegetation types occur in the Foreshore Reserve as listed below:

##### Western Half

- *Spinifex hirsutus* Grassland: Located on the foredune with *Spinifex longifolius*, *Tetragonia decumbens* and *Cakile maritima* present on the seaward facing slopes and *Ficinia nodosa* and *Carpobrotus virescens* frequent near the crest and leeward sides.
- *Olearia axillaris* Shrubland: Located immediately behind the foredune and forms a wide band parallel to the coast, containing *Cassytha* sp., *Pelargonium capitatum* and *Trachyandra divaricata*. It grades into the *Spyridium globulosum* Open Heath.
- *Spyridium globulosum* Open Heath: Located on the lower dunes and containing *Acacia cyclops*, *Hibbertia cuneiformis*, *Alyxia buxifolia*, *Pelargonium capitatum* and the creeper *Hardenbergia comptoniana*.

##### Eastern Half

- *Acacia rostellifera*/*Spyridium globulosum* Closed Shrub: An intermediate unit located in the central part of the site.
- *Juncus kraussii* Sedgeland: Located within the eastern low linear flat swale in the wetland areas, containing *Baumea juncea*, *Centella asiatica*, *Ficinia nodosa*, *Dampiera alata* and *Lepidosperma gladiatum*. Three isolated, mature Paperbark trees (*Melaleuca raphiophylla* and *Melaleuca cuticularis*) also occur in the wetlands.
- *Spyridium globulosum* Closed Heath: Making up the majority of the transitional vegetation on slightly higher ground within the swale, it contains similar species to the *Spyridium globulosum*

Open Heath on the low dunes and additionally a dense ground coverage of the Sword Sedge *Lepidosperma gladiatum*.

The vegetation in the wetlands in the Foreshore Reserve is a Threatened Ecological Community (TEC) – Floristic Community Type 19 ‘Sedgeland in Holocene Dune Swales’.

The 1 January fire did not affect any of the vegetation types on the western half of the Foreshore Reserve. All three vegetation types in the eastern half including large sections of the TEC were burnt to some extent.

### **2.3.2 Vegetation Condition**

The vegetation in most of the Foreshore Reserve pre-fire was rated as mostly being in Excellent Condition with only a few tracks through it.

A weed survey of the Foreshore Reserve conducted by PGV Environmental in May 2015 identified the most prevalent introduced species in the area as Rose Pelargonium (*Pelargonium capitatum*) and False Onion Weed (*Trachyandra divaricata*). Both species were more common on the western part of the Foreshore Reserve on sand dunes. The wetlands on the site contained few weeds.

Hares Tail Grass (*Lagurus ovatus*) and Geraldton Carnation Weed (*Euphorbia terracina*) were also present in parts of the Foreshore Reserve.

**Plate 1: Aerial Photography of a Section of the Site from January 2016 showing burnt areas (Nearmap, 2016)**



**Plate 2: Burnt Central Section of the Foreshore Reserve (January 2016)**



## **2.4 Native Fauna**

The Foreshore Reserve at Golden Bay contains a population of Southern Brown Bandicoots, or Quenda (*Isoodon obesulus*). The size and health of the Bandicoot population has been monitored by the developers for 4 years.

A number of the Quenda were relocated to Paganoni Reserve in July 2016 due to the reduced habitat as a result of the fire in the Foreshore Reserve. The remaining population in the Foreshore Reserve will continue to be monitored during Spring and Autumn. Once the habitat in the foreshore reserve has recovered sufficiently it will be determined by the Department of Parks and Wildlife if Quenda will be re-introduced to supplement the existing population.

The Foreshore Reserve contains an itinerant population of Western Grey Kangaroos (*Macropus fuliginosus*) that moves within the foreshore reserves north and south of Golden Bay. The presence of kangaroos may impact on the vegetation in the burnt area by grazing the regenerating plants. The condition of the wetland vegetation may be impacted by kangaroos moving through or resting in the dense sedgelands. Management of the kangaroo population is not limited to Golden Bay as they range up and down the coastal corridor. A global approach across multiple land managers may be required if the number of kangaroos needs to be managed.

## **2.5 Pest Fauna**

The Foreshore Reserve contains a large number of rabbits as evidenced by the amount of rabbit faeces, diggings and a burrow. The abundance of rabbits may affect the regeneration of plants in the burnt area by over-grazing.

### 3 MONITORING RESULTS

---

#### 3.1 Monitoring Plot Establishment

A total of nine 10m x 10m monitoring plots was established in the burnt areas of the Foreshore Reserve on 27 July 2016 by Dr Paul van der Moezel of PGV Environmental.

The plots were chosen to be representative of the variety of vegetation types burnt.

The plots were aligned on northings and eastings with the corners of each plot pegged with small steel pegs. The co-ordinates of the plot were taken using a hand-held GPS from the centre of the plot. A photo was taken from the south-east corner of each plot looking towards the north-west corner.

The pre-fire vegetation type was assessed for each plot using the burnt vegetation as a guide.

Six of the nine monitoring plots were located on low sand dunes while three were in flat swales containing wetland TEC vegetation. Plot GBF6 was transitional between the dryland and wetland vegetation types while plot GBF7 contained slightly raised areas on the edge of the wetland swale.

The pre-fire vegetation in the monitoring plots was assessed as being the following:

##### **Dunes**

Plot GBF1	<i>Acacia rostellifera/Spyridium globulosum</i> Open Heath over <i>Lepidosperma gladiatum</i> Open Sedgeland
Plot GBF 3	<i>Acacia rostellifera/Spyridium globulosum</i> Closed Tall Scrub (3.5-4m, >70%) over <i>Lepidosperma gladiatum</i> Sedgeland (30%)
Plot GBF4	<i>Acacia rostellifera/Spyridium globulosum</i> Shrubland (1.5m, 10%) over <i>Lepidosperma gladiatum/Trachyandra divaricata</i> Sedgeland (60%)
Plot GBF6	<i>Spyridium globulosum/Exocarpos sparteus</i> Open Heath (1.5m, 50-70%) over <i>Lepidosperma gladiatum/Baumea juncea</i> Open Sedgeland (20-30%)
Plot GBF8	<i>Acacia rostellifera/Spyridium globulosum</i> Closed Tall Scrub (4m, 70-80%) over <i>Lepidosperma gladiatum</i> Sedgeland
Plot GBF9	<i>Spyridium globulosum</i> Tall Shrubland (3.5m, 10%) over <i>Lepidosperma gladiatum/Trachyandra divaricata</i> Sedgeland (50%)

##### **Wetlands/TEC**

Plot GBF2	<i>Baumea juncea/Ficinia nodosa</i> Closed Sedgeland (90%) over <i>Centella asiatica</i> Herbland
Plot GBF5	<i>Baumea juncea</i> Sedgeland (90%) over <i>Centella asiatica</i> Herbland
Plot GBF7	<i>Baumea juncea</i> Closed Sedgeland (80-90%) over <i>Centella asiatica</i> Herbland

Within each plot the percentage cover and average height of all species were recorded. Where possible, the post-fire recovery mechanism was assessed for each species.

A follow-up assessment of the plots on 11 October 2016 was made to record any new emergence of ephemeral species in spring.

The plots were assessed on 18 April 2017 and 24 October 2017. This report presents the results of the 2017 monitoring surveys.

## **3.2 Monitoring Plot Results**

The monitoring plot data are provided in Appendix 1 and summarised in Tables 1 and 2. An overall aerial photo of the site from February 2017 is provided at Plate 3. Comparison photos of each monitoring plot from the baseline in July 2016 and October 2017 are provided in Plates 5-12.

### **3.2.1 Growth**

The growth of *Acacia rostellifera* in the two dunal plots (GB3 and GB8) that had a tall and dense cover of *A. rostellifera* pre-fire continues well with plants growing from 0.4-0.6m in October 2016 up to 1.5m in October 2017. It may still take 2 years to reach the pre-fire height of 3.5-4m. The post-fire regeneration mechanism of sprouting has assisted the rapid growth of *A. rostellifera*.

Plots that were assessed as having *Spyridium globulosum* as a dominant pre-fire shrub are recovering at a much slower rate due to the post-fire recovery mechanism of growing from seed for *S. globulosum* rather than sprouting.

Sword Sedge (*Lepidosperma gladiatum*) recovered quickly in all plots attaining its pre-fire height (0.7-1m) and percentage cover by April 2017 with little further growth after that.

The dense sedge cover in the three wetland/TEC plots was well advanced in October 2016 and had fully recovered by April 2017 with the height of the dominant species *Baumea juncea* and *Ficinia nodosa* up to 1m tall.

An unusual phenomenon was observed in the wetland in which monitoring plot GB 7 is located. Prior to the fire the wetland contained one mature *Melaleuca preissiana* tree up to 4m high on the edge of the wetland. In April 2017 thousands of seedlings were recorded beneath the tree as well as up to 40m away to the west on the perimeter of the wetland as well as in the core of the wetland. The seedlings had survived through to October 2017 and grown up to 0.3-0.5m tall (Plate 4). The future structure of the wetland vegetation may be very different in several years' time compared to the pre-fire condition if the *M. preissiana* seedlings survive through to maturity.

**Plate 3: Aerial Photography of a Section of the Site from 2017 showing regeneration (National Map, 2017)**



**Plate 4: Dense regeneration of *Melaleuca preissiana* seedlings near GBF 7**



**Table 1: Height and Cover of Monitoring Plot Vegetation**

Plot	Vegetation (Pre-fire)	Pre-fire		Post-fire (July 2016)			Post Fire (April 2017)			Post Fire (October 2017)		
		Height (m)	% Cover <sup>1</sup>	Height (m)	% Cover dominant stratum	Overall cover (%)	Height (m)	% Cover dominant stratum	Overall cover (%)	Height (m)	% Cover dominant stratum	Overall cover (%)
GBF1	<i>Acacia rostellifera/Spyridium globulosum</i> Open Heath over <i>Lepidosperma gladiatum</i> Open Sedgeland (10-20%)	1.5	20-30	<0.1	<1	1-2	0.3	1	15	0.5	12	30
GBF3	<i>Acacia rostellifera/Spyridium globulosum</i> Closed Tall Scrub over <i>Lepidosperma gladiatum</i> Sedgeland (30%)	3.5-4	>70	0.6	20	30-40	1	30	50	1.5	40	70
GBF4	<i>Acacia rostellifera/Spyridium globulosum</i> Shrubland over <i>Lepidosperma gladiatum/Trachyandra divaricata</i> Sedgeland (60%)	1.5	10	0.3	1	40-50	0.5	2	50-55	0.7	2	65
GBF6	<i>Spyridium globulosum/Exocarpos sparteus</i> Open Heath over <i>Lepidosperma gladiatum/Baumea juncea</i> Open Sedgeland (20-30%)	1.5	50-70	<0.1	<1	5	0.3	<1	40	0.5-1	2	60
GBF8	<i>Acacia rostellifera/Spyridium globulosum</i> Closed Tall Scrub over <i>Lepidosperma</i>	4	70-80	0.4	15	25-30	1.2	40	65	1.5	50	70

Plot	Vegetation (Pre-fire)	Pre-fire		Post-fire (July 2016)			Post Fire (April 2017)			Post Fire (October 2017)		
	<i>gladiatum</i> Sedgeland (20-30%)											
GBF9	<i>Spyridium globulosum</i> Tall Shrubland over <i>Lepidosperma gladiatum</i> / <i>Trachyandra divaricata</i> Sedgeland (50%)	3.5	10	<0.1	<1	30-40	<1	<1	40	0.3	<1	50
	<b>Wetland/TEC Vegetation</b>											
GBF2	<i>Baumea juncea</i> / <i>Ficinia nodosa</i> Closed Sedgeland (90%) over <i>Centella asiatica</i> Herbland	1	90	0.5	70	70-75	0.8	100	100	0.8	100	100
GBF5	<i>Baumea juncea</i> Sedgeland (90%) over <i>Centella asiatica</i> Herbland	1	90	0.4	75	75-80	1	85	100	0.8	95	100
GBF7	<i>Baumea juncea</i> Closed Sedgeland (80-90%) with occasional <i>Acacia saligna</i> shrubs over <i>Centella asiatica</i> Herbland	1	80-90	0.4	60	60-70	0.6	80	90	0.7	80	90

**Table 2: Number of Species in Monitoring Plots**

Plot	Vegetation (Pre-fire)	No. Species - July 2016			No. Species - October 2016			No. Species – April 2017			No. Species – October 2017		
	Dune Vegetation	Native	Non-native	Total	native	Non-native	Total	native	Non-native	Total	Native	Non-native	Total
GBF1	<i>Acacia rostellifera</i> / <i>Spyridium globulosum</i> Open Heath over <i>Lepidosperma gladiatum</i> Open Sedgeland (10-20%)	7	4	11	9	12	21	9	1	10	12	8	20
GBF3	<i>Acacia rostellifera</i> / <i>Spyridium globulosum</i> Closed Tall Scrub over <i>Lepidosperma gladiatum</i> Sedgeland (30%)	7	7	14	10	10	20	5	3	8	7	6	13
GBF4	<i>Acacia rostellifera</i> / <i>Spyridium globulosum</i> Shrubland over <i>Lepidosperma gladiatum</i> / <i>Trachyandra divaricata</i> Sedgeland (60%)	6	7	13	10	14	24	6	5	11	5	12	17
GBF6	<i>Spyridium globulosum</i> / <i>Exocarpos sparteus</i> Open Heath over <i>Lepidosperma gladiatum</i> / <i>Baumea juncea</i> Open Sedgeland (20-30%)	7	5	12	10	11	21	13	5	18	14	10	24

Plot	Vegetation (Pre-fire)	No. Species - July 2016			No. Species - October 2016			No. Species – April 2017			No. Species – October 2017		
GBF8	<i>Acacia rostellifera</i> / <i>Spyridium globulosum</i> Closed Tall Scrub over <i>Lepidosperma gladiatum</i> Sedgeland (20-30%)	5	4	9	7	10	17	5	6	11	11	9	20
GBF9	<i>Spyridium globulosum</i> Tall Shrubland over <i>Lepidosperma gladiatum</i> / <i>Trachyandra divaricata</i> Sedgeland (50%)	6	7	13	9	13	22	4	6	10	9	10	19
	<b>Wetland/TEC Vegetation</b>												
GBF2	<i>Baumea juncea</i> / <i>Ficinia nodosa</i> Closed Sedgeland (90%) over <i>Centella asiatica</i> Herbland	8	4	12	8	5	13	7	0	7	7	1	8
GBF5	<i>Baumea juncea</i> Sedgeland (90%) over <i>Centella asiatica</i> Herbland	6	2	8	8	5	13	9	0	9	10	0	10
GBF7	<i>Baumea juncea</i> Closed Sedgeland (80-90%) with occasional <i>Acacia saligna</i> shrubs over <i>Centella asiatica</i> Herbland	9	11	20	13	16	29	13	3	16	13	6	19

**Plate 5a: GBF Plot 1 July 2016**



**Plate 5b: GBF Plot 1 October 2017**



**Plate 6a: GBF Plot 2 July 2016**



**Plate 6b: GBF Plot 2 October 2017**



**Plate 7a: GBF Plot 3 July 2016**



**Plate 7b: GBF Plot 3 October 2017**



**Plate 8a: GBF Plot 4 July 2016**



**Plate 8b: GBF Plot 4 October 2017**



**Plate 9a: GBF Plot 5 July 2016**



**Plate 9b: GBF Plot 5 October 2017**



**Plate 10a: GBF Plot 6 July 2016**



**Plate 10b: GBF Plot 6 October 2017**



**Plate 11a: GBF Plot 7 July 2016**



**Plate 11b: GBF Plot 7 October 2017**



**Plate 12a: GBF Plot 8 July 2016**



**Plate 12b: GBF Plot 8 October 2017**



**Plate 13a: GBF Plot 9 July 2016**



**Plate 13b: GBF Plot 9 October 2017**



### 3.2.2 Species Richness

Species richness was variable from October 2016 through to April 2017 and October 2017.

The average species richness in the six dunal plots in October 2017 was 18.8 (range 13-24) compared to 20.8 (range 17-24) in October 2016 (Table 2). Seedlings of some common coastal species including *Olearia axillaris*, *Scaevola crassifolia* and *Hardenbergia comptoniana* were recorded in several plots in 2017 for the first time.

Three ephemeral species *Calandrinia liniflora*, *Crassula colorata* and *Parietaria debilis* were not recorded in many plots in October 2017. Their absence is more likely due to seasonal conditions rather than the effects of fire as none of these species is known as a post-fire ephemeral that germinates abundantly after a fire then dies away quickly after a short time.

Species richness in the three wetland TEC plots averaged 12.3 (range 8-19) compared to 18.3 (range 13-29) in October 2016 (Table 2). The reduction was mostly due a lower number of introduced species as well as some native species.

Water levels in the wetlands in the foreshore reserve at Golden Bay are at their highest in September/October each year. In October 2016 the wetlands were waterlogged but contained very little above-ground water apart from a very small corner of GBF 7. The water levels in the wetlands in 2017 were significantly higher than 2016 due to the amount and pattern of rainfall throughout the year. As a result of the higher groundwater levels all wetland contained above ground water, up to 0.30m deep in October.

The loss of some species native and introduced species from the wetland plots was due to the sensitivity of these species to inundation. This should be regarded as a positive result as it prevents shrub species such as *Acacia rostellifera*, *A. saligna* and *Spyridium globulosum* from invading the sedgeland and changing the structure of the wetland/TEC vegetation.

Some of the low-lying dunal plots that were not wetlands also experienced high water levels in 2017. The waterlogged conditions resulted in the death of some shrub species including *Olearia axillaris* (Plate 14), *Spyridium globulosum* (Plate 15) and *Exocarpos sparteus* from plots GBF 1 and GBF 6.

**Plate 14 Dead *Olearia axillaris* GBF 1**



**Plate 15 Dead *Spyridium globulosum* GBF 6**



### 3.3 Weeds

Introduced species that were most commonly recorded in the monitoring plots are shown in Table 3.

Rose Pelargonium (*Pelargonium capitatum*) which was present in all plots in October 2016 was recorded in fewer plots in October 2017 mostly due to the impact of higher water levels in the wetlands. The species was considered to be spreading in GBF 6 with many seedlings recorded. Seedlings of Blackberry Nightshade (*Solanum nigrum*) and Pigface (*Carpobrotus edulis*) were also seen in higher numbers in some of the dune areas.

*Trachyandra divaricata* (Onion Weed) is an invasive weed in most coastal locations in the Perth Metropolitan Region. The species was recorded in five plots in October 2016 and was abundant in two. The location and percent cover of *T. divaricata* was the same in October 2017 indicating that it might not proliferate after a fire in coastal areas.

Fleabane (*Conyza bonariensis*) was not recorded in October 2017. The appearance of dead plants in many of the plots indicated the annual species may have had an earlier flowering period in 2017..

**Table 3: Introduced Species Recorded in more than three Monitoring Plots**

Species	Common Name	October 2016			October 2017		
		Dune Plots	Wetland Plots	Total	Dune Plots	Wetland Plots	Total
<i>Pelargonium capitatum</i>	Rose Pelargonium	6	3	9	5	1	6
<i>Oenothera</i> species	Evening Primrose	5	2	7	4	0	4
<i>Lolium perenne</i>	Rye Grass	4	3	7	2	0	2
<i>Dischisma arenarium</i>		6	1	7	6	0	6
<i>Carpobrotus edulis</i>	Pigface	4	2	6	5	1	6
<i>Crassula glomerata</i>		4	1	5	6	1	7
<i>Trachyandra divaricata</i>	False Onion Weed	4	1	5	4	0	4
<i>Lysimachia arvensis</i>	Pimpernel	4	1	5	3	1	4
<i>Solanum nigrum</i>	Blackberry Nightshade	4	1	5	3	0	3
<i>Hypochaeris</i> species	Flatweed	3	1	4	1	0	1
<i>Conyza bonariensis</i>	Fleabane	4	0	4	0	0	0
<i>Cerastium glomeratum</i>	Chickweed	4	0	4	0	0	0
<i>Sonchus oleraceus</i>	Sow Thistle	3	1	4	3	1	4
<i>Ehrharta calycina</i>	Veltdgrass	2	0	2	3	0	3

The other species are all commonly recorded in coastal dunes in the Perth Metropolitan Region. Most are ephemeral weeds that would be extremely difficult to eradicate and are not considered a problem weed in the foreshore reserve, such as Chickweed, Pimpernel, Sow Thistle, *Dischisma arenarium* and *Crassula glomerata*.

### **3.4 Post-Fire Regeneration Mechanisms**

A total of 76 plant species have been recorded in the nine monitoring plots in 2016 and 2017 (Appendix 2). Of these, 44 are native and 32 introduced.

Appendix 2 lists the post-fire regeneration mechanism of the species recorded where it was able to be observed. Plant species generally have two mechanisms of regeneration after fire. The first mechanism is for the burnt plant to resprout either from underground stems or bulbs/corms etc. The second mechanism is regeneration from seed, usually after the parent plant has been completely killed by the fire. Some species are able to regenerate by both sprouting and seeding. The heat of the fire can also influence the mechanism of regeneration for some species. For example, a plant may be able to recover by sprouting after a relatively cool burn but regenerates from seed after a hot burn that kills the entire plant.

The majority of native plants in the foreshore reserve were recorded as regenerating after fire by seeding. The two dominant shrub species on the dunal areas, *Acacia rostellifera* and *Spyridium globulosum* both regenerate by seed, however *Acacia rostellifera* also resprouts from the base of burnt shrubs.

The difference in early growth for *Acacia rostellifera* from sprouting (up to 1.5m tall in October 2017) compared to the growth of *Spyridium globulosum* seedlings (up to 0.4m tall) shows the competitive advantage of the sprouting mechanism, at least in the early stages.

The wetland sedge species all regenerate by sprouting from the underground stems which is the reason for the rapid regeneration of these areas soon after the fire.

### **3.5 Grazing**

A small mob of kangaroos are present in the foreshore reserve at Golden Bay and freely roam into adjacent areas of Secret Harbour to the north and Singleton to the south. Some grazing by rabbits, and possibly kangaroos, was observed in the foreshore reserve in 2016, however no grazing was observed in the monitoring plots in 2017.

## 4 CONCLUSIONS AND RECOMMENDATIONS

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The results of the post-fire vegetation monitoring of the Golden Bay Foreshore Reserve following the 1 January 2016 are as follows:

- Nine 10m x 10m permanent monitoring plots was established in the burnt areas of the Foreshore Reserve. Six plots were on low sand dunes and three in swales containing wetlands and Threatened Ecological Community 19;
- The plots were monitored for species presence, height and cover in April and October 2017;
- The growth of *Acacia rostellifera* in the dunal plots has progressed rapidly with plants up to 1.5m tall in October 2017. The other dominant pre-fire shrub species, *Spyridium globulosum* which regenerates from seed, was much smaller at around 0.4m tall;
- The growth of sedges in the three wetland/TEC plots reached pre-fire levels very quickly with all wetlands at pre-fire height and density by April 2017;
- Water levels in the wetlands and some of the lower-lying dunal plots was significantly higher in 2017 compared to 2016 resulting in wetlands being inundated and the low-lying dunal plots being waterlogged more than usual. As a result, several species not tolerant of waterlogging or inundation died in 2017, including *Olearia axillaris*, *Spyridium globulosum* and *Exocarpos sparteus*. The impact of the high 2017 water levels on the regeneration of the low-lying dunal plots will be monitored in 2018;
- A total of 76 species has been recorded in the monitoring plots in 2016 and 2017. The majority of native species in the Foreshore Reserve were recorded as regenerating after fire by seeding. The remainder regenerated by sprouting from underground stems and roots and bulbs/corms etc. *Acacia rostellifera* regenerated by both seeding and sprouting;
- Some introduced species such as Rose Pelargonium, Pigface and Blackberry Nightshade have spread in some plots since monitoring began in July 2016. However, these species were present in the foreshore reserve prior to the fire and may be returning to their pre-fire level;
- No grazing by rabbits or kangaroos was observed in the monitoring plots. Some grazing has been observed in the foreshore reserve, however this is not having a detrimental impact on the recovery of the vegetation after the fire;
- The burnt areas are expected to retain their pre-fire cover within around 5 years after the fire without any necessary intervention with regards to revegetation or weeding; and
- Final monitoring of the burnt area in the Foreshore Reserve will occur in April 2018 and October 2018.

## 5 REFERENCES

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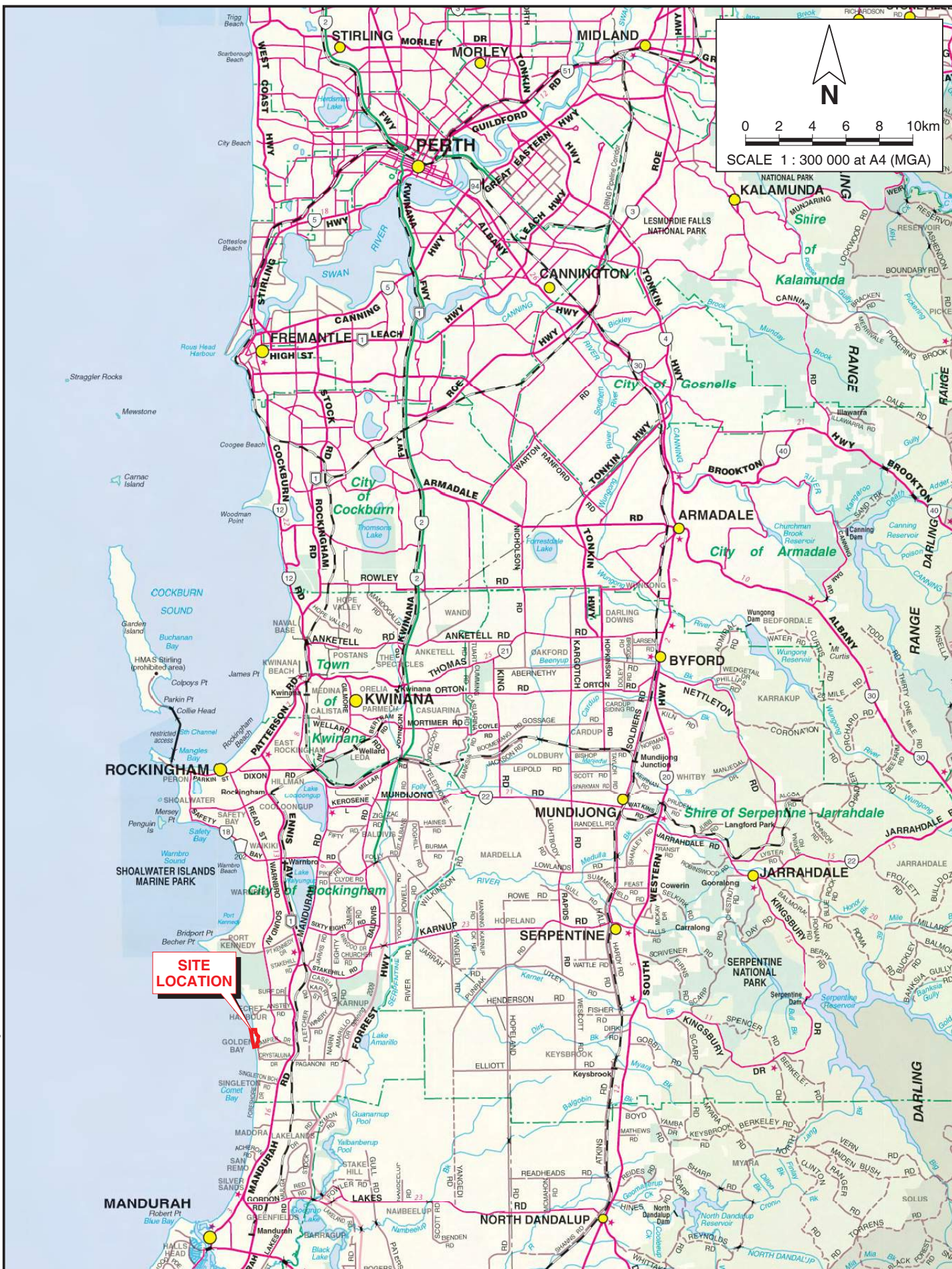
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# FIGURES





# **APPENDIX 1**

## **Monitoring Plot Data**

## Species List - Golden Bay Foreshore Reserve Post-Fire Monitoring Plots

Species	Regeneration Mechanism	
	Seed	Sprout/Bulb
<b>MONOCOTYLEDONS</b>		
<i>Acanthocarpus preissii</i>	+	
* <i>Aira</i> sp.	+	
<i>Baumea juncea</i>		+
* <i>Bromus diandrus</i>	+	
<i>Caladenia latifolia</i>	ND	ND
<i>Conostylis candicans</i>	?	?
<i>Cynodon dactylon</i>		+
* <i>Cyperus tenuiflorus</i>		+
* <i>Ehrharta calycina</i>	+	
<i>Ficinia nodosa</i>		+
<i>Isolepis cernua</i>		+
<i>Isolepis marginata</i>	+	
<i>Juncus kraussii</i>		+
<i>Juncus pallidus</i>		+
* <i>Lagurus ovatus</i>	+	
<i>Lepidosperma gladiatum</i>		+
* <i>Lolium perenne</i>	+	
* <i>Poa annua</i>	+	
* <i>Romulea rosea</i>		+
<i>Schoenoplectus validus</i>		+
<i>Sporobolus virginicus</i>		+
<i>Thysanotus patersonii</i>		+
* <i>Trachyandra divaricata</i>	?	?
* <i>Vulpia myuros</i>	+	
<b>DICOTYLEDONS</b>		
<i>Acacia cyclops</i>	+	
<i>Acacia rostellifera</i>	+	+
<i>Acacia saligna</i>	+	
<i>Alyxia buxifolia</i>	+	
<i>Apium prostratum</i>	+	
* <i>Arctotheca calendula</i>	+	
<i>Atriplex</i> sp.	+	
* <i>Bartsia trixago</i>	+	
<i>Brassicaceae</i> sp.	+	
<i>Calandrinia liniflora</i>	+	
<i>Calandrinia brevipedata</i>	+	
* <i>Carpobrotus edulis</i>	+	
<i>Cassytha racemosa</i>		+

Species	Regeneration Mechanism	
	Seed	Sprout/Bulb
<i>Centella asiatica</i>		+
* <i>Cerastium glomeratum</i>	+	
<i>Clematis linearifolia</i>		+
* <i>Conyza bonariensis</i>	+	
<i>Crassula colorata</i>	+	
* <i>Crassula glomerata</i>	+	
* <i>Cuscuta epithymum</i>	+	
* <i>Dischisma arenarium</i>	+	
<i>Epilobium billardioreanum</i>	+	
* <i>Euphorbia terracina</i>	+	
<i>Exocarpos sparteus</i>	+	
<i>Hardenbergia comptoniana</i>	+	+
<i>Hibbertia cuneiformis</i>		+
* <i>Hypochaeris glabra</i>	+	
* <i>Hypochaeris radicata</i>	+	
<i>Leucopogon parviflorus</i>		+
<i>Lobelia anceps</i>	+	
* <i>Lysimachia arvensis</i>	+	
* <i>Lythrum hyssopifolia</i>	+	
<i>Melaleuca preissiana</i>	+	+
<i>Myoporum caprarioides</i>	+	
* <i>Oenothera drummondii</i>	+	
* <i>Oenothera stricta</i>	+	
<i>Olearia axillaris</i>	+	
* <i>Parietaria debilis</i>	+	
* <i>Pelargonium capitatum</i>	+	
* <i>Podotrochea angustifolia</i>	+	
<i>Rhagodia baccata</i>	+	
<i>Samolus junceus</i>	+	
<i>Samolus repens</i>	+	
<i>Scaevola crassifolia</i>	+	
<i>Senecio pinnatifolius</i>	+	
* <i>Solanum nigrum</i>	+	
* <i>Sonchus oleraceus</i>	+	
* <i>Sonchus sp</i>	+	
<i>Sphaerolobium ?calicicola</i>	+	
<i>Spyridium globulosum</i>	+	
* <i>Symphyotrichum squamatum</i>	+	
* <i>Taraxacum officinale</i>	+	
<i>Trachymene pilosa</i>	+	
* <i>Trifolium campestre</i>	+	

\* introduced species

## **APPENDIX 2**

### **Quadrat Data**

# QUADRAT GBF1

50 382543 E 6412176 N

**Pre-fire Vegetation:** *Acacia rostellifera*/*Spyridium globulosum* Open Heath (1.5m, 20-30%) over *Lepidosperma gladiatum* Open Sedgeland (10-20%)

**Landform:** Flat, low-lying, not wetland



QUADRAT (10 x 10m) – 24 Oct 2017

Peg in SE corner only

SPECIES	HEIGHT (m)	COVER (%)
<i>Lepidosperma gladiatum</i>	0.7	15
<i>Ficinia nodosa</i>	0.7	4
<i>Acacia rostellifera</i>	0.5	2
<i>Baumea juncea</i>	0.5	<1
<i>Juncus kraussii</i>	0.7	1
<i>Acacia saligna</i>	0.5	10
<i>Scaevola crassifolia</i>		
<i>Olearia axillaris</i>	Dead	
* <i>Sonchus</i> sp	0.1	<1
* <i>Lysimachia arvensis</i>	<0.1	<1
* <i>Dischisma arenarium</i>	<0.1	<1
<i>Crassula colorata</i>		
* <i>Conyza bonariensis</i>	Dead	
<i>Senecio pinnatifolius</i>	0.3	<1
* <i>Carpobrotus edulis</i>		
* <i>Lolium perenne</i>	0.3	<1
* <i>Brassicaceae</i> sp		
<i>Spyridium globulosum</i>	0.4	<1
<i>Calandrinia</i> sp.		

SPECIES	HEIGHT (m)	COVER (%)
* <i>Crassula glomerata</i>	0.1	15
* <i>Pelargonium capitatum</i>	0.3	<1
<i>Acanthocarpus preissii</i>	0.2	<1
<i>Isolepis marginata</i>	<0.1	<1
* <i>Solanum nigrum</i>	<0.1 seedlings	<1
<i>Caladenia latifolia</i>		
* <i>Hypochaeris radicata</i>	flat	<1
* <i>Taraxacum officinale</i>		
* <i>Oenothera drummondii</i>		
<i>Hardenbergia comptoniana</i>	climber	<1
<i>Cassytha sp</i>	climber	<1
<b>TOTAL COVER</b>		<b>30</b>

\* introduced species

Red = newly recorded species

## QUADRAT GBF2

50 382501 E 6412149 N

**Pre-fire Vegetation:** *Baumea juncea*/*Ficinia nodosa* Closed Sedgeland (90%) over  
*Centella asiatica* Herbland

**Landform:** Swale, damp peaty soil, wetland



QUADRAT (10 x 10m) – 24 Oct 2017

Peg in SE corner only

SPECIES	HEIGHT (m)	COVER (%)
<i>Baumea juncea</i>	0.7	70
<i>Ficinia nodosa</i>	0.8	50
<i>Samolus repens</i>	0.3	1
<i>Acacia saligna</i>		
* <i>Lolium perenne</i>		
<i>Sporobolus virginicus</i>		
<i>Apium prostratum</i>	0.5	<1
<i>Spyridium globulosum</i>	0.4	<1
<i>Lobelia anceps</i>		
<i>Centella asiatica</i>	0.3	20
<i>Sphaerolobium ?calcicola</i>	0.3	<1
* <i>Sonchus oleraceus</i>		
* <i>Carpobrotus edulis</i>	0.3	<1
* <i>Pelargonium capitatum</i>		
* <i>Trifolium campestre</i>		
<i>Epilobium billardioreanum</i>		
<b>TOTAL COVER</b>		<b>100</b>

\* introduced species

Red = newly recorded species



# QUADRAT GBF3

50 382461 E 6412160 N

**Pre-fire Vegetation:** *Acacia rostellifera*/*Spyridium globulosum* Closed Tall Scrub (3.5-4m, >70%) over *Lepidosperma gladiatum* Sedgeland (30%)

**Landform:** Top of low rise, dry sandy soils



QUADRAT (10 x 10m) – 24 Oct 2017

Pegs in SW and SE corners

SPECIES	HEIGHT (m)	COVER (%)
<i>Acacia rostellifera</i>	1.5	40
<i>Lepidosperma gladiatum</i>	1	25
* <i>Trachyandra divaricata</i>	0.4	1
* <i>Lolium perenne</i>		
* <i>Lagurus ovatus</i>		
<i>Calandrinia liniflora</i>		
* <i>Hypochaeris radicata</i>		
<i>Parietaria debilis</i>		
* <i>Dischisma arenarium</i>	<0.1	<1
<i>Scaevola crassifolia</i>	0.3-0.9	2
* <i>Bromus diandrus</i>		
* <i>Crassula glomerata</i>	<0.1	5
* <i>Cerastium glomeratum</i>		
<i>Isolepis marginata</i>	<0.1	<1
* <i>Pelargonium capitatum</i>	0.3	<1
<i>Spyridium globulosum</i>	0.4	<1
* <i>Conyza bonariensis</i>	Dead	
<i>Thysanotus patersonii</i>		
<i>Clematis linearifolia</i>	climber	1
<i>Hardenbergia comptoniana</i>		
<i>Rhagodia baccata</i>	0.4	1

<i>*Ehrharta calycina</i>	0.3	5
<i>*Carpobrotus edulis</i>	0.3	<1
<b>TOTAL COVER</b>		<b>70</b>

\* introduced species

Red = newly recorded species

# QUADRAT GBF4

50 382427 E 6412262 N

**Pre-fire Vegetation:** *Acacia rostellifera*/*Spyridium globulosum* Shrubland (1.5m, 10%) over *Lepidosperma gladiatum*/*Trachyandra divaricata* Sedgeland (60%)

**Landform:** Upper slopes of low rise, dry sandy soil



QUADRAT (10 x 10m) – 24 Oct 2017

Peg in SE corner only

SPECIES	HEIGHT (m)	COVER (%)
<i>Acacia rostellifera</i>	0.7	2
<i>Lepidosperma gladiatum</i>	0.4-0.5	40
* <i>Trachyandra divaricata</i>	0.4	20
* <i>Podotheca angustifolia</i>		
* <i>Solanum nigrum</i>		
* <i>Sonchus oleraceus</i>	0.1	<1
<i>Conostylis candicans</i>		
* <i>Lolium perenne</i>		
<i>Calandrinia liniflora</i>		
* <i>Crassula glomerata</i>	<0.1	2
<i>Parietaria debilis</i>		
* <i>Cynodon dactylon</i>		
* <i>Ehrharta calycina</i>		
<i>Isolepis marginata</i>		
* <i>Dischisma arenarium</i>	<0.1	2
* <i>Euphorbia terracina</i>	0.4	<1
* <i>Conyza bonariensis</i>	Dead	
<i>Crassula colorata</i>		

SPECIES	HEIGHT (m)	COVER (%)
* <i>Cerastium glomeratum</i>		
* <i>Lagurus ovatus</i>	0.3	<1
<i>Scaevola thesioides</i>	0.1 seedling	<1
* <i>Vulpia myuros</i>	0.1	<1
* <i>Romulea rosea</i>	0.1	<1
<i>Spyridium globulosum</i> seedling	0.3	<1
<i>Scaevola crassifolia</i>	0.2	<1
* <i>Carpobrotus edulis</i>	0.2	<1
* <i>Pelargonium capitatum</i>	0.2	2
* <i>Oenothera drummondii</i>	0.4	<1
* <i>Cuscuta epithymum</i>	climber	2
<i>Hardenbergia comptoniana</i>		
<i>Cassytha racemosa</i>		
<b>TOTAL COVER</b>		<b>65</b>

\* introduced species

Red = newly recorded species

# QUADRAT GBF5

50 382466 E 6412278 N

**Pre-fire Vegetation:** *Baumea juncea* Sedgeland (90%) over *Centella asiatica*  
Herbland

**Landform:** Swale, damp peaty soil, wetland



QUADRAT (10 x 10m) – 24 Oct 2017

Peg in SE and NE corner

SPECIES	HEIGHT (m)	COVER (%)
<i>Baumea juncea</i>	0.8	90
<i>Ficinia nodosa</i>	0.8	5
<i>Juncus kraussii</i>	0.7	<1
<i>Acacia cyclops</i>	0.6	<1
<i>Centella asiatica</i>	0.3	40
<i>Acacia saligna</i>	0.5	<1
<i>Samolus junceus</i>	0.5	<1
<i>Samolus repens</i>		
<i>Apium prostratum</i>	0.4	<1
<i>Spyridium globulosum</i>	Dead	
<i>Lobelia anceps</i>	0.4	1
<i>Sporobolus virginicus</i>	0.3	<1
<i>Sphaerolobium ?calicicola</i>		
* <i>Lolium perenne</i>		
* <i>Lysimachia arvensis</i>		
* <i>Romulea rosea</i>		
<i>Atriplex sp.</i>		
* <i>Pelargonium capitatum</i>		
* <i>Arctotheca calendula</i>		

SPECIES	HEIGHT (m)	COVER (%)
TOTAL COVER		100

\* introduced species

Red = newly recorded species

## QUADRAT GBF6

50 382527 E 6412277 N

**Pre-fire Vegetation:** *Spyridium globulosum*/*Exocarpos sparteus* Open Heath  
(1.5m, 50-70%) over *Lepidosperma gladiatum*/*Baumea juncea* Open  
Sedgeland (20-30%)

**Landform:** Flat, low-lying, not wetland



QUADRAT (10 x 10m) – 24 Oct 2017

Pegs in SE and NE corners

SPECIES	HEIGHT (m)	COVER (%)
<i>Lepidosperma gladiatum</i>	1	25
* <i>Conyza bonariensis</i>	Dead	
<i>Juncus kraussii</i>	0.6	<1
<i>Ficinia nodosa</i>	0.7	<1
<i>Baumea juncea</i>	0.6	20
<i>Leucopogon parviflorus</i>	0.3	<1
<i>Rhagodia baccata</i>	0.4	5
* <i>Solanum nigrum</i>	0.3	<1
<i>Scaevola crassifolia</i>	Dead	
<i>Exocarpos sparteus</i>	Dead	
<i>Lobelia anceps</i>	0.5	<1
* <i>Lolium perenne</i>		
<i>Parietaria debilis</i>		
* <i>Crassula glomerata</i>	0.1	20
<i>Calandrinia liniflora</i>		
* <i>Dischisma arenarium</i>	0.1	1
<i>Olearia axillaris</i>	0.2	<1
* <i>Lysimachia arvensis</i>	0.2	<1

SPECIES	HEIGHT (m)	COVER (%)
<i>Isolepis marginata</i>	<0.1	1
* <i>Carpobrotus edulis</i>	0.1	1
* <i>Cerastium glomeratum</i>		
* <i>Pelargonium capitatum</i>	0.5	5
<i>Spyridium globulosum</i>	0.4	<1
<i>Acacia saligna</i>	0.5-1	2
* <i>Hypochaeris glabra</i>		
* <i>Conyza bonariensis</i>	Dead	
* <i>Oenothera drummondii</i>	0.4	2
<i>Myoporum caprarioides</i>	0.4	<1
* <i>Lagurus ovatus</i>	0.3	<1
* <i>Ehrharta calycina</i>	0.2	1
* <i>Arctotheca calendula</i>	0.1	<1
<i>Hardenbergia comptoniana</i>	climber	<1
<i>Cassytha sp</i>	climber	<1
<b>TOTAL COVER</b>		<b>60</b>

\* introduced species

Red = newly recorded species

# QUADRAT GBF7

50 382459 E 6412348 N

**Pre-fire Vegetation:** *Baumea juncea* Closed Sedgeland (80-90%) with occasional *Acacia saligna* shrubs over *Centella asiatica* Herbland

**Landform:** Swale, damp peaty soil, wetland, some water in north-east corner



QUADRAT (10 x 10m) – 24 Oct 2017

NE small peg and SE tall peg

SPECIES	HEIGHT (m)	COVER (%)
<i>Juncus kraussii</i>	1	1
<i>Baumea juncea</i>	0.6	70
* <i>Cyperus tenuiflorus</i>	Dead?	
<i>Ficinia nodosa</i>	0.7	10
<i>Schoenoplectus validus</i>	0.8	<1
<i>Lepidosperma gladiatum</i>	0.5	<1
* <i>Symphyotrichum squamatum</i>	0.5	4
<i>Apium prostratum</i>	0.4	10
<i>Melaleuca preissiana</i>	0.3-0.5	10
<i>Lobelia anceps</i>	0.4	<1
<i>Acacia rostellifera</i>	0.4	<1
<i>Samolus repens</i>		
* <i>Trachyandra divaricata</i>		
* <i>Lolium perenne</i>		
* <i>Lagurus ovatus</i>		
* <i>Sonchus oleraceus</i>	0.2	<1
* <i>Romulea rosea</i>	0.1	<1
<i>Olearia axillaris</i>	Dead	

SPECIES	HEIGHT (m)	COVER (%)
<i>Centella asiatica</i>	0.2	20
* <i>Dischisma arenarium</i>		
* <i>Oenothera drummondii</i>		
<i>Trachymene pilosa</i>		
<i>Eryngium pinnatifidum</i>		
<i>Acacia cyclops</i>	0.6	<1
<i>Spyridium globulosum</i>	0.2	<1
* <i>Solanum nigrum</i>		
* <i>Trifolium sp.</i>		
* <i>Cynodon dactylon</i>		
<i>Acacia saligna</i>	0.2	4
* <i>Pelargonium capitatum</i>	0.3	1
* <i>Lysimachia arvensis</i>	0.1	<1
* <i>Carpobrotus edulis</i>		
* <i>Oenothera stricta</i>		
* <i>Crassula glomerata</i>	<0.1	1
* <i>Hypochaeris glabra</i>		
<i>Hardenbergia comptoniana</i>		
<b>TOTAL COVER</b>		<b>90</b>

\* introduced species

Red = newly recorded species

# QUADRAT GBF8

50 382413 E 6412428 N

**Pre-fire Vegetation:** *Acacia rostellifera*/*Spyridium globulosum* Closed Tall Scrub  
(4m, 70-80%) over *Lepidosperma gladiatum* Sedgeland (20-30%)

**Landform:** Upper slopes of dune



QUADRAT (10 x 10m) – 24 Oct 2017

Peg in SE corner only

SPECIES	HEIGHT (m)	COVER (%)
<i>Acacia rostellifera</i>	1.5	50
<i>Lepidosperma gladiatum</i>	1.1	15
* <i>Podotheca angustifolia</i>		
* <i>Trachyandra divaricata</i>	0.4	1
* <i>Lysimachia arvensis</i>		
* <i>Oenothera drummondii</i>	0.4	1
<i>Rhagodia baccata</i>	0.5	5
* <i>Solanum nigrum</i>	0.4	<1
<i>Scaevola crassifolia</i>	0.5	1
<i>Olearia axillaris</i>	0.5	<1
* <i>Ehrharta calycina</i>	0.5	1
<i>Exocarpos sparteus</i>	0.5	<1
<i>Acanthocarpus preissii</i>	0.4	<1
<i>Spyridium globulosum</i>	0.4	<1
* <i>Bromus diandrus</i>	0.3	<1
<i>Conostylis candicans</i>	0.2	<1
<i>Calandrinia liniflora</i>		
* <i>Dischisma arenarium</i>	<0.1	<1

SPECIES	HEIGHT (m)	COVER (%)
<i>Isolepis marginata</i>	<0.1	2
* <i>Pelargonium capitatum</i>		
<i>Parietaria debilis</i>		
* <i>Crassula glomerata</i>	0.1	4
<i>Calandrinia brevipedata</i>		
* <i>Conyza bonariensis</i>	Dead	
* <i>Carpobrotus edulis</i>	0.3	4
* <i>Arctotheca calendula</i>	flat	<1
<i>Hardenbergia comptoniana</i>	climber	<1
<i>Cassytha sp</i>		
<b>TOTAL COVER</b>		<b>70</b>

\* introduced species

Red = newly recorded species

# QUADRAT GBF9

50 382410 E 6412509 N

**Pre-fire Vegetation:** *Spyridium globulosum* Tall Shrubland (3.5m, 10%) over  
*Lepidosperma gladiatum*/*Trachyandra divaricata* Sedgeland (50%)

**Landform:** Mid-slope of dune



QUADRAT (10 x 10m) – 24 Oct 2017

Peg in SE corner only

SPECIES	HEIGHT (m)	COVER (%)
<i>Lepidosperma gladiatum</i>	0.5	25
* <i>Trachyandra divaricata</i>	0.4	20
<i>Hibbertia cuneiformis</i>	0.8	1
* <i>Conyza bonariensis</i>	Dead	
<i>Scaevola crassifolia</i>	0.4	1
* <i>Lolium perenne</i>	0.4	<1
<i>Rhagodia baccata</i>	0.3	<1
* <i>Vulpia myuros</i>	0.2	<1
* <i>Crassula glomerata</i>	<0.1	1
* <i>Solanum nigrum</i>		
* <i>Sonchus oleraceus</i>	0.1	<1
* <i>Lysimachia arvensis</i>	0.1	<1
<i>Parietaria debilis</i>		
* <i>Dischisma arenarium</i>	0.1	1
<i>Isolepis marginata</i>		
<i>Crassula colorata</i>		
* <i>Carpobrotus edulis</i>	0.2	2
<i>Conostylis candicans</i>	0.1	<1
<i>Acanthocarpus preissii</i>	0.1	<1

SPECIES	HEIGHT (m)	COVER (%)
* <i>Cerastium glomeratum</i>		
* <i>Brassicaceae sp.</i>		
<i>Calandrinia liniflora</i>		
<i>Calandrinia brevipedata</i>		
<i>Hardenbergia comptoniana</i>	climber	3
* <i>Pelargonium capitatum</i>	0.5	2
<i>Spyridium globulosum</i>	0.3 + seedlings	<1
* <i>Oenothera drummondii</i>	0.4	2
* <i>Oenothera stricta</i>		
<i>Cassytha sp</i>	climber	1
* <i>Cuscuta epithymum</i>		
<b>TOTAL COVER</b>		<b>50</b>

\* introduced species

Red = newly recorded species

# QUADRAT GBF1

50 382543 E 6412176 N

**Pre-fire Vegetation:** *Acacia rostellifera*/*Spyridium globulosum* Open Heath (1.5m, 20-30%) over *Lepidosperma gladiatum* Open Sedgeland (10-20%)

**Landform:** Flat, low-lying, not wetland



QUADRAT (10 x 10m) – 18 April 2017

Peg in SE corner only (replaced April 2017)

SPECIES	HEIGHT (m)	COVER (%)
<i>Lepidosperma gladiatum</i>	0.7	10
<i>Ficinia nodosa</i>	0.5	4
<i>Acacia rostellifera</i>	0.3	1
<i>Baumea juncea</i>	0.5	<1
<i>Juncus kraussii</i>	0.4	<1
<i>Scaevola crassifolia</i>	0.3	<1
<i>Olearia axillaris</i>	0.3	<1
* <i>Sonchus</i> sp		
* <i>Lysimachia arvensis</i>		
* <i>Dischisma arenarium</i>		
<i>Crassula colorata</i>		
* <i>Conyza bonariensis</i>	To 1m	1
<i>Senecio pinnatifolius</i>		
* <i>Carpobrotus edulis</i>		
* <i>Lolium perenne</i>		
* <i>Brassicaceae</i> sp		
<i>Spyridium globulosum</i>	0.2-0.4	<1
<i>Calandrinia</i> sp.		
* <i>Crassula glomerata</i>		

SPECIES	HEIGHT (m)	COVER (%)
* <i>Pelargonium capitatum</i>		
<i>Caladenia latifolia</i>		
* <i>Hypochaeris radicata</i>		
* <i>Taraxacum officinale</i>		
* <i>Oenothera drummondii</i>		
<i>Hardenbergia comptoniana</i>	0.1 seedling	<1
<b>TOTAL COVER</b>		<b>15</b>

\* introduced species

Red = newly recorded species

## QUADRAT GBF2

50 382501 E 6412149 N

**Pre-fire Vegetation:** *Baumea juncea*/*Ficinia nodosa* Closed Sedgeland (90%) over *Centella asiatica* Herbland

**Landform:** Swale, damp peaty soil, wetland



QUADRAT (10 x 10m) – 18 April 2017

Peg in SE corner only (replaced April 2017)

SPECIES	HEIGHT (m)	COVER (%)
<i>Baumea juncea</i>	0.7	50
<i>Ficinia nodosa</i>	0.8	50
<i>Samolus repens</i>		
<i>Acacia saligna</i>		
* <i>Lolium perenne</i>		
<i>Sporobolus virginicus</i>	0.2	<1
<i>Apium prostratum</i>	0.5	5
<i>Lobelia anceps</i>	0.6	30
<i>Centella asiatica</i>	0.3	25
* <i>Sonchus oleraceus</i>		
* <i>Carpobrotus edulis</i>		
* <i>Pelargonium capitatum</i>		
* <i>Trifolium campestre</i>		
<i>Epilobium billardioreanum</i>	0.4	<1
<b>TOTAL COVER</b>		<b>100</b>

\* introduced species

Red = newly recorded species

### QUADRAT GBF3

50 382461 E 6412160 N

**Pre-fire Vegetation:** *Acacia rostellifera*/*Spyridium globulosum* Closed Tall Scrub (3.5-4m, >70%) over *Lepidosperma gladiatum* Sedgeland (30%)

**Landform:** Top of low rise, dry sandy soils



QUADRAT (10 x 10m) – 18 April 2017

Pegs in SW, SE and NW corners

SPECIES	HEIGHT (m)	COVER (%)
<i>Acacia rostellifera</i>	1	30
<i>Lepidosperma gladiatum</i>	0.6-0.9	20
* <i>Trachyandra divaricata</i>	0.4	<1
* <i>Lolium perenne</i>		
* <i>Lagurus ovatus</i>		
<i>Calandrinia liniflora</i>		
* <i>Hypochaeris radicata</i>		
<i>Parietaria debilis</i>		
* <i>Dischisma arenarium</i>		
<i>Scaevola crassifolia</i>	0.3-0.8	1
* <i>Bromus diandrus</i>		
* <i>Crassula glomerata</i>		
* <i>Cerastium glomeratum</i>		
<i>Isolepis marginata</i>		
* <i>Pelargonium capitatum</i>	0.1	<1
<i>Spyridium globulosum</i>	0.4	<1
* <i>Conyza bonariensis</i>	1	<1
<i>Thysanotus patersonii</i>		
<i>Clematis linearifolia</i>		
<i>Hardenbergia comptoniana</i>		
<i>Rhagodia baccata</i>	0.2	<1

<b>TOTAL COVER</b>		<b>50</b>
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\* introduced species

Red = newly recorded species

## QUADRAT GBF4

50 382427 E 6412262 N

**Pre-fire Vegetation:** *Acacia rostellifera*/*Spyridium globulosum* Shrubland (1.5m, 10%) over *Lepidosperma gladiatum*/*Trachyandra divaricata* Sedgeland (60%)

**Landform:** Upper slopes of low rise, dry sandy soil



QUADRAT (10 x 10m) – 18 April 2017

Peg in SE corner only

SPECIES	HEIGHT (m)	COVER (%)
<i>Acacia rostellifera</i>	0.5	2
<i>Lepidosperma gladiatum</i>	0.5	30
* <i>Trachyandra divaricata</i>	0.4	20
* <i>Podotheca angustifolia</i>		
* <i>Solanum nigrum</i>		
* <i>Sonchus oleraceus</i>		
<i>Conostylis candicans</i>		
* <i>Lolium perenne</i>		
<i>Calandrinia liniflora</i>		
* <i>Crassula glomerata</i>		
<i>Parietaria debilis</i>		
* <i>Cynodon dactylon</i>		
* <i>Ehrharta calycina</i>		
<i>Isolepis marginata</i>		
* <i>Dischisma arenarium</i>		
* <i>Euphorbia terracina</i>	0.4	<1
* <i>Conyza bonariensis</i>	0.4	<1
<i>Crassula colorata</i>		

SPECIES	HEIGHT (m)	COVER (%)
* <i>Cerastium glomeratum</i>		
<i>Spyridium globulosum</i> seedling	0.1	<1
<i>Scaevola crassifolia</i>	0.2	<1
* <i>Carpobrotus edulis</i>		
* <i>Pelargonium capitatum</i>	0.2	1
* <i>Oenothera drummondii</i>	0.2	<1
* <i>Cuscuta epithymum</i>		
<i>Hardenbergia comptoniana</i>	0.1 seedling	<1
<i>Cassytha racemosa</i>	climber	<1
<b>TOTAL COVER</b>		<b>50-55</b>

\* introduced species

Red = newly recorded species

# QUADRAT GBF5

50 382466 E 6412278 N

**Pre-fire Vegetation:** *Baumea juncea* Sedgeland (90%) over *Centella asiatica*  
Herbland

**Landform:** Swale, damp peaty soil, wetland



QUADRAT (10 x 10m) – 18 April 2017

Peg in SE corner only

SPECIES	HEIGHT (m)	COVER (%)
<i>Baumea juncea</i>	1	80
<i>Ficinia nodosa</i>	1	5
<i>Juncus kraussii</i>	0.6	<1
<i>Centella asiatica</i>	0.3	40
<i>Acacia saligna</i>	0.5	<1
<i>Samolus junceus</i>		
<i>Samolus repens</i>		
<i>Apium prostratum</i>	0.5	2
<i>Spyridium globulosum</i>	0.4	<1
<i>Lobelia anceps</i>	0.4	1
<i>Sphaerolobium ?calcicola</i>	0.4	<1
* <i>Lolium perenne</i>		
* <i>Lysimachia arvensis</i>		
* <i>Romulea rosea</i>		
<i>Atriplex sp.</i>		
* <i>Pelargonium capitatum</i>		
* <i>Arctotheca calendula</i>		
<b>TOTAL COVER</b>		<b>100</b>

\* introduced species

Red = newly recorded species

# QUADRAT GBF6

50 382527 E 6412277 N

**Pre-fire Vegetation:** *Spyridium globulosum*/*Exocarpos sparteus* Open Heath  
(1.5m, 50-70%) over *Lepidosperma gladiatum*/*Baumea juncea* Open  
Sedgeland (20-30%)

**Landform:** Flat, low-lying, not wetland



QUADRAT (10 x 10m) – 18 April 2017

Pegs in SE and NE corners

SPECIES	HEIGHT (m)	COVER (%)
<i>Lepidosperma gladiatum</i>	0.9	20
* <i>Conyza bonariensis</i>	To 1m	<1
<i>Juncus kraussii</i>	0.7	<1
<i>Ficinia nodosa</i>	0.6	<1
<i>Baumea juncea</i>	0.5	15
<i>Leucopogon parviflorus</i>	0.5	<1
<i>Rhagodia baccata</i>	0.4	2
* <i>Solanum nigrum</i>	0.3	<1
<i>Scaevola crassifolia</i>	0.3	<1
<i>Exocarpos sparteus</i>	0.3	<1 one only
<i>Lobelia anceps</i>	0.3	<1
* <i>Lolium perenne</i>		
<i>Parietaria debilis</i>		
* <i>Crassula glomerata</i>		
<i>Calandrinia liniflora</i>		
* <i>Dischisma arenarium</i>		
<i>Olearia axillaris</i>	0.6	1
* <i>Lysimachia arvensis</i>		

SPECIES	HEIGHT (m)	COVER (%)
<i>Isolepis marginata</i>		
* <i>Carpobrotus edulis</i>	0.2	<1
* <i>Cerastium glomeratum</i>		
* <i>Pelargonium capitatum</i>	To 0.4	2
<i>Spyridium globulosum</i>	0.4	1 many seedlings
<i>Acacia saligna</i>	0.3	1
* <i>Hypochaeris glabra</i>		
* <i>Conyza bonariensis</i>		
* <i>Oenothera drummondii</i>	0.3	2
<i>Hardenbergia comptoniana</i>	climber	<1
<b>TOTAL COVER</b>		<b>40</b>

\* introduced species

Red = newly recorded species

# QUADRAT GBF7

50 382459 E 6412348 N

**Pre-fire Vegetation:** *Baumea juncea* Closed Sedgeland (80-90%) with occasional *Acacia saligna* shrubs over *Centella asiatica* Herbland

**Landform:** Swale, damp peaty soil, wetland, some water in north-east corner



QUADRAT (10 x 10m) – 18 April 2017

NE small peg and SE tall peg

SPECIES	HEIGHT (m)	COVER (%)
<i>Juncus kraussii</i>	0.8	1
<i>Baumea juncea</i>	0.6	70
* <i>Cyperus tenuiflorus</i>	0.6	5
<i>Ficinia nodosa</i>	0.8	10
<i>Schoenoplectus validus</i>	1.2	<1
<i>Lepidosperma gladiatum</i>	1	1
* <i>Symphotrichum squamatum</i>	1	5
<i>Apium prostratum</i>	0.6	10
<i>Melaleuca preissiana</i>	0.3 seedlings	5
<i>Lobelia anceps</i>	0.3	<1
<i>Samolus repens</i>	0.3	<1
* <i>Trachyandra divaricata</i>		
* <i>Lolium perenne</i>		
* <i>Lagurus ovatus</i>		
* <i>Sonchus oleraceus</i>	0.3	<1
* <i>Romulea rosea</i>		
<i>Olearia axillaris</i>	0.7	<1
<i>Centella asiatica</i>	0.2	20

SPECIES	HEIGHT (m)	COVER (%)
<i>*Dischisma arenarium</i>		
<i>*Oenothera drummondii</i>		
<i>Trachymene pilosa</i>		
<i>Eryngium pinnatifidum</i>		
<i>Acacia cyclops</i>	0.5	<1
<i>Spyridium globulosum</i>	0.2 seedling	<1
<i>*Solanum nigrum</i>		
<i>*Trifolium sp.</i>		
<i>*Cynodon dactylon</i>		
<i>Acacia saligna</i>		
<i>*Pelargonium capitatum</i>		
<i>*Carpobrotus edulis</i>		
<i>*Oenothera stricta</i>		
<i>*Crassula glomerata</i>		
<i>*Hypochaeris glabra</i>		
<i>Hardenbergia comptoniana</i>		
<b>TOTAL COVER</b>		<b>90</b>

\* introduced species

Red = newly recorded species

# QUADRAT GBF8

50 382413 E 6412428 N

**Pre-fire Vegetation:** *Acacia rostellifera*/*Spyridium globulosum* Closed Tall Scrub  
(4m, 70-80%) over *Lepidosperma gladiatum* Sedgeland (20-30%)

**Landform:** Upper slopes of dune



QUADRAT (10 x 10m) – 18 April 2017

Peg in SE corner only (replaced April 2017)

SPECIES	HEIGHT (m)	COVER (%)
<i>Acacia rostellifera</i>	1.2	40
<i>Lepidosperma gladiatum</i>	1	10
* <i>Podotheca angustifolia</i>		
* <i>Trachyandra divaricata</i>	0.4	<1
* <i>Lysimachia arvensis</i>		
* <i>Oenothera drummondii</i>	0.4	1
<i>Rhagodia baccata</i>	0.4	5
* <i>Solanum nigrum</i>	0.3	8
<i>Scaevola crassifolia</i>	0.3	1
<i>Olearia axillaris</i>	0.3	<1
* <i>Ehrharta calycina</i>		
<i>Calandrinia liniflora</i>		
* <i>Dischisma arenarium</i>		
<i>Isolepis marginata</i>		
* <i>Pelargonium capitatum</i>	0.2	1
<i>Parietaria debilis</i>		
* <i>Crassula glomerata</i>		
<i>Calandrinia brevipedata</i>		

SPECIES	HEIGHT (m)	COVER (%)
* <i>Conyza bonariensis</i>	0.6	1
* <i>Carpobrotus edulis</i>	0.1	<1
<i>Cassytha sp</i>		
<b>TOTAL COVER</b>		<b>65</b>

\* introduced species

Red = newly recorded species

# QUADRAT GBF9

50 382410 E 6412509 N

**Pre-fire Vegetation:** *Spyridium globulosum* Tall Shrubland (3.5m, 10%) over  
*Lepidosperma gladiatum*/*Trachyandra divaricata* Sedgeland (50%)

**Landform:** Mid-slope of dune



QUADRAT (10 x 10m) – 18 April 2017

Peg in SE corner only

SPECIES	HEIGHT (m)	COVER (%)
<i>Lepidosperma gladiatum</i>	0.5	20
* <i>Trachyandra divaricata</i>	0.3	15
<i>Adriana quadripartita</i>	0.6	<1
* <i>Conyza bonariensis</i>	0.5	1
<i>Scaevola crassifolia</i>	0.3	1
* <i>Crassula glomerata</i>		
* <i>Solanum nigrum</i>		
* <i>Sonchus oleraceus</i>		
* <i>Lysimachia arvensis</i>		
<i>Parietaria debilis</i>		
* <i>Dischisma arenarium</i>		
<i>Isolepis marginata</i>		
<i>Crassula colorata</i>		
* <i>Carpobrotus edulis</i>	0.1	<1
* <i>Cerastium glomeratum</i>		
* <i>Brassicaceae sp.</i>		
<i>Calandrinia liniflora</i>		
<i>Calandrinia brevipedata</i>		
<i>Hardenbergia comptoniana</i>	climber	2

SPECIES	HEIGHT (m)	COVER (%)
* <i>Pelargonium capitatum</i>	0.2	1
<i>Spyridium globulosum</i>		
* <i>Oenothera drummondii</i>	0.5	1
* <i>Oenothera stricta</i>		
* <i>Cuscuta epithymum</i>	climber	<1
<b>TOTAL COVER</b>		<b>40</b>

\* introduced species

Red = newly recorded species