



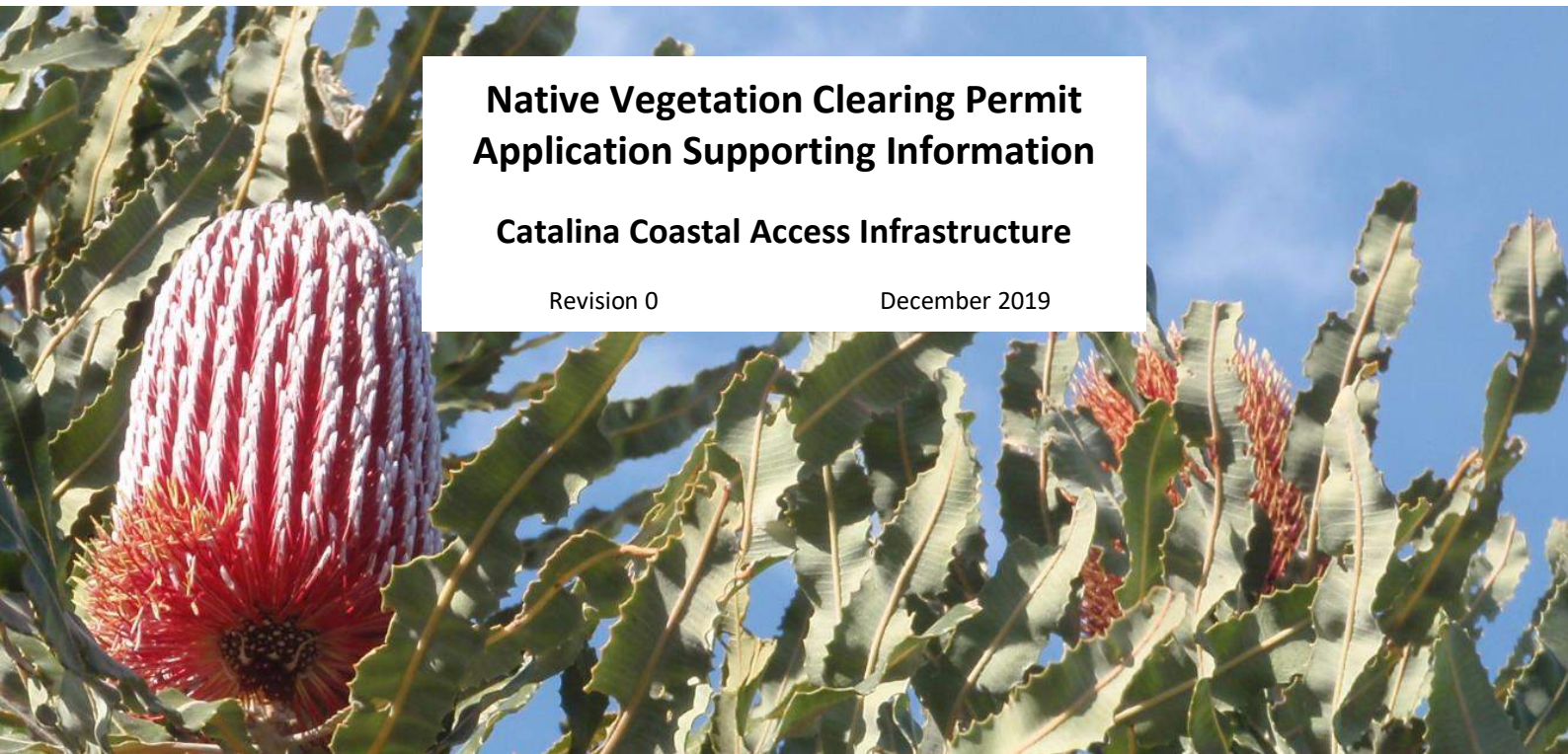
COTERRA
ENVIRONMENT

**Native Vegetation Clearing Permit
Application Supporting Information**

Catalina Coastal Access Infrastructure

Revision 0

December 2019



CALIBRE | COMMITMENT | COLLABORATION

This report was prepared by: Coterra Pty Ltd trading as COTERRA ENVIRONMENT

ABN: ABN: 92 143 411 456

Our Ref: SATCAT18

Author(s): K. Watts

Reviewer: R. Murray

Report Version: Revision 0

Date: December 2019

This report was prepared for:

Tamala Park Regional Council

PO Box 655

Innaloo WA 6918

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1 Introduction

1.1 Background

The Catalina land development site is located in the north-west corridor of the Perth Metropolitan Region (Figure 1). The Tamala Park Regional Council (TPRC) is the corporate entity representing the interests of seven local governments which own the Tamala Park landholding.

The TPRC comprises the following seven local government members:

- Town of Cambridge
- City of Joondalup
- City of Perth
- City of Stirling
- Town of Victoria Park
- City of Vincent
- City of Wanneroo

These member Councils have a joint holding in the project. The Satterley Property Group act as project managers and exclusive selling agents on the TPRC's behalf.

The TPRC was established in 2006 for the specific purpose of developing the Tamala Park landholding. The purpose of the Tamala Park Regional Council is to undertake the rezoning, subdivision, development, marketing and sale of the Tamala Park land.

Catalina Estate is subject to the Tamala Park Local Structure Plan which was approved by the Western Australian Planning Commission (WAPC) in 2011 and will facilitate a new urban development comprising around 2,500 lots. The first phase of construction and development commenced in 2011. To date, 924 lots have been sold in the Catalina Estate with approximately 888 houses completed or under construction.

Consisting a total of approximately 180 ha, the development area is divided into three Precincts known as 'Catalina Beach' located west of Marmion Avenue, 'Catalina Central' located east of Marmion Avenue and 'Catalina Grove' located east of Connolly Drive (the development plan for the site adjacent to the proposed clearing area is provided in Appendix 1).

1.2 Need for the Coastal Access Infrastructure

The Catalina Beach precinct is located approximately 500 m from the coastline, and given the projected increase in the local population it has been determined in consultation with the City of Wanneroo that a formal coastal access route should be created to enable residents and visitors to the area to access this section of the coast in a controlled manner. At present, a number of informal bush tracks exist, used by people gain 4WD access to the beach. Given the informal nature of these tracks, damage to vegetation and dune structures enhanced further by wind erosion has occurred as a result of this uncontrolled access. It is envisaged that the provision of this coastal access infrastructure will deter residents from contributing to the environmental degradation caused by uncontrolled 4WD access and enable these areas to regenerate.

In addition to the above, a Coastal Aquatic Risk Assessment was undertaken by Surf Life Saving Western Australia (SLSWA, 2014) for the coastal zone fronting Catalina Estate. The findings of this assessment concluded:

- The current formal beach access locations to Claytons Beach (north of Catalina Estate at Mindarie) and Burns Beach (3 km south of Catalina Estate) lead beach-goers to potentially hazardous areas, consisting of rock / reef platforms, steep dunes, rips, strong currents and submerged rocks.
- Two locations were identified as the preferred beach access location fronting the Catalina Estate, due to safe swimming conditions and absence of the potential hazards present in the existing access locations to the north and south.
- Infrastructure recommended to support safe aquatic recreation in this area includes:
 - Defined access tracks
 - Designated emergency vehicle access points
 - System of safety signage and consideration of a lifesaving operational, storage, first aid and surveillance facility for future service provision
 - Showers / toilets
 - Parking
 - Café / kiosk

1.3 Native Vegetation Clearing Permit Application

This Native Vegetation Clearing Permit (NVCP) application is for the clearing of up to 3.0 ha of coastal vegetation within approximately 3.8 ha of land west of the Catalina residential development. The overall 3.8 ha zone, which is shown on Figure 2, is based 10m buffer along each side of the preliminary engineering design footprint (2.37 ha). The maximum 3.0 ha clearing area includes an additional clearing allowance to accommodate adjustments which may come out of the detailed design stage of the project.

A Development Application for construction of the coastal infrastructure associated with this clearing permit is being lodged with the City of Wanneroo. It is noted that clearing of native vegetation cannot be initiated across the subject area without a NVCP. Whilst clearing for an access track is generally exempt from requiring a NVCP, the track is proposed to be located within an Environmentally Sensitive Area (ESA), and therefore the exemption does not apply in this circumstance. For this reason Coterra Environment, on behalf of TPRC, are seeking a NVCP for the proposed construction of beach access infrastructure.

2 Previous Environmental Investigations

2.1 Negotiated Planning Solution

A portion of the Catalina development area was identified in the Bush Forever documentation in December 2000 as part of Bush Forever Site no. 323, as a 'Negotiated Planning Solution' site. In the years following the release of Bush Forever, State Government agencies and the TPRC assessed biodiversity issues and the expectations for development of this land through the Negotiated Planning Solution (NPS) process. The original TPRC landholdings west of the now-established Marmion Avenue totalled 121.5 ha. As a result of the extensive NPS process the TPRC ceded 89 ha of land originally part of the Tamala Park landholdings to the Government for reservation as Bush Forever conservation land (becoming Bush Forever Site No. 323). With this area excised from the Tamala Park landholding, 32.5 ha remained within the Catalina Beach precinct for urban development purposes.

2.2 Proposed Dual Use Coastal Path between Mindarie and Burns Beach - Environmental Study and Topographical Survey Report (GHD, 2013)

The Department of Planning commissioned GHD to undertake an investigation across a large stretch of the coastal vegetation between Burns Beach (south of Catalina Estate) and Mindarie (north of Catalina Estate) to determine the environmental feasibility of constructing a dual use coastal path between these two locations (GHD, 2013). The study area encompassed the current proposed coastal access route footprint (the subject of this NVCP application). The investigation encompassed:

- Desktop review of environmental factors
- A desktop review of LiDAR data and latest aerial imagery
- Buried services investigation, using the Dial Before You Dig (DBYD) system
- Level 1 flora reconnaissance survey
- Level 1 fauna reconnaissance survey
- Topographical feature survey of preferred route alignments
- Development of two coastal dual use path alignments

2.3 Level 1 Flora and Vegetation Assessment of Lot 17 Marmion Avenue, Clarkson (Mattiske Consulting Pty Ltd, 2000)

Mattiske Consulting Pty Ltd undertook a vegetation and flora survey to review the options for the Structure Plan covering Lot 17 Mindarie and in particular the area west of Marmion Avenue. This survey included a significant portion of the previous extent of Bush Forever Site No. 322, however did not extend throughout the foreshore reserve. It incorporated a review of previous studies in the general area, including surveys undertaken by Kinhill Stearns (1983), Alan Tingay and Associates (1999) and Mattiske Consulting Pty Ltd (1999).

2.4 Declared Rare and Priority Flora Search for the Area Ceded to Bush Forever Site 322 (Syrinx, 2009)

Syrinx undertook a broad-scale Declared Rare Flora and Priority Flora Survey across the area of Bush Forever 322 surrendered by TPRC during the Negotiated Planning Solution. No Declared Rare Flora were recorded, however a Priority 2 moss (*Fabronia hampeana*) was found growing on a number of zamia palms. Vegetation condition and vegetation communities were also recorded.

2.5 Level 2 Flora and Vegetation Survey (BEC, 2016)

A Level 2 Flora and Vegetation Survey was undertaken in November 2016 (Appendix 2) for the proposed coastal infrastructure access route (encompassing a greater area than the final clearing footprint determined) by Bennett Environmental Consulting (BEC, 2016). The survey identified four vegetation units, and vegetation condition ranging from Very Good to Good within this localised area. Recommendations were made on the construction of the tracks, the hard stand near the beach, rehabilitation due to site works associated with this construction and closure and rehabilitation of other off road tracks through the area.

3 Site Characteristics

3.1 Topography, Landform and Geomorphology

The subject area is steeply undulating, with topography ranging generally from 0 mAHD at the water's edge to 32 – 34 mAHD on the dune crests and ridgelines (Figure 2).

The foreshore area is located within the Quindalup Dune System, a coastal dune formation of unconsolidated Holocene aeolian deposits (Safety Bay Sand) and Tamala limestone, occurring to the west of the Spearwood Dunes. The major formations are moderately inclined to steep sided, complex parabolic dunes. Active foredune ridges also occur adjacent to the coast. The dominant soils are rapidly drained, uniform pale calcareous sands with minimal profile development (Wells and Clarke, 1986).

3.2 Groundwater

Regional groundwater contours mapped in the Perth Groundwater Atlas (DoW, 2017) indicate that maximum groundwater levels occur between 2 mAHD at the eastern portion of the access road, to 0 mAHD at the water's edge. Groundwater flows in a westerly direction discharging to the ocean.

3.3 Vegetation and Flora

A Level 2 Flora and Vegetation Survey was undertaken by BEC (2016) in November 2016, across two potential access route options (within which the subject area occurs). The findings of this survey are presented below.

3.3.1 Regional Vegetation Complex

Regional vegetation mapping undertaken by Heddle et al. (1980) indicates that the original extent of the Quindalup Complex is mapped across the proposed clearing area. The current reservation status of this complex is provided in Table 3-1.

Table 3-1: Historical and current extent and reservation of regional vegetation complexes

Veg Complex	Total Pre-European Extent (ha) on SCP	Percentage remaining on SCP	Percentage remaining in secure tenure on SCP	Total Pre-European Extent (ha) in CoW	Percentage remaining in CoW	Percentage remaining in secure tenure in CoW
Quindalup	38,503	55.38% (21,323 ha)	10.83%	38,503	55.38% (21,323 ha)	10.83%

Source: Local Biodiversity Program (2010) and (2013)

3.3.2 Vegetation Units

Four different vegetation units were recorded from the survey area (BEC, 2016) (Figure 3), described as:

- Open Heath of *Melaleuca cardiophylla* over Very Open Grassland dominated by **Ehrharta longiflora* over Herbland dominated by **Raphanus raphanistrum*, **Crassula glomerata* and **Petrohragia dubia* over Sedgeland dominated by *Lomandra maritima* and *Desmocladius flexuosus*;
- Tall Open Scrub of *Acacia rostellifera* and *Spyridium globulosum* over Low Shrubland of *Melaleuca systena* over Open Grassland dominated by **Ehrharta longiflora* over Open Herbland dominated by **Lysimachia arvensis* over Very Open Sedgeland of *Lomandra maritima* and *Desmocladius flexuosus*;

- Shrubland of *Acacia rostellifera* over Low Shrubland dominated by *Rhagodia baccata* subsp. *dioica* and *Scaevola crassifolia* over Very Open Grassland dominated by **Ehrharta longiflora* over Open Herbland dominated by *Acanthocarpus preissii*, **Crassula glomerata* and **Trachyandra divaricata* over Sedgeland of *Lepidosperma gladiatum*; and
- Low Open Shrubland of *Olearia axillaris*, *Scaevola crassifolia*, **Pelargonium capitatum* and *Rhagodia baccata* subsp. *dioica* over Grassland dominated by *Spinifex longifolius* over Very Open Herbland dominated by **Trachyandra divaricata*.

3.3.3 Vegetation Condition

The condition of the vegetation through which the access route is proposed is described by BEC (2016) as being mostly in Good, Very Good to Good or Very Good condition. Cleared or highly disturbed areas and tracks were recognised as Good to Degraded or Degraded (Figure 3). Table 3-2 provides a description of each of the condition ratings (Keighery, 1994).

Table 3-2: Condition Rating Scale (Keighery, 1994)

Rating	Description	Explanation
1	Pristine	Pristine or nearly so, no obvious signs of disturbance.
2	Excellent	Vegetation structure intact, disturbance affecting individual species and weeds are non-aggressive species.
3	Very Good	Vegetation structure altered, obvious signs of disturbance.
4	Good	Vegetation structure significantly altered by very obvious signs of multiple disturbances. Retains basic vegetation structure or ability to regenerate it.
5	Degraded	Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching good condition without intensive management.
6	Completely Degraded	The structure of the vegetation is no longer intact and the area is completely or almost completely without native species.

3.3.4 Conservation Significant Flora and Vegetation Communities

No threatened or priority species were located during the survey (BEC, 2016).

A search of the former Department of Parks and Wildlife (DPaW) Threatened (TEC) and Priority Ecological Communities (PEC) List found no conservation significant ecological communities occurring in the subject area (BEC, 2016). The vegetation communities recorded during the survey are not described as likely to be of conservation significance as a TEC or PEC (BEC, 2016).

3.3.5 Bush Forever

The access road and carpark are proposed to be constructed within Bush Forever Site No. 322 – Burns Beach Bushland. A portion of this coastal bushland reserve was previously under the ownership of TPRC and was ceded to the Crown for conservation (see Section 2).

3.4 Fauna and Habitat

GHD (2013) completed a Level 1 fauna and habitat assessment for the proposed coastal path between Mindarie and Burns Beach which included the subject area, reporting that 28 fauna species were recorded within the vicinity, consisting of 21 birds (all native) and three mammals (one native and two exotic/naturalised), and four reptiles (all native). No species of conservation significance were recorded during the field assessment. Previous survey of adjacent land has found quendas and an array of reptiles (G. Harewood, pers com, 2018).

While tailed black cockatoos are known to occur within the vicinity of the subject area. Based on the four vegetation units, no potential breeding tree species i.e. salmon gum (*E. salmonophloia*), wandoo, tuart, jarrah, flooded gum (*E. rudis*), york gum (*E. loxophleba* subsp. *loxophleba*), powderbark (*E. accedens*), karri and marri, blackbutt (*E. patens*), tuart (DEE, 2017) have been recorded within the subject area and the vegetation types do not support the typical foraging species commonly used by Carnaby's black cockatoo (DEC, 2011).

4 Assessment against Clearing Principles

Table 4-1 provides assessment of the proposed clearing against the EPA's ten clearing principles, as provided in Schedule 5 of the *Environmental Protection Act 1986*.

Table 4-1: Assessment Against Clearing Principles

Native Vegetation Clearing Principles	Assessment of Proposed Changes
1. Native vegetation should not be cleared if it comprises a high level of biological diversity	<p>A search of the NatureMap database in January 2017 (central point of subject area plus 2 km buffer) found 19 plant species, 61 animal species and 4 fungi species potentially occurring in the area.</p> <p>The Flora and Vegetation Survey undertaken by BEC (2016) recorded 68 taxa, of which 26 were weeds / non-native species (list is provided in Appendix 2). Four species were recorded from all vegetation units; <i>Acacia cyclops</i>, <i>Acanthocarpus preissii</i>, * <i>Olearia axillaris</i> and <i>Spyridium globulosum</i> (BEC, 2016). Over a large distance between Catalina Estate and the coast, this is not considered to represent a high level of biodiversity.</p> <p>The vegetation condition varied between very good and good except along the track where it was degraded. Weeds were common throughout the remnant bushland but were very dense along the edges of the track (BEC, 2016). Clearing is proposed to utilise existing tracks as far as possible.</p>
2. Native vegetation should not be cleared if it comprises the whole or a part of, or is necessary for the maintenance of, a significant habitat for fauna indigenous to Western Australia	<p>The study undertaken by GHD (2013) describes four broad fauna habitat types, of which three are likely to occur within the subject area:</p> <ol style="list-style-type: none"> 1. Medium to tall shrub land and woodlands on parallel dunes. 2. Blow-outs including mobile dune system. 3. Low lying shrubs and grasses on littoral dunes. <p>From the vegetation descriptions provided in BEC (2016), the vegetation onsite may provide some habitat to the graceful sun moth (<i>Synemon gratiosa</i>), a Priority 4 fauna species, due to the presence of habitat plant <i>Lomandra maritima</i> within the AR vegetation unit.</p> <p>The clearing of an access route and car park to facilitate the use of the beach area adjacent to Catalina Estate is unlikely to have an impact on significant fauna habitat, due to the small area of clearing proposal and attempts to utilise existing tracks and dune blowouts to minimise clearing.</p>
3. Native vegetation should not be cleared if it includes, or is necessary for the continued existence of, rare flora	<p>Dr Eleanor Bennett conducted a Level 2 Flora and Vegetation Survey of the subject area which included a targeted search for Declared Rare and Priority flora, as listed under state and federal legislation (BEC, 2016). No Declared Rare or Priority flora (DRF) were identified within the area.</p> <p>As such, no rare flora will be impacted by the proposed clearing.</p>
4. Native vegetation should not be cleared if it comprises the whole or a part of, or is necessary for the maintenance of, a threatened ecological community	<p>Of the vegetation types surveyed on site, none are listed as threatened ecological communities.</p> <p>As such, no threatened ecological communities will be impacted by the proposed clearing.</p>
5. Native vegetation should not be cleared if it is significant as a remnant of native vegetation in an area	<p>The majority of the proposed clearing area lies within the original mapped extent of the Quindalup vegetation complex (Table 3-1). There is over 55% of this complex remaining on the Swan Coastal Plain, with over 68% of its original extent remaining within the City of Wanneroo. As such, this complex is considered well-represented.</p>

Native Vegetation Clearing Principles	Assessment of Proposed Changes
that has been extensively cleared	
6. Native vegetation should not be cleared if it is growing in, or in association with, an environment associated with a watercourse or a wetland	There are no surface water features noted within the subject area.
7. Native vegetation should not be cleared if the clearing of the vegetation is likely to cause appreciable land degradation	It is unlikely that the proposed clearing of the native vegetation will result in land degradation, due to engineering measures proposed to stabilise the road and carpark structures within the landscape. Such measures include rock pitching within table drains adjacent to asphalt road and complying with CoW's batter grade requirements.
8. Native vegetation should not be cleared if the clearing of the vegetation is likely to have an impact on the environmental values of any adjacent or nearby conservation areas	The access road and carpark are proposed to be constructed within Bush Forever Site No. 322 – Burns Beach Bushland (including Crown reserves R20561 and R35890). Whilst this area is considered protected for conservation (Bush Forever and zoned Regional Parks and Recreation / Foreshore Reserve under the District Planning Scheme 2), the proposed access route has been aligned as far as possible with an existing track, and the carpark has been sited within an existing dune blowout to reduce the amount of clearing required and to provide access to a safe swimming beach. The provision of a formal access route is expected to reduce the damage to dunes and vegetation as a result of uncontrolled access on informal 4WD tracks.
9. Native vegetation should not be cleared if the clearing of the vegetation is likely to cause deterioration in the quality of the surface or underground water	Low impact drainage infrastructure (with gross pollutant traps where appropriate) will be provided for the increased hard stand resulting from the construction of the road and carpark. The risk of impacts to quality of groundwater are considered to be low.
10. Native vegetation should not be cleared if clearing the vegetation is likely to cause, or exacerbate, the incidence or intensity of flooding	Given the minimal extent of clearing proposed, the sandy nature of coastal soils and the location of the carpark and road behind the fore dune, the proposed clearing is not likely to have any impact on the potential for the area to experience flooding.

5 Proposed Foreshore Management

Management of the constriction of use of the access track has been documented within the Catalina Estate Coastal Access Infrastructure Foreshore Management Plan (FMP). The current version of the document (Revision 6) has been reviewed by both the City of Wanneroo and the Department of Planning, Lands and Heritage (DPLH).

Mr Ben Bassett, Senior Planning Officer from DPLH, has advised via email (dated 19 August 2019) that:

The FMP provides a comprehensive assessment and framework for the proposed access infrastructure and is consistent with the Tamala Conservation Park Establishment Plan March 2012. The Council report provides a detailed assessment of the FMP (refer to this report for detail).

The FMP also identifies the approvals required to progress the access infrastructure.

The FMP satisfies the requirements of SPP2.6, and should any DA's be submitted with the access infrastructure in accordance with the FMP, there should be no impediment from an SPP2.6 perspective to issuing approval

A copy of the FMP is provided in Appendix 3.

6 Conclusion

The proposed clearing to construct an access road and carpark for public access to a safe swimming beach adjacent to the Catalina Estate development is not considered to be at variance with any of the native vegetation clearing principles, as discussed in Section 4.

The Level 2 Flora and Vegetation Survey undertaken in November 2016 found no threatened or priority species and no vegetation communities described as likely to be of conservation significance as a TEC or PEC.

The infrastructure footprint has been designed to minimise clearing, with large extents located within previously cleared tracks and dune blowouts. Additionally, the provision of the access road is expected to significantly reduce the use of informal tracks and damage to existing vegetation and dune structure as a result of uncontrolled vehicle access.

The proposal will provide an alternative access to a beach location recommended by Surf Life Saving WA due to safe swimming conditions and absence of the potential hazards present in the existing access locations to the north, such as Claytons Beach.

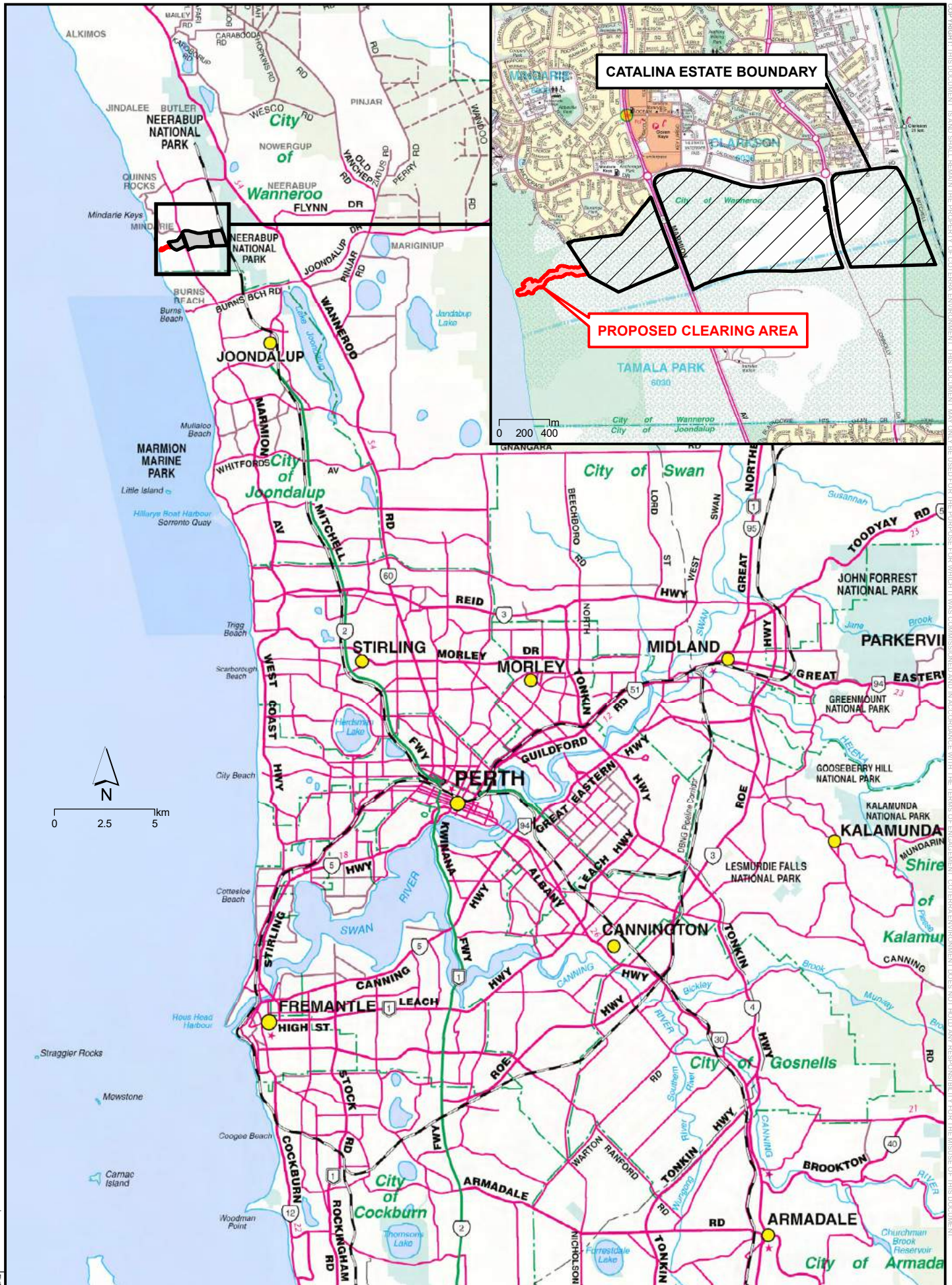
Management and mitigation actions associated with the proposed development are detailed in the Foreshore Management Plan to ensure the access road is constructed and used in an environmentally acceptable manner.

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




Figures




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LEGEND

-  Proposed Clearing Area (3.8 ha)
-  Cadastre
-  Contour mAHD



N



0 10 20 40 60 80 m

Scale: 1:1,500 @ A3
GDA 1994 MGA Zone 50



ENVIRONMAPS | T: 0406 590 006
Environmental Mapping Solutions | www.environmentmaps.com.au

Source: Cadastre - Landgate, 2015
Orthophoto - NearMaps, 28.10.16

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ENVIRONMENT

Job: SATCAT07a
Doc: 002
Date: 22/01/2018
Ph: (08) 9381 5513
Fax: (08) 9381 5514
E: info@coterra.com.au

Tamala Park Regional Council
CATALINA COASTAL ACCESS AND CARPARK (NVCP)
LOTS 15448, 3050 & 9505 TAMALA PARK

PROPOSED CLEARING AREA

Figure 2

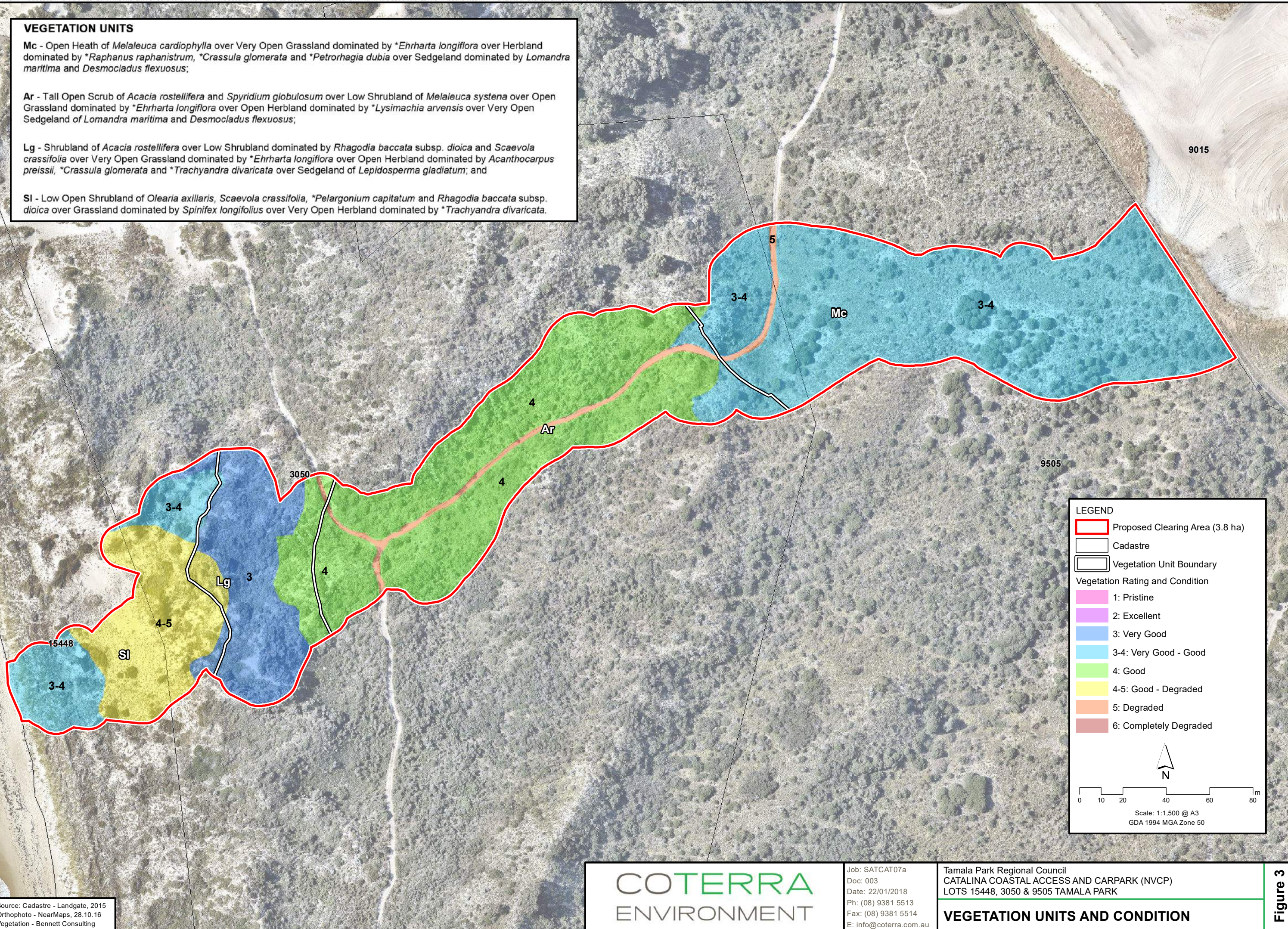
VEGETATION UNITS

Mc - Open Heath of *Melaleuca cardiophylla* over Very Open Grassland dominated by *Ehrharta longiflora* over Herbland dominated by *Raphanus raphanistrum*, *Crassula glomerata* and *Petrrohagia dubia* over Sedgeland dominated by *Lomandra maritima* and *Desmocladius flexuosus*;

Ar - Tall Open Scrub of *Acacia rostellifera* and *Spyridium globulosum* over Low Shrubland of *Melaleuca systema* over Open Grassland dominated by *Ehrharta longiflora* over Open Herbland dominated by *Lysimachia arvensis* over Very Open Sedgeland of *Lomandra maritima* and *Desmocladius flexuosus*;

Lg - Shrubland of *Acacia rostellifera* over Low Shrubland dominated by *Rhagodia baccata* subsp. *dioica* and *Scaevola crassifolia* over Very Open Grassland dominated by *Ehrharta longiflora* over Open Herbland dominated by *Acanthocarpus preissii*, *Crassula glomerata* and *Trachyandra divaricata* over Sedgeland of *Lepidosperma gladiatum*; and

Sl - Low Open Shrubland of *Olearia axillaris*, *Scaevola crassifolia*, *Pelargonium capitatum* and *Rhagodia baccata* subsp. *dioica* over Grassland dominated by *Spinifex longifolius* over Very Open Herbland dominated by *Trachyandra divaricata*.



LEGEND

- Proposed Clearing Area (3.8 ha)
- Cadastre
- Vegetation Unit Boundary

Vegetation Rating and Condition

- 1: Pristine
- 2: Excellent
- 3: Very Good
- 3-4: Very Good - Good
- 4: Good
- 4-5: Good - Degraded
- 5: Degraded
- 6: Completely Degraded



N



0 10 20 40 60 80 m

Scale: 1:1,500 @ A3
GDA 1994 MGA Zone 50

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Source: Cadastre - Landgate, 2015
Orthophoto - NearMaps, 28.10.16
Vegetation - Bennett Consulting

COTERRA
ENVIRONMENT

Job: SATCAT07a
Doc: 003
Date: 22/01/2018
Ph: (08) 9381 5513
Fax: (08) 9381 5514
E: info@coterra.com.au

Tamala Park Regional Council
CATALINA COASTAL ACCESS AND CARPARK (NVCP)
LOTS 15448, 3050 & 9505 TAMALA PARK

VEGETATION UNITS AND CONDITION

Figure 3

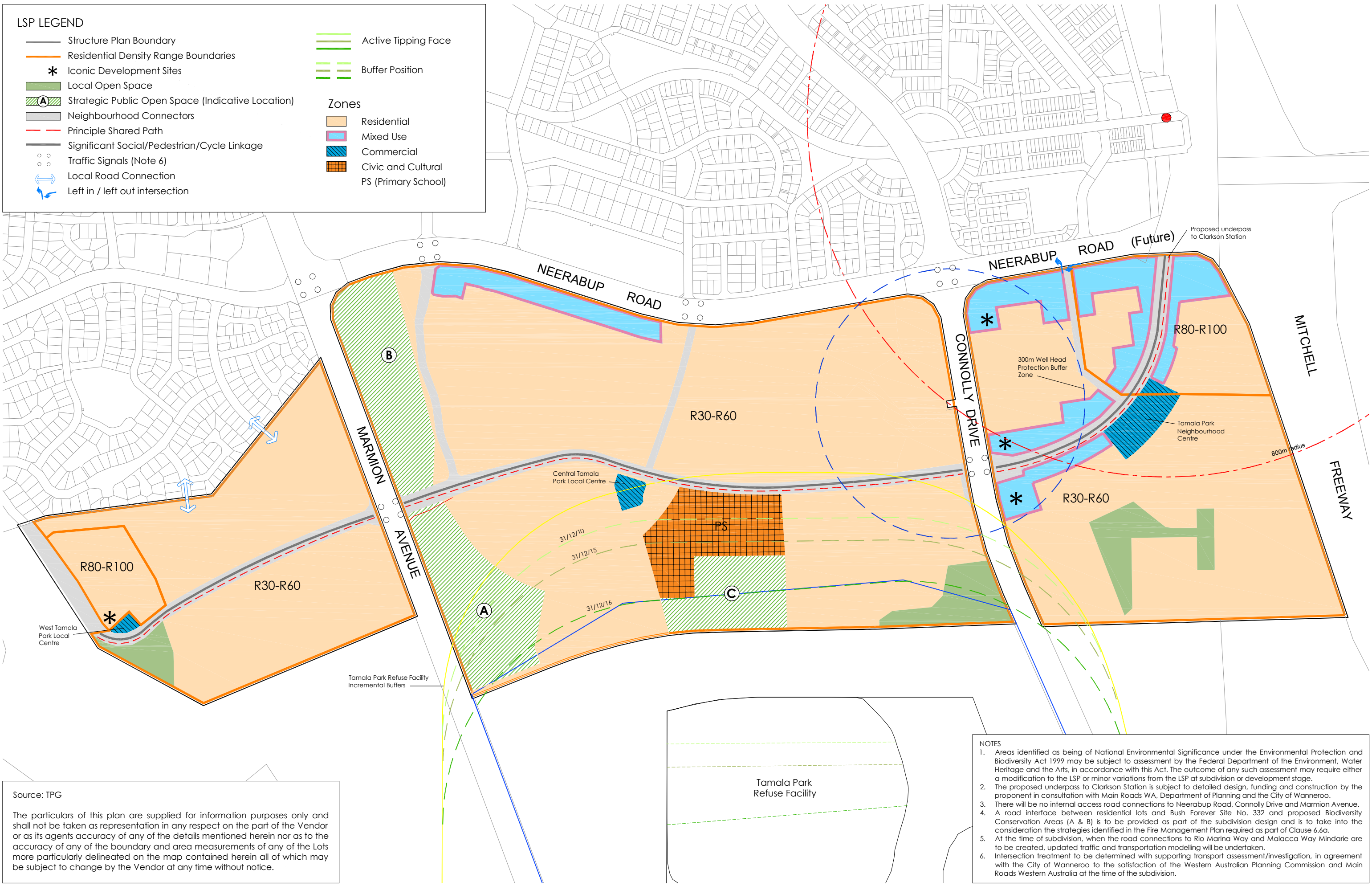


Appendix 1 Catalina Estate Development Plan

LSP LEGEND

- Structure Plan Boundary
- Residential Density Range Boundaries
- * Iconic Development Sites
- Local Open Space
- Strategic Public Open Space (Indicative Location)
- Neighbourhood Connectors
- Principle Shared Path
- Significant Social/Pedestrian/Cycle Linkage
- Traffic Signals (Note 6)
- Local Road Connection
- Left in / left out intersection

- Active Tipping Face
 - Buffer Position
- Zones**
- Residential
 - Mixed Use
 - Commercial
 - Civic and Cultural
 - PS (Primary School)



Source: TPG

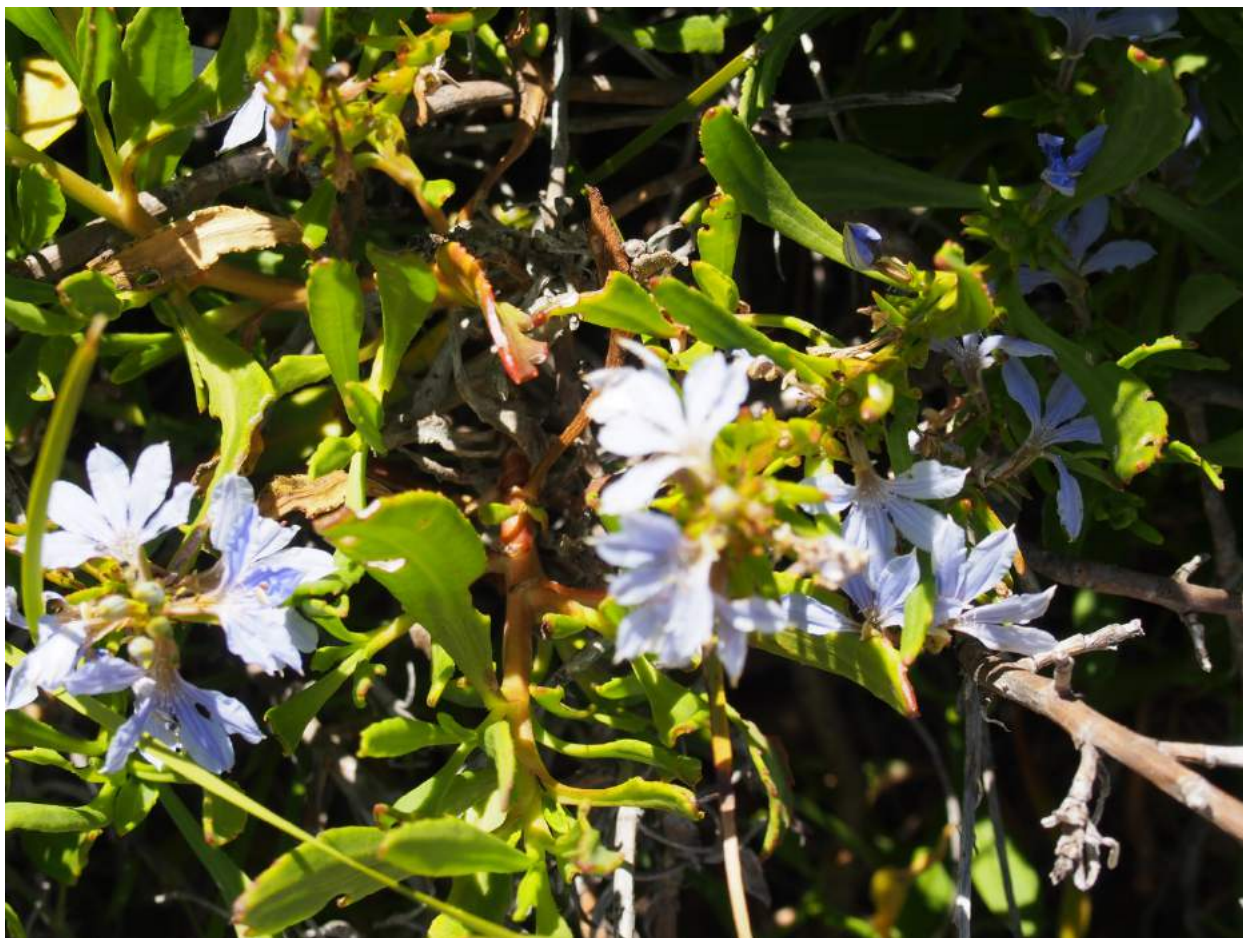
The particulars of this plan are supplied for information purposes only and shall not be taken as representation in any respect on the part of the Vendor or as its agents accuracy of any of the details mentioned herein nor as to the accuracy of any of the boundary and area measurements of any of the Lots more particularly delineated on the map contained herein all of which may be subject to change by the Vendor at any time without notice.

- NOTES**
1. Areas identified as being of National Environmental Significance under the Environmental Protection and Biodiversity Act 1999 may be subject to assessment by the Federal Department of the Environment, Water Heritage and the Arts, in accordance with this Act. The outcome of any such assessment may require either a modification to the LSP or minor variations from the LSP at subdivision or development stage.
 2. The proposed underpass to Clarkson Station is subject to detailed design, funding and construction by the proponent in consultation with Main Roads WA, Department of Planning and the City of Wanneroo.
 3. There will be no internal access road connections to Neerabup Road, Connolly Drive and Marmion Avenue.
 4. A road interface between residential lots and Bush Forever Site No. 332 and proposed Biodiversity Conservation Areas (A & B) is to be provided as part of the subdivision design and is to take into the consideration the strategies identified in the Fire Management Plan required as part of Clause 6.6a.
 5. At the time of subdivision, when the road connections to Rio Marina Way and Malacca Way Mindarie are to be created, updated traffic and transportation modelling will be undertaken.
 6. Intersection treatment to be determined with supporting transport assessment/investigation, in agreement with the City of Wanneroo to the satisfaction of the Western Australian Planning Commission and Main Roads Western Australia at the time of the subdivision.



Appendix 2 Flora and Vegetation Survey Report

Botanical Assessment of Proposed Access Roads from Catalina to the Beach



Prepared for:

Coterra Environment
Level 3,
25 Prowse Street,
West Perth WA 6005

Prepared by:

Bennett Environmental Consulting Pty Ltd



PO Box 341
KALAMUNDA 6926
November 2016

STATEMENT OF LIMITATIONS

Scope of Services

This report (“the report”) has been prepared in accordance with the scope of services set out in the contract, or as otherwise agreed, between the Client and Eleanor Bennett (“the Author”). In some circumstances a range of factors such as time, budget, access and/or site disturbance constraints may have limited the scope of services.

Reliance on Data

In preparing the report, the Author has relied upon data, surveys, analyses, designs, plans and other information provided by the Client and other individuals and organisations, most of which are referred to in the report (“the data”). Except as otherwise stated in the report, the Author has not verified the accuracy or completeness of the data. To the extent that the statements, opinions, facts, information, conclusions and/or recommendations in the report (“conclusions”) are based in whole or part on the data, those conclusions are contingent upon the accuracy and completeness of the data. The Author will not be liable in relation to incorrect conclusions should any data, information or condition be incorrect or have been concealed, withheld, misrepresented or otherwise not fully disclosed to the Author.

Environmental Conclusions

In accordance with the scope of services, the Author has relied upon the data and has conducted environmental field monitoring and/or testing in the preparation of the report. The nature and extent of monitoring and/or testing conducted is described in the report.

The conclusions are based upon field data and the environmental monitoring and/or testing carried out over a limited period of time and are therefore merely indicative of the environmental condition of the site at the time of preparing the report. Also it should be recognised that site conditions, can change with time.

Within the limitations imposed by the scope of services, the field assessment and preparation of this report have been undertaken and performed in a professional manner, in accordance with generally accepted practices and using a degree of skill and care ordinarily exercised by reputable environmental consultants under similar circumstances. No other warranty, expressed or implied, is made.

Report for Benefit of Client

The report has been prepared for the benefit of the Client and no other party. The Author assumes no responsibility and will not be liable to any other person or organisation for or in relation to any matter dealt with or conclusions expressed in the report, or for any loss or damage suffered by any other person or organisation arising from matters dealt with or conclusions expressed in the report (including without limitation matters arising from any negligent act or omission of the Author or for any loss or damage suffered by any other party relying upon the matters dealt with or conclusions expressed in the report). Other parties should not rely upon the report or the accuracy or completeness of any conclusions and should make their own enquiries and obtain independent advice in relation to such matters.

Other Limitations

The Author will not be liable to update or revise the report to take into account any events or emergent circumstances or facts occurring or becoming apparent after the date of the report. The scope of services did not include any assessment of the title to or ownership of the properties, buildings and structures referred to in the report nor the application or interpretation of laws in the jurisdiction in which those properties, buildings and structures are located.

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SUMMARY

Bennett Environmental Consulting Pty Ltd undertook a Level 2 botanical survey of two proposed access roads from the new development at Catalina through remnant bushland to the beach. Some sections of the proposed roads were common, namely the eastern end where it commences at the edge of the housing development and the western end where there is a car park proposed. It is proposed to make a hard surface road with a car park close to the beach where it bifurcates the southern survey area was through remnant bushland and the northern section was along a current off road track.

Four different vegetation units recorded from the survey area. These were:

1. Open Heath of *Melaleuca cardiophylla* over Very Open Grassland dominated by **Ehrharta longiflora* over Herbland dominated by **Raphanus raphanistrum*, **Crassula glomerata* and **Petrohragia dubia* over Sedgeland dominated by *Lomandra maritima* and *Desmocladius flexuosus*;
2. Tall Open Scrub of *Acacia rostellifera* and *Spyridium globulosum* over Low Shrubland of *Melaleuca systena* over Open Grassland dominated by **Ehrharta longiflora* over Open Herbland dominated by **Lysimachia arvensis* over Very Open Sedgeland of *Lomandra maritima* and *Desmocladius flexuosus*;
3. Shrubland of *Acacia rostellifera* over Low Shrubland dominated by *Rhagodia baccata* subsp. *dioica* and *Scaevola crassifolia* over Very Open Grassland dominated by **Ehrharta longiflora* over Open Herbland dominated by *Acanthocarpus preissii*, **Crassula glomerata* and **Trachyandra divaricata* over Sedgeland of *Lepidosperma gladiatum*; and
4. Low Open Shrubland of *Olearia axillaris*, *Scaevola crassifolia*, **Pelargonium capitatum* and *Rhagodia baccata* subsp. *dioica* over Grassland dominated by *Spinifex longifolius* over Very Open Herbland dominated by **Trachyandra divaricata*.

The vegetation condition varied between very good and good except along the track where it was degraded. Weeds were common throughout the remnant bushland but were very dense only along the edges of the track.

A total of 31 vascular plant families, 58 genera and 68 taxa were recorded during the survey, of which 26 taxa were weeds. None of the species were threatened or priority species and none of the weeds were listed as Declared Plants.

Recommendations were made on the construction of the tracks, the hard stand near the beach, rehabilitation due to site works associated with this construction and closure and rehabilitation of other off road tracks through the area. It is important that endemic species relevant to each vegetation unit be planted, in particular *Spinifex longifolius* and *Spinifex hirsutus* in preference to Marram Grass close to the strand line and in the foredunes.

1. INTRODUCTION

1.1 Background

Bennett Environmental Consulting Pty Ltd was commissioned by Coterra Environment to undertake a Level 2 assessment of two alternate routes proposed for a hard surfaced road from the new extension of the Catalina housing development to the beach. The development at Catalina commenced in 2012 and a new section is currently being prepared for additional housing.

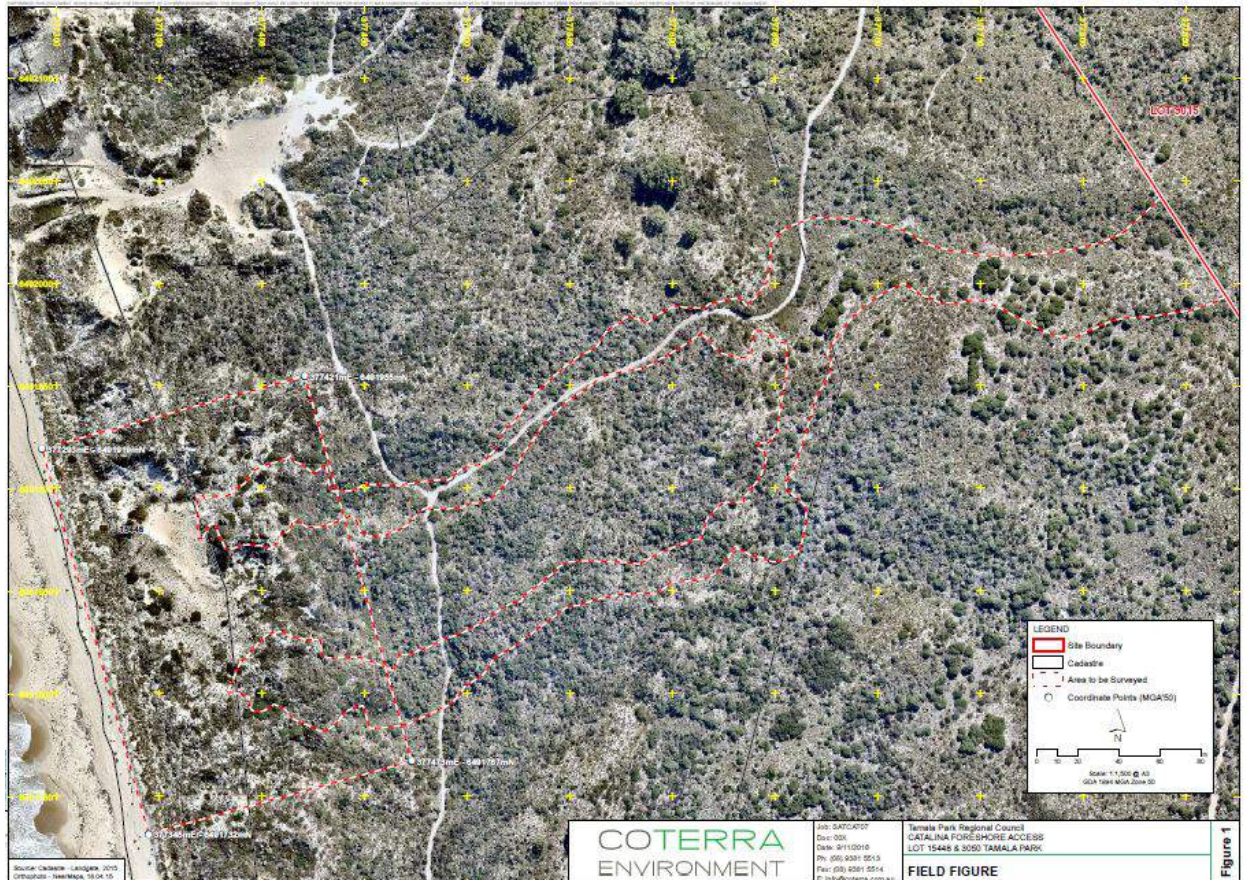


Diagram 1. Study area outlined in red/white lines. The white area indicates current tracks and the red line at the top right hand corner is where the current expansion will terminate.

Both of the tracks in Diagram 1 end in a rectangular area where it is proposed to construct a car park.

The survey area is included in the conservation area known as Tamala Park and managed by the Western Australian Planning Commission. The narrow coastal section is included in Bush Forever Site Number 322 – Burns Beach Bushland (Government of Western Australia, 2000). The Tamala Park Regional Council (2016) was formed in 2006 specifically to implement the urban development of the Tamala Park Project, marketed as Catalina. As part of environmental offsets, the Tamala Park Regional Council transferred 91 hectares of land, adjoining the foreshore reserve, to the Western Australian Planning Commission to form part of the future Coastal reserve from Burns Beach to Mindarie. This offset includes the study area.

1.2 Scope of Works

The requirements for this project were to:

- i. Undertake a Level 2 vegetation survey (Environmental Protection Authority and Department of Parks and Wildlife, 2015) of the proposed roads and the car parking area as indicated in Diagram 2; and
- ii. Search for threatened or priority flora within the proposed development areas.

2. BACKGROUND INFORMATION

2.1 Geology and Landform

The site is included in the Quindalup unit which consists of calcareous sands occurring as beach ridges and parabolic dunes. A detailed description of the soils and landforms was undertaken for the coastal area Mindarie to Quinns Rocks (Ecoscape Australia Pty. Ltd, 2004). A typical transect from west to east through the dune system included fore dunes gradually rising to higher primary and secondary dunes further away from the coast.

Although the current study area was not included in this detailed dune analysis some soil units can be inferred. Diagram 2 is a section of this study showing Mindarie which is just north of the survey area and the dune system recorded there.

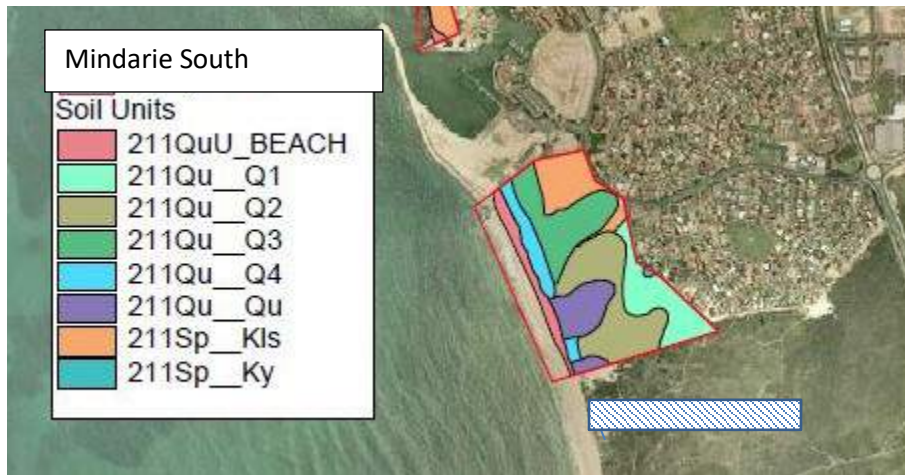


Diagram 2. Soils and Landforms described for Mindarie South including the cross hatched current study area.

From Diagram 2 it can be inferred that the current study area includes following the soil units: which are described as:

211QuU_Beach = Beach;

211Qu_Qu = Presently unstable sand;

211Qu_Q4 = the youngest Quindalup phase of irregular dunes with slopes up to 20%, consisting of loose pale brown sand with no soil profile development;

211Qu_Q2 = the second Quindalup phase consisting of a complex pattern of dunes with moderate relief. These sands have organic staining to a depth of about 20cm, passing into pale brown sand with some cementation below 1m;

211Qu_Q1 = the oldest Quindalup phase of dunes or remnants with low relief, consisting of calcareous soils with organic staining to 30cm, overlying pale brown sand with definite cementation below 1m.

2.2 Vegetation

The Interim Biogeographical Regionalisation for Australia (IBRA) (Thackway and Cresswell, 1995) recognizes 85 bioregions. The IBRA is used as the common unit to compare biological and biophysical attributes. Bioregions represent a landscape-based approach to classifying the land surface and each region is defined by a set of major environmental influences, which shape the occurrence of flora and fauna and their interaction with the physical environment. The site occurs in the Swan Coastal Plain, which has been subdivided into the northern section and the southern section. The study area is located in the southern section, abbreviated SWA2 (Mitchell, Williams and Desmond, 2002).

Prior to the above classification Beard (1981) classified the vegetation of Western Australia. Western Australia was divided into three main Botanical Provinces, Southwest, Eremaean and Northern. The

survey area occurs in the Southwest Botanical Province Beard (1990). Beard (1981) described the vegetation of the site as Coastal Heath and Thicket.

Heddlé *et al.* (1980) described the vegetation complexes of the Darling System at a scale of 1:250 000. There was found to be a distinct pattern of plant distribution linked to landforms, soils and climate. The most obvious trend was associated with increasing aridity from west to east on the Darling Plateau. The vegetation changes observed were a decrease in height and percentage cover of the tallest stratum and a distinct change in floristics. The site occurs within the Quindalup Vegetation Complex which is restricted to the coastal dunes. The Quindalup Complex consists of two alliances - the strand and fore dune alliance and the mobile and stable dune alliance. The vegetation differs in the species composition from one area to another because of differences in the dune environment due to edaphic and topographical factors and shelter from salt laden winds.

Bush Forever (Government of Western Australia, 2000) states that 48% of the Quindalup Complex remained vegetated within the Swan Coastal Plain in 2000. The area proposed for protection is 20%.

2.3 Threatened Ecological Communities

An ecological community is a naturally occurring biological assemblage that occurs in a particular type of habitat. A Threatened Ecological Community is one which falls into one of the following categories, presumed totally destroyed, critically endangered, endangered or vulnerable (Department of Parks and Wildlife, 2016b).

A restricted ecological community which does not meet the criteria for a Threatened Ecological Community is added to the Priority Ecological Community List. Priorities 1, 2, and 3 are adequately known but are not currently believed to be threatened. Those that have recently been removed from the threatened list are listed as Priority 4. Conservation dependent ecological communities are placed in Priority 5.

The Department of Parks and Wildlife (2016b) lists Threatened and Priority Ecological Communities recorded for Western Australia but none were listed as occurring in the study area.

2.4 Significant Flora

Prior to undertaking the field work a search was undertaken of NatureMap (Department of Parks and Wildlife, 2016d) for a 5 km buffer from the centre at 115° 42' 26" E, 31° 42' 06"S. This search resulted in the species listed in Table 2.

Table 1. Code and description of Threatened and Priority Flora (Government Gazette of WA (2015) with the threatened species split into their IUCN (2015) categories

Code	Declared Rare and Priority Flora Categories
T	T (Threatened) -Extant Taxa. Taxa, which have been adequately searched for and are deemed to be in the wild either rare, in danger of extinction, or otherwise in need of special protection. This category is further subdivided: CE: Flora that are considered likely to become extinct or rare, as critically endangered flora. E: Flora that are considered likely to become extinct or rare, as endangered flora. V: Flora that are considered likely to become extinct or rare, as vulnerable flora.
X	DRF (Declared Rare Flora) -Presumed Extinct Taxa. Taxa which have not been collected, or otherwise verified, over the past 50 years despite thorough searching, or of which all known wild populations have been destroyed more recently.
1	Priority One -Poorly Known Taxa. Taxa, which are known from one or a few (generally <5) populations, which are under threat.
2	Priority Two -Poorly Known Taxa. Taxa which are known from one or a few (generally <5) populations, at least some of which are not believed to be under immediate threat.
3	Priority Three -Poorly Known Taxa. Taxa, which are known from several populations, at least some of which are not believed to be under immediate threat.
4	Priority Four -Rare Taxa. Taxa which are considered to have been adequately surveyed and which whilst being rare, are not currently threatened by any identifiable factors.

Table 1 presents the definitions of Declared Rare and the four Priority Flora ratings under the Wildlife Conservation Act (1950) as extracted from Government Gazette of WA (2015).

Table 2. Threatened and Priority Flora Species List recorded in the selected area with W.A. Government Gazette Threatened Flora code and categories and Priority Flora code and categories listed by the Department of Parks and Wildlife (2016a). Description extracted from FloraBase (Western Australian Herbarium, 2016)

Taxon	Code	Description
Threatened Flora		
<i>Eucalyptus argutifolia</i>	V	(Mallee), 1.5-4 m high, bark smooth. Fl. white, Mar to Apr. Shallow soils over limestone. Slopes or gullies of limestone ridges, outcrops.
<i>Marianthus paralius</i>	CE	Almost prostrate, eventually scandent, woody shrub. Fl. red, Sep to Nov. White sand over limestone. Low coastal cliffs.
Priority Flora		
<i>Acacia benthamii</i>	P2	Shrub, ca 1 m high. Fl. yellow, Aug to Sep. Sand. Typically on limestone breakaways.
<i>Fabronia hampeana</i>	P2	Moss commonly on <i>Macrozamia riedlei</i> trunks.
<i>Lecania turicensis</i> var. <i>turicensis</i>	P2	Lichen
<i>Tetralia</i> sp. Chandala (G.J. Keighery 17055)	P2	No description provided.
<i>Conostylis bracteata</i>	P3	Rhizomatous, tufted or shortly proliferous perennial, grass-like or herb, 0.2-0.45 m high. Fl. yellow, Aug to Sep. Sand, limestone. Consolidated sand dunes.
<i>Hibbertia spicata</i> subsp. <i>leptotheca</i>	P3	Erect or spreading shrub, 0.2-0.5 m high. Fl. yellow, Jul to Oct. Sand. Near-coastal limestone ridges, outcrops & cliffs.
<i>Jacksonia gracillima</i>	P3	No description provided.
<i>Pimelea calcicola</i>	P3	Erect to spreading shrub, 0.2-1 m high. Fl. pink, Sep to Nov. Sand. Coastal limestone ridges.
<i>Sarcozona bicarinata</i>	P3	Shrub, ca 0.1 m high. Fl. white, Aug. White sand.
<i>Jacksonia sericea</i>	P4	Low spreading shrub, to 0.6 m high. Fl. orange, usually Dec or Jan to Feb. Calcareous & sandy soils.

3. METHOD

The site was surveyed using the method set out in the Environmental Protection Authority and Department of Parks and Wildlife (2016). The two proposed roads were walked to ensure a record was made of each vegetation unit, their associated species and any additional species (opportunistic species) recorded outside of the quadrat but within the same vegetation unit. Where a vegetation unit was recorded a temporary 10m x 10m quadrat was set up using a compass and oriented due N,S,E,W. Quadrats were placed to record the variation in the vegetation and associated species. The location of the quadrats is shown in Appendix D Map 1. All species, including weeds were recorded. The vegetation, flora, Threatened and Priority Flora surveys were conducted concurrently. For each quadrat, the following were recorded in the field:

- GPS reading (WGS84, equivalent to Geocentric Datum of Australia 1994 (GDA94)) at NW corner;
- Digital photograph taken at the NW corner;
- Soil type;
- Presence, size and type of any outcropping rocks;
- Topography – eg. ridge, upper slope, middle slope, lower slope, drainage line, minor creek, major creek, wetland;
- Vegetation condition using the scale of Keighery (1994) outlined in Table 5;
- Presence of any Threatened or Priority Flora or other significant flora;
- Additional information including dieback, age since fire, predators, erosion, weeds, grazing, tracks etc.; and
- All species were listed together with their percentage cover within the quadrat and average height.

The area outside of each quadrat was also surveyed to record additional (opportunistic) species for that vegetation unit.

The vegetation units recorded at the site are described using the vegetation classification in Bush Forever (from Government of Western Australia, 2000) as described in Table 3 and the vegetation condition (from Keighery, 1994) as in Table. 4.

Table 3. Vegetation Classification (from Government of Western Australia, 2000)

LIFE FORM / HEIGHT CLASS	Canopy Cover			
	DENSE 70 % - 100%	MID DENSE 30% - 70%	SPARSE 10% - 30%	VERY SPARSE 2% - 10%
Trees over 30 m	Tall Closed Forest	Tall Open Forest	Tall Woodland	Tall Open Woodland
Trees 10 – 30 m	Closed Forest	Open Forest	Woodland	Open Woodland
Trees under 10m	Low Closed Forest	Low Open Forest	Low Woodland	Low Open Woodland
Tree Mallee	Closed Tree Mallee	Tree Mallee	Open Tree Mallee	Very Open Tree Mallee
Shrub Mallee	Closed Shrub Mallee	Shrub Mallee	Open Shrub Mallee	Very Open Shrub Mallee
Shrubs over 2 m	Closed Tall Scrub	Tall Open Scrub	Tall Shrubland	Tall Open Shrubland
Shrubs 1 – 2 m	Closed Heath	Open Heath	Shrubland	Open Shrubland
Shrubs under 1m	Closed Low Heath	Open Low Heath	Low Shrubland	Low Open Shrubland
Grasses	Closed Grassland	Grassland	Open Grassland	Very Open Grassland
Herbs	Closed Herbland	Herbland	Open Herbland	Very Open Herbland
Sedges	Closed Sedgeland	Sedgeland	Open Sedgeland	Very Open Sedgeland

Table 4. Explanation of Vegetation Condition Rating (Keighery, 1994)

Rating	Description	Explanation
1	Pristine	Pristine or nearly so, no obvious signs of disturbance.
2	Excellent	Vegetation structure intact, disturbance affecting individual species and weeds are non-aggressive species.
3	Very Good	Vegetation structure altered, obvious signs of disturbance.
4	Good	Vegetation structure significantly altered by very obvious signs of multiple disturbances. Retains basic vegetation structure or ability to regenerate it.
5	Degraded	Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching good condition without intensive management.
6	Completely Degraded	The structure of the vegetation is no longer intact and the area is completely or almost completely without native species.

4. RESULTS

A botanical survey was undertaken on 17th November 2016 when transects were walked within the proposed roads. Prior to undertaking the field work an overlay on an aerial photograph of the track options was provided on the aerial of the site together with the easting and northing. To ensure the transects walked and the quadrats established were within the proposed development areas, way points were entered into the GPS to be used in the field. This enabled walking from one of the way points to the next ensuring that the transects walked were within the proposed area of disturbance.

By referring to Diagram 1 it can be seen that there is one road nominated from the current development site for a distance before it bifurcates, resulting in two possible road alignments which remain separated but both lead to the same larger area proposed as a car park

A total of four quadrats were surveyed. The locations of these are mapped in Appendix D Map 1, and a full description for each quadrat is provided in Appendix B.

4.1 Vegetation

There were four different vegetation units recorded from the survey area. These were:

1. Open Heath of *Melaleuca cardiophylla* over Very Open Grassland dominated by **Ehrharta longiflora* over Herbland dominated by **Raphanus raphanistrum*, **Crassula glomerata* and **Petrohragia dubia* over Sedgeland dominated by *Lomandra maritima* and *Desmocladius flexuosus*. This was represented by quadrat caq1;
2. Tall Open Scrub of *Acacia rostellifera* and *Spyridium globulosum* over Low Shrubland of *Melaleuca systena* over Open Grassland dominated by **Ehrharta longiflora* over Open Herbland dominated by **Lysimachia arvensis* over Very Open Sedgeland of *Lomandra maritima* and *Desmocladius flexuosus*. This was represented by quadrat caq2;
3. Shrubland of *Acacia rostellifera* over Low Shrubland dominated by *Rhagodia baccata* subsp. *dioica* and *Scaevola crassifolia* over Very Open Grassland dominated by **Ehrharta longiflora* over Open Herbland dominated by *Acanthocarpus preissii*, **Crassula glomerata* and **Trachyandra divaricata* over Sedgeland of *Lepidosperma gladiatum*. This was represented by quadrat caq3; and
4. Low Open Shrubland of *Olearia axillaris*, *Scaevola crassifolia*, **Pelargonium capitatum* and *Rhagodia baccata* subsp. *dioica* over Grassland dominated by *Spinifex longifolius* over Very Open Herbland dominated by **Trachyandra divaricata*. This was represented by quadrat caq4.

The vegetation units are mapped in Appendix D, Map 2. The vegetation changed from the east (quadrat caq1), then further west to quadrat caq2, then quadrat caq3 and near the beach to quadrat caq4. This change was gradual with an overlap of some species. Just above the strand line there was an area up to 5m wide where Marram Grass (**Ammophila arenaria*) was established in amongst the endemic grass *Spinifex longifolius*. The Marram Grass plants were all relatively young so it was uncertain if they had been planted or if rhizomes had come down on the current from Mindarie. Marram Grass has been used a lot to stabilize dunes but it is a weed which has the ability to change the ecosystem of the dunes it invades.

4.2 Vegetation Condition

Bushland has been historically subject to ongoing degradation and is especially susceptible to disturbances arising as a result of indirect impacts from surrounding developments and human activity. Degradation is caused by a wide range of factors, including isolation, edge effects, weed invasion, plant diseases, changes in fire frequency, landscape fragmentation, increased predation on native fauna by feral animals, decrease in species richness and general modification of ecological function. These issues affect the biodiversity rating and ecological viability of areas of remnant vegetation and should be assessed in line with conservation values.

Vegetation condition was rated according to the vegetation condition scale used in Keighery (1994). Table 4 provides the vegetation condition rating and Table 5 the vegetation condition of each of the quadrats.

Table 5. Vegetation Condition Recorded from the quadrats surveyed

Vegetation Condition	Quadrat Number
Very good	caq3
Very good to good	caq1, caq4
Good	caq2
Good to degraded	Some sections in the area of caq4
Degraded	Track through part of northern route

It can be seen from Table 5 that most of the vegetation was in good or better condition. The only area which was degraded was the along the off road vehicle track. The vegetation condition is mapped in Appendix D Map 3.

4.3 Taxa

A total of 31 vascular plant families, 58 genera and 68 taxa were recorded during the survey. All species observed are listed under vascular plant families in Appendix A.

4.4 Significant Taxa

No threatened or priority species were located during the survey.

4.5 Weeds

A total of 26 weeds were recorded from the survey area. All have been determined as weeds by the Western Australian Herbarium (2016) and Department of Parks and Wildlife (2016c). There are several ratings allocated to each weed in the Invasive Plant Prioritisation but only three have been selected to include in this report. These are ecological impacts, invasiveness and current distribution which are shown in Table 8 for each of the non-endemic species recorded. Thirteen of the weeds recorded have a high ecological impact on the natural vegetation.

Weeds that are, or may, become, a problem to agriculture or the environment can be formally classified as Declared Plants under the *Agriculture and Related Resources Protection Act, 1976* (Department of Agriculture and Food, 2016). The Department of Agriculture and Food Western Australia and the Agriculture Protection Board maintain a list of Declared Plants for Western Australia. None of the weeds listed in Table 6 are Declared Plants.

Table 6. Weeds Recorded From the Site

Species	Common Name	Ecological Impacts	Invasiveness	Current Distribution
		Ecological impact L = low impact species M = medium impact species H=high impact species U = unknown impact	Rate of dispersal R=rapid M=moderate S=slow U=unknown	L = limited (localised) M = moderate H = high E = extensive (widespread) U =unknown
* <i>Ammophila arenaria</i>	Marram Grass	U	S	L
* <i>Avena barbata</i>	Bearded Grass	H	R	E
* <i>Briza maxima</i>	Blowfly Grass	U	R	E
* <i>Bromus diandrus</i>	Great Brome	H	R	E
* <i>Crassula glomerata</i>	Stonecrop	U	R	E
* <i>Cuscuta epithymum</i>	Lesser Dodder	M	M	E
* <i>Ehrharta calycina</i>	Perennial Veldt Grass	H	R	E
* <i>Ehrharta longiflora</i>	Annual Veldt Grass	H	R	E
* <i>Euphorbia terracina</i>	Geraldton Carnation Weed	H	R	H
* <i>Heliophila pusilla</i>	Heliophila	H	M	H
* <i>Hordeum leporinum</i>	Barley Grass	H	U	E
* <i>Lactuca serriola</i>	Prickly Lettuce	H	R	H
* <i>Lagurus ovatus</i>	Hare's Tail Grass	H	R	E
* <i>Lolium loliaceum</i>	Stiff Rye Grass	H	R	E
* <i>Lysimachia arvensis</i>	Pimpernel	U	R	E
* <i>Oenothera glazioviana</i>	Evening Primrose	L	M	H
* <i>Pelargonium capitatum</i>	Rose Pelargonium	H	R	E
* <i>Petrorhagia dubia</i>	Velvet Pink	M	R	E
* <i>Raphanus raphanistrum</i>	Wild Radish	U	M	M
* <i>Romulea rosea</i>	Guildford Grass	U	R	E
* <i>Silene gallica</i>	French Catchfly	L	M	E
* <i>Sonchus oleraceus</i>	Common Sowthistle	U	R	E
* <i>Tetragona decumbens</i>	Sea Spinach	H	R	E
* <i>Trachyandra divaricata</i>	Dune Onion Weed	M	R	H
* <i>Urospermum picroides</i>	False Hawkbit	M	R	M
* <i>Vulpia myuros</i>	Rat's Tail Fescue	H	R	H

Thirteen of the weeds listed above are recorded as having a high impact on the environment. The most common weeds listed as having a high impact throughout the site were **Avena barbata*, **Ehrharta longiflora*, **Euphorbia terracina*, **Lagurus ovatus* and **Pelargonium capitatum*.

4.6 Rehabilitation

With the planned development of an access road rehabilitation and weed control will need to be undertaken. It is essential that all species used in rehabilitation are endemic to the particular vegetation unit. Appendix C lists all endemic species together with the quadrat they were recorded. By referring back to Section 4.1 the vegetation unit associated with each quadrat can be determined.

Four species were recorded from all vegetation units; *Acacia cyclops*, *Acanthocarpus preissii*, ** Olearia axillaris* and *Spyridium globulosum*. Seed collection should commence immediately and seedlings established before any site works are undertaken. Cuttings especially of *Spinifex longifolius* and *Spinifex hirsutus* should be undertaken in the sections of the car park area proposed for disturbance. The manual prepared by the Department of Planning (2011) provides excellent examples of how to propagate species. For example “the rooted cuttings of grasses (e.g. *Spinifex hirsutus* and *Spinifex longifolius*) that grow on the seaward slope of foredunes have given good results. The roots used for cuttings must be healthy and either yellowish or white in colour and the transplant site should be well moistened”. Successes have been achieved by the methods they outline and *Spinifex* plants must be used along the strand line and foredune in preference to Marram Grass.

Marram Grass has been used a lot to stabilize dunes as it is adapted to sand accretion with the burial promoting leaf elongation and the development of rhizomes from the axillary buds. Florabase (Western Australian Herbarium, 2016) includes a comprehensive description about this species its general biology, notes and general control. In the notes section the following information is provided. “It traps sand and builds dunes at rates much greater than that of the native species, thus out competing the native species. It interferes with the natural dynamics of the dune systems. It out-competes native vegetation and interferes with the natural dynamics of dune systems, including changing topography, adversely affecting long term development of coastal barriers, inhibits transgressive dune development, increases steepness of slopes and restricts movement of sand from beach to interior dunes. Also disrupts structure and reduces diversity of dunal arthropod communities. Harbours symbiotic nitrogen-fixing bacteria within stems and rhizomes that may contribute to its proliferation on nutrient-poor sand. Seed set, viability and survival is low, however viability of buds remains high following submergence in seawater, giving the potential for long-distance vegetative dispersal to other beaches.”

The above information exemplifies why *Spinifex longifolius* and *Spinifex hirsutus* root cuttings should be propagated and used in preference to Marram Grass.

Coastal Planning and Management Manual (Department of Planning, (2011) provides a lot of information including weeds and their management and the selection of species for rehabilitation. In addition it outlines the different methods that can be used in rehabilitation including, direct seeding, use of nursery grown seedlings, seeds and required treatments to break dormancy, cuttings, division, layering as well as the different methods used for planting out. Planting and direct seeding must be undertaken with the onset of the winter rains.

4.7 Management of the Tamala Park Region

Several committees have been established that deal with the management of the coastal area from Mindarie to Burns Beach. These include:

1. The Tamala Park Regional Council (TPRC) is a local government group formed in 2006 specifically to implement the urban development of the Tamala Park Project (marketed as Catalina) with representatives from Town of Cambridge, City of Joondalup, City of Perth, City of Stirling, Town of Victoria Park, City of Vincent and City of Wanneroo. They manage the development of the Tamala Park Local Structure Plan covering residential density and associated requirements.

2. The Community Advisory Committee (set up in 2008 with representatives from the City of Wanneroo and City of Joondalup) was formed to produce a plan for the long term environmental management of the area between Burns Beach and Mindarie. This committee developed the Tamala Conservation Park plan, and includes members from a wide cross section of State and Local Government Agencies and community organisations. One of the many initiatives suggested by the committee is “that funding for comprehensive weed mapping and flora and fauna surveys be provided as a matter of priority for interim management of the area” – which is endorsed by author of tis current survey.
3. In March 2012 a Tamala Conservation Park was proposed and an establishment plan prepared (Western Australian Planning Commission, 2012). The area under consideration is outlined below in Diagram 3 and it can be seen that it includes the current survey area. This was proposed to be managed by the Department of Environment and Conservation (now Department of Parks and Wildlife). The Establishment Plan did not include a timetable for creation of the Conservation Park as it is understand that part of the land covered remains in private ownership. The Tamala Conservation Park has three broad zones of usage, conservation and protection, natural environmental use and recreational use (Western Australian Planning Commission, 2012). With conservation and protection the primary management concern is to ensure no further disturbance to the bushland ensuring that public access is restricted and only via walk paths. Access to the beach has been poorly managed with off road vehicle tracks crossing the bushland.



Diagram 3. Area outlined in red proposed as Tamala Conservation Park.

5. DISCUSSION

The proposed access roads were through remnant bushland with a section of the northern alternative route along an existing off road track. Four different vegetation units were recorded from the survey area. These were:

- 1 Open Heath of *Melaleuca cardiophylla* over Very Open Grassland dominated by **Ehrharta longiflora* over Herbland dominated by **Raphanus raphanistrum*, **Crassula glomerata* and **Petrorhagia dubia* over Sedgeland dominated by *Lomandra maritima* and *Desmocladius flexuosus*;
- 2 Tall Open Scrub of *Acacia rostellifera* and *Spyridium globulosum* over Low Shrubland of *Melaleuca systena* over Open Grassland dominated by **Ehrharta longiflora* over Open Herbland dominated by **Lysimachia arvensis* over Very Open Sedgeland of *Lomandra maritima* and *Desmocladius flexuosus*;
- 3 Shrubland of *Acacia rostellifera* over Low Shrubland dominated by *Rhagodia baccata* subsp. *dioica* and *Scaevola crassifolia* over Very Open Grassland dominated by **Ehrharta longiflora* over Open Herbland dominated by *Acanthocarpus preissii*, **Crassula glomerata* and **Trachyandra divaricata* over Sedgeland of *Lepidosperma gladiatum*; and
4. Low Open Shrubland of *Olearia axillaris*, *Scaevola crassifolia*, **Pelargonium capitatum* and *Rhagodia baccata* subsp. *dioica* over Grassland dominated by *Spinifex longifolius* over Very Open Herbland dominated by **Trachyandra divaricata*.

The vegetation condition varied between very good and good except along the track where it was degraded. Weeds were common throughout the remnant bushland but were very dense along the edges of the track.

A total of 31 vascular plant families, 58 genera and 68 taxa were recorded during the survey, of which 26 taxa were weeds. None of the species were threatened or priority species and none of the weeds were listed as Declared Plants.

Marram grass (**Ammophila arenaria*) was established in amongst *Spinifex longifolius* plants above the strand. The Marram plants were all relatively young so it was uncertain if they had been planted or if they had established from rhizomes which had come down on the current from Mindarie.



Photograph of Marram Grass established above the strand line.

It is important that native species in particular *Spinifex longifolius* and *Spinifex hirsutus* be planted in preference to Marram Grass close to the strand line and in the foredunes.

It is suggested that the northern route be the one selected as some sections of this route are already degraded. The car park area should be fenced off to ensure off road drivers do not continue across the dunes and onto the beach. A fenced off sand track path should be constructed down to the beach from the car park.

The sides of the selected road must be stabilised as both routes traverse steep sided dunes, although this is not such a concern on the northern route as a track has already cut through a section of the area. In some sections the sand may need to have a wall constructed otherwise erosion will cause the sides to collapse and cover the road which could make it impassable. The environment must be conserved. This includes the dune system as well as the vegetation. People must be discouraged from walking through the dunes as this will most likely result in the destruction of some area.

The Community Advisory Committee (set up in 2008 with representatives from the City of Wanneroo and City of Joondalup) recommended that there be fenced, hard stand access from Long Beach Promenade through the reserve to the beach but with no hard stand access through to the beach. Public access to the beach must be managed to protect the environmental values of the area.

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APPENDIX A
Species List

LEGEND

ABBREVIATION	DESCRIPTION
subsp.	subspecies
var.	variety
*	weed

Vascular Plant Family	Taxon
Aizoaceae	
	<i>Carpobrotus virescens</i>
	* <i>Tetragonia decumbens</i>
Asparagaceae	
	<i>Acanthocarpus preissii</i>
	<i>Lomandra maritima</i>
	<i>Thysanotus arenarius</i>
Asphodelaceae	
	* <i>Trachyandra divaricata</i>
Asteraceae	
	* <i>Lactuca serriola</i>
	<i>Olearia axillaris</i>
	<i>Ozothamnus cordatus</i>
	<i>Senecio pinnatifolius</i> var. <i>latilobus</i>
	* <i>Sonchus oleraceus</i>
	* <i>Urospermum picroides</i>
Brassicaceae	
	* <i>Heliophila pusilla</i>
	* <i>Raphanus raphanistrum</i>
Caryophyllaceae	
	* <i>Petrorhagia dubia</i>
	* <i>Silene gallica</i>
Chenopodiaceae	
	<i>Rhagodia baccata</i> subsp. <i>baccata</i>
	<i>Rhagodia baccata</i> subsp. <i>dioica</i>
	<i>Threlkeldia diffusa</i>
Convolvulaceae	
	* <i>Cuscuta epithymum</i>
Crassulaceae	
	<i>Crassula colorata</i>
	* <i>Crassula glomerata</i>
Cyperaceae	
	<i>Isolepis marginata</i>
	<i>Lepidosperma calcicola</i>
	<i>Lepidosperma gladiatum</i>
Ericaceae	
	<i>Leucopogon parviflorus</i>
Euphorbiaceae	
	* <i>Euphorbia terracina</i>
Fabaceae	
	<i>Acacia cyclops</i>
	<i>Acacia rostellifera</i>
	<i>Acacia saligna</i>
	<i>Gompholobium capitatum</i>
	<i>Hardenbergia comptoniana</i>
	<i>Kennedia prostrata</i>

Vascular Plant Family	Taxon
Geraniaceae	
	<i>*Pelargonium capitatum</i>
Goodeniaceae	
	<i>Scaevola crassifolia</i>
	<i>Scaevola globulifera</i>
Haemodoraceae	
	<i>Conostylis aculeata</i> subsp. <i>cygnorum</i>
	<i>Conostylis candicans</i>
Hemerocallidaceae	
	<i>Dianella revoluta</i> var. <i>divaricata</i>
Iridaceae	
	<i>*Romulea rosea</i>
Lamiaceae	
	<i>Hemiandra pungens</i>
Lauraceae	
	<i>Cassytha flava</i>
Myrtaceae	
	<i>Melaleuca cardiophylla</i>
	<i>Melaleuca systema</i>
Onagraceae	
	<i>*Oenothera glazioviana</i>
Phyllanthaceae	
	<i>Phyllanthus calycinus</i>
Poaceae	
	<i>*Ammophila arenaria</i>
	<i>Austrostipa flavescens</i>
	<i>*Avena barbata</i>
	<i>*Briza maxima</i>
	<i>*Bromus diandrus</i>
	<i>*Ehrharta calycina</i>
	<i>*Ehrharta longiflora</i>
	<i>*Hordeum leporinum</i>
	<i>*Lagurus ovatus</i>
	<i>*Lolium loliaceum</i>
	<i>Paspalum vaginatum</i>
	<i>Poa porphyroclados</i>
	<i>Spinifex hirsutus</i>
	<i>Spinifex longifolius</i>
	<i>*Vulpia myuros</i>
Polygalaceae	
	<i>Comesperma integerrimum</i>
Primulaceae	
	<i>*Lysimachia arvensis</i>
Ranunculaceae	
	<i>Clematis linearifolia</i>
Restionaceae	
	<i>Desmocladus flexuosus</i>

Vascular Plant Family	Taxon
Rhamnaceae	
	<i>Spyridium globulosum</i>
Rubiaceae	
	<i>Opercularia vaginata</i>
Santalaceae	
	<i>Exocarpos sparteus</i>

APPENDIX B

Quadrat Data

LEGEND

ABBREVIATION	DESCRIPTION
subsp.	subspecies
var.	variety
*	weed

QUADRAT caq1**GPS (WGS84):** 377775E; 6492000N**Location:** Most eastern section of the proposed road**Topography:** Upper slope to crest of sand dune**Soil:** Grey sand**Litter:** Branches 10%; Leaves 20%**Vegetation Description:** Open Heath of *Melaleuca cardiophylla* over Very Open Grassland dominated by **Ehrharta longiflora* over Herbland dominated by **Raphanus raphanistrum*, **Crassula glomerata* and **Petrorhagia dubia* over Sedgeland dominated by *Lomandra maritima* and *Desmocladius flexuosus***Vegetation Condition:** Good to very good**Notes:** Numerous weeds

SPECIES	HEIGHT (cm)	% COVER
<i>Acacia cyclops</i>	70	1
<i>Acanthocarpus preissii</i>	30	2
<i>Austrostipa flavescens</i>	90	1
* <i>Avena barbata</i>	90	5
* <i>Bromus diandrus</i>	60	<1
<i>Conostylis aculeata</i> subsp. <i>cygnorum</i>	50	12
* <i>Crassula glomerata</i>	5	15

SPECIES	HEIGHT (cm)	% COVER
<i>Desmodcladus flexuosus</i>	50	10
<i>Dianella revoluta</i> subsp. <i>divaricata</i>	70	1
* <i>Ehrharta calycina</i>	90	2
* <i>Ehrharta longiflora</i>	80	20
* <i>Euphorbia terracina</i>	70	5
<i>Hardenbergia comptoniana</i>	twiner	<1
* <i>Lagurus ovatus</i>	30	2
<i>Leucopogon parviflorus</i>	60	1
* <i>Lolium loliaceum</i>	70	<1
<i>Lomandra maritima</i>	60	50
* <i>Lysimachia arvensis</i>	20	5
<i>Melaleuca cardiophylla</i>	200	50
* <i>Petrorhagia dubia</i>	60	15
<i>Phyllanthus calycinus</i>	50	2
* <i>Raphanus raphanistrum</i>	90	20
<i>Rhagodia baccata</i> subsp. <i>baccata</i>	50	2
* <i>Silene gallica</i>	60	10
* <i>Sonchus oleraceus</i>	50	1
<i>Spyridium globulosum</i>	200	5
* <i>Urospermum picroides</i>	60	3
<i>Acacia rostellifera</i>	opportunistic	
<i>Acacia saligna</i>	opportunistic	
<i>Clematis linearifolia</i>	opportunistic	
<i>Comesperma integerrimum</i>	opportunistic	
<i>Exocarpus sparteus</i>	opportunistic	
<i>Gompholobium capitatum</i>	opportunistic	
* <i>Hordeum leporinum</i>	opportunistic	
<i>Isolepis marginata</i>	opportunistic	
<i>Kennedia prostrata</i>	opportunistic	
<i>Lepidosperma calcicola</i>	opportunistic	
<i>Melaleuca systema</i>	opportunistic	
<i>Olearia axillaris</i>	opportunistic	
* <i>Pelargonium capitatum</i>	opportunistic	
<i>Thysanotus arenarius</i>	opportunistic	

QUADRAT caq2**GPS (WGS84):** 377550E; 6491850E**Location:** Southern proposed track**Topography:** Middle slope**Soil:** Grey sand**Litter:** Branches 5%; Leaves 25%**Vegetation Description:** Tall Open Scrub of *Acacia rostellifera* and *Spyridium globulosum* over Low Shrubland of *Melaleuca systena* over Open Grassland dominated by **Ehrharta longiflora* over Open Herbland dominated by **Lysimachia arvensis* over Very Open Sedgeland of *Lomandra maritima* and *Desmocladius flexuosus***Vegetation Condition:** Good**Notes:** Very occasional *Xanthorrhoea preissii* recorded opportunistically

SPECIES	HEIGHT (cm)	% COVER
<i>Acacia rostellifera</i>	300	15
<i>Austrostipa flavescens</i>	90	2
<i>*Briza maxima</i>	50	5
<i>Clematis linearifolia</i>	twiner	2
<i>Conostylis aculeata</i> subsp. <i>cygnorum</i>	30	1
<i>*Crassula glomerata</i>	10	5
<i>Desmocladius flexuosus</i>	40	5
<i>Dianella revoluta</i> subsp. <i>divaricata</i>	70	1

SPECIES	HEIGHT (cm)	% COVER
* <i>Ehrharta calycina</i>	80	5
* <i>Ehrharta longiflora</i>	60	10
* <i>Euphorbia terracina</i>	60	5
<i>Gompholobium capitatum</i>	30	<1
* <i>Lagurus ovatus</i>	50	<1
<i>Lepidosperma calcicola</i>	50	1
* <i>Lolium loliaceum</i>	90	<1
<i>Lomandra maritima</i>	50	5
* <i>Lysimachia arvensis</i>	30	15
<i>Melaleuca systema</i>	80	10
<i>Opercularia vaginata</i>	40	<1
<i>Poa porphyroclados</i>	70	1
* <i>Romulea rosea</i>	40	<1
* <i>Sonchus oleraceus</i>	60	<1
<i>Spyridium globulosum</i>	250	40
<i>Acanthocarpus preissii</i>	opportunistic	
* <i>Bromus diandrus</i>	opportunistic	
<i>Cassytha flava</i>	opportunistic	
<i>Comesperma integerrimum</i>	opportunistic	
<i>Conostylis candicans</i>	opportunistic	
<i>Hardenbergia comptoniana</i>	opportunistic	
<i>Leucopogon parviflorus</i>	opportunistic	
<i>Olearia axillaris</i>	opportunistic	
* <i>Pelargonium capitatum</i>	opportunistic	
<i>Rhagodia baccata</i> subsp. <i>baccata</i>	opportunistic	
<i>Scaevola globulifera</i>	opportunistic	
* <i>Trachyandra divaricata</i>	opportunistic	

QUADRAT caq3

GPS (WGS84): 377425E; 6491800N

Location: Last tall dune before beach

Topography: Upper slope to crest

Soil: Pale grey sand

Litter: Leaves 20%

Vegetation Description:. Shrubland of *Acacia rostellifera* over Low Shrubland dominated by *Rhagodia baccata* subsp. *dioica* and *Scaevola crassifolia* over Very Open Grassland dominated by **Ehrharta longiflora* over Open Herbland dominated by *Acanthocarpus preissii*, **Crassula glomerata* and **Trachyandra divaricata* over Sedgeland of *Lepidosperma gladiatum*

Vegetation Condition: Very Good

Notes: Valleys between the dunes had dense cover (>75%) of *Lepidosperma gladiatum*



SPECIES	HEIGHT (cm)	% COVER
<i>Acacia rostellifera</i>	150	15
<i>Acanthocarpus preissii</i>	30	5
<i>*Bromus diandrus</i>	80	1
<i>*Crassula glomerata</i>	5	10
<i>*Ehrharta longiflora</i>	70	5
<i>Hardenbergia comptoniana</i>	twiner	<1
<i>*Lactuca serriola</i>	10	<1

SPECIES	HEIGHT (cm)	% COVER
<i>Lepidosperma gladiatum</i>	120	40
<i>Olearia axillaris</i>	70	1
* <i>Pelargonium capitatum</i>	50	1
<i>Rhagodia baccata</i> subsp. <i>dioica</i>	100	5
<i>Scaevola crassifolia</i>	80	5
<i>Senecio pinnatifolius</i> var. <i>latilobus</i>	40	1
* <i>Sonchus oleraceus</i>	70	2
* <i>Trachyandra divaricata</i>	60	5
<i>Carpobrotus virescens</i>	opportunistic	
<i>Cassutha flava</i>	opportunistic	
<i>Clematis linearifolia</i>	opportunistic	
* <i>Cuscuta epithymum</i>	opportunistic	
* <i>Heliophila pusilla</i>	opportunistic	
<i>Hemiandra pungens</i>	opportunistic	
* <i>Lagurus ovatus</i>	opportunistic	
<i>Melaleuca systema</i>	opportunistic	
<i>Ozothamnus cordatus</i>	opportunistic	
<i>Poa porphyroclados</i>	opportunistic	
<i>Scaevola globulifera</i>	opportunistic	
<i>Spyridium globulosum</i>	opportunistic	
* <i>Tetragona decumbens</i>	opportunistic	
<i>Threlkeldia diffusa</i>	opportunistic	
<i>Thysanotus arenarius</i>	opportunistic	

QUADRAT caq4**GPS (WGS84):** 377325E; 6491875N**Location:** Just back from the beach**Topography:** Fore dune**Soil:** Pale grey/white sand**Litter:** Leaves 5%**Vegetation Description:.** Low Open Shrubland of *Olearia axillaris*, *Scaevola crassifolia*, **Pelargonium capitatum* and *Rhagodia baccata* subsp. *dioica* over Grassland dominated by *Spinifex longifolius* over Very Open Herbland dominated by **Trachyandra divaricata***Vegetation Condition:** Good to very good**Notes:** Just before the drop down to the water there was a belt about 5m wide where young Marram grass (**Ammophila arenaria*) was dominant and growing between the plants of *Spinifex longifolius*. Many of the plants recorded a dense infestation of the native parasitic twiner *Cassytha flava* If the infestation is very heavy it has the capacity to kill plants

SPECIES	HEIGHT (cm)	% COVER
<i>Acanthocarpus preissii</i>	50	2
<i>*Avena barbata</i>	100	5
<i>Cassytha flava</i>	twiner	30
<i>*Crassula glomerata</i>	10	2
<i>Olearia axillaris</i>	100	3
<i>Ozothamnus cordatus</i>	40	<1

SPECIES	HEIGHT (cm)	% COVER
<i>*Pelargonium capitatum</i>	50	5
<i>Rhagodia baccata</i> subsp. <i>dioica</i>	50	2
<i>Scaevola crassifolia</i>	50	5
<i>*Sonchus oleraceus</i>	70	1
<i>Spinifex longifolius</i>	80	40
<i>*Tetragona decumbens</i>	30	1
<i>*Trachyandra divaricata</i>	60	15
<i>*Vulpia myuros</i>	15	2
<i>Acacia cyclops</i>	opportunistic	
<i>*Ammophila arenaria</i>	opportunistic	
<i>Carpobrotus virescens</i>	opportunistic	
<i>Crassula colorata</i>	opportunistic	
<i>*Oenothera glazioviana</i>	opportunistic	
<i>Paspalum vaginatum</i>	opportunistic	
<i>Spinifex hirsutus</i>	opportunistic	
<i>Spyridium globulosum</i>	opportunistic	
<i>Threlkeldia diffusa</i>	opportunistic	

APPENDIX C**Endemic species recorded from each quadrat (introduced species removed)****LEGEND**

ABBREVIATION	DESCRIPTION
subsp.	subspecies
var.	variety
*	weed
+	species recorded

ENDEMIC SPECIES	QUADRAT NUMBER			
	caq1	caq2	caq3	caq4
<i>Acacia cyclops</i>	+	+	+	+
<i>Acacia rostellifera</i>	+	+	+	
<i>Acacia saligna</i>	+			
<i>Acanthocarpus preissii</i>	+	+	+	+
<i>Ammophila arenaria</i>				+
<i>Austrostipa flavescens</i>	+	+		
<i>Carpobrotus virescens</i>			+	+
<i>Cassutha flava</i>		+	+	+
<i>Clematis linearifolia</i>	+	+	+	
<i>Comesperma integerrimum</i>	+	+		
<i>Conostylis aculeata</i> subsp. <i>cygnorum</i>	+	+		
<i>Conostylis candicans</i>		+		
* <i>Crassula glomerata</i>	+	+	+	+
<i>Desmocladius flexuosus</i>	+	+		
<i>Dianella revoluta</i> subsp. <i>divaricata</i>	+	+		
<i>Exocarpus sparteus</i>	+			
<i>Gompholobium capitatum</i>	+	+		
<i>Hardenbergia comptoniana</i>	+	+	+	
<i>Hemiandra pungens</i>			+	
<i>Isolepis marginata</i>	+			
<i>Kennedia prostrata</i>	+			
<i>Lepidosperma calcicola</i>	+	+		
<i>Lepidosperma gladiatum</i>			+	
<i>Leucopogon parviflorus</i>	+	+		
<i>Lomandra maritima</i>	+	+		
<i>Melaleuca cardiophylla</i>	+			
<i>Melaleuca systema</i>	+	+	+	
<i>Olearia axillaris</i>	+	+	+	+
<i>Opercularia vaginata</i>		+		
<i>Ozothamnus cordatus</i>			+	+
<i>Paspalum vaginatum</i>				+
<i>Phyllanthus calycinus</i>	+			
<i>Poa porphyroclados</i>		+	+	
<i>Rhagodia baccata</i> subsp. <i>baccata</i>	+	+		
<i>Rhagodia baccata</i> subsp. <i>dioica</i>			+	+
<i>Scaevola crassifolia</i>			+	+
<i>Scaevola globulifera</i>		+	+	
<i>Senecio pinnatifolius</i> var. <i>latilobus</i>			+	
<i>Spinifex hirsutus</i>				+
<i>Spinifex longifolius</i>				+

ENDEMIC SPECIES	QUADRAT NUMBER			
	caq1	caq2	caq3	caq4
<i>Spyridium globulosum</i>	+	+	+	+
<i>Threlkeldia diffusa</i>			+	
<i>Thysanotus arenarius</i>	+		+	

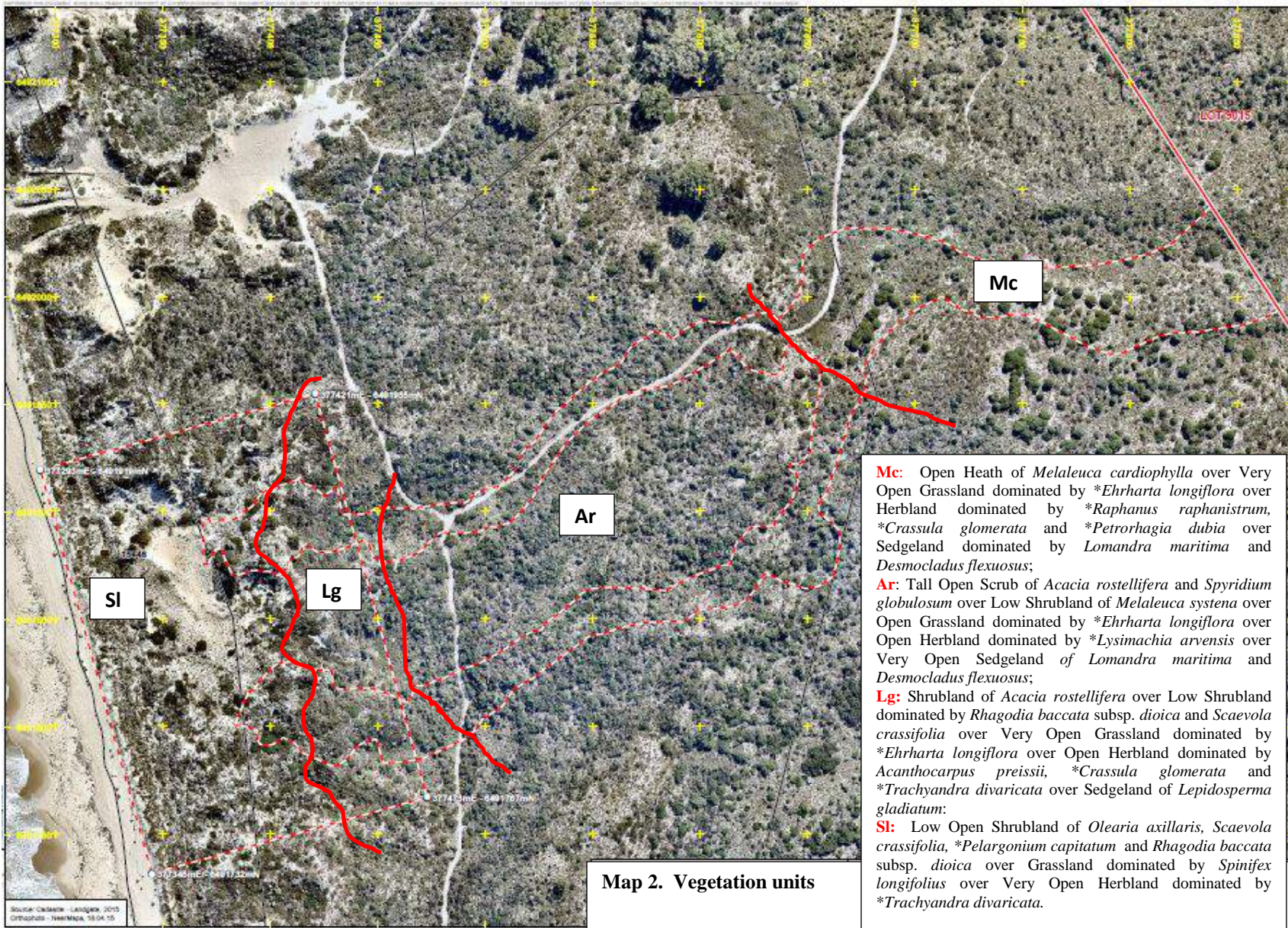
APPENDIX D

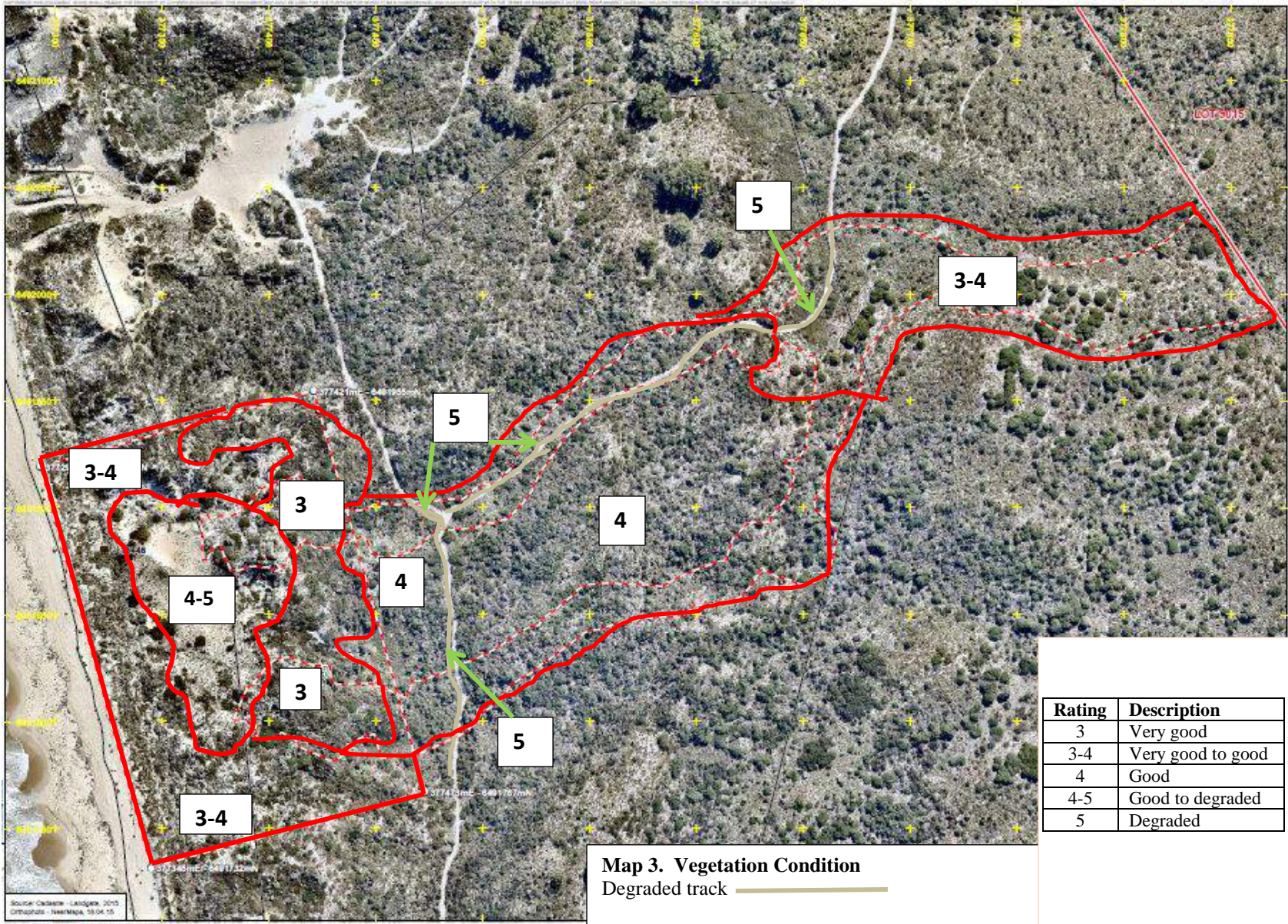
Maps

1. Location of quadrats
2. Vegetation units
3. Vegetation condition



Map 1. Location of quadrats







Appendix 3 Foreshore Management Plan



COTERRA
ENVIRONMENT



Foreshore Management Plan

Catalina Estate Coastal Access Infrastructure

Revision 6, February 2019

CALIBRE | COMMITMENT | COLLABORATION

Foreshore Management Plan

Catalina Estate Coastal Access Infrastructure

Revision 6, February 2019

This report was prepared by:

Coterra Pty Ltd trading as COTERRA ENVIRONMENT
ABN: 92 143 411 456

Our Ref: SATCAT18
Author(s): K. Thomson / S. Harley
Reviewer: K. Watts / K. Cooper
Report Version: Revision 6
Date: February, 2019

This report was prepared for:

Tamala Park Regional Council
PO Box 655
INNALOO WA 6918

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EXECUTIVE SUMMARY

The Tamala Park urban development project (Catalina Estate) is located in the north-west corridor of the Perth Metropolitan Region. Given the projected increase in the local population it is proposed that a formal coastal access route should be created to enable the local community to have access to a safe swimming beach. At present, a number of informal bush tracks exist, used by people to gain four-wheel-drive access to the beach. Given the informal nature of these tracks, damage to vegetation and dune structures, which has been enhanced further by wind erosion, has occurred as a result of this uncontrolled access.

A coastal access road has been proposed to provide local access to a safe beach for the local community. The proposed access leads to a beach area which has been identified to be free of hazards that are present in adjacent areas, and is therefore Surf Life Saving Western Australia's (SLSWA) preferred location. The proposed location is also consistent with the Tamala Conservation Park Establishment Plan (WAPC, 2012), which recommended that community access to safe swimming areas adjacent to Tamala Park, with public road access, appropriately located facilities such as car parking, toilets and potential surf-life-saving facilities should be investigated and provided. Access to this beach will provide an alternative to Claytons Beach which is subject to hazards to swimmers, such as rips and strong currents.

The location of the proposed access route and the carpark area have been carefully selected to follow existing informal tracks or areas of damaged vegetation and minimise impacts on flora and values in the area.

An asphalt two-way road is proposed to be constructed, leading visitors to a beach carpark adjacent to the foredune, providing at least 30 bays (including one ACROD bay). From the car park, a 3 m wide pedestrian path will provide access to the beach for pedestrians as well as authorised vehicles as necessary. Areas have been provisionally allocated for future additional buildings, such as storage buildings for surf-lifesaving equipment and an ablution block but as this infrastructure is not yet proposed to be installed it does not form part of the current FMP.

This FMP has been prepared by the Tamala Park Regional Council (TPRC) in the best interest of the community to facilitate the opening of a safe and useable swimming beach and for the benefit of the City of Wanneroo (CoW) who are responsible for this area. The FMP specifically addresses the impacts of the provision of beach access infrastructure. The objective of this FMP is to provide measures to ensure controlled public access to a safe swimming and aquatic activity beach, providing commitments for the protection and where possible enhancement of the conservation value of the adjacent foreshore area. The FMP will support applications for Development Approval and a Native Vegetation Clearing Permit.

Management measures to minimise the environmental impact of the proposed coastal access infrastructure are provided in the below implementation table.

Table A: Implementation Summary Table

Action	Pre-Construction	During Construction	Post-Construction
<p>Vegetation Management and Rehabilitation</p>	<ul style="list-style-type: none"> • Coordinate with the City's Land Development Group (Planning and Sustainability Division) on the matter of appropriate revegetation areas, vegetation species and surface stabilisation techniques for treatment of swales, batters and slopes at the appropriate time, when detailed design work is being undertaken, and prior to the preparation of any Development Application documents. • Undertake seed and cutting collection from the clearing footprint area and surrounds, remaining as close as possible to areas to be rehabilitated. • Propagation of selected seeds (i.e. those species not proposed for direct seeding) at an accredited nursery. 	<ul style="list-style-type: none"> • Ongoing propagation of selected seeds (i.e. those species not proposed for direct seeding) at an accredited nursery as required. 	<ul style="list-style-type: none"> • Ongoing propagation of selected seeds (i.e. those species not proposed for direct seeding) at an accredited nursery as required. • Removal of any rubbish present within the rehabilitation area. • Two weed control events to be undertaken in and directly adjacent to proposed rehabilitation areas within 6 months prior to planting. • Undertake direct seeding and planting of tubestock. • One weed control event to be undertaken in late winter/early spring approximately 12 months after planting. • Installation of tree guards as required. • Removal of tree guards. • Provide brushing and / or hydromulching (no seed) as required in erosion prone areas. • Vegetation and weed monitoring undertaken annually in Spring within rehabilitation areas. • Preparation of a monitoring report and submission to the CoW annually, outlining the progress of the development as well as the progress against success criteria and the rehabilitation success. • Where success criteria are not met, contingency actions will be undertaken. • Contingency actions may include: <ul style="list-style-type: none"> - Infill planting - Additional weed control - Erosion control measures

Action	Pre-Construction	During Construction	Post-Construction
Fauna Management	<ul style="list-style-type: none"> Undertake fauna survey of clearing area to advise relocation program details (to be agreed with CoW). 	<ul style="list-style-type: none"> Start and run equipment for 10 minutes prior to clearing commencing. Where possible, undertake clearing outside of the Black cockatoo breeding season (i.e. between July and November). Observe vegetation for any fauna that may be trapped, injured or occupying an unseen nest or shelter. If feasible, felled vegetation to be left in situ overnight. Engage a fauna relocation specialist to oversee site clearing works. 	<ul style="list-style-type: none"> Install signage indicating speed limit of 30 km/hr. Wildlife crossing signage to be installed at both entrance points to the access road
Dieback Management		<ul style="list-style-type: none"> Should any off-site fill be required this is to be obtained from a dieback free source. Prior to entering the site any construction equipment and construction materials must be clean and free of any adhered soil/mud. Construction equipment to stay within the construction zone. Imported material for construction works is to be stored in areas clear of vegetation which do not drain towards retained vegetation. Plants used in the landscaping works to be from a dieback free source. Restrict uncontrolled vehicles accessing retained vegetation areas. Construction contractors to be provided with dieback management information. 	

Action	Pre-Construction	During Construction	Post-Construction
Access Management	<ul style="list-style-type: none"> • Install clearing protection fencing to prevent accidental clearing of vegetation to be retained as per CoW specification TS 01-12-0. • Maintain clearing protection fencing to prevent accidental clearing of vegetation to be retained. 	<ul style="list-style-type: none"> • Temporary fencing will be installed around development site at the commencement of construction works to restrict third party access through the construction site and foreshore reserve. • Contractors will check fencing on a weekly basis and report and repair damage as necessary. 	<ul style="list-style-type: none"> • Provide fencing along the access road and carpark boundaries as per CoW standard TS01-3 style to restrict off-road vehicles from leaving the road and entering the vegetated foreshore reserve area. • Install fencing along the pedestrian access track to beach as per CoW specification TS 01-4-2.
Erosion and Dust Management		<ul style="list-style-type: none"> • Vehicle speeds will be kept below 30 km/hr • Vehicle will remain within the construction area. • Use brushing, mulching and fibre matting where necessary to stabilise sand. 	
Stormwater Management	<ul style="list-style-type: none"> • Detailed engineering design, including stormwater infrastructure, will be included in the Development Application prepared for submission to the City of Wanneroo for the proposed works. • Drainage infrastructure will be designed to address WSUD principles as well as having the specific objectives of managing direct flows into the Bush Forever vegetation, and minimising potential erosion. 	<ul style="list-style-type: none"> • Drainage infrastructure to be constructed as per the Development Application. 	

Action	Pre-Construction	During Construction	Post-Construction
Fire Management		<ul style="list-style-type: none"> • Clearing and construction should be undertaken outside of high fire risk conditions where possible. • Fire extinguishers and equipment to be readily available for all vehicles / machinery and must be tagged, inspected and certified according to relevant standards. • Smoking will be prohibited within the construction area. Designated smoking areas will be positioned away from the foreshore vegetation. 	<ul style="list-style-type: none"> • Coastal access road corridor to act as a firebreak. • Restrict unauthorised access to coastal bushland (see Vegetation and Fauna Protection action).
Beach Safety Management			<ul style="list-style-type: none"> • Coastal hazard signage is to be provided within the carpark. SLSWA and CoW shall approve the signage prior to installation by TPRC.

The proposed development of coastal access infrastructure within the foreshore reserve is subject to the following planning and environmental approvals:

- Development Application (CoW / WAPC)
- Detailed engineering design and landscape design drawings (CoW)
- Native vegetation clearing permit (DWER)

The coastal access road and associated infrastructure will remain under the ownership of both CoW and WAPC, in accordance with the existing reserve boundaries. This is in keeping with the CoW's formal agreement to continue managing (wholly or in part) the reserves between Burns Beach and Mindarie (WAPC, 2012).



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- Appendix B: Coastal Hazard Risk Management and Adaption Plan (MP Rogers, 2019)
- Appendix C: Level 2 Flora and Vegetation Survey (BEC, 2016)
- Appendix D: Fauna Species – Database Search Results
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- Appendix F: Weed Species List
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1.0 INTRODUCTION

1.1 Project Background

The Tamala Park urban development project, marketed as Catalina Estate is located in the north-west corridor of the Perth Metropolitan Region (Figure 1).

The Tamala Park Regional Council (TPRC) is the corporate entity established in 2006 for the specific purpose of facilitating rezoning, subdivision, development, marketing and sale of the Tamala Park landholding. The TPRC comprises the following 7 local government members: Town of Cambridge, City of Joondalup, City of Perth, City of Stirling, Town of Victoria Park, City of Vincent and City of Wanneroo. These member Councils have a joint holding in the project. The Satterley Property Group act as project managers and exclusive selling agents on the TPRC's behalf.

The Catalina Project is subject to the Tamala Park Local Structure Plan (Appendix A) which was approved by the Western Australian Planning Commission (WAPC) in 2011 and will facilitate a new urban development comprising around 2,500 lots. The first phase of construction and development commenced in 2011. To date, over 900 lots have been sold in the Catalina Estate with approximately 700 houses completed or under construction.

Consisting a total of approximately 180 ha, the development area is divided into three Precincts known as 'Catalina Beach' located west of Marmion Avenue, 'Catalina Central' located east of Marmion Avenue and 'Catalina Grove' located east of Connolly Drive.

Given the expected demand for access to beach areas from the local population in the future it is proposed that a formal coastal access route be created to enable the local community to access the section of the coast to the west of the Catalina Estate to enable convenient access to a safe swimming beach as an alternative to Claytons Beach, which is subject to hazards to swimmers. At present, a number of informal bush tracks exist, used by people to gain four-wheel-drive access to the beach. Given the informal nature of these tracks and the uncontrolled access which has occurred this has resulted in damage to vegetation and dune structures which is enhanced further by wind erosion.

1.1.1 Negotiated Planning Solution

A portion of the Catalina Estate (Catalina Beach cell) was identified in Bush Forever documentation in December 2000 as part of Bush Forever Site No. 322 as a 'Negotiated Planning Solution' site. In 2006 agreement was reached between the WAPC and TPRC on the Negotiated Planning Solution (NPS). The original TPRC landholdings totalled 121.5 ha. As a result of the extensive NPS process the TPRC ceded 89 ha of land originally part of the Tamala Park landholding to the Crown for reservation as Bush Forever conservation land (becoming Bush Forever Site No. 322).

1.1.2 Foreshore Tenure

Following implementation of the NPS the coastal land ceded to the crown (Lot 9505) is now vested with the Western Australian Planning Commission. The foreshore land

parcels to the west of this lot include Reserves R20561 and R35890. Both of these reserves are vested with the City of Wanneroo.

The location of these reserves is shown in Figure 2.

1.2 Proposed Coastal Infrastructure

The proposed coastal access road has been designed to provide a local route to the beach for Catalina residents and the general public. An asphalt two-way road is proposed to be constructed, leading visitors to a beach carpark adjacent to the foredune, providing at least 30 bays (including one ACROD bay). From the car park, a 3 m wide pedestrian path will provide access to the beach for pedestrians as well as authorised vehicles as necessary. It is the developer's preference that the pedestrian beach access path be constructed using stabilised limestone, and if alternative materials are to be required, this shall be specified in the conditions of development approval. The 3 m width of the path is consistent with the City of Wanneroo path specifications, and the City's engineers (Assets Directorate) will be consulted to ensure the risk of damage due to storm events and/or sand erosion is addressed to avoid or minimise premature damage through appropriate design treatment.

A small area adjacent to the southern boundary of the carpark has been provisionally allocated to enable the future development of mobile infrastructure to facilitate Surf Life Saving WA beach patrols and associated equipment storage. A provisional site has also been supplied for the future construction of an ablution block / change rooms. These assets are not currently proposed and indicative locations only are provided.

The alignment of the proposed access route and the location of the carpark area have been carefully selected to minimise impacts to flora and values in the area. Where possible the proposed access route follows the alignment of existing informal bush tracks or areas of damaged vegetation. The proposed carpark area is to be located within a degraded area of minimal or declining vegetation.

The location of the carpark area is based the Coastal Aquatic Risk Assessment (2014) undertaken by Surf Life Saving Western Australia (SLSWA) which identified the site as a preferred beach access location, due to safe swimming conditions and absence of potential hazards present in the existing access locations to the north and south.

The carpark location was selected above the larger dune blowout area which occurs further to the south for the following reasons:

- It was the preferred location identified by SLSWA
- The larger dune blowout is located approximately 1.5 km from the Catalina Beach development boundary. This distance is no longer considered walkable compared to the 550 m distance associated with the location proposed.

Figure 2 provides a concept design for the proposed infrastructure.

The concept plan has been developed within the local and regional context of the foreshore area, with environmental considerations such as flora and fauna

protection at the forefront of the design. Current and future coastal vulnerability modelling has also been considered in the planning of the infrastructure design and footprint.

It is also consistent with the Tamala Conservation Park Establishment Plan (WAPC, 2012), which recommended that given the increased demand from the community for access to safe swimming areas adjacent to Mindarie and the future Tamala Park project that a public recreational swimming area off Long Beach Promenade should be identified. This document also recommend that public road access, with appropriately located facilities such as car parking, toilets and potential surf-life-saving facilities should be investigated and provided.

It is noted that the implementation of the proposed design elements will be subject to future planning approvals, including Development Approval and the granting of a Native Vegetation Clearing Permit.

1.3 Scope and Purpose of Report

1.3.1 Foreshore Management Area Boundary

The coastal access infrastructure concept plan is shown in Figure 2, and also provides the extent of foreshore area to which this Foreshore Management Plan applies. This plan applies only to the areas proposed to be modified for the construction of the access infrastructure (i.e. the earthworks footprint). It is noted that locations for the possible public amenities and possible surf lifesaving equipment storage areas shown on this figure have been included to enable these assets to be provided for in the future if desired by SLSWA or the CoW. These assets are not currently proposed and locations are provided on the figure for indicative purposes only.

The concept plan traverses the following three reserve lots:

- R20561 (Primary interest holder: City of Wanneroo)
- R35890 (Primary interest holder: City of Wanneroo)
- Lot 9505 (Registered Proprietor: Western Australian Planning Commission)

1.3.2 Native Vegetation Clearing Permit Application

In order to facilitate the clearing of native vegetation to allow the coastal access road to be constructed a Native Vegetation Clearing Permit (NVCP) is required from the Department of Water and Environmental Regulation (DWER). This management plan will be supplied to DWER as supporting information for the clearing permit application.

1.3.3 Development Application

The construction of the coastal access road and associated infrastructure will also require Development Application Approval from the City of Wanneroo and WAPC. This management plan will also form part of the Development Application information package, along with detailed engineering and landscape design drawings.

The landscape design drawings will include the proposed location and species of trees to be planted within the car park site.

1.4 Management Plan Objectives

The objective of this FMP is to provide measures to ensure controlled public access to a safe swimming and aquatic activity beach, whilst providing commitments to the protection and where possible enhancement of the conservation value of the adjacent foreshore area.

2.0 RELEVANT GUIDANCE DOCUMENTS

2.1 Environmental Protection Act 1986

The *Environmental Protection Act 1986* ('the Act') is the pre-eminent environmental legislation in Western Australia. Development projects are regulated under Part IV of the Act.

Assessment opportunities under the Act occur at rezoning stage (region scheme and/or town planning scheme, if applicable) under Section 48A of the Act or subdivision / development stage under Section 38 of the Act.

The Act also has a number of Environmental Protection Policies and regulations which provide guidance on environmental management.

2.2 State Planning Policy 2.6 - State Coastal Planning Policy

The State Planning Policy 2.6 (SPP 2.6) provide guidance relating to managing development and land use change within the coastal zone; establishment of foreshore reserves; and to protection, conservation and enhancement of coastal values (WAPC, 2013a).

The policy provides a framework to undertake risk management process in relation to coastal erosion and inundation. SPP 2.6 requires Coastal Hazard Risk Management and Adaptation Planning (CHRMAP) be undertaken for coastal areas with the potential to be vulnerable to coastal processes over future planning timeframes (WAPC, 2013a).

CHRMAP should include context assessment, vulnerability assessment, risk identification, analysis, evaluation, adaptation, funding arrangements, maintenance, review and communication. Where risk assessment identify a level of risk that is unacceptable to the affected community or proposed development, adaptation measures need to be prepared to reduce those risks down to acceptable levels. Adaptation measures include (WAPC, 2013a):

- Avoid the presence of new development within an area identified to be affected by coastal hazards.
- Planned or managed retreat – Locate public infrastructure within coastal hazard risk area but plan for the removal / demolition / relocation of coastal assets at the appropriate time.
- Accommodation adaptation measures including design and/or management strategies that render the risk from the identified coastal hazard acceptable.
- Coastal protection works where there is a need to preserve the foreshore reserve, public access or public safety, property and infrastructure that is not expendable.

SPP 2.6 and the associated SPP 2.6 Guidelines (WAPC, 2013b) also includes guidance relating to the preparation of Foreshore Management Plans. A FMP should generally describe the process and values of the coastal site under consideration, identification of the location of proposed infrastructure and facilities, discussion in

relation to the protection of environmental and cultural values of the site and describe the proposed development and associated design and management measures (including tenure, land use, wastewater, stormwater, coastal hazard risk management and adaptation and ongoing management and maintenance).

2.3 Environmental Protection Authority Guidance Statement No. 33

Environmental Protection Authority (EPA) Guidance Statement No. 33 – *Environmental Guidance for Planning and Development* (EPA, 2008) provides general advice on the environmental management recommendations near waterways. This guidance includes:

- Coastal foreshores are considered to be of high conservation significance in the Perth Metropolitan Region.
- Protect wetland, streamline and estuarine fringing vegetation and coastal vegetation.
- It is desirable to protect and enhance ecological linkages and to increase the buffer or foreshore reserve width in places to connect with remnant vegetation.
- Any clearing and construction activities near waterways or water bodies should minimise the risk of increasing sedimentation, turbidity and pollution.

2.4 Perth Coastal Planning Strategy (in Directions 2031 and Beyond)

Directions 2031 recognises that planning for future growth of the city must manage the increasing pressures on our vulnerable coastal environment by balancing development with the protection, conservation and enhancement of coastal values and the anticipated impacts of climate change, particularly sea level rise. The Perth Coastal Planning Strategy supports this approach by:

- providing guidance and support to decision making on the future land use, development and conservation of the Perth metropolitan coastline;
- promoting integrated coastal zone management; and
- providing guidance for the location, scale and density of developments appropriate for the Perth coastline over the next 10 to 15 years.

Directions 2031 and Beyond (WAPC, 2010) and the draft North-West Subregional Structure Plan (WAPC, 2015) recognise Clarkson as a secondary activity centre and Catalina Estate as urban development land, resulting in an increase to the residential population.

2.5 City of Wanneroo Local Planning Policy (LPP) 4.21 – Coastal Assets Policy

This policy applies to all future works / infrastructure proposed within the City's coastal foreshore reserve, and guides the type, location and extent of proposed assets. It complements the SPP 2.6 and calculated coastal vulnerability timeframes.

2.6 Tamala Conservation Park Establishment Plan

The Tamala Conservation Park Establishment Plan (TCPEP) was prepared by the Western Australian Planning Commission (WAPC) to guide the coordinated long-term management of the coastal bushland between Burns Beach and Mindarie. (Tamala Park Bushland; Bush Forever Site 322). It describes the relevant conservation and recreation values and identifies the proposed boundaries of the Park. It outlines management objectives, various park management options, tenure and the overall establishment process.

A Community Advisory Committee (CAC) was created to develop the TCPEP and included representatives from City of Wanneroo (CoW), City of Joondalup (CoJ), State government agencies, adjoining property developers (including Tamala Park Regional Council) and conservation and community interest groups. A technical advisory group was also established to provide technical advice and recommendations from State and local government authorities.

The TCPEP provides the following guidance relevant to this Foreshore Management Plan:

- Documentation of the CoW's in-principle support of the provision of facilities associated with the development of a swimming beach at the northern end of the Park on land managed by the CoW, subject to further environmental and engineering studies and an agreement on funding.
- The former Department of Environment and Conservation (DEC) (now Department of Biodiversity, Conservation and Attractions [DBCA]) provided its support to the protection of the Park as a Class A Nature reserve for management as a conservation park (The Cities of Wanneroo and Joondalup currently manage all of the foreshore areas as "C" class reserves for recreation). It was recognised that whilst containing high conservation value, the Park permits an element of suitable managed passive recreation.
- The Park is described as having three main broad usages:
 - Conservation and protection, excluding or limiting access to dedicated walk trails. Usually managed by DEC (now DBCA).
 - Natural environment uses, where bushland is adjacent to some level of developed amenity and public access, with appropriate controls in place. Usually (but not exclusively) managed by DEC (now DBCA).
 - Recreation areas are identified and set aside specifically for public use, and include swimming / fishing beaches and associated infrastructure. The CAC recommends that any swimming beaches and associated access infrastructure should be managed by the relevant local government authority (i.e. CoW in this instance) whilst the remainder of the conservation park be vested in the DEC (now DBCA). DEC provided their support for this recommendation.
- Other relevant recommendations include:

- As a matter of priority, the CoW, the City of Joondalup and the WAPC consider jointly funding appropriate studies for a shared path from Burns Beach to Mindarie.
- Given the increased demand from the community for access to safe swimming areas adjacent to Mindarie and the future Tamala Park project, the local government shall identify a public recreational swimming area off Long Beach Promenade. It is proposed that fenced hard-stand public road access, with appropriately located facilities such as car parking, toilets and potential surf-life-saving facilities will be investigated and provided. There should be no vehicular access beyond the hard-stand onto the beach, other than for management or emergency purposes.
- Funding for comprehensive weed mapping and flora and fauna surveys is to be provided for interim management of the area.

2.7 City of Wanneroo Coastal Management Plan (Part 1)

The City of Wanneroo Coastal Management Plan (CMP) (CoW, 2012) was developed to guide the future uses of the City's coastal environment, borne out of several enquiries and petitions received by the CoW regarding dog and horse beach provisions.

Part 1 of the CMP comprises a data capture of the current environment, existing facilities and known issues. Community consultation was undertaken to address the needs of the community and take into account recommendations for future coastal uses.

Identified issues for Tamala Park beach area were:

- Unauthorised sand boarding in the southern end of the study area; and
- Four-wheel-drive issues in the southern section of the study area.

Recommendations from the CMP relating to the Tamala Park beach area included:

- Car parking and beach access could possibly be located in the Tamala Park development, avoiding the use of Longbeach Promenade.
- Other potential future uses include
 - Proposed DUP to connect Burns Beach with Tamala Park;
 - Blow out is proposed for revegetation; and
 - Potential change room and toilet at the access way from Long Beach Promenade.

2.8 Coastal Hazard Risk Management and Adaptation Planning Guidelines

The Western Australian coastal zone is vulnerable to physically process hazards and adverse impacts from inundation and erosion. Climate change has the potential to

increase some of these impacts. Early consideration of these matters and the adaptation and management of appropriate planning responses can provide economic, environmental and social benefits (WAPC & DoP, 2014).

Coastal Hazard Risk Management and Adaptation Planning (CHRMAP) as advocated by the State government includes the following elements (WAPC & DoP, 2014):

- Establish the context
- Coastal hazard risk identification/vulnerability assessment
- Coastal hazard risk analysis
- Coastal hazard risk evaluation
- Coastal hazard risk adaptation planning
- Monitor and review

3.0 PREVIOUS ENVIRONMENTAL INVESTIGATIONS

3.1 Proposed Dual Use Coastal Path between Mindarie and Burns Beach - Environmental Study and Topographical Survey Report (GHD, 2013)

The Department of Planning commissioned GHD to undertake an investigation across a large stretch of the coastal vegetation between Burns Beach (south of Catalina Estate) and Mindarie (north of Catalina Estate) to determine the environmental feasibility of constructing a dual use coastal path between these two locations (GHD, 2013). The study area encompassed the current proposed coastal infrastructure footprint. The investigation encompassed:

- Desktop review of environmental factors
- A desktop review of LiDAR data and latest aerial imagery
- Buried services investigation, using the Dial Before You Dig (DBYD) system
- Level 1 flora reconnaissance survey
- Level 1 fauna reconnaissance survey
- Topographical feature survey of preferred route alignments
- Development of two coastal dual use path alignments

3.2 City of Wanneroo Coastal Vulnerability Study & Hazard Mapping (CHRMAP Part 1 and 2)

3.2.1 Part 1 - Coastal Vulnerability Study & Hazard Mapping (MP Rogers, 2015)

A Coastal Vulnerability Assessment and Hazard Mapping was undertaken as Part 1 of the Coastal Hazard Risk Management and Adaptation Planning process, in accordance with the State Planning Policy 2.6: State Coastal Policy, for the entire coastline of the City of Wanneroo land area (MP Rogers, 2015). The study investigated the potential future impacts of climate change on the City's beaches and foreshore areas. It identified a number of assets that may be vulnerable to coastal erosion within the next 100 years.

The scope of this investigation was to cover the hazard identification and risk assessment components of the CHRMAP for the entire coastline within the City of Wanneroo, stretching from Tamala Park to north of Two Rocks. It covered eight tertiary sediment cells, which included the beach adjacent to Catalina Estate within Sediment Cell 29a - (Mindarie Keys North to Burns Beach Salient). A knowledge summary and gap analysis was completed to provide background to the coastal processes along this coastline.

Coastal hazard lines were presented for present day, as well as timeframes to 2030, 2050, 2070, 2090 and 2120. These hazard lines were used to determine the potential vulnerability of assets to coastal hazards over relevant timeframes. Assets

considered in this assessment included built form, environmental and cultural assets.

3.2.2 Part 2 - Risk Assessment & Adaptation Planning (Cardno, 2018)

The Risk Assessment and Adaptation Planning (Part 2) component of the City's CHRMAP (Cardno, 2018) used the results of the coastal vulnerability study and hazard mapping to apply a risk and vulnerability assessment to key areas with vulnerable assets and / or timeframes. Through a stakeholder engagement process, key areas and adaptation options were identified with the guidance of a community values assessment.

The risk assessment and adaptation planning found that the Priority Ecological Community (PEC) found within the bushland adjacent to Catalina Estate within the Bush Forever site would be exposed to an increasing level of risk over time. An adaptation plan was developed which addressed the areas of dune care / sand management for the preservation of the community.

3.3 Coastal Aquatic Risk Assessment (SLSWA, 2014)

A Coastal Aquatic Risk Assessment was undertaken by Surf Life Saving Western Australia for TPRC for the coastal zone fronting Catalina Estate, due to the influx of residents to the area projected by the estate development (Surf Life Saving WA, 2014). The objectives of the assessment included determination of the suitability of the beach adjacent to Catalina Estate for recreation activities, provision of recommendations regarding zoning for various activities, and identification of infrastructure deemed necessary to support safe aquatic recreation in the area. The results of the risk assessment include:

- Current formal beach access locations to Claytons Beach (north of Catalina Estate at Mindarie) and Burns Beach (3 km south of Catalina Estate) lead beach-goers to potentially hazardous areas, consisting of rock / reef platforms, steep dunes, rips, strong currents and submerged rocks.
- Of two locations investigated, 'Node A' was identified as the preferred beach access location, due to safe swimming conditions and absence of the potential hazards present in the existing access locations to the north and south. (This preference is reflected in the proposed location of the coastal access infrastructure) (Figure 2).
- Infrastructure recommended to support safe aquatic recreation in this area includes:
 - Defined access tracks
 - Designated emergency vehicle access points
 - System of safety signage and consideration of a lifesaving operational, storage, first aid and surveillance facility for future service provision
 - Showers / toilets

- Parking
- Café / kiosk

Discussion on the proposed implementation of these recommendations within this FMP is summarised as follows:

- Access tracks and vehicle access points – Section 6.1.
- Safety signage – Section 7.3.8.
- Future SLSWA storage facility and amenities buildings – Not proposed as part of this FMP. Future potential and indicative locations are discussed in Sections 1.2 and 1.3.1.
- Parking – Section 6.1.2
- Café / kiosk – Not proposed as part of this FMP

3.4 Previous Ecological Surveys

The following ecological surveys have been undertaken within the subject area and/or the surrounding environment.

Level 1 Flora and Vegetation Assessment of Lot 17 Marmion Avenue, Clarkson (Mattiske Consulting Pty Ltd, 2000) and previous surveys

Mattiske Consulting Pty Ltd undertook a vegetation and flora survey to review the options for the Structure Plan covering Lot 17 Mindarie and in particular the area west of Marmion Avenue. This survey included a significant portion of the previous extent of Bush Forever Site No. 322, however did not extend throughout the foreshore reserve. It incorporated a review of previous studies in the general area, including surveys undertaken by Kinhill Stearns (1983), Alan Tingay and Associates (1999) and Mattiske Consulting Pty Ltd (1999).

Declared Rare Flora and Priority Flora Search for Area Ceded to Bush Forever 322 (Syrinx, 2009)

Syrinx undertook a broad-scale Declared Rare Flora and Priority Flora Survey across the area of Bush Forever 322 surrendered by TPRC during the Negotiated Planning Solution. No Declared Rare Flora were recorded, however a Priority 2 moss (*Fabronia hampeana*) was found growing on a number of zamia palms. Vegetation condition and vegetation communities were also recorded.

Level 1 Flora Reconnaissance Survey and Level 1 Fauna Reconnaissance Survey for the Dual Use Coastal Path between Mindarie and Burns Beach (GHD, 2013)

3.5 Botanical Assessment of the Proposed Coastal Access Road (BEC, 2016)

A Level 2 Flora and Vegetation Survey was undertaken in November 2016 (Attachment 2) for the proposed coastal infrastructure footprint (encompassing a greater area than the final clearing footprint determined) by Bennett Environmental Consultants (BEC, 2016). The survey identified four vegetation units, and vegetation



condition ranged from Very Good to Good within this localised area. Recommendations were made on the construction of the tracks, the hard stand near the beach, rehabilitation due to site works associated with this construction and closure and rehabilitation of other off road tracks through the area.

4.0 CONSULTATION

4.1 Historical Consultation

Community consultation which previously occurred relating to the Tamala Conservation Park Establishment Plan included:

- In early 2008, the City of Wanneroo received two petitions requesting Council's consideration of the construction of a shared path and the development of a management plan to protect the environmental values of the area.
- The WAPC established a Community Advisory Committee, with nominated representatives from both the City of Joondalup and City of Wanneroo for the purpose of producing an establishment plan to guide the long-term management of the area (including the recommendation for a beach access road and facilities).
- Public comment was sought on the establishment plan and this was incorporated, as relevant, into the final version of the plan.

4.2 Consultation to Inform Preparation of the FMP

A meeting was held onsite on 15/01/2015 with representatives from CoW, TPRC and the Catalina Estate consultant team, whereby the coastline adjacent to Catalina Estate was walked. The group walked from the north-western boundary of the TPRC's landholdings and potential options for the location of the coastal access node were inspected.

Node A (as referred to within the SLSWA report and consistent with the concept plan in Figure 2) was agreed as being the most appropriate access point to the beach. The CoW's final position on the carpark location will be based on:

- CoW's position on coastal setbacks;
- The importance of increasing usage at proposed coastal infrastructure location compared to Clayton's Beach (hazardous / rocky beach further north); and
- Coastal erosion information; and
- Input from the Department of Planning (DoP).

A subsequent meeting was held on 05/11/2015 with the DoP and TPRC representatives, with outcomes being:

- DoP had no objection in principle to TPRC's proposed beach access proposal.
- DoP highlighted the environmental constraints including Bush Forever, flora and vegetation values and Quindalup dunes.
- DoP propose the conservation area from TPRC southern boundary to the foreshore up to existing Mindarie being managed by the City of Wanneroo.

- DoP propose the conservation area south of TPRC landholdings to Peet Burns Beach development being managed by DPAW (now DBCA).
- The City of Wanneroo support TPRC's beach access proposal; and
- Funding for any future pedestrian walk (DUP between Burns Beach and Tamala Park) is deemed to require State level funding.

Revision 3 of this FMP was submitted to the CoW for review and comment in 2018. This report (Revision 5) addresses the comment received on the first version of the document.

5.0 ENVIRONMENTAL CONTEXT

5.1 Climate and Weather

The weather in the Perth metropolitan area tends to be Mediterranean in nature, with hot, dry summers and cool, wet winters. The nearest coastal weather station is at Swanbourne (Site No. 9215) which lies ~30 km south of the foreshore area (BOM, 2016). The mean annual rainfall in Swanbourne is 721.2 mm (over 20 years between 1993 and 2016). Wind speed and direction averages (January and July, 9 am and 3 pm) are provided in Plates 1 to 4 below. The trend in summer is mostly morning easterlies, with strong and predictable south-westerlies in the afternoons, whilst the winter trend is for morning easterlies and variable wind patterns in the afternoons, slightly trending to westerlies / north-westerlies / south westerlies.

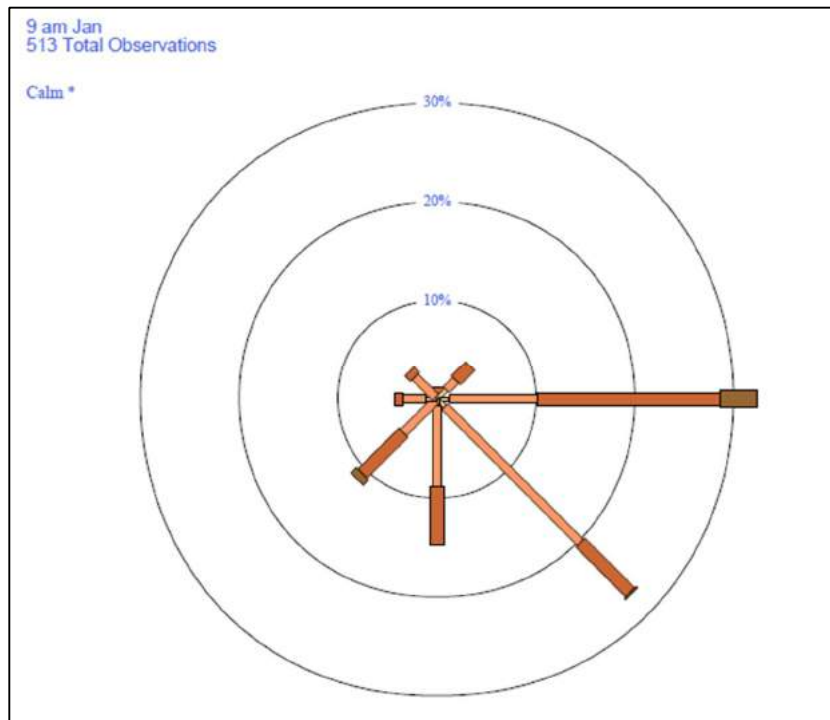
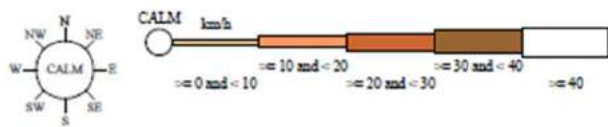


Plate 1: Wind rose (Swanbourne) - 9 am January Observations (BOM, 2016)

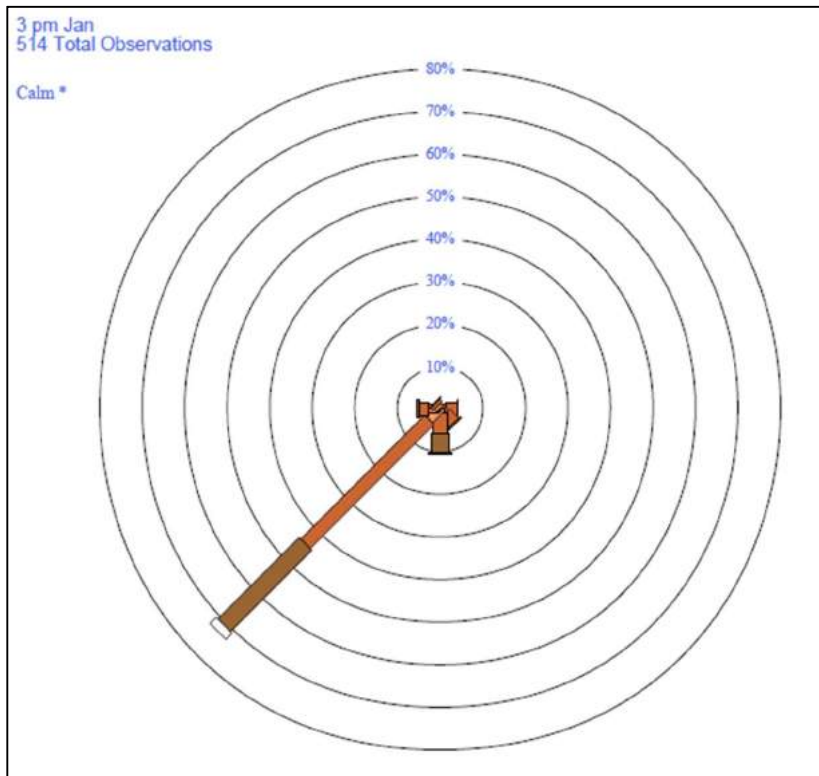


Plate 2: Wind rose (Swanbourne) - 3 pm January Observations (BOM, 2016)



Plate 3: Wind rose (Swanbourne) - 9 am July Observations (BOM, 2016)

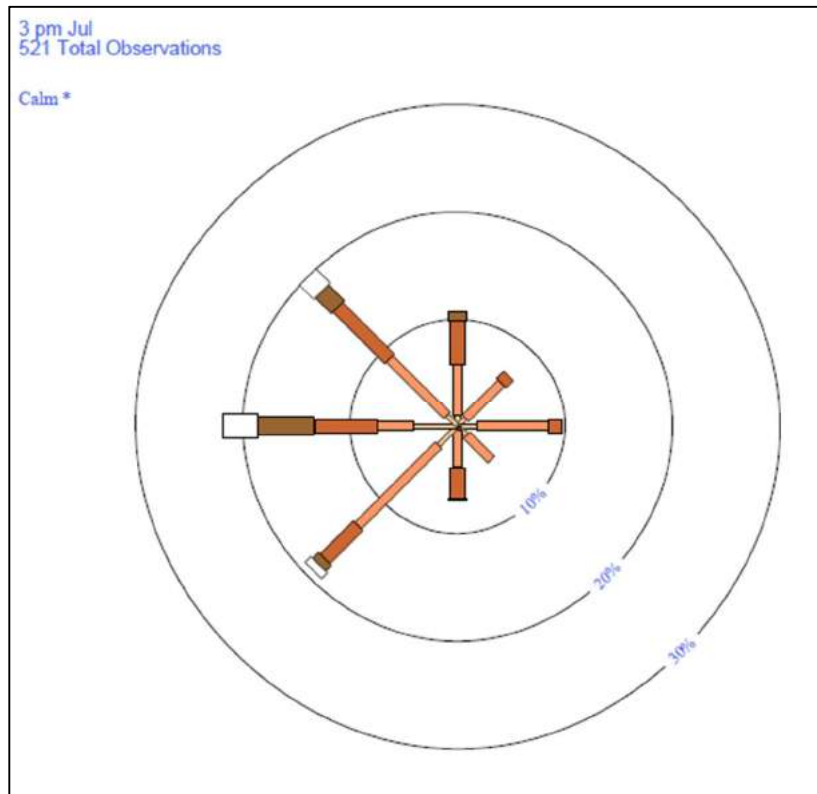


Plate 4: Wind rose (Swanbourne) – 3 pm July Observations (BOM, 2016)

5.2 Climate Change and Sea Level Rise

Sea level rise attributed to the various scenarios of climate change has been modelled for the next 100 years, by the Intergovernmental Panel on Climate Change (IPCC). Increases in the global sea level are likely to lead to accelerated vulnerability (i.e. beach erosion), and various formulas have been employed to quantify the likely impacts (MP Rogers, 2015 and 2019). DoT (2010) completed an assessment of the potential increase in sea level that could be experienced on the Western Australian coast in the coming 100 years, the results of which have since been adopted by the WAPC for use in coastal planning in Western Australia (including SPP 2.6). This sea level rise scenario is provided in Plate 5.

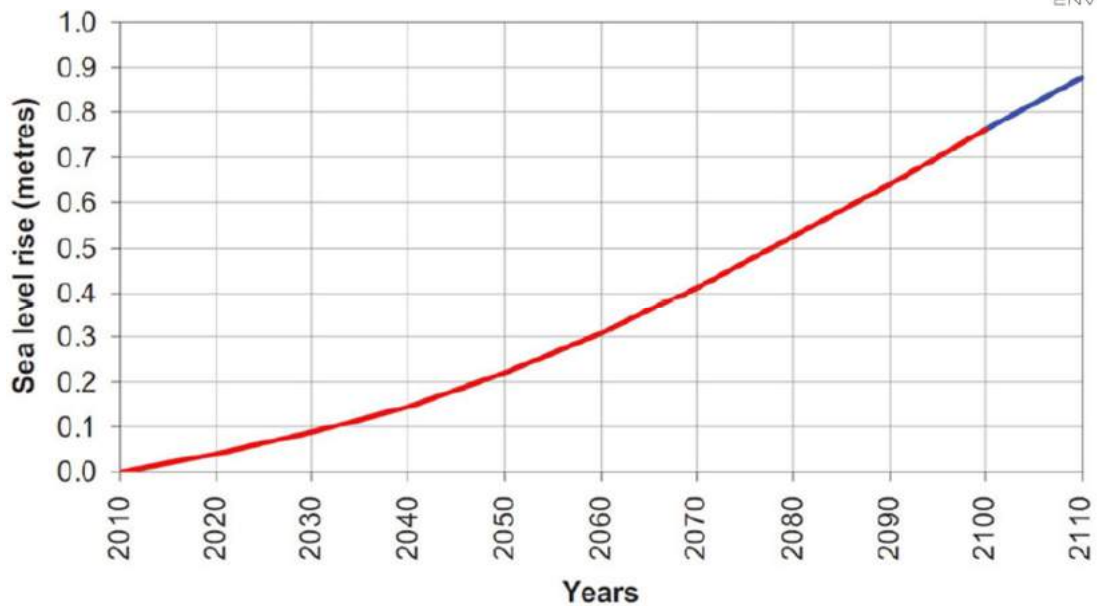


Plate 5: Recommended sea level rise scenario for coastal planning in WA (DoT, 2010)

5.3 Coastal Hazard Risk

As a requirement of SPP 2.6, a CHRMAP is required to be undertaken for any proposed development located in an area that may be at risk of coastal hazards and inundation.

5.3.1 City of Wanneroo CHRMAP

MP Rogers (2015) undertook Coastal Vulnerability Study and Hazard Mapping (Part 1) of the City of Wanneroo’s coastline, for a 100 year planning period. The location of the proposed beach access and carpark occurs within Zone 3 of Tertiary Sediment Cell 29a (Mindarie Keys North to Burns Beach) (MP Rogers, 2015) (Figure 3).

The Risk Assessment and Adaptation Planning (Part 2) component of the City’s CHRMAP (Cardno, 2018) used the results of the coastal vulnerability study and hazard mapping to apply a risk and vulnerability assessment to key areas with vulnerable assets and / or timeframes.

These reports are discussed in more detail in Section 3.2.

5.3.2 Catalina Estate Coastal Access Infrastructure CHRMAP (MP Rogers, 2019)

A site specific Coastal Hazard Risk Management & Adaptation Plan was subsequently prepared for the Catalina Estate coastal access route and associated infrastructure and assets (MP Rogers, 2019). The CHRMAP addresses the following:

- Establishment of the context
- Coastal hazard identification and vulnerability
- Risk analysis and evaluation
- Risk management and adaptation planning

- Implementation plan

This CHRMAP is provided in Appendix B and is summarised below. The development of the adaptation plan is informed by the coastal erosion and inundation hazards at the coastal location of the beach access infrastructure. The CHRMAP considers the potential risks posed by coastal hazards over a range of horizons covering the 100 year planning timeframe to the year 2120, as required by SPP 2.6 for development on the coast.

5.3.2.1 Key Assets

The key assets considered within the CHRMAP (MP Rogers, 2019) include only those new assets proposed as part of the Catalina Estate development. Existing assets, which include the beach, dunes and vegetation were assessed as part of the City's CHRMAP processes and would remain unchanged as a result of the proposed construction of the coastal access infrastructure.

As such, the key assets covered by this CHRMAP include the following.

- Beach access path
- 30 bay car park
- Coastal access road
- Land area for potential future SLSWA outpost and toilet block/change rooms (note: these infrastructure assets are not currently proposed and as such, no plans have been prepared and cannot be assessed within the current version of the CHRMAP)

5.3.2.2 Coastal Erosion and Inundation

Using the methodology specified in SPP 2.6, MP Rogers (2015) assessed the appropriate coastal erosion hazard allowances across the planning horizons introduced previously. Figure 3 provides the risk presented by coastal erosion hazards following the consideration of the following factors:

- (S1 Erosion) Allowance for the current risk of storm erosion associated with the 100 year ARI event.
- (S2 Erosion) Allowance for long term shoreline movement trends.
- (S3 Erosion) Allowance for erosion caused by future sea level rise.
- (Allowance for Uncertainty) Allowance of 0.2 m/year for unforeseen or unaccounted for shoreline change

MP Rogers (2015) also undertook a coastal inundation assessment as required by the SPP 2.6 to determine the potential exposure of the City of Wanneroo open coastline to inundation associated with severe storm surge (equivalent to a 500 year ARI event). The SBEACH modelling undertaken suggests the inundation influence of the extreme water level associated with storm surge (based on historic Fremantle harbour data) plus wind and wave setup from the 5 m contour to the beach plus allowance for Sea Level Rise results in the following modelled Total Water Levels:

- Present Day (2015): +2.8 mAHD
- 2030: +2.9 mAHD
- 2050: +3.0 mAHD
- 2070: +3.2 mAHD
- 2090: +3.4 mAHD
- 2120: +3.8 mAHD

This methodology through which the coastal hazard mapping was developed is discussed in detail in the CoW CHRMAP Part 1 (MP Rogers, 2015).

5.3.2.3 Coastal Vulnerability

The built form assets considered as part of the CHRMAP for the Catalina Estate coastal access infrastructure were assessed in relation to their level of exposure to coastal hazards, as well as their sensitivity to the impacts caused by these hazards and their ability to respond to them (termed adaptive capacity).

5.3.2.4 Risk Assessment and Coastal Adaptation Approach

MP Rogers (2019:17) reports that there is a high likelihood that the beach access track would be impacted by coastal erosion from the time it is constructed. This is an unavoidable consequence of constructing a track down to a beach, and management and maintenance of this track will need to be completed over its lifetime to accommodate these changes. Termination of the path approximately 5 to 10 m behind the front face of the dunes at an appropriately low level (making way to a graded sand track) is recommended to allow a degree of change to the shoreline without loss of the path itself in the near future.

The likelihood of the remainder of the assets being impacted by coastal erosion is expected to be rare until at least 2070 (refer to Appendix B).

The majority of the assets, with the exception of the lower portions of the beach access path, are located at elevations above 15 mAHD and are therefore a long way above the potential inundation levels. As a result, the only asset that could be prone to inundation during severe events would be the beach access path (MP Rogers, 2019:18).

The entirety of the proposed carpark lies behind the 2050 vulnerability line (Figure 3), with a significant portion of the hardstand area behind the 2070 vulnerability line. It is noted that roads and carparks typically have a lifespan of 30 years, therefore this location is considered appropriate for the anticipated lifespan. Beyond this timeframe (2070), if the shoreline has experienced erosion that is consistent with the allowance made in the coastal hazard assessment, then a planned or managed retreat of the infrastructure could be completed to prevent an increase in exposure to coastal hazard risk.

The risks identified in relation to the location of the assets are loss of infrastructure from potential future coastal erosion and inundation. The adaptation strategy proposed follows the planned or managed retreat adaptation option identified in

SPP 2.6. The location of the proposed coastal access infrastructure meets the requirements of LPP 4.21 (MP Rogers, 2019:26). MP Rogers (2019:26) concludes that “the higher value, and potentially more rigid assets such as the car park, coastal access road and land area for the SLS outpost and/or toilet block and change rooms, avoid the risk of coastal hazards over the relevant planning horizon to 2070”.

This is considered suitable in this situation; at the conclusion of the carpark lifespan funds would need to be allocated to upgrade or reinstate the carpark regardless of location. Planning to relocate the carpark at this time would be logical, and MP Rogers (2019) have provided a suggested landward location for the future relocation of the carpark in their report (Appendix B).

5.4 Landform and Geomorphology

The foreshore area is located within the Quindalup Dune System, a coastal dune formation of unconsolidated Holocene aeolian deposits (Safety Bay Sand) and Tamala limestone, occurring to the west of the Spearwood Dunes. The major formations are moderately inclined to steep sided, complex parabolic dunes. Active foredune ridges also occur adjacent to the coast. The dominant soils are rapidly drained, uniform pale calcareous sands with minimal profile development (Wells and Clarke, 1986).

The foreshore reserve is steeply undulating, being located over the primary dune system to the coast. The access track is undulating as it traverses the natural dune features. It ranges from 0 mAHD at the water’s edge to 32 – 34 mAHD on the dune crests and ridgelines (Figure 4).

5.5 Groundwater

Regional groundwater contours mapped in the Perth Groundwater Atlas (DoW, 2017) indicate that maximum groundwater levels occur between 2 mAHD at the eastern portion of the access road, to 0 mAHD at the water’s edge (groundwater flows in a westerly direction discharging to the ocean).

5.6 Vegetation and Flora

The vegetation within the foreshore area is mapped as part of the regional Quindalup Complex. The Quindalup Complex consists of two alliances - the strand and fore dune alliance and the mobile and stable dune alliance. The vegetation differs in the species composition from one area to the other because of differences in the dune environment due to edaphic and topographical factors and shelter from salt laden winds (BEC, 2016)

This vegetation complex is considered well-represented across the Swan Coastal Plain, with 55% of the original extent remaining (Local Biodiversity Program, 2013).

5.6.1 Vegetation Type and Condition

Bennett Environmental Consulting (BEC) undertook a Level 2 flora and vegetation survey over the proposed coastal infrastructure footprint in November 2016 to

determine the vegetation type and condition within the infrastructure development area (to be impacted) (Appendix C).

A total of 31 vascular plant families, 58 genera and 68 taxa were recorded during the survey, of which 26 taxa were weeds (BEC, 2016).

The survey found four different vegetation types occurring, described as follows (Figure 5):

- Open Heath of *Melaleuca cardiophylla* over Very Open Grassland dominated by **Ehrharta longiflora* over Herbland dominated by **Raphanus raphanistrum*, **Crassula glomerata* and **Petrorhagia dubia* over Sedgeland dominated by *Lomandra maritima* and *Desmocladius flexuosus*;
- Tall Open Scrub of *Acacia rostellifera* and *Spyridium globulosum* over Low Shrubland of *Melaleuca systema* over Open Grassland dominated by **Ehrharta longiflora* over Open Herbland dominated by **Lysimachia arvensis* over Very Open Sedgeland of *Lomandra maritima* and *Desmocladius flexuosus*;
- Shrubland of *Acacia rostellifera* over Low Shrubland dominated by *Rhagodia baccata subsp. dioica* and *Scaevola crassifolia* over Very Open Grassland dominated by **Ehrharta longiflora* over Open Herbland dominated by *Acanthocarpus preissii*, **Crassula glomerata* and **Trachyandra divaricata* over Sedgeland of *Lepidosperma gladiatum*; and
- Low Open Shrubland of *Olearia axillaris*, *Scaevola crassifolia*, **Pelargonium capitatum* and *Rhagodia baccata subsp. dioica* over Grassland dominated by *Spinifex longifolius* over Very Open Herbland dominated by **Trachyandra divaricata*.

The vegetation condition of the area is described by BEC (2016) as varying between Very Good and Good, according to the Keighery condition rating scale (Figure 6). The only exception to this is along the cleared track, which is degraded.

Table 1 provides a description of each of the condition ratings (Keighery, 1994).

Table 1: Condition Rating Scale (Keighery, 1994)

Rating	Description	Explanation
1	Pristine	Pristine or nearly so, no obvious signs of disturbance.
2	Excellent	Vegetation structure intact, disturbance affecting individual species and weeds are non-aggressive species.
3	Very Good	Vegetation structure altered, obvious signs of disturbance.
4	Good	Vegetation structure significantly altered by very obvious signs of multiple disturbances. Retains basic vegetation structure or ability to regenerate it.
5	Degraded	Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching good condition without intensive management.
6	Completely Degraded	The structure of the vegetation is no longer intact and the area is completely or almost completely without native species.

5.6.2 Threatened Ecological Communities

None of the vegetation types recorded within the subject area are considered to be representative of a Threatened Ecological Community (TEC) or Priority Ecological Community (PEC) (BEC, 2016).

A search of the Department of Parks and Wildlife Threatened and Priority Ecological Community database (DPaW, 2016) found no communities occurring in the subject area (BEC, 2016). Whilst a search of the federal *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) Protected Matters database identifies the TEC “Banksia Woodlands of the Swan Coastal Plain” as possibly occurring, the vegetation survey confirms that this TEC is not present in the area.

5.6.3 Conservation Significant Flora

No flora species listed under state (*Wildlife Conservation Act 1950*) or federal (EPBC Act) legislation as conservation significant were recorded during the Syrinx (2009) conservation significant flora survey or the BEC (2016) survey.

Syrinx (2009) recorded a Priority 3 moss (*Fabronia hampeana*) within the greater Tamala Conservation Park, however this was not recorded by BEC (2016) within the proposed coastal infrastructure footprint.

5.6.4 Weeds

Syrinx (2009) noted that the most prevalent weed within Bush Forever Site 322 is Geraldton carnation weed (*Euphorbia terracina*), covering more than one third of the site. Other notable weeds included rose geranium (*Pelargonium capitatum*), although limited to the edges of the tracks and veldt grass (*Ehrharta calycina*).

BEC (2016) recorded 26 weed taxa during the flora and vegetation survey of the proposed coastal infrastructure footprint, of which none are considered to be Declared Plants under the *Biosecurity and Agriculture Management Act 2007*. Many of these were introduced grasses.

5.6.5 Phytophthora Dieback

The study area occurs on the Quindalup Dunes, the soils of which tend to be well-drained and highly calcareous. As such, the occurrence and expression of plant disease such as phytophthora dieback (*Phytophthora cinnamomi*) is limited.

5.6.6 Bush Forever

The access road and carpark are proposed to be constructed within Bush Forever Site No. 322 – Burns Beach Bushland. A portion of this coastal bushland reserve was previously under the ownership of TPRC and was ceded to the Crown for conservation (see Section 1.1.1).

5.7 Fauna and Habitat

The Tamala Conservation Park forms part of an important wildlife refuge and corridor linkage from the coast to Neerabup National Park and beyond to the State

forest areas on the Gnangara Mound (WAPC, 2012). A limited survey of the park previously identified 54 bird species, three native mammal species, and 23 different types of reptiles in the area (Kinhill Stearns, 1983).

A search of the WA Museum and DBCA NatureMap database (a polygon over the subject area and surrounds) found 50 fauna species potentially occurring in the area, with several of these considered threatened and four given priority status (Table 2; Appendix D). The EPBC Act Protected Matters database (a polygon over the subject area and surrounds plus 2 km buffer) found 34 threatened species potentially occurring within the subject area (Appendix D). Many of these are shorebirds (i.e. albatross, petrel) that may occur along this coastline, but are unlikely to be impacted by the clearing of vegetation to create the access road and carpark hardstand area.

Table 2: Likelihood of Threatened and Priority Fauna species occurring within the vicinity of the subject area

Species	Conservation status		Habitat	Likelihood of presence within the subject area
	WC Act	EPBC Act		
<i>Anous tenuirostris melanops</i> (Australian Lesser Noddy)	E	V	The Australian lesser noddy is only known to breed in Houtman Abrolhos, with colonies on Pelsaert Wooded and Morley Islands. The oceanic range of the Australian lesser noddy is largely unknown (TSSC, 2015).	Unlikely to occur within the vicinity of the site. GHD (2013) report species very unlikely to occur within subject area.
<i>Calidris ferruginea</i> (Curlew Sandpiper)	V	CE	The species is widespread around coastal and sub-coastal plains from Cape Arid to south-west Kimberley. They occur in large numbers, in thousands to tens of thousands, at Port Hedland Saltworks, Eighty-mile Beach, Roebuck Bay and Lake Macleod (TSSC, 2015a).	Unlikely to occur within the vicinity of the subject area.
<i>Calyptorhynchus latirostris</i> (Carnaby's Cockatoo)	T	E	Typically occurs in woodlands and scrubs of semiarid interior of Western Australia, in non-breeding season wandering in flocks to coastal areas, especially pine plantations and Banksia woodlands. Food includes the flowers, nectar and seeds of Banksia, Dryandra, Hakea, Eucalyptus, Corymbia, Grevillea, also seeds of Pinus.	Likely to occur within the vicinity of the site. Subject area within modelled distribution for CC (DEE, 2017). However, foraging plant species not within the subject area (DEC, 2011).
<i>Calyptorhynchus banksii subsp. naso</i> (Forest Red-tailed Black Cockatoo)	T	V	It inhabits the dense <i>Eucalyptus marginata</i> (Jarrah), <i>E. diversicolor</i> (Karri) and <i>Corymbia calophylla</i> (Marri) forests receiving more than 600mm of annual average rainfall.	Likely to occur within the vicinity of the subject area. Subject area within modelled distribution for RTBC (DEE, 2017). However, foraging plant species not within the subject area (DEC, 2011).

Species	Conservation status		Habitat	Likelihood of presence within the subject area
	WC Act	EPBC Act		
<i>Caretta caretta</i> (Loggerhead Turtle)	E	E	Nesting locations Dirk Hartog Island, Muiron Islands, Gnaraloo Bay, Ningaloo coast (plus 20km buffer). Primarily herbivorous, foraging on algae, seagrass and mangroves. In their pelagic juvenile stage, they feed on algae, pelagic crustaceans and molluscs (DEE, 2017).	Site outside the known WA nesting areas (DEE, 2017a). Unlikely to occur within the vicinity of the site.
<i>Chelonia mydas</i> (Green Turtle)	V	V	Nesting locations Adele Island, Maret Island, Cassini Island, Lacepede Islands, Barrow Island, Montebello Islands (all with sandy beaches), Serrurier Island, Dampier Archipelago, Thevenard Island, Northwest Cape, Ningaloo coast	Site outside the known WA nesting areas (DEE, 2017a). Unlikely to occur within the vicinity of the site.
<i>Dasyurus geoffroii</i> (Chuditch, Western Quoll)	V	V	Inhabits eucalypt forests (particularly jarrah), dry woodland and mallee shrubland. Utilises fallen hollow logs and burrows for dens in wooded habitats. Fragmented and scattered distribution within the Western and Simpson Deserts, and towards the Kimberley coast.	Unlikely to occur within the vicinity of the site due the lack of suitable habitat.
<i>Diomedea chlororhynchos</i> (Yellow-nosed Albatross)	E	V	The Indian Yellow-nosed Albatross breeds on islands of the southern Indian Ocean. The southern limit of breeding may be determined by the distance to subtropical waters used for feeding (Weimerskirch et al. 1986).	Unlikely to occur within the vicinity of the site due the lack of suitable habitat.
<i>Halobaena caerulea</i> (Blue Petrel)		V	The blue petrel previously bred on Macquarie Island itself, but breeding is now restricted to offshore stacks near Macquarie Island (TSSC, 2015b)	Unlikely to occur within the vicinity of the site. Outside of known distribution and lack of suitable habitat on site.
<i>Isodon fusciventer</i> (Quenda, Southwestern brown bandicoot)	P4	-	Quenda have a patchy distribution through the Jarrah and Karri forest, the Swan Coastal Plain. Scrubby, often swampy, vegetation with dense cover up to 1 m high, often feeds in adjacent forest and woodland that is burnt on a regular basis and in areas of pasture and cropland lying close to dense cover.	Suitable habitat- may likely to occur within the vicinity of the site.
<i>Leipoa ocellata</i> (Malleefowl)	V	V	Found principally in the semi-arid to arid zone in shrublands and low woodlands dominated by mallee	Unlikely to occur within the vicinity of the site due the lack of suitable habitat. GHD (2013) very unlikely that species occurs within the subject area.
<i>Neelaps calonotos</i> (Black-striped Snake)	P3	-	Occurs in Banksia woodlands and sandy areas of the Perth region.	Suitable habitat- may likely to occur within the vicinity of the site. Likely to occur within the subject area (GHD, 2013)
<i>Rostratula australis</i> (Australian Painted-snipe)	E	E	The Australian painted snipe occurs in shallow freshwater (occasionally brackish) wetlands, both ephemeral and permanent, such as lakes, swamps, claypans, inundated or waterlogged grassland/saltmarsh, dams, rice crops, sewage farms and bore drains, generally with a good cover of grasses, rushes and reeds, low scrub, <i>Muehlenbeckia spp</i> (TSSC, 2013)	Unlikely to occur within the vicinity of the site due the lack of suitable habitat

Species	Conservation status		Habitat	Likelihood of presence within the subject area
	WC Act	EPBC Act		
<i>Synemon gratiosa</i> (Graceful Sunmoth)	P4		It is associated with two habitat types: coastal heathland on Quindalup dunes, thought to be the preferred habitat, where it is restricted to secondary sand dunes where the host plant <i>Lomandra maritima</i> is locally abundant; and Banksia woodland on Spearwood and Bassendean dunes, where the second known host plant <i>L. hermaphrodita</i> is widespread (DEC, 2011).	One vegetation type occurring on site contains Sedgeland dominated by <i>Lomandra maritima</i> . Suitable habitat likely to occur in the vicinity of the site. Suitable habitat within the vicinity of the subject area (GHD, 2013).

GHD (2013:27) completed a Level 1 fauna and habitat assessment for the proposed coastal path between Mindarie and Burns Beach which included the subject area, reporting that 28 fauna species were recorded within the vicinity, consisting of 21 birds (all native) and three mammals (one native and two exotic/naturalised), and four reptiles (all native). No species of conservation significance were recorded during the field assessment. Four broad fauna habitat types were identified occurring within the vicinity including: Previous survey of adjacent land has found quendas and an array of reptiles (G. Harewood, *pers com*, 2018).

While black cockatoos are known to occur within the vicinity of the subject area based on the four vegetation units (Figure 5), no potential breeding tree species i.e. salmon gum (*E. salmonophloia*), wandoo, tuart, jarrah, flooded gum (*E. rudis*), york gum (*E. loxophleba subsp. loxophleba*), powderbark (*E. accedens*), karri and marri, blackbutt (*E. patens*), tuart (DEE, 2017) have been recorded within the subject area and the vegetation types do not support the typical foraging species commonly used by Carnaby's black cockatoo (DEC, 2011).

A Level 1 fauna survey plus a targeted survey for black cockatoos and associated habitat is proposed to be undertaken for the subject area prior to the commencement of site works. The results of this survey will advise the fauna relocation program for the construction of the beach access infrastructure (to be agreed with the CoW prior to the commencement of site works). If a more comprehensive survey is required, this can be incorporated into the conditions of Development Approval.

5.8 Heritage Values

5.8.1 Aboriginal Heritage

A search of the Department of Aboriginal Affairs (DAA) (DAA, 2017) heritage database identified no Registered Sites of Aboriginal heritage significance within the subject area.

5.8.2 European Heritage

A search was conducted of the Heritage Council of Western Australia database (Heritage Council of WA, 2017). No places of heritage significance were located within the subject area.

6.0 COASTAL ACCESS INFRASTRUCTURE

6.1 Public Use and Access

6.1.1 Beach Car Park Access Vehicular Road

The proposed concept plan (Figure 2) provides a two-way vehicular road originating with the Catalina Estate development (Catalina Beach) and terminating at a 30-bay car park (including one ACROD bay), designed in line with the CoW's standard infrastructure specifications. A typical cross section is provided in Figure 2, and includes a 6 m wide asphalt pavement, with a 1.8 m wide pedestrian path and table drain within the road verges. Street lighting will be provided along the length of the access road.

Fencing will be provided along the access road edge to restrict uncontrolled off-road vehicle access. Fencing along the access road will be rural conservation style fencing (as per City standard drawing TS01-3: Appendix E) with a 200 mm gap provided between the bottom of the wire and the ground to facilitate ground dwelling fauna movement. This fencing style will facilitate continued north-south movement of ground dwelling fauna species within the coastal bushland. Pedestrian 'kissing' gates (Appendix D) will be installed, which will also facilitate kangaroo movement.

The provision of this access road is intended to provide authorised and controlled access to the coastline, directing users to a beach location deemed to be safe for swimming and other aquatic recreational activities (SLSWA, 2014).

6.1.2 Beach Access Car Park

The beach carpark providing 30 car parking bays (including one ACROD bay) is proposed to be constructed in line with the City's specifications for recreation area carparks. Street lighting will be provided within the car park.

Ten bicycle parking facilities will be provided adjacent to the carpark.

Fencing along the Car Park will also be rural conservation style fencing (as per City standard drawing TS01-3: Appendix E) with a 200 mm gap provided between the bottom of the wire and the ground to facilitate ground dwelling fauna movement. This fencing style will facilitate continued north-south movement of ground dwelling fauna species within the coastal bushland. Pedestrian 'kissing' gates (Appendix E) will be installed, which will also facilitate kangaroo movement.

One in every four car bays will include a shade tree (Figure 2). Detailed carpark design will be included in the Development Application.

6.1.3 Pedestrian Beach Access Pathway

A beach access path is proposed to be constructed between the southern boundary of the car park leading over the fore dune to the beachfront, as shown in the concept plan (Figure 2). A visual example of the fore dune in this location is shown in Plate 6.

It is the developer's preference that the pedestrian beach access path be constructed using stabilised limestone, and if alternative materials are to be required, this shall be specified in the conditions of development approval. The path will be 3 m wide, which is consistent with the City of Wanneroo path specifications. The westerly end of the path will be aligned in a north-westerly direction to minimise the accumulation of sand (relative to the prevailing winds on this coastline) and will receive specific engineering design attention, in consultation with the City's engineers.

Beach accessway fencing will be installed along the path edges to prevent uncontrolled pedestrian access outside of this area, which could result in damage to the dune and coastal vegetation in this area. The beach accessway fencing will be compliant with the CoW's fencing specifications shown in drawing TS 01-4-2 (Appendix E). Lockable bollards will be installed at the carpark end of the beach accessway to prevent uncontrolled vehicular access to the beachfront.

The accessway will be installed as part of the construction program associated with the development application for the project.



Plate 6: Foredune over which an access track will be constructed to provide pedestrian and maintenance vehicle accessway to the beachfront (photo taken facing west)

6.2 Stormwater and Wastewater

Stormwater will be generated from the handstand road, carpark and beach access path surfaces. The stormwater drainage design proposed to manage the runoff, which addresses Water Sensitive Urban Design principles as advocated by the Department of Water (DoW, 2008), includes:

- Construction of table drains adjacent to the beach access road to facilitate infiltration of stormwater at or close to source.

- Installation of soak wells associated with the carpark to facilitate infiltration at source from this surface.
- Drainage design to reflect pre-development hydrology where possible.
- Drainage to utilise natural low points in the landscape to increase the ability to retain natural topography and vegetation.
- Installation of small areas of rock pitching as necessary to minimise erosion of the sandy substrate.

The depth to groundwater in the areas proposed for drainage infrastructure varies from approximately 8 to 32 m below ground level. The soils at the subject area are highly permeable and conducive to supporting infiltration.

Specific drainage infrastructure is not proposed to be installed along the beach access path alignment due to the limited surface area of this asset and the objective to minimise clearing of vegetation to installation of additional infrastructure. Along this path direct runoff into the adjacent highly permeable coastal sands is proposed for stormwater management.

Detailed engineering design, including stormwater infrastructure, will be included in the Development Application prepared for submission to the City of Wanneroo for the proposed works. Drainage infrastructure will be designed to address WSUD principles as well as having the specific objectives of managing direct flows into the Bush Forever vegetation, and minimising potential erosion.

Facilities that will generate wastewater are not proposed as part of this development. If an amenities building was to be constructed in the future this would be subject to a separate design and assessment process.

6.3 Detailed Engineering and Landscape Design

Prior to commencement of construction detailed engineering and landscape plan will require submission to the CoW. Design features which will be addressed in these plans will include:

Engineering

- Alignment of the western end of the beach access path, noting that aligning the path in a north east orientation at this point is preferable to minimise sand accumulation. The westerly end of the path will receive specific engineering design attention, in consultation with the City's engineers (Assets Directorate) to ensure the risk of damage due to storm events and/or sand erosion is addressed, and to avoid or minimise premature damage (i.e. within the engineering design life of the structure) through appropriate design treatment.
- Stormwater drainage design and location of stormwater infrastructure.
- Demonstration that a safe trafficable connection between the coastal access road and development site is being achieved.

- Location and materials proposed for the construction of the 1.8 m wide pedestrian path.

Landscape

- Tree species selection and planting location within the car park.

7.0 MANAGEMENT ACTIONS

7.1 Pre-Construction

7.1.1 Vegetation and Fauna Protection – Infrastructure layout and design

The proposed foreshore access infrastructure (road, carpark and associated facilities, and pedestrian access track) has been the subject of much consideration, particularly with regard to environmental impacts. A number of surveys have been undertaken over the greater area, as well as at a smaller scale in order to understand the environmental values present. The infrastructure footprint has been located as per the concept plan in order to minimise clearing as far as possible, as well as minimising impacts to the dune structure and managing for potential future erosion.

The road has been aligned as far as possible (subject to engineering considerations) to overlap existing informal tracks. The carpark has been located within a degraded dune blowout supporting very little vegetation to further minimise clearing required for construction.

Where clearing is required, it is necessary for the safe and efficient construction of the access infrastructure and has been focused in areas of lower condition vegetation, as far as possible.

7.2 During Construction

7.2.1 Vegetation Management – Temporary Fencing

Temporary fencing is to be installed adjacent to clearing areas at the commencement of site works to prevent accidental clearing of vegetation to be retained. This fencing is to meet the CoW specifications for native vegetation protection fencing as shown in drawing TS 01-12-0 (Appendix E).

7.2.2 Fauna Management

The following actions will be undertaken to minimise the impacts to any potential resident fauna during clearing:

- A fauna relocation specialist will be engaged to oversee site clearing works and relocate any fauna that does not depart the immediate area of its own accord, i.e. snakes, birds, etc.
- Equipment will be started and allowed to run for 10 minutes prior to clearing commencing to encourage fauna to move away from this noise source.
- Clearing will, where possible, be undertaken outside of the black cockatoo breeding season (i.e. between July and November), to avoid inflicting damage to breeding fauna and their young (noting that breeding is uncommon on the Swan Coastal Plain). Should clearing occur within this period the following will be undertaken:

- Habitat tree assessments of potential breeding trees within 10 m of the construction area (if present) will be checked by a qualified fauna specialist for nesting hollows and use by black cockatoos.
 - If active black cockatoo nests are located on site, the tree will be clearly demarcated (with fencing and signage) and not cleared or disturbed until further assessment and consultation with relevant authorities has been undertaken.
- Vegetation will be observed for any fauna that may be trapped, injured or occupying an unseen nest or shelter, and if feasible, felled vegetation will be left in situ overnight to allow the escape of any resident fauna species before removal.

7.2.3 Dieback Management

In order to prevent the spread of pathogen into the foreshore area the following actions as advocated by the '*Managing Phytophthora Dieback – Guidelines for Local Government*' (Dieback Working Group, 2000) and '*Managing Phytophthora Dieback in Bushland – A guide for landholder and conservation groups*' (Dieback Working Group, 2008) will be undertaken:

- Should any off-site fill be required for use within the foreshore this material will be obtained from a dieback free source.
- Prior to entering the site any construction equipment and construction materials (i.e. pipes, bricks etc) must be clean and free of any adhered soil/mud.
- Construction equipment to stay within the construction zone and avoid moving into bushland areas.
- Imported material for construction works is to be stored in areas clear of vegetation which do not drain towards retained vegetation.
- Plants used in the landscaping works onsite are to be from a dieback free source.
- Restrict uncontrolled vehicles accessing retained vegetation areas.
- Information in relation to dieback management is to be provided to the construction contractors as part of the site induction.

7.2.4 Erosion and Dust Management

The CoW Earthworks and Sand Drift Policy (LPP 4.18) provides guidance on dust management measures to be employed during earthworks. Assessment of the proposed works against the Site Risk Assessment included in this policy identified the site to have a Level 1 classification. As recommended by this policy for Level 1 sites no specific provisions are required. Irrespective of this the following management measures will be undertaken during the construction program:

- Vehicle speeds will be kept below 30 km/hr.
- Vehicle will remain within the construction area, and not be permitted to access other parts of the coastal zone.

- Brushing, mulching and fibre matting will be used where necessary to stabilise sand as a component of the rehabilitation program.

7.2.5 Construction Site Access Management

Temporary fencing will be installed around the development site at the commencement of construction works to restrict third party access through the construction site and foreshore reserve.

Contractors will check fencing on a weekly basis throughout the construction period and report and repair damage as necessary.

7.2.6 Fire Management

Where possible, clearing and construction should be undertaken outside of high fire risk conditions. Fire extinguishers should be available for all vehicles and machinery being used onsite, and all firefighting equipment must be tagged, inspected and certified according to relevant standards.

Smoking will be prohibited within the construction area. Designated smoking areas will be positioned away from the foreshore vegetation.

7.3 Post-Construction

7.3.1 Rehabilitation

Rehabilitation works are proposed to be undertaken in the previously vegetated areas adjacent to the road and carpark footprint required to be cleared and / or modified to enable construction of the access infrastructure (as per the engineering design). The approximate extent of these areas corresponds to the extent of batters shown on Figure 2. The exact boundary of these areas will be confirmed in mapping provided to the CoW prior to rehabilitation works commencing.

The rehabilitation program will be undertaken by a specialist rehabilitation consultant. This consultant will have input to the final species selection to ensure that success of the program is maximised. The consultant will coordinate with the City's Land Development Group (Planning and Sustainability Division) on the matter of appropriate vegetation species and surface stabilisation techniques for treatment of swales, batters and slopes at the appropriate time, when detailed design work is being undertaken, and prior to the preparation of any Development Application documents.

7.3.1.1 Seed Collection, Cuttings and Propagation

Seed and plant cuttings are proposed to be collected from the clearing footprint area and surrounding foreshore reserve by a suitably qualified person, remaining as close as possible to areas to be rehabilitated to ensure that all species used in rehabilitation are endemic to that particular vegetation type. A license will be required from DBCA prior to the collection of plant components, which will require authority from the landowner (CoW / WAPC) prior to issue, as well as requiring a competently qualified person to collect plant components. Cuttings of *Spinifex longifolius* and *Spinifex hirsutus* will be undertaken in the sections of the car park

area proposed for disturbance, prior to clearing. Propagation of these species (and others) is guided by the Coastal Planning and Management Manual (DoP, 2011).

Should additional seed or tubestock be required for revegetation outside of the seed bank collected from the foreshore area, local provenance seed should be sourced where possible (potentially from the seed bank collected for revegetation within Catalina Estate, if there is excess stock). Otherwise, general nursery stock may be used to supplement planting.

7.3.1.2 Weed Control

During the flora and vegetation survey, weeds were recorded in high density near tracks and cleared areas (BEC, 2016). A list of weed species present in the area is provided in Appendix F. Those that were identified by Mattiske Pty Ltd (2000) as representing the most serious threat (ie. high invasiveness, wide distribution, high ecological impact) are identified within this table.

Weed control is proposed to be undertaken within a 2 m buffer directly adjacent to the proposed rehabilitation areas prior to planting being undertaken. Weeds compete for moisture to the detriment of native plants in areas where plants are to be grown with minimal or no water; as such it is important to control weed growth in rehabilitation areas prior to revegetation (DoP, 2011). DoP (2011) provides additional guidance regarding weeds and their management in coastal areas.

Two weed control events will be undertaken within proposed rehabilitation areas in the six months prior to planting. Weed control will largely be undertaken through a herbicide spraying program, however the following control measures will be enacted:

- Spraying is to take place only on calm days to reduce the risk of spray drift.
- Herbicides should always be used as per specifications on the Material Safety Data Sheets (MSDS) supplied with all herbicides.

A post-planting weed control event will also be undertaken in late winter/early spring following planting. This will allow for additional removal of weeds prior to flowering and seed propagation.

Following establishment, a spring weed monitoring event will occur annually, and weed control will be undertaken where necessary up until handover (5 years following construction).

7.3.1.3 Species Selection

A species planting list has been derived from the species list recorded by BEC (2016) (Appendix C) with input from the rehabilitation consultant in relation to the stock onsite available for collection and most suitable species to include in the program (Appendix G).

Endemic *Spinifex* species should be used in the foredune area as an alternative to the introduced marram grass (*Ammophila arenaria*). Marram grass has been used along the Western Australian coastline to stabilise dunes, as it is adapted to sand accretion with the burial promoting leaf elongation and the development of rhizomes from the axillary buds (BEC, 2016). It traps sand and builds dunes at rates

much greater than that of the native species, thus out competing the native species and interfering with the natural dynamics of the dune systems (WA Herbarium, 2016).

Final species selection and location of planting will be confirmed with the CoW prior to commencement of the rehabilitation program, based on availability and suitability in proposed rehabilitation areas. Species must be carefully selected to maximise survival rates, as different species are adapted to different environments, such as:

- Exposed locations (such as beach front, dune crests, windward face of dune)
- Partially protected areas
- Protected areas (such as dune swales, leeward face of dune)

7.3.1.4 Proposed Revegetation

Revegetation will be undertaken in the previously vegetated areas surrounding the coastal infrastructure that is required to be cleared and / or modified during construction. Revegetation will be vital to ensure stabilisation of these areas.

Preparation of planting areas will include:

- Weed control (see above)
- Removal of rubbish or debris
- Brushing and / or hydromulching (no seed impregnated) as required in erosion prone areas

Tubestock will be planted at a density appropriate to the species, location and likelihood of success. The target for the revegetation planting will be to achieve an average plant density of 2 plants/m² across the rehabilitation area. Direct seeding may be used in conjunction with tubestock planting. Stock will be sourced from the seeds and cutting collected onsite, and supplemented with purchased seeds or tubestock where required.

All plants will have plant guards installed following planting, to be removed once deemed large and robust enough to survive without this protection.

Water crystals or tablets will be placed around the roots of tubestock considered likely to be sensitive to dehydration, however species planted will be representative of the local vegetation communities and as such will be generally drought tolerant.

7.3.2 **Fauna Management**

7.3.2.1 Speed Limitation

The beach access road is proposed to be constructed through an ecologically sensitive area. As such, measures are proposed to minimise impacts to wildlife as a result of allowing vehicles access through this area.

Reducing vehicle speed provides fauna adequate time to move out of the path of an oncoming vehicle, as well as providing the motorist more time to respond to the situation. The speed limit along the beach access road will be limited to 30 km / hr

to provide for the safety of pedestrians using the pedestrian path, and to protect fauna likely to cross over the road. Additionally, wildlife crossing signage will be installed as described below.

7.3.2.2 Wildlife Crossing Signage

To improve awareness of facility users, wildlife crossing signage shall be installed at both entrance points to the access road. Examples of signage are provided in Plate 7.



Plate 7: Example wildlife road awareness sign

7.3.3 Access Management

Rural conservation style fencing (Appendix E) will be installed along the coastal access road boundaries. It is important that fauna movement between the northern and southern sections of the foreshore reserve adjacent to Catalina Estate be maintained, and that the fencing along the beach access road does not isolate these two areas to potentially create an anthropogenic barrier to the existing populations of ground dwelling fauna species. To facilitate this the fencing will include a 200 mm gap between the bottom of the wire and the ground.

A lockable gate will be installed at the entrance to the access road from Catalina Estate, to enable access to vehicles to be restricted at certain times. Specification to be agreed with the CoW.

7.3.4 Erosion and Dust Management

By providing coastal access infrastructure originating at Catalina Estate, access to the foreshore reserve will be restricted to the designated access locations. Beachgoers are required to utilise the formal infrastructure proposed and any off-road access is considered illegal. This does not extend to authorised vehicles, which are permitted to access the foreshore reserve as required. This action serves to

reduce the anthropogenic impact to the dune system and minimise coastal erosion as a result of human use.

Erosion control measures will be undertaken within proposed rehabilitation areas, as discussed in Section 7.3.1.4.

7.3.5 Stormwater Management

The access road and carpark have been designed to allow for stormwater runoff from the introduced impermeable surfaces. As discussed in Section 6.2, a table drain will be constructed adjacent to the road and the entire extent of the carpark. Outfall from the table drain will only occur in significant rainfall events, and is limited to three outfall locations into the dunes. Small areas of rock pitching will be installed as necessary to minimise erosion of the sandy substrate, which will assist in providing a stable substrate for vegetation to establish around the outfalls (Figure 2). Given the low expected nutrient inputs from road drainage, inclusion of vegetation within the swales to assist with nutrient uptake is not proposed.

The specific drainage infrastructure required and any maintenance requirements will be identified following completion of the detailed engineering design. Detailed engineering drawings will be provided prior to road construction (this is a standard WAPC condition). Drainage infrastructure will be designed to address WSUD principles as well as having the specific objectives of managing direct flows into the Bush Forever vegetation, and minimising potential erosion.

7.3.6 Fire Management

The coastal access road will provide a firebreak through the foreshore reserve, as the road pavement is 6 m wide and the pedestrian path provides an additional 1.8 m separation. With the table drain and road verge included, the total cleared width of the road is approximately 9 m.

Controlling access to the coastal node by providing appropriate infrastructure will limit unauthorised vehicles and pedestrian access through the foreshore area, reducing the risk of fire ignition relating to human influence.

7.3.6.1 Adjacent Residential Area

There are no residences or habitable built structures proposed for development within the proposed coastal infrastructure footprint.

The Bushfire Management Plan (FirePlan, 2014) prepared for the Catalina Beach precinct addresses the fire management measures that are required as a result of the precinct's proximity to the foreshore reserve.

7.3.6.2 Emergency Access

Access to the coastal access node vehicles will be via the main access road, which enables two-way traffic and has sufficient space for vehicles to pull over and / or overtake to make way for emergency vehicles. The trafficable surface of the access road (including path) is 7.8 m.

7.3.7 Beach Safety Management

7.3.7.1 Safety Signage

Appropriate coastal hazard signage is recommended to be installed at the beach access carpark outlining the hazards of the area and encouraging awareness and vigilance, as part of a greater education and awareness program (SLSWA, 2014). An example of this type of signage is provided in Plate 8. In this case, QR code signs are used to enable those with smart phone technology to access the beachsafe.org website for live and local beach conditions in a number of foreign languages. Generally this is an initiative assisted by the Department of Health and the Surf Life Saving Association of WA through local government recommendations (SLSWA, 2014).



Plate 8: Example of recommended safety signage

8.0 SUCCESS CRITERIA

8.1 Monitoring and Reporting

A rehabilitation consultant / botanist will undertake monitoring to assess weed cover and plant survival rates against success criteria. These monitoring events will occur annually commencing in the Spring of the year planting was undertaken (i.e. approximately 3 months after planting). Monitoring to be ongoing for 5 years after practical completion (until handover) to ensure success criteria have been met and to implement contingency measures where required. Contingency actions are described in Section 8.3 below.

Monitoring will also make note and include photos of any signs of erosion or storm damage to rehabilitated areas to enable appropriate management measures.

8.2 Completion Criteria

The success of the rehabilitation program will be determined by comparing the monitoring results to the success criteria provided in Table 3.

Table 3: Success Criteria for Rehabilitation Works

Criteria	Performance Target
Average density of plants	≥ 2 plants / m ²
Plant diversity (% of planted species surviving)	70%
Ground coverage (% of area)	25%
Weed coverage	<20%

8.3 Contingency Actions

Where success criteria are not met, contingency actions will be undertaken to rectify the various issues. Contingency actions may include:

- Infill planting to increase plant numbers, plant species, ground coverage and / or replace damaged or dead seedlings
- Additional weed control to reduce weed coverage
- Erosion control measures, such as application of hydromulch (not impregnated with seed), installation of brushing / matting / rock pitching (if near asphalt surfaces), and / or infill planting (with pegging where deemed necessary)

Handover of the areas will occur five years after practical completion of the FMP area.

9.0 IMPLEMENTATION PLAN

9.1 Implementation Actions Summary

A summary of actions for implementation is provided in Table 4.

Responsibility for undertaking the works identified on Table 4 will remain with the Tamala Park Regional Council until handover occurs. Handover and the management of the infrastructure will be handed over to the City five years after practical completion of all items in the FMP.

Table 4: Implementation Summary

Action	Pre-Construction	During Construction	Post-Construction
<p>Vegetation Management and Rehabilitation</p>	<ul style="list-style-type: none"> • Coordinate with the City's Land Development Group (Planning and Sustainability Division) on the matter of appropriate revegetation areas, vegetation species and surface stabilisation techniques for treatment of swales, batters and slopes at the appropriate time, when detailed design work is being undertaken, and prior to the preparation of any Development Application documents. • Undertake seed and cutting collection from the clearing footprint area and surrounds, remaining as close as possible to areas to be rehabilitated. • Propagation of selected seeds (i.e. those species not proposed for direct seeding) at an accredited nursery. 	<ul style="list-style-type: none"> • Ongoing propagation of selected seeds (i.e. those species not proposed for direct seeding) at an accredited nursery as required. 	<ul style="list-style-type: none"> • Ongoing propagation of selected seeds (i.e. those species not proposed for direct seeding) at an accredited nursery as required. • Removal of any rubbish present within the rehabilitation area. • Two weed control events to be undertaken in and directly adjacent to proposed rehabilitation areas within 6 months prior to planting. • Undertake direct seeding and planting of tubestock. • One weed control event to be undertaken in late winter/early spring approximately 12 months after planting. • Installation of tree guards as required. • Removal of tree guards. • Provide brushing and / or hydromulching (no seed) as required in erosion prone areas. • Vegetation and weed monitoring undertaken annually in Spring within rehabilitation areas. • Preparation of a monitoring report and submission to the CoW annually, outlining the progress of the development as well as the progress against success criteria and the rehabilitation success. • Where success criteria are not met, contingency actions will be undertaken. • Contingency actions may include: <ul style="list-style-type: none"> - Infill planting - Additional weed control - Erosion control measures

Action	Pre-Construction	During Construction	Post-Construction
Fauna Management	<ul style="list-style-type: none"> Undertake fauna survey of clearing area to advise relocation program details (to be agreed with CoW). 	<ul style="list-style-type: none"> Start and run equipment for 10 minutes prior to clearing commencing. Where possible, undertake clearing outside of the Black cockatoo breeding season (i.e. between July and November). Observe vegetation for any fauna that may be trapped, injured or occupying an unseen nest or shelter. If feasible, felled vegetation to be left in situ overnight. Engage a fauna relocation specialist to oversee site clearing works. 	<ul style="list-style-type: none"> Install signage indicating speed limit of 30 km/hr. Wildlife crossing signage to be installed at both entrance points to the access road
Dieback Management		<ul style="list-style-type: none"> Should any off-site fill be required this is to be obtained from a dieback free source. Prior to entering the site any construction equipment and construction materials must be clean and free of any adhered soil/mud. Construction equipment to stay within the construction zone. Imported material for construction works is to be stored in areas clear of vegetation which do not drain towards retained vegetation. Plants used in the landscaping works to be from a dieback free source. Restrict uncontrolled vehicles accessing retained vegetation areas. Construction contractors to be provided with dieback management information. 	

Action	Pre-Construction	During Construction	Post-Construction
Access Management	<ul style="list-style-type: none"> • Install clearing protection fencing to prevent accidental clearing of vegetation to be retained as per CoW specification TS 01-12-0. • Maintain clearing protection fencing to prevent accidental clearing of vegetation to be retained. 	<ul style="list-style-type: none"> • Temporary fencing will be installed around development site at the commencement of construction works to restrict third party access through the construction site and foreshore reserve. • Contractors will check fencing on a weekly basis and report and repair damage as necessary. 	<ul style="list-style-type: none"> • Provide fencing along the access road and carpark boundaries as per CoW standard TS01-3 style to restrict off-road vehicles from leaving the road and entering the vegetated foreshore reserve area. • Install fencing along the pedestrian access track to beach as per CoW specification TS 01-4-2.
Erosion and Dust Management		<ul style="list-style-type: none"> • Vehicle speeds will be kept below 30 km/hr • Vehicle will remain within the construction area. • Use brushing, mulching and fibre matting where necessary to stabilise sand. 	
Stormwater Management	<ul style="list-style-type: none"> • Detailed engineering design, including stormwater infrastructure, will be included in the Development Application prepared for submission to the City of Wanneroo for the proposed works. • Drainage infrastructure will be designed to address WSUD principles as well as having the specific objectives of managing direct flows into the Bush Forever vegetation, and minimising potential erosion. 	<ul style="list-style-type: none"> • Drainage infrastructure to be constructed as per the Development Application. 	

Action	Pre-Construction	During Construction	Post-Construction
Fire Management		<ul style="list-style-type: none"> • Clearing and construction should be undertaken outside of high fire risk conditions where possible. • Fire extinguishers and equipment to be readily available for all vehicles / machinery and must be tagged, inspected and certified according to relevant standards. • Smoking will be prohibited within the construction area. Designated smoking areas will be positioned away from the foreshore vegetation. 	<ul style="list-style-type: none"> • Coastal access road corridor to act as a firebreak. • Restrict unauthorised access to coastal bushland (see Vegetation and Fauna Protection action).
Beach Safety Management			<ul style="list-style-type: none"> • Coastal hazard signage is to be provided within the carpark. SLSWA and CoW shall approve the signage prior to installation by TPRC.

10.0 CONCLUSION AND FUTURE APPROVALS

The proposed development of an access road and carpark facilities to the beach adjacent to Catalina Estate is considered to be important in ensuring safe, environmentally sound and convenient access to a safe coastal environment for swimming and other water-based activities.

The proposal to provide an access road and carpark facilities is also consistent with the Tamala Conservation Park Establishment Plan (WAPC, 2012). The Establishment Plan recommends that community access to safe swimming areas adjacent to Tamala Park, with public road access, appropriately located facilities such as car parking, toilets and potential surf-life-saving facilities should be investigated and provided.

The location of the carpark area and beach access is also based on the Coastal Aquatic Risk Assessment (2014) undertaken by Surf Life Saving Western Australia which identified the site as a preferred beach access location, due to safe swimming conditions and absence of potential hazards present in the existing access locations to the north and south.

The proposed development of coastal access infrastructure within the foreshore reserve is subject to the following planning and environmental approvals:

- Development Application (CoW / WAPC)
- Detailed engineering design and landscape design drawings (CoW)
- Native vegetation clearing permit (DWER)

The coastal access road and associated infrastructure will remain under the ownership of both CoW and WAPC, in accordance with the existing reserve boundaries. This is in keeping with the CoW's formal agreement to continue managing (wholly or in part) the reserves between Burns Beach and Mindarie (WAPC, 2012).

11.0 REFERENCES

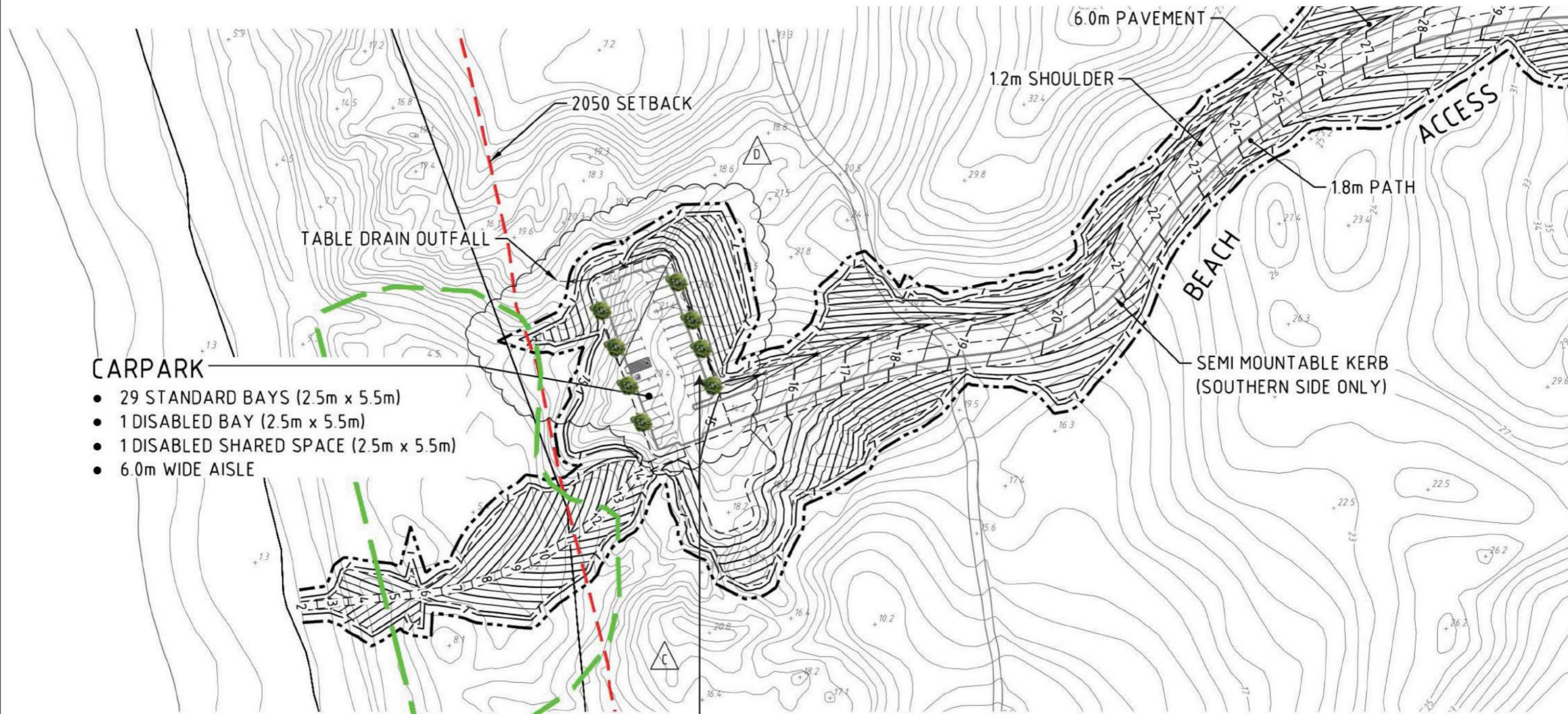
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FIGURES





CARPARK

- 29 STANDARD BAYS (2.5m x 5.5m)
- 1 DISABLED BAY (2.5m x 5.5m)
- 1 DISABLED SHARED SPACE (2.5m x 5.5m)
- 6.0m WIDE AISLE

**NODE A:
AS IDENTIFIED
BY SLSWA**

CAR PARK PLANTING:

8No. MELALEUCA LANCEOLATA TREES, INSTALLED AT 30LITRE SIZE. TREES PLANTED AT 1.5M OFFSET FROM KERB AND A MINIMUM OF ONE TREE PER 4 CAR BAYS.

NON IRRIGATED AND MANUAL WATERING VIA WATER TRUCK WILL BE REQUIRED FOR ESTABLISHMENT AND DURING SUMMER MONTHS FOR A PERIOD OF AT LEAST 2 YEARS.

TREES TO BE INSTALLED IN TREE WELL WITH FLUSH KERB TO ALLOW CAR PARK SURFACE RUNOFF.

BOLLARDS TO BE PROVIDED EITHER SIDE OF TREE FOR PROTECTION.

LEGEND

- EXISTING CONTOUR (1.0m)
- DESIGN CONTOUR (1.0m)
- DESIGN CONTOUR (0.5m)
- CLEARING/EARTHWORKS BOUNDARY

NOTES

1. ALL LEVELS IN METRES TO AHD. EXISTING SURVEY BY MNG SURVEYORS
2. BATTERS TO EXISTING SURFACE AT 1:3 (CUT), 1:6 (FILL) AND 1:4 (FILL) WHERE PATH IS PRESENT, UNLESS NOTED OTHERWISE
3. ALL UNSUITABLE MATERIAL TO BE REMOVED BY THE CONTRACTOR TO APPROVED TIPPING SITE PRIOR TO COMMENCEMENT OF CONSTRUCTION. ALL FEES TO BE PAID BY CONTRACTOR.
4. EXTENT OF CLEARING AND EARTHWORKS TO BE LIMITED TO THE CLEARING BOUNDARY UNLESS AGREED WITH THE SUPERINTENDENT.
5. ALL CLEARED MATERIAL TO BE MULCHED AND STOCKPILED ON SITE AS DIRECTED BY THE SUPERINTENDENT.
6. CONTRACTOR TO LOCATE ALL EXISTING SERVICES PRIOR TO COMMENCEMENT OF WORKS ON SITE
7. CONTRACTOR TO GRADE EVENLY BETWEEN DESIGN CONTOURS AND MATCH INTO EXISTING SURFACE AT LIMIT OF EARTHWORKS BOUNDARY WHERE APPROPRIATE.
8. EXCESS CUT FROM EARTHWORKS SHALL BE PLACED ON SITE AS DIRECTED BY THE SUPERINTENDENT.
9. THE CONTRACTOR SHALL LIMIT THE MOVEMENT OF EQUIPMENT AND MANPOWER TO WITHIN THE CLEARING/EARTHWORKS BOUNDARY AND PROTECT ALL VEGETATION AND EXISTING SERVICES ON SITE.
10. 12m RING LOCK FENCE TO BE INSTALLED AROUND PERIMETER OF CLEARING BOUNDARY.

INDIAN OCEAN

CARPARK

- 29 STANDARD BAYS (2.5m x 5.5m)
- 1 DISABLED BAY (2.5m x 5.5m)
- 1 DISABLED SHARED SPACE (2.5m x 5.5m)
- 6.0m WIDE AISLE

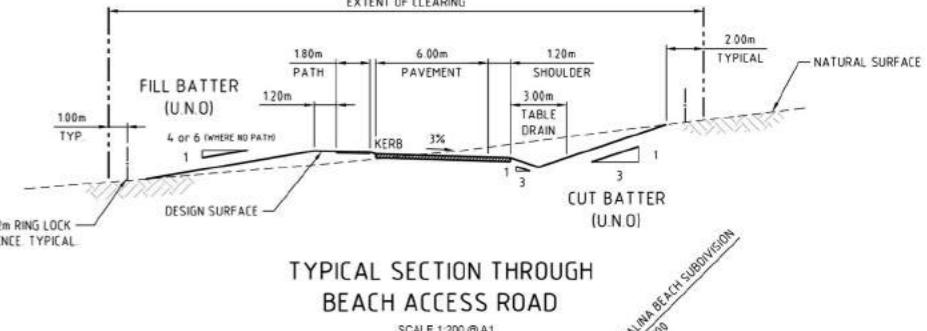
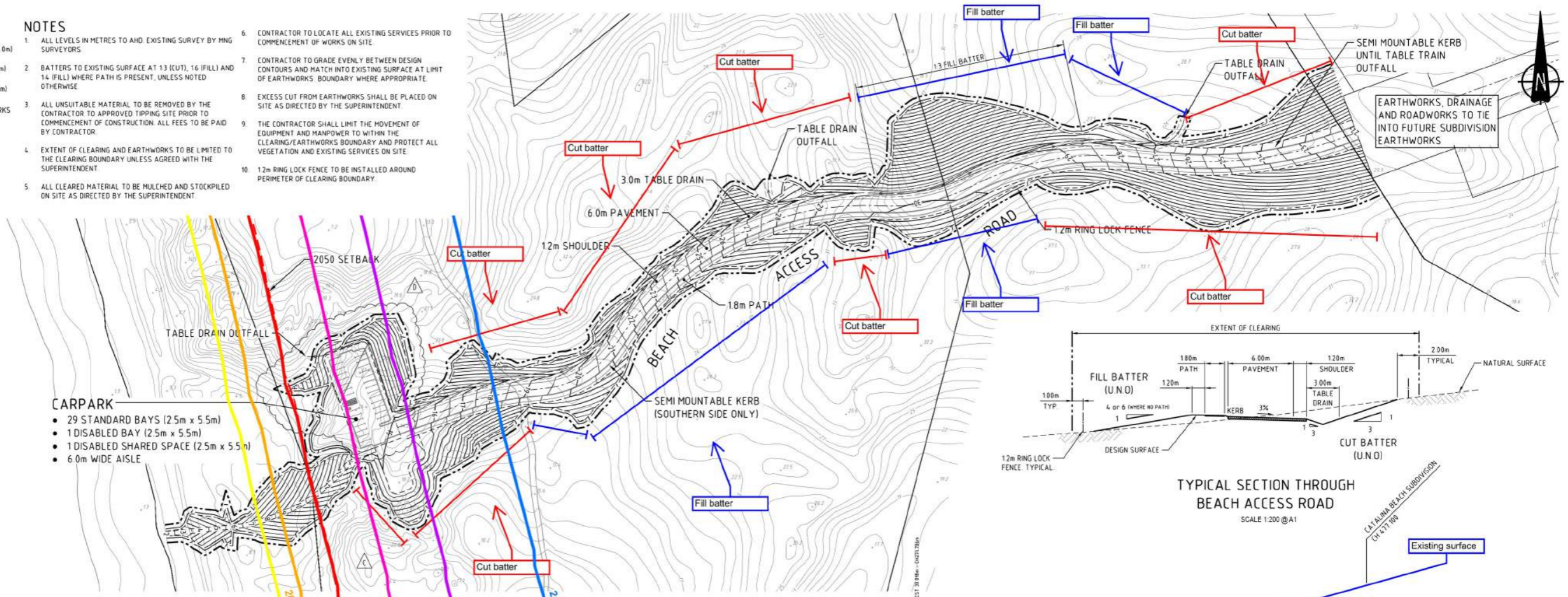


WARNING TO CONTRACTOR UXO
THE SITE IS IDENTIFIED AS HAVING RISK OF UNEXPLODED ORDNANCE.

IF ENCOUNTERED, ANY ORDNANCE MUST BE CONSIDERED AS LIVE AND THE W.A. POLICE DEPARTMENT SHOULD BE CONTACTED IMMEDIATELY.

NOTICE TO CONTRACTOR

IT IS THE CONTRACTORS RESPONSIBILITY TO INVESTIGATE THE NATURE AND LOCATION OF ALL SERVICES WHICH MAY BE ENCOUNTERED AND TO CONSULT WITH THE RELEVANT SERVICE AUTHORITIES PRIOR TO COMMENCEMENT OF EXCAVATIONS. FAILURE TO DO SO OR TO TAKE DUE CARE SHALL NOT LIMIT THE CONTRACTORS LIABILITY FOR REPAIR OF ALL SERVICES DAMAGED BY HIM DURING CONSTRUCTION WORKS. THE CONTRACTOR SHALL TAKE ALL PRECAUTIONS NECESSARY FOR THE PROTECTION OF ALL EXISTING SERVICES.



Vertical Curve	VC=30m	VC=40m	VC=10m	VC=40m	VC=100m	VC=70m	VC=70m	
K value	K=7.30	K=9.36	K=12.27	K=22.99	K=10.93	K=11.86	K=23.04	
Grade	4.034%	8.143%	3.871%	6.316%	8.056%	-1.096%	-3.962%	
DATUM 50								
DESIGN SURFACE	0.000	14.294	15.695	15.394	15.654	15.876	16.572	
PEGGED CL LEVEL	12.300	15.714	16.952	17.887	16.676	16.571	17.648	
NATURAL SURFACE	14.294	15.394	16.572	17.887	16.676	16.571	17.648	
PEGGED CL LEVEL	14.294	15.394	16.572	17.887	16.676	16.571	17.648	
CHAINAGE	0.000	12.300	20.000	27.672	30.714	32.557	40.000	
HORIZ. ALIGNMENT	R135m		R-45m		R135m		R-180m	
CROSSFALL	LHS -3%		RHS 3%		LHS -3%		RHS 3%	

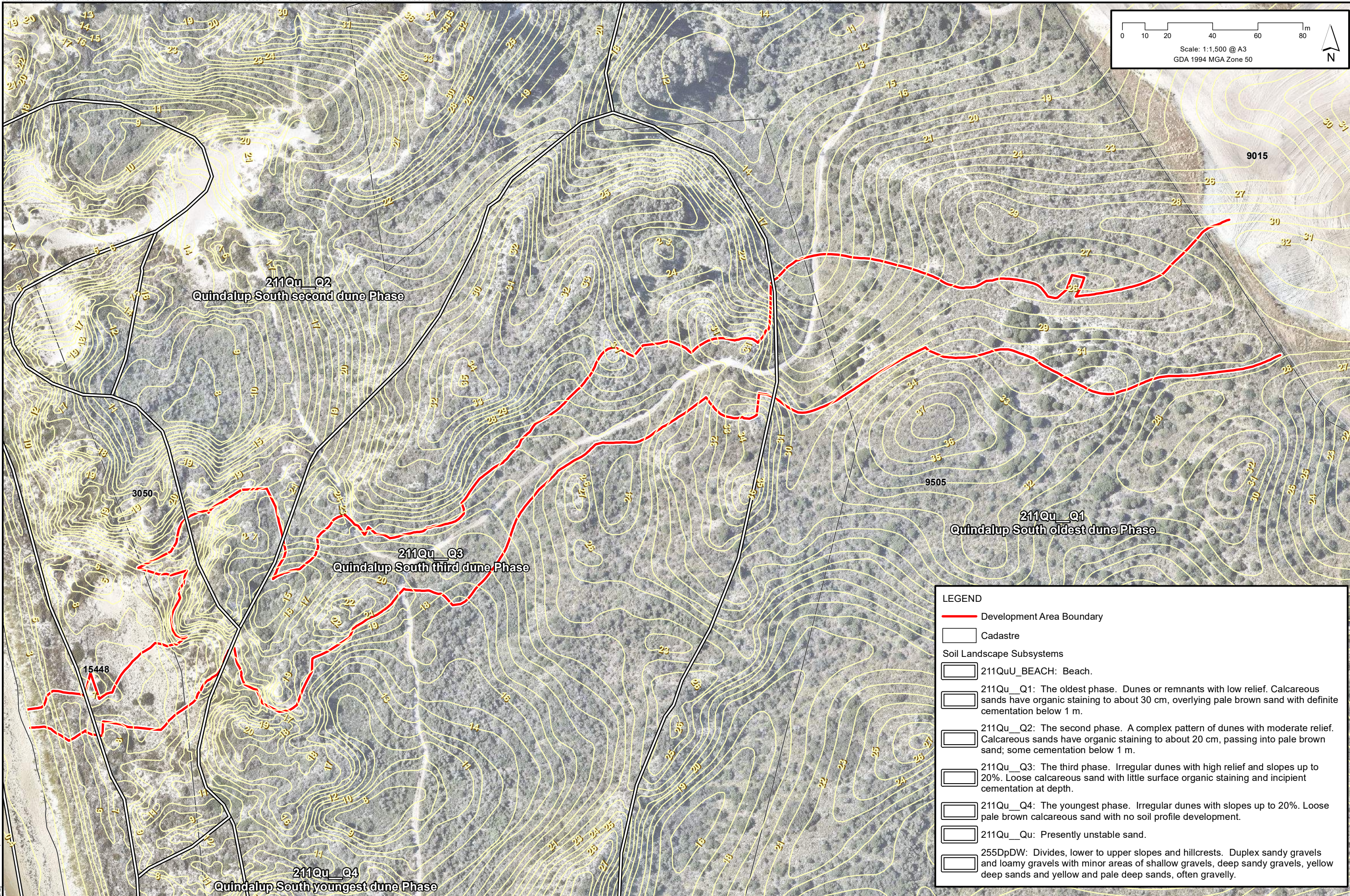
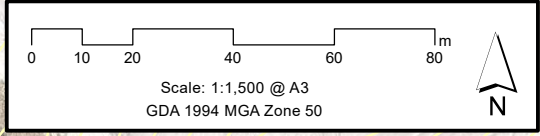
BEACH ACCESS ROAD
HORIZONTAL SCALE 1:1000 @ A1
VERTICAL SCALE 1:200 @ A1





Job: SATCAT18
Doc: 003
Date: 26.02.19
Ph: (08) 9381 5513
Fax: (08) 9381 5514
E: info@coterra.com.au

Tamala Park Regional Council
FORESHORE MANAGEMENT PLAN
LOT 15448 & 3050 TAMALA PARK
COASTAL EROSION HAZARD MAPPING








Figure 3



LEGEND

-  Development Area Boundary
-  Cadastre

Soil Landscape Subsystems

-  211QuU_BEACH: Beach.
-  211Qu_Q1: The oldest phase. Dunes or remnants with low relief. Calcareous sands have organic staining to about 30 cm, overlying pale brown sand with definite cementation below 1 m.
-  211Qu_Q2: The second phase. A complex pattern of dunes with moderate relief. Calcareous sands have organic staining to about 20 cm, passing into pale brown sand; some cementation below 1 m.
-  211Qu_Q3: The third phase. Irregular dunes with high relief and slopes up to 20%. Loose calcareous sand with little surface organic staining and incipient cementation at depth.
-  211Qu_Q4: The youngest phase. Irregular dunes with slopes up to 20%. Loose pale brown calcareous sand with no soil profile development.
-  211Qu_Qu: Presently unstable sand.
-  255DpDW: Divides, lower to upper slopes and hillcrests. Duplex sandy gravels and loamy gravels with minor areas of shallow gravels, deep sandy gravels, yellow deep sands and yellow and pale deep sands, often gravelly.

Source: Cadastre - Landgate, 2015
Orthophoto - NearMaps, 28.10.16
Soils - DAFWA, 13.06.13
Topography - DoW, 2014

COTERRA
ENVIRONMENT

Job: SATCAT18
Doc: 004
Date: 9/10/2018
Ph: (08) 9381 5513
Fax: (08) 9381 5514
E: info@coterra.com.au

Tamala Park Regional Council
FORESHORE MANAGEMENT PLAN
LOT 15448 & 3050 TAMALA PARK
TOPOGRAPHY AND SOILS

Figure 4

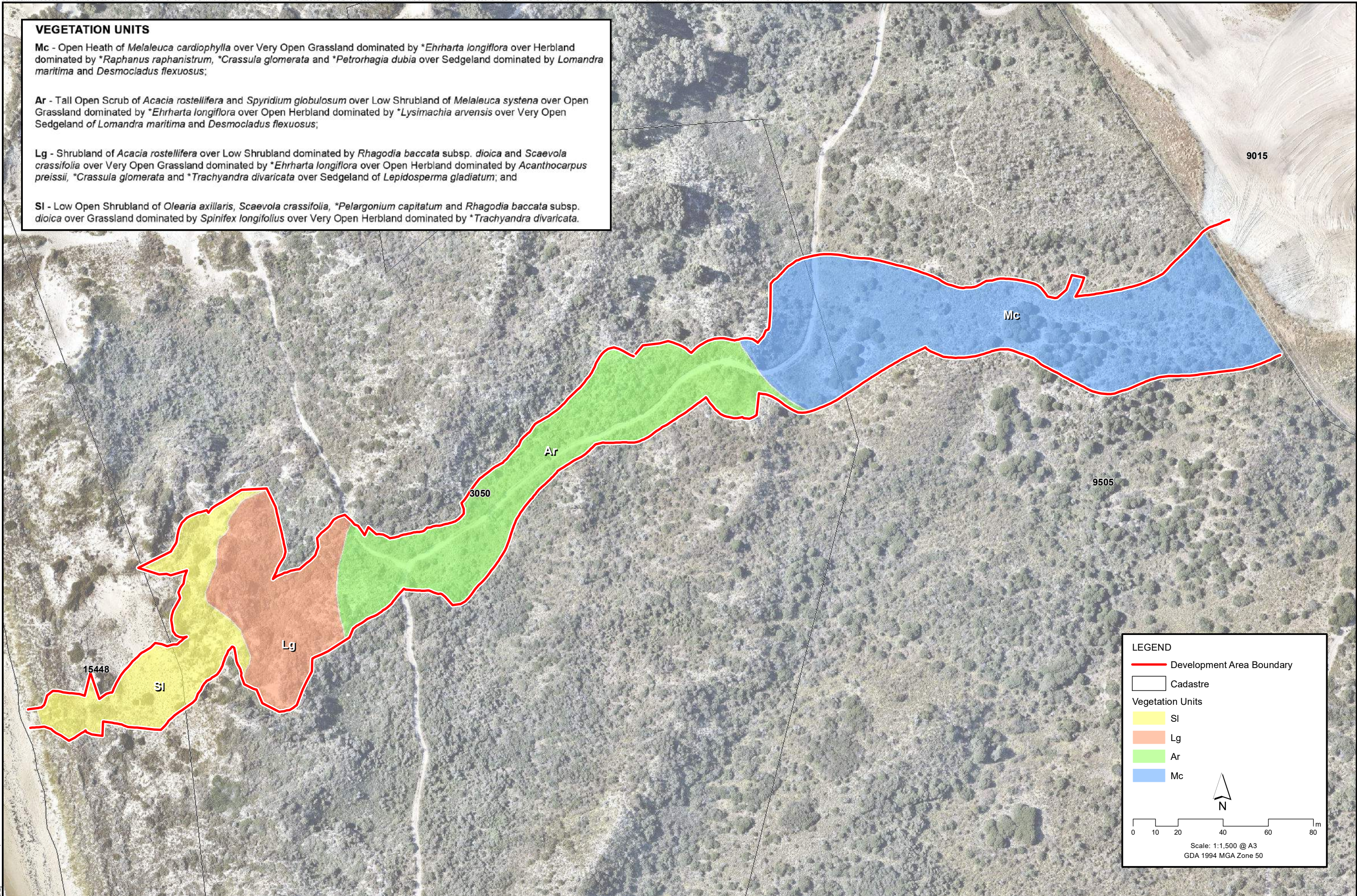
VEGETATION UNITS

Mc - Open Heath of *Melaleuca cardiophylla* over Very Open Grassland dominated by *Ehrharta longiflora* over Herbland dominated by *Raphanus raphanistrum*, *Crassula glomerata* and *Petrorhagia dubia* over Sedgeland dominated by *Lomandra maritima* and *Desmocladius flexuosus*;

Ar - Tall Open Scrub of *Acacia rostellifera* and *Spyridium globulosum* over Low Shrubland of *Melaleuca systema* over Open Grassland dominated by *Ehrharta longiflora* over Open Herbland dominated by *Lysimachia arvensis* over Very Open Sedgeland of *Lomandra maritima* and *Desmocladius flexuosus*;

Lg - Shrubland of *Acacia rostellifera* over Low Shrubland dominated by *Rhagodia baccata* subsp. *dioica* and *Scaevola crassifolia* over Very Open Grassland dominated by *Ehrharta longiflora* over Open Herbland dominated by *Acanthocarpus preissii*, *Crassula glomerata* and *Trachyandra divaricata* over Sedgeland of *Lepidosperma gladiatum*; and

Sl - Low Open Shrubland of *Olearia axillaris*, *Scaevola crassifolia*, *Pelargonium capitatum* and *Rhagodia baccata* subsp. *dioica* over Grassland dominated by *Spinifex longifolius* over Very Open Herbland dominated by *Trachyandra divaricata*.



LEGEND

- Development Area Boundary
- Cadastre

Vegetation Units

- Sl
- Lg
- Ar
- Mc

N

0 10 20 40 60 80 m

Scale: 1:1,500 @ A3
GDA 1994 MGA Zone 50

ENVIRONMAPS | 0406 590 006
Environmental Mapping Solutions | www.environmentmaps.com.au

Source: Cadastre - Landgate, 2015
Orthophoto - NearMaps, 28.10.16
Vegetation - Bennett Consulting

COTERRA
ENVIRONMENT

Job: SATCAT18
Doc: 005
Date: 9/10/2018
Ph: (08) 9381 5513
Fax: (08) 9381 5514
E: info@coterra.com.au

Tamala Park Regional Council
FORESHORE MANAGEMENT PLAN
LOT 15448 & 3050 TAMALA PARK

VEGETATION UNITS (BEC, 2016)

Figure 5

LEGEND

- Development Area Boundary
- Cadastre

Vegetation Condition

- 1: Pristine
- 2: Excellent
- 3: Very Good
- 3-4: Very Good - Good
- 4: Good
- 4-5: Good - Degraded
- 5: Degraded
- 6: Completely Degraded

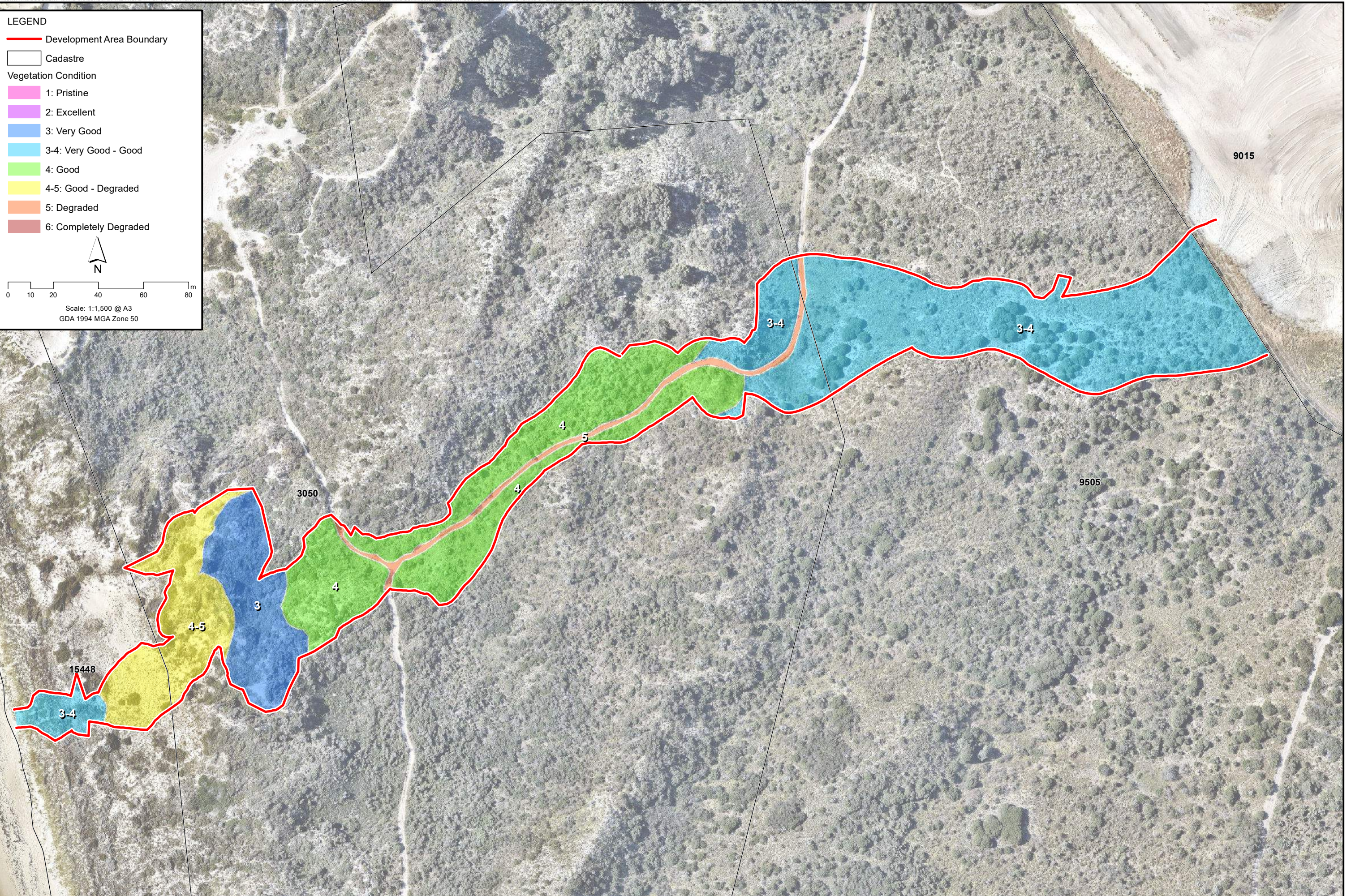


N




0 10 20 40 60 80 m

Scale: 1:1,500 @ A3
GDA 1994 MGA Zone 50



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Environmental Mapping Solutions | www.environmentmaps.com.au

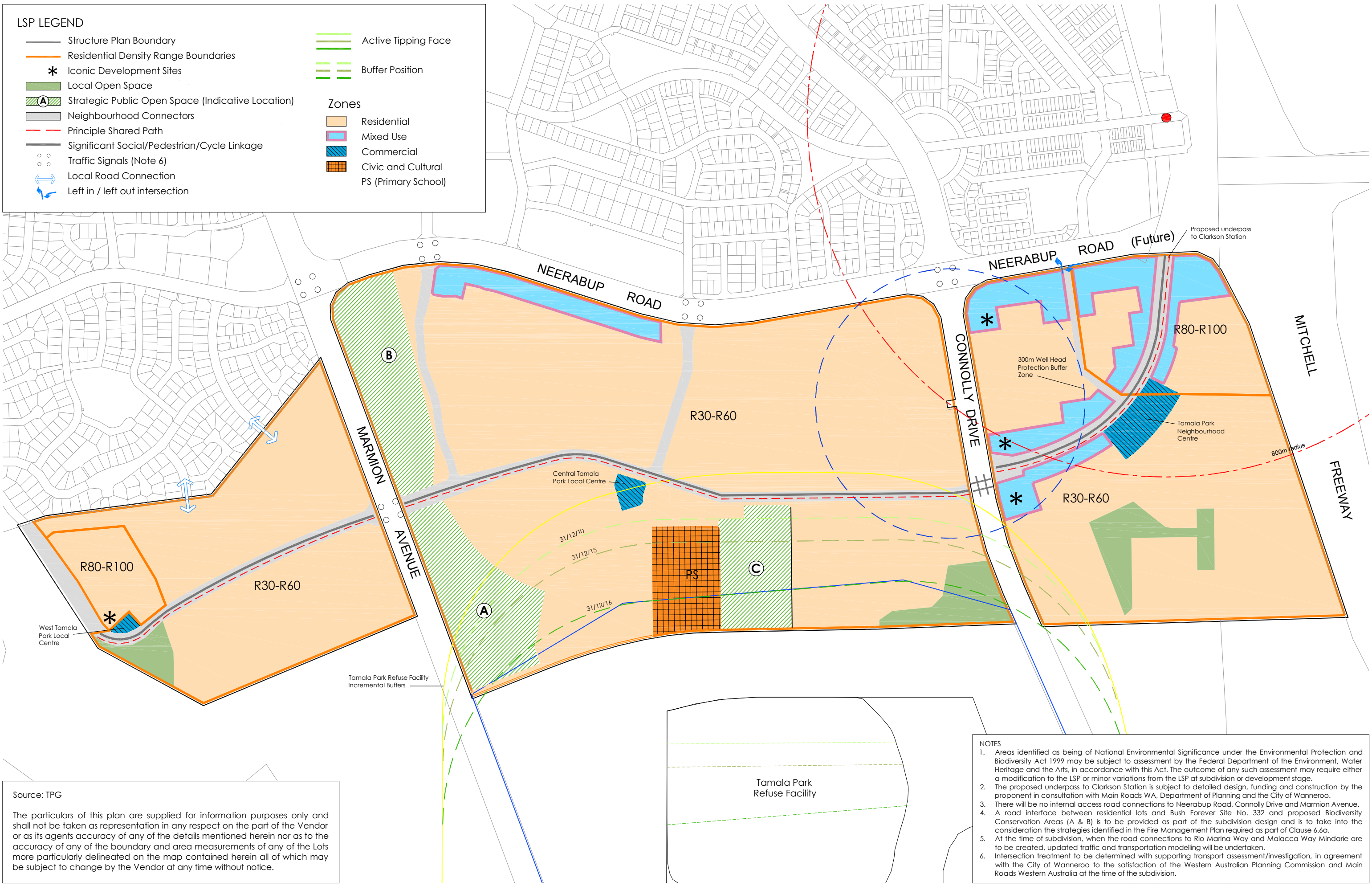
Source: Cadastre - Landgate, 2015
Orthophoto - NearMaps, 28.10.16
Vegetation - Bennett Consulting

	Job: SATCAT18 Doc: 006 Date: 9/10/2018 Ph: (08) 9381 5513 Fax: (08) 9381 5514 E: info@coterra.com.au	Tamala Park Regional Council FORESHORE MANAGEMENT PLAN LOT 15448 & 3050 TAMALA PARK VEGETATION CONDITION (BEC, 2016)	Figure 6
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APPENDIX A - TAMALA PARK LOCAL STRUCTURE PLAN MAP

LSP LEGEND

- Structure Plan Boundary
 - Residential Density Range Boundaries
 - * Iconic Development Sites
 - Local Open Space
 - Strategic Public Open Space (Indicative Location)
 - Neighbourhood Connectors
 - Principle Shared Path
 - Significant Social/Pedestrian/Cycle Linkage
 - Traffic Signals (Note 6)
 - Local Road Connection
 - Left in / left out intersection
- Active Tipping Face
 - Buffer Position
- Zones**
- Residential
 - Mixed Use
 - Commercial
 - Civic and Cultural
 - PS (Primary School)



Source: TPG

The particulars of this plan are supplied for information purposes only and shall not be taken as representation in any respect on the part of the Vendor or as its agents accuracy of any of the details mentioned herein nor as to the accuracy of any of the boundary and area measurements of any of the Lots more particularly delineated on the map contained herein all of which may be subject to change by the Vendor at any time without notice.

- NOTES**
1. Areas identified as being of National Environmental Significance under the Environmental Protection and Biodiversity Act 1999 may be subject to assessment by the Federal Department of the Environment, Water Heritage and the Arts, in accordance with this Act. The outcome of any such assessment may require either a modification to the LSP or minor variations from the LSP at subdivision or development stage.
 2. The proposed underpass to Clarkson Station is subject to detailed design, funding and construction by the proponent in consultation with Main Roads WA, Department of Planning and the City of Wanneroo.
 3. There will be no internal access road connections to Neerabup Road, Connolly Drive and Marmion Avenue.
 4. A road interface between residential lots and Bush Forever Site No. 332 and proposed Biodiversity Conservation Areas (A & B) is to be provided as part of the subdivision design and is to take into the consideration the strategies identified in the Fire Management Plan required as part of Clause 6.6a.
 5. At the time of subdivision, when the road connections to Rio Marina Way and Malacca Way Mindarie are to be created, updated traffic and transportation modelling will be undertaken.
 6. Intersection treatment to be determined with supporting transport assessment/investigation, in agreement with the City of Wanneroo to the satisfaction of the Western Australian Planning Commission and Main Roads Western Australia at the time of the subdivision.

APPENDIX B – COASTAL HAZARD RISK MANAGEMENT AND ADAPTION PLAN (MP ROGERS)

R1137 Draft A

January 2019

Satterley Property Group

**Catalina Estate
Coastal Hazard Risk Management & Adaptation
Plan**

marinas

boat harbours

canals

breakwaters

jetties

seawalls

dredging

reclamation

climate change

waves

currents

tides

flood levels

water quality

siltation

erosion

rivers

beaches

estuaries

Suite 1, 128 Main Street, Osborne Park, WA 6017
p: +618 9254 6600
e: admin@coastsandports.com.au
w: www.coastsandports.com.au

K1602, Report R1137 Draft A
Record of Document Revisions

Rev	Purpose of Document	Prepared	Reviewed	Approved	Date
A	Draft for MRA review	C Doak	T Hunt	C Doak	11.01.19

Form 035 18/06/2013

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1. Introduction

Development of foreshore infrastructure associated with the Catalina Estate is contemplated within the *Catalina Estate Coastal Access Infrastructure Foreshore Management Plan (FMP)* (Coterra Environment, 2018). The FMP sets out that its main objectives are to “*ensure controlled public access to a safe swimming and aquatic activity beach, whilst providing commitments to the protection and where possible enhancement of the conservation value of the adjacent foreshore area.*”

The FMP provides a comprehensive review of the overall development requirements for assets within the foreshore area, including details of:

- relevant guidance documents and controls;
- environmental investigations and context;
- consultation;
- management actions;
- success criteria; and
- implementation plans.

However, to complement the FMP a Coastal Hazard Risk Management and Adaptation Plan (CHRMAP) is required to review and quantify the potential coastal hazard risks associated with the proposed infrastructure and to outline how the risks will be addressed in the future.

To provide guidance regarding the risks posed by coastal hazards, Satterley Property Group engaged specialist coastal and port engineers, M P Rogers & Associates Pty Ltd (MRA), to complete a CHRMAP for the proposed coastal infrastructure. This CHRMAP covers the following key items:

- Establishment of the context.
- Coastal hazard identification and vulnerability.
- Risk analysis and evaluation.
- Risk management and adaptation planning.
- Implementation plan.

Details regarding each of these items will be provided in this report.

2. Context

2.1 Purpose

The potential vulnerability of the coastline and the subsequent risk to the community, economy and environment needs to be considered for any coastal development or infrastructure.

SPP2.6 requires that the responsible management authority or development proponent prepares a CHRMAP where an existing or proposed development or infrastructure may be at risk from coastal hazards over the planning timeframe. The main purpose of the CHRMAP is to define areas of the coastline which could be vulnerable to coastal hazards and to outline the preferred approach for the monitoring and management of these hazards where required.

A CHRMAP can be a powerful planning tool to help provide clarity to existing and future developers, users, managers or custodians of the coastline. This is done by defining levels of risk exposure, management practices and adaptation techniques that the development proponent, with agreement from the appropriate management authority, considers acceptable in response to the present and future risks posed by coastal hazards.

Specifically, the purpose of this CHRMAP is as follows:

- Outline the coastal hazard risks associated with the proposed coastal access infrastructure and how these risks may change over time.
- Provide guidance on appropriate future management and adaptation planning for the proposed coastal access infrastructure, including monitoring.

2.2 Objectives

The key objectives of this plan are as follows:

- Ensure that provision of the proposed coastal access infrastructure is in accordance with relevant planning requirements and that the proponent and key stakeholders understand the potential likelihood of proposed assets being impacted by coastal hazards over each planning horizon.
- Outline the required coastal adaptation approach in a project specific Implementation Plan that is acceptable to key stakeholders.

2.3 Proposed Infrastructure

The extent of coastal access infrastructure that is proposed for the Catalina Estate is relatively minor given the classification of the area as a local beach. The infrastructure that is proposed is largely provided to formalise access to the beach and is configured in a way that minimises the impact on the surrounding environment. Provision of formalised beach access will help to reduce the damage to the dune system that currently occurs as a result of largely unrestricted access.

A description of the coastal access infrastructure and the reasoning behind its proposed location is provided within the FMP, which states as follows.

“The proposed coastal access road has been designed to provide a local route to the beach for Catalina residents and the general public. An asphalt two-way road is proposed to be constructed, leading visitors to a beach carpark adjacent to the foredune, providing at least 30 bays (including one ACROD bay). From the car park, a

3m wide stabilised limestone walking path will provide access to the beach for pedestrians as well as authorised vehicles as necessary. The path will be 3m in width to minimise clearing and disturbance to the surrounds. This is consistent with the City of Wanneroo path specifications.

A small area adjacent to the southern boundary of the carpark has been provisionally allocated to enable the future development of mobile infrastructure to facilitate Surf Life Saving WA beach patrols and associated equipment storage. A provisional site has also been supplied for the future construction of an ablution block / change rooms.

These assets are not currently proposed and indicative locations only are provided. The alignment of the proposed access route and the location of the carpark area have been carefully selected to minimise impacts to flora and values in the area. Where possible the proposed access route follows the alignment of existing informal bush tracks or areas of damaged vegetation. The proposed carpark area is to be located within a degraded area of minimal or declining vegetation.

The location of the carpark area is based the Coastal Aquatic Risk Assessment (2014) undertaken by Surf Life Saving Western Australia (SLSWA) which identified the site as a preferred beach access location, due to safe swimming conditions and absence of potential hazards present in the existing access locations to the north and south. The carpark location was selected above the larger dune blowout area which occurs further to the south for the following reasons:

- *It was the preferred location identified by SLSWA*
- *The larger dune blowout is located approximately 1.5km from the Catalina Beach development boundary. This distance is no longer considered walkable compared to the 550m distance associated with the location proposed.”*

A layout plan for the proposed infrastructure is provide in Figure 2.1.

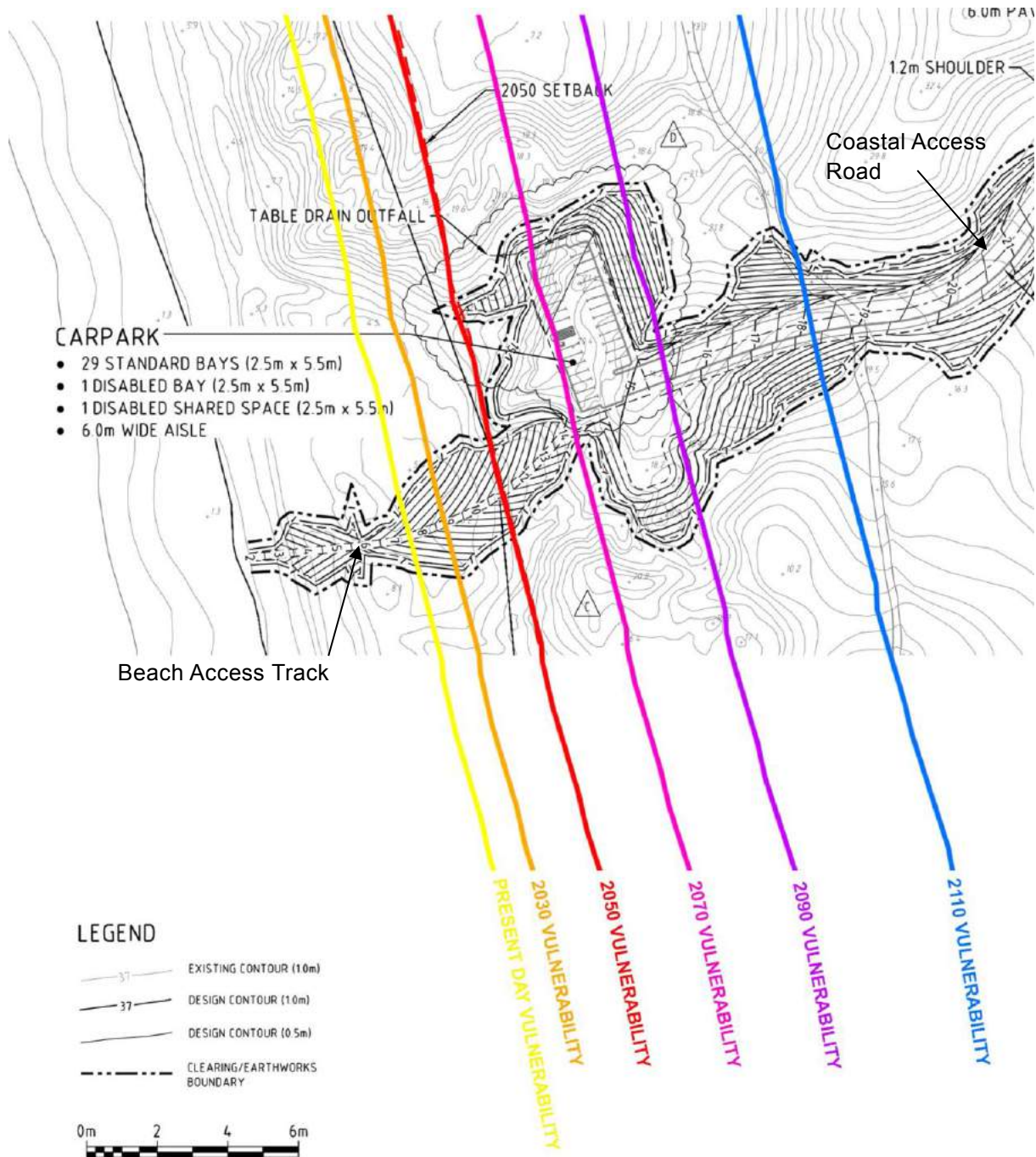


Figure 2.1 Proposed layout of Coastal Access Infrastructure

2.4 Scope

The *CHRMAP Guidelines* (WAPC 2014) provide a specific framework for the preparation of a CHRMAP. This is outlined in the flowchart presented in Figure 2.2, which shows the risk management and adaptation process.

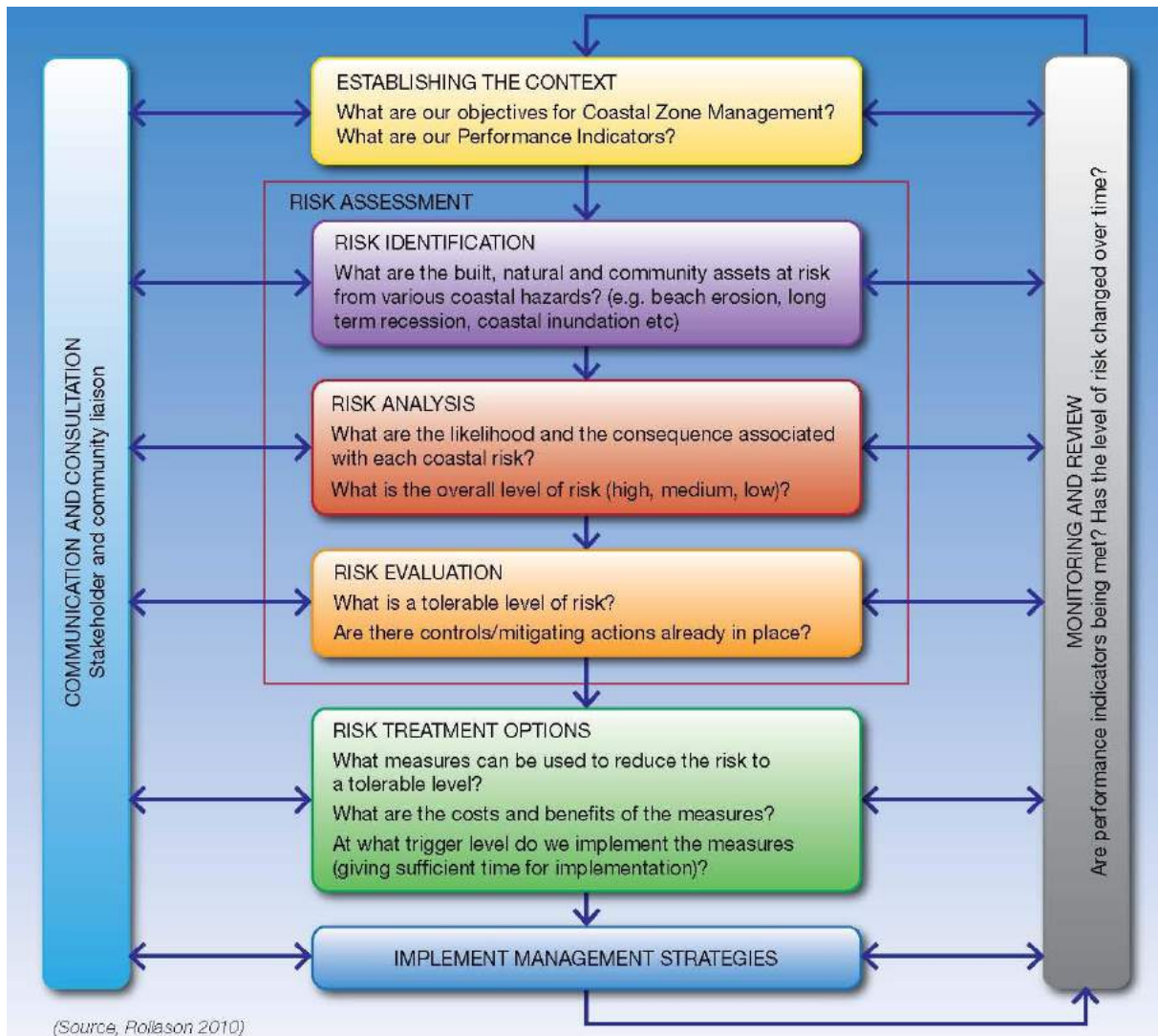


Figure 2.2 Risk Management & Adaptation Process Flowchart (WAPC 2014)

As presented in the flowchart, the process for the development of a meaningful CHRMAP requires a number of fundamental inputs. These inputs enable the assessment and analysis of risk, which should ultimately be informed by input received from key stakeholders, to help shape the subsequent adaptation strategies.

The management of coastal hazard risk associated with the proposed coastal access infrastructure will be required to present a proposed adaptation plan that is acceptable to the stakeholders. As a result, the approach that has been taken for this plan is to develop a management methodology that allows for flexibility into the future and is consistent with relevant state and local planning strategies and guidelines.

The development of the adaptation plan will be informed by the coastal erosion and inundation hazards at the site. The extent of the coastal erosion and inundation hazards at the proposed location of the infrastructure is presented within Section 3 of this report.

This CHRMAP will consider the potential risks posed by coastal hazards over a range of horizons covering the 100 year planning timeframe to the year 2120, as required by SPP2.6 for development on the coast.

Intermediate planning horizons will also be considered in order to assess how risk profiles may change in the future and to inform the requirement for adaptation strategies. This is particularly significant where these intermediate planning horizons better align with the expected service lives of proposed development. The intermediate planning horizons that will be considered in this CHRMAP are based on the available erosion hazard line horizons, discussed in Section 3.1, and are listed below.

- Present day.
- 2030.
- 2050.
- 2070.
- 2090.
- 2120.

Based on the results of the risk assessment, risk mitigation strategies will be developed, where required, in order to provide a framework for future management. However, it is important to realise that the risk assessment will be based on the outcomes of the coastal vulnerability assessment, which, by their nature, are justifiably conservative. This is due to the uncertainty around coastal dynamics when predicting impacts over long timeframes. As a result, the framework for future risk management strategies should be considered to be a guide of future requirements.

The actual requirement for implementation of these management actions should ultimately be informed by a coastal monitoring regime. The purpose of this coastal monitoring regime is to identify changes in the shoreline or sea level that could alter, either positively or negatively, the risk exposure of the proposed assets and infrastructure.

2.5 Existing Planning Controls

The FMP (Coterra, 2018) provides details of a range of controls that are applicable to the development of the foreshore. More specific details of applicable controls from a development perspective are provided in the following section.

2.5.1 State Planning Policy 2.6 (SPP 2.6)

Within Western Australia, State Planning Policy 2.6: State Coastal Planning Policy (SPP2.6; WAPC, 2013) and associated guideline documents, provides guidance on the assessment of coastal hazard risks for assets or infrastructure located near the coast. This guidance is provided in the form of a methodology to assess the potential extent of coastal hazard impacts, as well as for the development of appropriate coastal hazard risk mitigation and adaptation strategies.

The key requirement of SPP2.6 is to develop a coastal management and adaptation framework for assets or infrastructure that could be at risk of impact by coastal hazards over various planning horizons.

The first step in this process is to identify the risks presented by relevant coastal hazards. SPP2.6 provides guidance on the different coastal hazards that must be considered when

assessing coastal risks. SPP2.6 recommends consideration be given to the following coastal hazards:

- severe storm erosion events (termed the “S1” allowance within SPP2.6);
- long term shoreline changes caused by ongoing effects of coastal processes (termed the “S2” allowance within SPP2.6);
- recession of the shoreline caused by potential sea level rise (termed the “S3” allowance within SPP2.6); and
- storm surge inundation (termed the “S4” allowance within SPP2.6).

Following the hazard identification, the associated risks are considered with reference to the expected life of assets or infrastructure located near the coast.

Generally, this consists of preparation of a CHRMAP to provide guidance on responding to these risks. The management and adaptation strategies are governed by a range of criteria including the social, economic and environmental value of the underlying assets as determined via community and stakeholder engagement.

2.5.2 City of Wanneroo CHRMAP

The City is responsible for the management of approximately 32 km of coastline along the northern corridor of the Perth Metropolitan area. Various works have previously been undertaken by the City to describe the coastal risks and associated management guidelines for its coastline. This work culminated in the preparation of a City-wide CHRMAP, which was ultimately endorsed by Council and adopted in August 2018.

The CHRMAP comprised two main work components, a coastal vulnerability study and hazard mapping component (MRA, 2015) and a risk assessment and adaptation planning component (Cardno, 2018).

Coastal Vulnerability Study & Hazard Mapping (MRA 2015)

MRA were engaged by the City to complete Stage 1 of the CHRMAP process – the coastal vulnerability assessment and hazard mapping.

The scope of this investigation was to cover the hazard identification and risk assessment components of the CHRMAP for the entire coastline within the City of Wanneroo, stretching from Tamala Park to north of Two Rocks. A knowledge summary and gap analysis was completed to provide background to the coastal processes along the City’s coastline.

Coastal hazard lines were presented for present day, as well as timeframes to 2030, 2050, 2070, 2090 and 2120. These hazard lines were used to determine the potential vulnerability of assets to coastal hazards over relevant timeframes. Assets considered in this assessment included built form, environmental and cultural assets.

Risk Assessment & Adaptation Planning (Cardno, 2018)

Using the results from the coastal vulnerability study and hazard mapping, a risk and vulnerability assessment was applied to key areas coincident with the most vulnerable assets and timeframes. Detailed adaptation options were investigated for these locations, with the risk assessment and adaptation options developed with the guidance of a community values assessment, completed through a stakeholder engagement process.

Of significance to Catalina Estate, the risk assessment and adaptation planning identified that the Priority Ecological Community (PEC) located within the Bush Forever Site would be exposed to an increasing level of risk over time. Consequently an adaptation plan was prepared for the area. The adaptation plan (refer Table 2.1) noted that there were no built assets within the area and that development within the coastal hazard areas should ultimately be avoided. In terms of preservation of the dune system, it was noted that dune care and/or sand management should be completed to help preserve the PEC whilst also ensuring that the dune system would be maintained in a manner that helped to preserve its natural protective function.

In this regard, dune care / sand management was defined as follows.

“Development of an ongoing program for revegetation and rehabilitation of the dune system. Installation of signage and access restrictions to prevent degradation of the dunes and vegetation by people. Incorporation of education programs on the importance of preserving natural dunes. Sand fencing to manage wind-blown erosion also falls under this category.”

This objective is consistent with the objectives outlined with the FMP, with a desire to control access through the area to a single focal point, thereby assisting with the preservation of the larger PEC area.

Table 2.1 Proposed adaptation pathways for the shoreline fronting Catalina Estate (Cardno, 2018)

Planning Timeframe	2015 - 2030	2030 - 2070	2070 - 2120	2120 - future
Assets	Undeveloped Land			
Pathway	<i>Avoid development (AV)</i>			
Trigger(s)	Undeveloped land lies within hazard extents (T10)			
Assets	Beach and Dunes			
Pathway	<i>Dune care / sand management (PR1)</i>			
Trigger(s)	Diminished beach and foreshore reserve (T9)			

2.5.3 City of Wanneroo Coastal Asset Policy (LPP 4.21)

Local Planning Policy 4.21, Coastal Assets Policy (LPP 4.21) was prepared by the City of Wanneroo. The policy applies to all future works proposed within the coastal foreshore reserve and its purpose is to:

- provide guidance to land developers, consultants, the community and contractors as to the type of permanent and temporary assets that the City will consider within the foreshore reserve; and
- guide the location of proposed assets relative to the projected onset of coastal processes as calculated in accordance with State Coastal Planning Policy 2.6 (SPP 2.6).

Generally, the policy provides a broad framework for assessing what types of assets and developments are acceptable within the coastal zone based on beach classification and relevant coastal hazards. Guidance is provided on the types (permanent vs temporary), design lives of and preferred management and adaptation measures for assets in the coastal zone based on their exposure to coastal risks.

The shoreline fronting Catalina Estate is classified as a local beach. LPP 4.21 therefore provides the following guidance regarding the acceptability and location of different assets within the foreshore area.

Table 2.2 LPP 4.21 guidance on acceptable assets within the foreshore reserve

Main Role/Function		Acceptable Permanent assets within foreshore parkland	Location or Parkland and Permanent Assets	Acceptable Permanent assets located outside of foreshore parkland	Location of permanent assets outside of foreshore parkland	Acceptable temporary assets
Local Beach	Local beaches are utilised by people living close by and are often accessed by foot or bicycle, as well as by car. Local beaches usually have very few facilities and infrastructure, and generally record relatively low rates of use (WAPC, 2013b).	<ul style="list-style-type: none"> • 2x bench seating • 1x outdoor shower • 1x drinking fountain • 1x picnic table • 1x lookout shelter • 2-3x beach access points • 1x barbecue • 1x bike rack • 4x play equipment items or nature play with sand or mulch soft fall where applicable 	<ul style="list-style-type: none"> • Foreshore parkland and permanent assets at local beach to be placed at 50 year vulnerability line or landward of this location 	<ul style="list-style-type: none"> • Car park (30 - 70 bays) • Dual use pathway • Emergency vehicle access 	<ul style="list-style-type: none"> • Car park: 50 year vulnerability line or landward of this location. • Dual use pathway: 30 year vulnerability line or landward of this location. 	<ul style="list-style-type: none"> • Cafe • SLS Outpost (as per section 7)

2.6 Stakeholder Engagement

Consultation with key stakeholders was completed to assist with the development of the proposed plan for the coastal access infrastructure. The extent of this consultation is outlined within the FMP. As outlined within the FMP, the plan for beach access was supported by key stakeholders.

2.7 Key Assets

The assets considered within this CHRMAP relate only to those new assets proposed as part of the Catalina Estate Development. Existing assets, which include the beach, dunes and PEC were assessed as part of the City's CHRMAP processes and would remain unchanged as a result of the proposed construction of the coastal access infrastructure.

The key assets covered by this CHRMAP include the following.

- Stabilised limestone beach access track.
- 30 bay car park.
- Coastal access road.
- Land area for potential future SLSWA outpost and toilet block/change rooms.

With regard to these assets it should be noted that the SLSWA outpost and toilet block/change rooms are not currently proposed. As such, the details of these items are not known with any certainty and cannot therefore be assessed within this version of the CHRMAP. This CHRMAP will therefore consider the land area itself as the asset prior to any further improvement. If the

SLSWA outpost or toilet block/change rooms are to be installed in the future, this CHRMAP can be reviewed and updated to incorporate this infrastructure.

2.8 Success Criteria

The success criteria for the CHRMAP will ultimately be as follows:

- Demonstrated understanding by the proponent and key stakeholders regarding the likelihood and subsequent risks of coastal hazards impacting identified assets over each planning horizon.
- Acceptance of a risk management and adaptation plan for the 100 year planning timeframe by the proponent and key stakeholders.
- Adoption of the Implementation Plan (refer to Section 8) as a tool for the future management of the area.

3. Coastal Hazards

The coastal hazards requiring consideration for development of the coast are specified by SPP2.6. These hazards include coastal inundation and the various components which contribute to shoreline erosion. These hazards were identified and assessed as part of the CHRMAP process (MRA, 2015). The coastal hazards were assessed for the range of planning horizons listed below.

- Present Day
- 2030
- 2050
- 2070
- 2090
- 2120

These timeframes were assessed to determine when certain infrastructure, assets or sites could become vulnerable to the coastal hazards. Consideration of these timeframes is required to develop appropriate coastal adaptation or management measures based on the expected life of the underlying assets.

The outcomes of the assessment are summarised in the following sections. These coastal hazards will need to be appropriately considered in the master-planning for the site.

3.1 Coastal Erosion

The risk presented by coastal erosion hazards varies with the coastal form and geomorphology, however for the general case of sandy coasts the following factors are considered.

- (S1 Erosion) Allowance for the current risk of storm erosion associated with the 100 year ARI event.
- (S2 Erosion) Allowance for long term shoreline movement trends.
- (S3 Erosion) Allowance for erosion caused by future sea level rise.
- (Allowance for Uncertainty) Allowance of 0.2 m/year for unforeseen or unaccounted for shoreline change.

Using the methodology specified in SPP 2.6, MRA (2015) assessed the appropriate coastal erosion hazard allowances across the planning horizons introduced previously. The relevant coastal erosion hazard allowances are presented in Table 3.1, with the coastal hazard mapping presented in Figure 3.1. It should be noted that the base year for the MRA (2015) assessment was 2015, with the longest planning horizon being a 105 year period to 2120. Therefore the allowances for provided by MRA (2015) consider a period that is longer than the standard 100 year required by SPP2.6.

Table 3.1 Coastal Erosion Hazard Allowances (MRA, 2015)

Component	Present Day (2015)	2030	2050	2070	2090	2120
S1 (m)	52	52	52	52	52	52
S2 (m)	0	0	0	0	0	0
S3 (m)	0	7	20	39	62	97
Allowance for Uncertainty (m)	0	3	7	11	15	21
Total Coastal Erosion Hazard Allowance (m)	52	62	79	102	129	170

In the figure, coastal erosion hazard lines are presented for each of the planning horizons. It is important to note that these lines **are not** a prediction of the shoreline for the relevant planning horizon. Rather, these lines provide an indication of the extent of vulnerability to certain coastal erosion hazards, assessed using the SPP 2.6 methodology, over the relevant planning horizon.

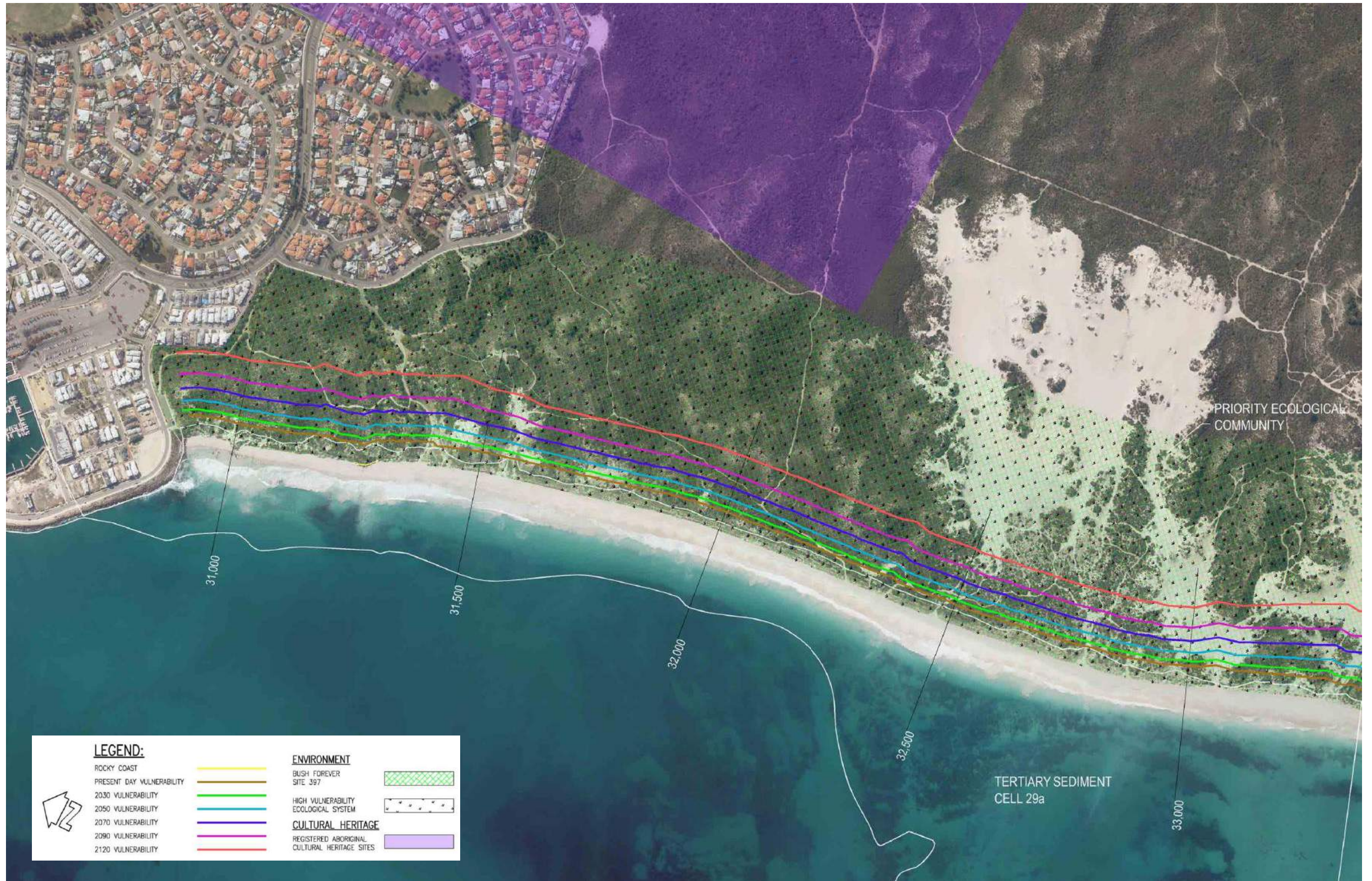


Figure 3.1 Catalina Estate Coastal Hazard Mapping

3.1.1 Inundation

SPP2.6 requires assessment of the potential exposure of areas to coastal inundation or coastal flooding, named the S4 Inundation allowance. The coastal inundation assessment is completed with reference to an event with a 0.2% chance of exceedance per year, also known as the 500 year ARI event.

An extreme analysis of the long term water level record available at Fremantle Fishing Boat Harbour was undertaken to determine the 500 year water level at the FFBH tide gauge. This is expected to provide a reasonable indication of the 500 year water level offshore of the City's shoreline. Allowances for nearshore wave set-up and sea level rise across the various planning horizons were then incorporated to determine estimates of the total water level during the 500 year inundation event. The determined inundation level across the various planning horizons are provided in Table 3.2.

Table 3.2 500 year ARI inundation levels

Component	Present Day (2015)	2030	2050	2070	2090	2120
500 yr ARI water level in Fremantle Fishing Boat Harbour (mAHD)	+1.44	+1.44	+1.44	+1.44	+1.44	+1.44
Allowance for nearshore setup (wind and wave) (m)	1.36	1.36	1.36	1.36	1.36	1.36
Allowance for Sea Level Rise (m)	-	0.07	0.2	0.39	0.62	0.97
Total Water Level (mAHD)	+2.8	+2.9	+3.0	+3.2	+3.4	+3.8

4. Coastal Vulnerability

The vulnerability of the proposed assets identified previously is related to their level of exposure to coastal hazards, as well as their sensitivity to the impacts caused by these hazards and their ability to respond to them (termed adaptive capacity). The assets that are being considered as part of this proposal are built form assets. Therefore, the level of vulnerability of the assets will ultimately be linked to their level of exposure. The slight exception to this is the stabilised limestone beach access path, which has a higher level of adaptive capacity since it can be regraded relatively easily to accommodate any shoreline change.

Further consideration of the risk and future management and adaptation requirements will be needed for these assets. Details of this risk assessment and future management and adaptation requirements are presented in subsequent sections of this report.

5. Risk Analysis

In accordance with WAPC (2014), a risk based approach will be used to assess the hazards and required mitigation and adaptation options for the proposed assets. As coastal hazards are the focus of this assessment, it is the likelihood and consequences of these coastal hazards that need to be considered. As stated previously, it is inherent in the proposal that there be no negative social or environmental impacts as a result of this development, with mitigation strategies already highlighted to address these issues.

5.1 Likelihood

Likelihood is defined as the chance of something happening (AS/NZS ISO 31000:2009). WAPC (2014) defines the likelihood as the chance of erosion or storm surge inundation occurring or how often they impact on existing and future assets and values. This requires consideration of the frequency and probability of the event occurring over a given planning timeframe.

The probability of an event occurring is often related to the AEP or the ARI. The use of the AEP to define impacts of coastal hazards over the planning timeframe assumes that events have the same probability of occurring each year. In the case of climate change and sea level rise, which has a large influence on the assessed coastal hazard risk, this is not true. In addition, there is insufficient data available to properly quantify the probability of occurrence. A scale of likelihood has therefore been developed, which follows the Australian Standard Risk Management Principles and Guidelines (AS/NZS ISO 31000:2009). This is presented in Table 5.1.

Table 5.1 Scale of Likelihood

Rating	Description/Frequency
Almost certain	There is a high possibility the event will occur as there is a history of frequent occurrence 90-100% probability of occurring over the timeframe.
Likely	It is likely the event will occur as there is a history of casual occurrence 60-90% probability of occurring over the timeframe.
Possible	The event may occur 40-60% probability of occurring over the timeframe.
Unlikely	There is a low possibility that the event will occur 10-40% probability of occurring over the timeframe.
Rare	It is highly unlikely that the event will occur, except in extreme/exceptional circumstances. 0-10% probability of occurring over the timeframe.

The likelihood and consequences of coastal hazards are different for erosion and inundation. As a result, the likelihood and consequence of erosion and inundation should be considered separately. The likelihood of the coastal hazard impacts is discussed in the following sections.

5.1.1 Coastal Erosion

The likelihood ratings given to the proposed development assets are based on the coastal erosion hazard lines (Figure 3.1) and the consideration of the probabilities of each of the allowances occurring within the respective planning horizons.

It is important to note that the hazard lines reaching a particular asset at the end of the planning horizon do not necessarily mean this will occur. This is due to the fact that it requires all of the following to occur:

- Erosion of 0.2 m/year (uncertainty allowance) in an area not identified as eroding.
- The upper estimate of erosion caused by sea level rise.
- The 100 year ARI severe storm event to be experienced at the end of the planning timeframe (ie when the other allowances have been realised).

Only if all of these occur will the erosion hazard lines be realised.

The assessment of the relative likelihood of each of the identified key assets, being impacted by erosion hazards over the 100 year planning timeframe, is presented in Table 5.2.

Table 5.2 Assessment of Likelihood of Coastal Erosion Impact

Key Assets	Present Day (2015)	2030	2050	2070	2090	2120
Stabilised limestone beach access track	Possible	Almost Certain	Almost Certain	Almost Certain	Almost Certain	Almost Certain
30 bay car park	Rare	Rare	Rare	Rare	Possible	Almost Certain
Coastal access road	Rare	Rare	Rare	Rare	Rare	Possible
Land area for potential future SLSWA outpost and toilet block/change rooms	Rare	Rare	Rare	Rare	Possible	Almost Certain

Notes: 1. Based on most exposed location of each asset group.

The assessment of likelihood of coastal erosion impact shows the following:

- There is a high likelihood that the beach access track would be impacted by coastal erosion from the time it is constructed. This is an unavoidable consequence of constructing a track down to a beach. Beaches are dynamic systems and experience ongoing movement in response to incident wave and water level conditions. As a result, the section of the path that joins the beach is likely to be impacted by these coastal dynamics on a regular basis.
- The likelihood of the remainder of the assets being impacted by coastal erosion is expected to be rare until at least 2070. Beyond this time the risk of impact would increase.

5.1.2 Coastal Inundation

Assessment of the likelihood of coastal inundation is slightly different to that for coastal erosion. This is due to the fact that the potential for coastal inundation will change in the future as the sea level rises. This means that an area that would only be inundated during a very severe event in the present day could potentially be inundated by a much less severe event in the future. Assessment of the probability of an area being inundated within a given planning horizon therefore needs to consider the changing probability of event occurrence throughout that planning timeframe.

Regardless, the majority of the assets, with the exception of the lower portions of the beach access path, are located at elevations above 15 mAHD and are therefore a long way above the potential inundation levels. As a result, the only asset that could be impacted by inundation would be the beach access path. An assessment of the likelihood of coastal inundation impact on the path is provided in Table 5.3.

Table 5.3 Assessment of Likelihood of Coastal Inundation Impact

Key Assets	Present Day (2015)	2030	2050	2070	2090	2120
Stabilised limestone beach access track	Possible	Almost Certain	Almost Certain	Almost Certain	Almost Certain	Almost Certain

As with the assessment of coastal erosion hazards, there is the potential that the lower portion of the beach access track would be inundated during severe events. This is the nature of beach access pathways, as providing access to the beach requires tracks to be at elevations that would be prone to inundation from time to time during severe events.

5.2 Consequence

The second part of the risk assessment is determining the consequence of the coastal hazards on the proposed assets. A scale of consequence has been developed which provides a range of impacts and is generally consistent with the Australian Standard Risk Management Principles and Guidelines (ISO 31000:2009).

Table 5.4 Scale of Consequence

Rating	Social	Economic	Environment
Catastrophic	Loss of life and serious injury. Large long term or permanent loss of services, employment wellbeing, finances or culture (75% of community affected), international loss, no suitable alternative sites exist	Damage to property, infrastructure or local economy > \$20M	Major widespread loss of environmental amenity and progressive irrecoverable environmental damage
Major	Serious injury. Medium term disruption to services, employment wellbeing, finances or culture (<50% of community affected), national loss, limited alternative sites exist	Damage to property, infrastructure or local economy > \$5M to \$20M	Severe loss of environmental amenity and a danger of continuing environmental damage
Moderate	Minor injury. Major short or minor long term disruption to services, employment wellbeing, finances or culture (<25% of community affected), regional loss, many alternative sites exist	Damage to property, infrastructure or local economy > \$500,000 to \$5M	Isolated but significant instances of environmental damage that might be reversed with intensive efforts. Recovery may take several years.
Minor	Small to medium disruption to services, employment wellbeing, finances or culture (<10% of community affected), local loss, many alternative sites exist	Damage to property, infrastructure or local economy > \$50,000 to \$500,000	Minor instances of environmental damage that could be reversed. Consistent with seasonal variability, recovery may take one year.
Insignificant	Minimal short-term inconveniences to services, employment, wellbeing, finances or culture (<5% of community affected), neighbourhood loss, many alternative sites exist	Damage to property, infrastructure or local economy < \$50,000	Minimal environmental damage, recovery may take less than 6 months.

Similar to the assessment of likelihood, the consequence rating has been completed separately for coastal erosion and coastal inundation. Typically for infrastructure and assets, the consequences associated with coastal erosion are more significant than those associated with coastal inundation. This arises due to the fact that coastal erosion is generally more permanent and more difficult to overcome than coastal inundation. For instance, if the foundations of a house were undermined by erosion it is likely that the house would fall. However, if a house was inundated, while there may be some damage, structural failure would be less likely.

The consequence ratings for coastal erosion and coastal inundation are outlined in the following sections. These consequence ratings are ultimately provided to inform stakeholder of the risks given their future management liabilities.

5.2.1 Coastal Erosion

The assessed consequences of coastal erosion for each of the planning horizons over the 100 year planning timeframe are outlined in Table 5.5.

Table 5.5 Assessment of Consequence of Coastal Erosion Impact

Key Assets	Present Day (2015)	2030	2050	2070	2090	2110
Stabilised limestone beach access track.	Insignificant	Insignificant	Insignificant	Insignificant	Insignificant	Insignificant
30 bay car park.	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate
Coastal access road.	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate
Land area for potential future SLSWA outpost and toilet block/change rooms.	Minor	Minor	Minor	Minor	Minor	Minor

The rationale behind the key consequence ratings for coastal erosion impact are provided below:

- The beach access track is relatively low value infrastructure and even if it was impacted by coastal erosion to some extent, it would still perform its function of providing a dedicated and focused path down to the beach. Some minor repairs or regrading could be required to knock down erosion scarps that could form at the end of the path, however the cost of these works would be small.
- Coastal erosion impacts on the car park or coastal access road would be more significant. Should coastal erosion impact these assets it is expected that the recovery costs could be in the order of \$500,000 to \$5 million. Social and environmental impacts would also be experienced given the loss of the assets and the potential for distribution of debris on the beach.
- The consequence of loss of the land area for potential use by SLSWA or for toilets/change rooms has been assessed as minor given the it is only the vacant land area that is being assessed at this stage.

5.2.2 Coastal Inundation

The assessed consequence of coastal inundation for the stabilised limestone beach access track has been assessed in Table 5.6. As noted previously, this is the only asset that could be impacted by inundation, so is the only asset considered here.

Table 5.6 Assessment of Consequence of Coastal Inundation Impact

Key Assets	Present Day (2015)	2030	2050	2070	2090	2110
Stabilised limestone beach access track.	Insignificant	Insignificant	Insignificant	Insignificant	Insignificant	Insignificant

The consequence of inundation on the beach access track has been assessed as insignificant, given the low value of the infrastructure and the fact that the use of the asset would not be significantly impacted once the inundation subsides.

6. Risk Evaluation

6.1 Risk Evaluation Matrix

The risk rating from a risk assessment is defined as “likelihood” x “consequence.” A risk matrix defining the levels of risk from combinations of likelihood and consequence has therefore been developed for the coastal hazards. This risk matrix is generally consistent with WAPC (2014).

Table 6.1 Risk Matrix

RISK LEVELS		CONSEQUENCE				
		Insignificant	Minor	Moderate	Major	Catastrophic
LIKELIHOOD	Almost Certain	Low	Medium	High	Extreme	Extreme
	Likely	Low	Medium	Medium	High	Extreme
	Possible	Low	Medium	Medium	Medium	High
	Unlikely	Low	Low	Medium	Medium	Medium
	Rare	Low	Low	Low	Low	Low

A risk tolerance scale assists in determining which risks are acceptable, tolerable and unacceptable. The risk tolerance scale used for the assessment is presented in Table 6.2.

Table 6.2 Risk Tolerance Scale

Risk Level	Action Required	Tolerance
Extreme	Immediate action required to eliminate or reduce the risk to acceptable levels	Intolerable
High	Immediate to short term action required to eliminate or reduce risk to acceptable levels	Intolerable
Medium	Reduce the risk or accept the risk provided residual risk level is understood	Tolerable
Low	Accept the risk	Acceptable

The risk tolerance scale has been reviewed and accepted for use by the proponent. It shows that the extreme and high risks need to be managed.

6.2 Risk Assessment

The risk assessment for the study area will be completed in accordance with the recommendations of AS5334 (Standards Australia 2013), which requires a detailed risk analysis to include a vulnerability analysis to thoroughly examine how coastal hazards and climate change

may affect the assets. This includes consideration of the adaptive capacity and vulnerability of the relevant assets.

6.2.1 Coastal Erosion

Based on the results of the risk analysis completed previously, Table 6.3 presents the coastal erosion risk levels for each of the identified key assets.

Table 6.3 Assessment of Risk of Coastal Erosion Impact

Key Assets	Present Day (2015)	2030	2050	2070	2090	2120
Stabilised limestone beach access track.	Low	Low	Low	Low	Low	Low
30 bay car park.	Low	Low	Low	Low	Medium	High
Coastal access road.	Low	Low	Low	Low	Low	Medium
Land area for potential future SLSWA outpost and toilet block/change rooms.	Low	Low	Low	Low	Medium	Medium

The results of the assessment show that all of the proposed assets have a Low coastal erosion hazard risk over the period to 2070. Based on Table 6.2, these risks are low enough to warrant acceptance without further consideration, however adopting the *as low as reasonably practical* (ALARP) approach means that methodologies that reduce further reduce any impacts should still be completed wherever possible if it means that better outcomes can be achieved.

Beyond 2070, the car park and land area available for the SLSWA outpost and toilet block/change rooms would have a medium level of risk by 2090, with the level of risk for the car park increasing to high by 2120. The risk for the coastal access road is lower by virtue of its increased distance from the coastline (as it is located landward of the car park).

Further consideration and discussion of the implications of these results, with regard to risk management, are provided in Section 7.

6.2.2 Coastal Inundation

Based on the results of the risk analysis completed previously, Table 6.4 presents the coastal inundation risk levels for the coastal access path.

Table 6.4 Assessment of Risk of Coastal Inundation Impact

Key Assets	Present Day (2015)	2030	2050	2070	2090	2120
Stabilised limestone beach access track.	Low	Low	Low	Low	Low	Low

The results of the assessment show that there is a low coastal hazard risk associated with the inundation of the beach access path. This is on the basis that inundation of the path would be temporary during severe events and would be unlikely to significantly impact the use of the path, over the longer term.

7. Risk Adaptation & Mitigation Strategies

SPP2.6 outlines a hierarchy of risk adaptation and mitigation options, where options that allow for a wide range of future strategies are considered more favourably. This hierarchy of options is reproduced in Figure 7.1.



Figure 7.1 Risk Management & Adaptation Hierarchy

These options are generally outlined below:

- Avoid – avoid new development within the area impacted by coastal hazards.
- Retreat – the relocation or removal of assets within an area identified as likely to be subject to intolerable risk of damage from coastal hazards.
- Accommodation – measures which suitably address the identified risks.
- Protect – used to preserve the foreshore reserve, public access and public safety, property and infrastructure.

The assessment of options is generally done in a progressive manner, moving through the various options until an appropriate mitigation option is found.

7.1 Coastal Adaptation Approach

The potential future movement of the shoreline and the risks posed from coastal hazards necessitates the requirement for coastal adaptation and risk mitigation planning. The City's LPP4.21 provides guidance in this regard, requiring foreshore car parks to be located on or landward of the 50 year planning horizon coastal hazard line (2070 line). Furthermore, it is noted that beach access paths should be provided and that Surf Life Saving outposts can also be provided, but these should be of a temporary nature. The spatial provision of land adjacent to the carpark therefore fulfils the requirements for the provision of this temporary outpost, however the provision of toilets or change rooms is not directly supported by LPP4.21 for a local beach. This issue can be reviewed if and when the provision of a toilet block or change rooms is completed in the future.

The location of the proposed coastal access infrastructure meets the requirements of LP4.21. The higher value, and potentially more rigid assets such as the car park, coastal access road and land area for the SLS outpost and/or toilet block and change rooms, **avoid** the risk of coastal hazards over the relevant planning horizon to 2070. Beyond this timeframe, if the shoreline has experienced erosion that is consistent with the allowance made in the coastal hazard assessment, then a **planned or managed retreat** of the infrastructure could be completed to prevent an increase in exposure to coastal hazard risk as outlined in Section 6. This would involve removal and remediation of the site of the existing infrastructure and reconstruction of the infrastructure in a more landward location.

The infrastructure could be retreated to an area landward of the 2120 coastal hazard line to help ensure serviceability for a further 50 year planning horizon. A logical area exists for the retreat of this infrastructure on the southern side of the access road, as shown in Figure 7.2. This area is relatively flat, which would limit any potential future earthworks requirements, reducing the extent of impact on the surrounding environment. As a further means of reducing the impact on the environment, the new beach access track could be located along the alignment of the previous extension of the coastal access road.

The beach access track, whilst assessed as a low overall risk given its low value, will be impacted by changes to the coastline. Management and maintenance of this track will need to be completed over its lifetime to **accommodate** these changes. To assist in this accommodation, it is recommended that the limestone path be terminated a distance of 5 to 10 m behind the front face of the dunes and at an appropriately low level. Termination of the limestone path behind the dunes allows for a degree of shoreline change without loss of the path itself and without the limestone being spread over the beach – which is considered a poor outcome in terms of the aesthetics of the beach. Access to the beach over the 5 to 10 m beyond the termination of the path should be provided over a graded sand track.

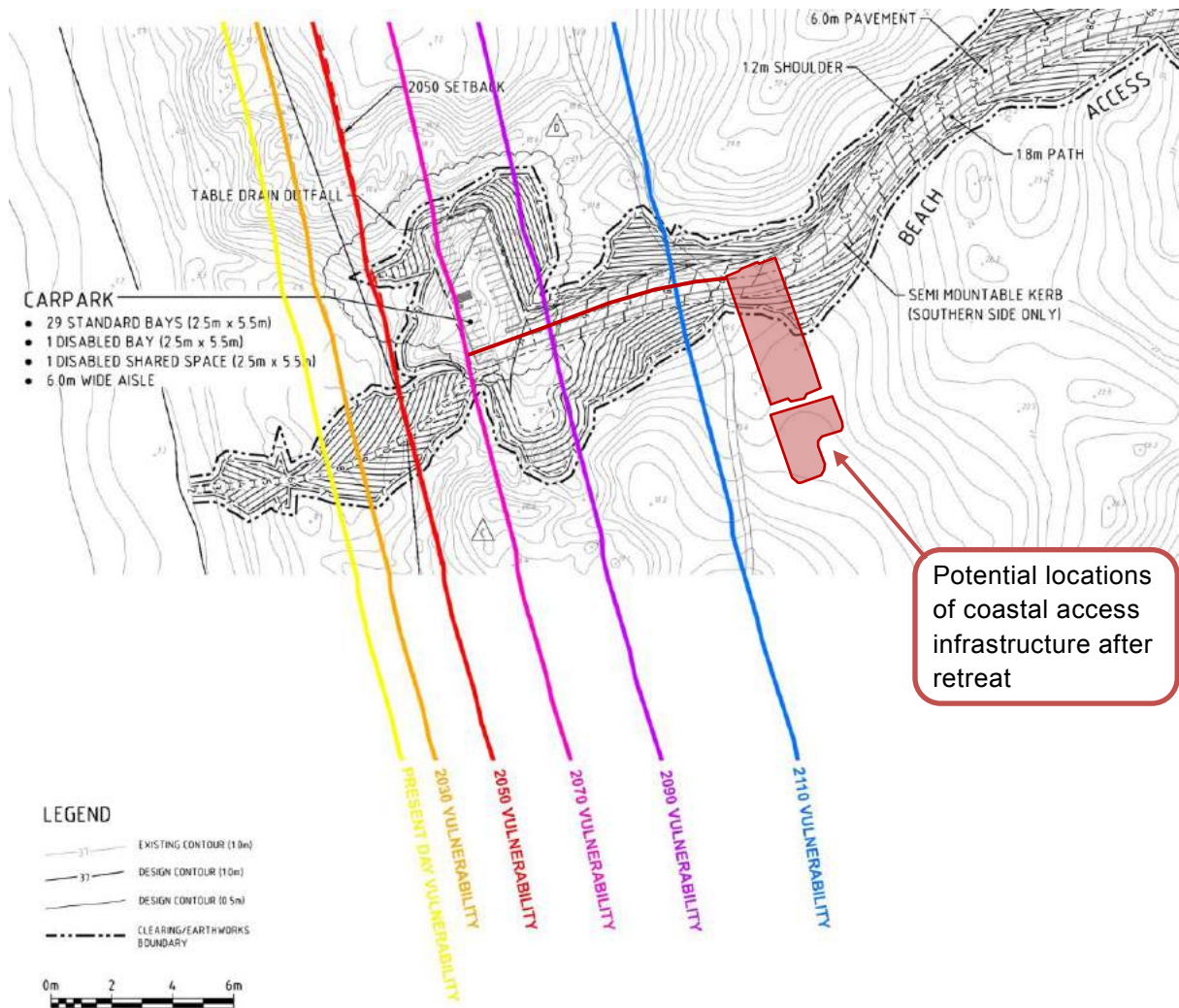


Figure 7.2 Proposed retreat location for coastal access infrastructure

It should be noted that the timeframes for coastal hazard risk exposure, based on the coastal hazard assessment, are far from certain given the complexity of the coastal system and the relatively large degree of unknowns regarding climate change and its impact on sea levels and subsequent coastal response. Therefore, whilst adaptation planning should be guided by the timeframes outlined within this report, the actual timing of coastal adaptation and management should be informed by a coastal monitoring program. This coastal monitoring program should track the movement of the coastline, with adaptation strategies enacted if and when the shoreline recedes to the extent that infrastructure could become vulnerable.

Based on a review of the coastal hazard assessment results, the vulnerability of the car park, access road and land area for the SLS outpost and/or toilet block and change rooms could be vulnerable to impact by severe storms if the shoreline erodes to within 52 m (the S1 allowance) of the landward edge of the infrastructure. Therefore a distance of 52 m should be used as a trigger value to prompt further review and potentially a decision regarding the retreat of the infrastructure. This means that if the shoreline erodes as a result of chronic erosion trends (i.e. not severe storm erosion) to within 52 m of the infrastructure then more detailed monitoring or adaptation should be completed. If the shoreline erodes to within 52 m of the infrastructure due to the impacts of severe storm erosion then the area should be monitored to assess the infrastructure vulnerability as the beach recovers from the storm impact.

The City's CHRMAP (Cardno, 2018) proposes a monitoring program be established for this section of coastline by 2030. The monitoring program is proposed to assess the extent of erosion adjacent to the PEC, however this monitoring would also capture changes relevant for the management of this coastal access infrastructure. Therefore, any monitoring plan that is developed for the PEC should also be appropriate to assess the vulnerability of the proposed coastal access infrastructure.

Implementation of this adaptation strategy would help to preserve coastal access in this region through to at least 2120, as required by SPP2.6.

8. Implementation Plan

The risk mitigation and adaptation strategies outlined in Section 7 set out the general proposed coastal management approach for the coastal access infrastructure. Direct guidance on when, what, how and by who these processes will be completed is provided within this Implementation Plan. For ease of reference, these details have been broken down to outline the requirements for each stage of the project and/or asset life.

8.1 Planning & Initial Construction

Coastal planning for this development involves mitigating against coastal hazard risks from erosion and inundation. The sole responsibility for any coastal hazard risks at the site is something that has been acknowledged and accepted by the proponent.

A summary of the requirements of the planning and construction stage is presented in Table 8.1.

Table 8.1 Implementation Plan – Planning & Initial Construction Stage

Requirement	Timing	Responsibility
Acceptance of hazards/vulnerability	Planning Stage	Proponent & City of Wanneroo
Appropriately locating the coastal access infrastructure to ensure that erosion and inundation risks are managed as best as possible	Planning & Construction Stage	Proponent (supported by engaged design team)

8.2 Operation Over the Infrastructure Service Life

Over the service lives of the proposed assets, there will be a requirement to monitor the shoreline to ascertain whether coastal risks to assets are increasing. As outlined previously, monitoring for these assets should be covered by monitoring proposed within the City’s CHRMAP (Cardno, 2018). There will also be a requirement to maintain the beach access track following changes to the shoreline. This monitoring and maintenance will be responsibility of the City.

If, at some stage during the service life of an asset, the risks from coastal hazards become intolerable, the relevant assets will be relocated in accordance with the managed retreat adaptation strategy.

A summary of the requirements during the operation of the assets over their service life is presented in Table 8.2.

Table 8.2 Implementation Plan – Operation Over Infrastructure Service Life

Requirement	Timing	Responsibility
Monitoring coastal hazard risk to assess if risks become intolerable and assets need to be retreated	Operation over service life	City of Wanneroo
Maintenance of the beach access path following shoreline change.	Operation over service life	City of Wanneroo
IF REQUIRED Asset relocation/retreat in accordance with the requirements outlined in Section 8.3	If risks to assets are intolerable	City of Wanneroo

8.3 Retreat of Assets

Retreat of assets after their service life requires that they be located in an area where the risk to that asset over its remaining service life is considered to be acceptable. A location for the relocation of the assets was proposed in Section 7.

A summary of the requirements during the replacement of assets is presented in Table 8.3.

Table 8.3 Implementation Plan – Retreat of Assets

Requirement	Timing	Responsibility
Retreat assets to new location at the end of their service life	End of service life (2070)	City of Wanneroo

9. Conclusions

This CHRMAP has been completed to provide guidance on the level of coastal risk and required adaptation and management actions associated with the proposed coastal access infrastructure for Catalina Estate. It has been completed in line with the recommendations of SPP2.6 and WAPC (2014), using previous investigations and studies including the City's CHRMAP (Cardno, 2018).

The siting of the proposed coastal access infrastructure is in accordance with the requirements of the City's Local Planning Policy 4.21 and clear and logical adaptation strategies exist for the proposed infrastructure.

10. References

Cardno 2018. *City of Wanneroo - Coastal Hazard Risk Management and Adaptation Plan*. Document Reference 59916812 Rev 1. Prepared for the City of Wanneroo.

Coterra Environment 2018. *Catalina Estate Coastal Access Infrastructure – Foreshore Management Plan*. Document reference SATCAT18 Revision 4.

City of Wanneroo 2016. *LPP 4.21: Coastal Assets Policy, Local Planning Policy 4.21*. City of Wanneroo.

MRA 2015. *Coastal Vulnerability Study & Hazard Mapping – CHRMAP Part 1*. Prepared for City of Wanneroo.

WAPC 2013, *SPP 2.6: State Coastal Planning Policy*. Planning and Development Act 2005.

WAPC 2014. *Coastal Hazard Risk Management and Adaptation Planning Guidelines*. Government of Western Australia, Perth.

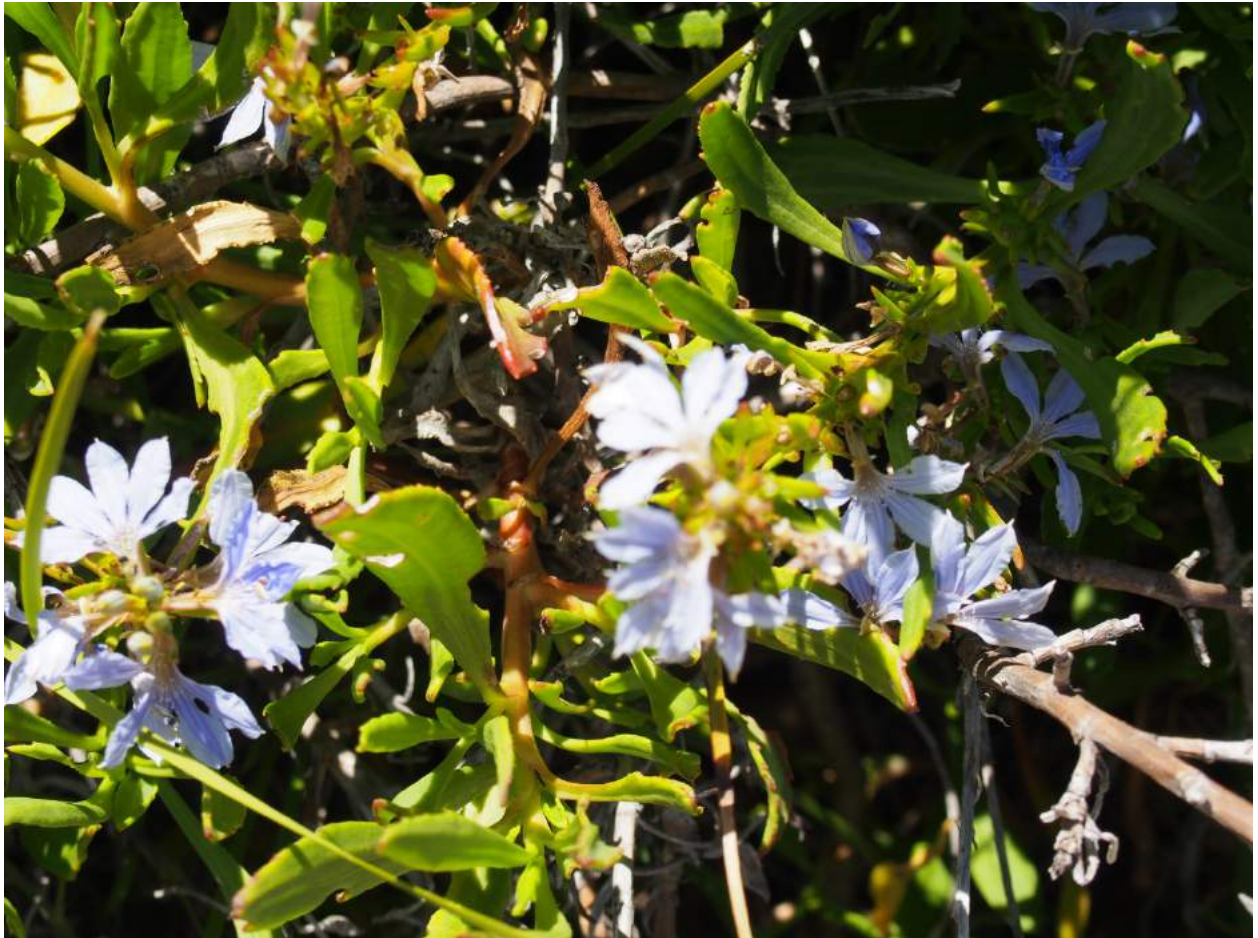
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APPENDIX C – LEVEL 2 FLORA AND VEGETATION SURVEY (BEC, 2016)

Botanical Assessment of Proposed Access Roads from Catalina to the Beach



Prepared for:

Coterra Environment
Level 3,
25 Prowse Street,
West Perth WA 6005

Prepared by:

Bennett Environmental Consulting Pty Ltd



PO Box 341
KALAMUNDA 6926
November 2016

STATEMENT OF LIMITATIONS

Scope of Services

This report (“the report”) has been prepared in accordance with the scope of services set out in the contract, or as otherwise agreed, between the Client and Eleanor Bennett (“the Author”). In some circumstances a range of factors such as time, budget, access and/or site disturbance constraints may have limited the scope of services.

Reliance on Data

In preparing the report, the Author has relied upon data, surveys, analyses, designs, plans and other information provided by the Client and other individuals and organisations, most of which are referred to in the report (“the data”). Except as otherwise stated in the report, the Author has not verified the accuracy or completeness of the data. To the extent that the statements, opinions, facts, information, conclusions and/or recommendations in the report (“conclusions”) are based in whole or part on the data, those conclusions are contingent upon the accuracy and completeness of the data. The Author will not be liable in relation to incorrect conclusions should any data, information or condition be incorrect or have been concealed, withheld, misrepresented or otherwise not fully disclosed to the Author.

Environmental Conclusions

In accordance with the scope of services, the Author has relied upon the data and has conducted environmental field monitoring and/or testing in the preparation of the report. The nature and extent of monitoring and/or testing conducted is described in the report.

The conclusions are based upon field data and the environmental monitoring and/or testing carried out over a limited period of time and are therefore merely indicative of the environmental condition of the site at the time of preparing the report. Also it should be recognised that site conditions, can change with time.

Within the limitations imposed by the scope of services, the field assessment and preparation of this report have been undertaken and performed in a professional manner, in accordance with generally accepted practices and using a degree of skill and care ordinarily exercised by reputable environmental consultants under similar circumstances. No other warranty, expressed or implied, is made.

Report for Benefit of Client

The report has been prepared for the benefit of the Client and no other party. The Author assumes no responsibility and will not be liable to any other person or organisation for or in relation to any matter dealt with or conclusions expressed in the report, or for any loss or damage suffered by any other person or organisation arising from matters dealt with or conclusions expressed in the report (including without limitation matters arising from any negligent act or omission of the Author or for any loss or damage suffered by any other party relying upon the matters dealt with or conclusions expressed in the report). Other parties should not rely upon the report or the accuracy or completeness of any conclusions and should make their own enquiries and obtain independent advice in relation to such matters.

Other Limitations

The Author will not be liable to update or revise the report to take into account any events or emergent circumstances or facts occurring or becoming apparent after the date of the report. The scope of services did not include any assessment of the title to or ownership of the properties, buildings and structures referred to in the report nor the application or interpretation of laws in the jurisdiction in which those properties, buildings and structures are located.

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SUMMARY

Bennett Environmental Consulting Pty Ltd undertook a Level 2 botanical survey of two proposed access roads from the new development at Catalina through remnant bushland to the beach. Some sections of the proposed roads were common, namely the eastern end where it commences at the edge of the housing development and the western end where there is a car park proposed. It is proposed to make a hard surface road with a car park close to the beach where it bifurcates the southern survey area was through remnant bushland and the northern section was along a current off road track.

Four different vegetation units recorded from the survey area. These were:

1. Open Heath of *Melaleuca cardiophylla* over Very Open Grassland dominated by **Ehrharta longiflora* over Herbland dominated by **Raphanus raphanistrum*, **Crassula glomerata* and **Petrohragia dubia* over Sedgeland dominated by *Lomandra maritima* and *Desmocladius flexuosus*;
2. Tall Open Scrub of *Acacia rostellifera* and *Spyridium globulosum* over Low Shrubland of *Melaleuca systena* over Open Grassland dominated by **Ehrharta longiflora* over Open Herbland dominated by **Lysimachia arvensis* over Very Open Sedgeland of *Lomandra maritima* and *Desmocladius flexuosus*;
3. Shrubland of *Acacia rostellifera* over Low Shrubland dominated by *Rhagodia baccata* subsp. *dioica* and *Scaevola crassifolia* over Very Open Grassland dominated by **Ehrharta longiflora* over Open Herbland dominated by *Acanthocarpus preissii*, **Crassula glomerata* and **Trachyandra divaricata* over Sedgeland of *Lepidosperma gladiatum*; and
4. Low Open Shrubland of *Olearia axillaris*, *Scaevola crassifolia*, **Pelargonium capitatum* and *Rhagodia baccata* subsp. *dioica* over Grassland dominated by *Spinifex longifolius* over Very Open Herbland dominated by **Trachyandra divaricata*.

The vegetation condition varied between very good and good except along the track where it was degraded. Weeds were common throughout the remnant bushland but were very dense only along the edges of the track.

A total of 31 vascular plant families, 58 genera and 68 taxa were recorded during the survey, of which 26 taxa were weeds. None of the species were threatened or priority species and none of the weeds were listed as Declared Plants.

Recommendations were made on the construction of the tracks, the hard stand near the beach, rehabilitation due to site works associated with this construction and closure and rehabilitation of other off road tracks through the area. It is important that endemic species relevant to each vegetation unit be planted, in particular *Spinifex longifolius* and *Spinifex hirsutus* in preference to Marram Grass close to the strand line and in the foredunes.

1. INTRODUCTION

1.1 Background

Bennett Environmental Consulting Pty Ltd was commissioned by Coterra Environment to undertake a Level 2 assessment of two alternate routes proposed for a hard surfaced road from the new extension of the Catalina housing development to the beach. The development at Catalina commenced in 2012 and a new section is currently being prepared for additional housing.



Diagram 1. Study area outlined in red/white lines. The white area indicates current tracks and the red line at the top right hand corner is where the current expansion will terminate.

Both of the tracks in Diagram 1 end in a rectangular area where it is proposed to construct a car park.

The survey area is included in the conservation area known as Tamala Park and managed by the Western Australian Planning Commission. The narrow coastal section is included in Bush Forever Site Number 322 – Burns Beach Bushland (Government of Western Australia, 2000). The Tamala Park Regional Council (2016) was formed in 2006 specifically to implement the urban development of the Tamala Park Project, marketed as Catalina. As part of environmental offsets, the Tamala Park Regional Council transferred 91 hectares of land, adjoining the foreshore reserve, to the Western Australian Planning Commission to form part of the future Coastal reserve from Burns Beach to Mindarie. This offset includes the study area.

1.2 Scope of Works

The requirements for this project were to:

- i. Undertake a Level 2 vegetation survey (Environmental Protection Authority and Department of Parks and Wildlife, 2015) of the proposed roads and the car parking area as indicated in Diagram 2; and
- ii. Search for threatened or priority flora within the proposed development areas.

2. BACKGROUND INFORMATION

2.1 Geology and Landform

The site is included in the Quindalup unit which consists of calcareous sands occurring as beach ridges and parabolic dunes. A detailed description of the soils and landforms was undertaken for the coastal area Mindarie to Quinns Rocks (Ecoscape Australia Pty. Ltd, 2004). A typical transect from west to east through the dune system included fore dunes gradually rising to higher primary and secondary dunes further away from the coast.

Although the current study area was not included in this detailed dune analysis some soil units can be inferred. Diagram 2 is a section of this study showing Mindarie which is just north of the survey area and the dune system recorded there.

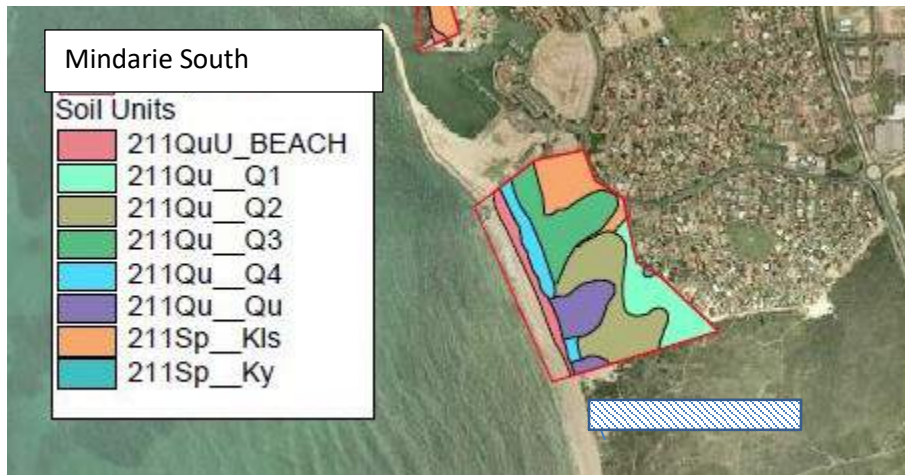


Diagram 2. Soils and Landforms described for Mindarie South including the cross hatched current study area.

From Diagram 2 it can be inferred that the current study area includes following the soil units: which are described as:

211QuU_Beach = Beach;

211Qu_Qu = Presently unstable sand;

211Qu_Q4 = the youngest Quindalup phase of irregular dunes with slopes up to 20%, consisting of loose pale brown sand with no soil profile development;

211Qu_Q2 = the second Quindalup phase consisting of a complex pattern of dunes with moderate relief. These sands have organic staining to a depth of about 20cm, passing into pale brown sand with some cementation below 1m;

211Qu_Q1 = the oldest Quindalup phase of dunes or remnants with low relief, consisting of calcareous soils with organic staining to 30cm, overlying pale brown sand with definite cementation below 1m.

2.2 Vegetation

The Interim Biogeographical Regionalisation for Australia (IBRA) (Thackway and Cresswell, 1995) recognizes 85 bioregions. The IBRA is used as the common unit to compare biological and biophysical attributes. Bioregions represent a landscape-based approach to classifying the land surface and each region is defined by a set of major environmental influences, which shape the occurrence of flora and fauna and their interaction with the physical environment. The site occurs in the Swan Coastal Plain, which has been subdivided into the northern section and the southern section. The study area is located in the southern section, abbreviated SWA2 (Mitchell, Williams and Desmond, 2002).

Prior to the above classification Beard (1981) classified the vegetation of Western Australia. Western Australia was divided into three main Botanical Provinces, Southwest, Eremaean and Northern. The

survey area occurs in the Southwest Botanical Province Beard (1990). Beard (1981) described the vegetation of the site as Coastal Heath and Thicket.

Heddlé *et al.* (1980) described the vegetation complexes of the Darling System at a scale of 1:250 000. There was found to be a distinct pattern of plant distribution linked to landforms, soils and climate. The most obvious trend was associated with increasing aridity from west to east on the Darling Plateau. The vegetation changes observed were a decrease in height and percentage cover of the tallest stratum and a distinct change in floristics. The site occurs within the Quindalup Vegetation Complex which is restricted to the coastal dunes. The Quindalup Complex consists of two alliances - the strand and fore dune alliance and the mobile and stable dune alliance. The vegetation differs in the species composition from one area to another because of differences in the dune environment due to edaphic and topographical factors and shelter from salt laden winds.

Bush Forever (Government of Western Australia, 2000) states that 48% of the Quindalup Complex remained vegetated within the Swan Coastal Plain in 2000. The area proposed for protection is 20%.

2.3 Threatened Ecological Communities

An ecological community is a naturally occurring biological assemblage that occurs in a particular type of habitat. A Threatened Ecological Community is one which falls into one of the following categories, presumed totally destroyed, critically endangered, endangered or vulnerable (Department of Parks and Wildlife, 2016b).

A restricted ecological community which does not meet the criteria for a Threatened Ecological Community is added to the Priority Ecological Community List. Priorities 1, 2, and 3 are adequately known but are not currently believed to be threatened. Those that have recently been removed from the threatened list are listed as Priority 4. Conservation dependent ecological communities are placed in Priority 5.

The Department of Parks and Wildlife (2016b) lists Threatened and Priority Ecological Communities recorded for Western Australia but none were listed as occurring in the study area.

2.4 Significant Flora

Prior to undertaking the field work a search was undertaken of NatureMap (Department of Parks and Wildlife, 2016d) for a 5 km buffer from the centre at 115° 42' 26" E, 31° 42' 06"S. This search resulted in the species listed in Table 2.

Table 1. Code and description of Threatened and Priority Flora (Government Gazette of WA (2015) with the threatened species split into their IUCN (2015) categories

Code	Declared Rare and Priority Flora Categories
T	T (Threatened) -Extant Taxa. Taxa, which have been adequately searched for and are deemed to be in the wild either rare, in danger of extinction, or otherwise in need of special protection. This category is further subdivided: CE: Flora that are considered likely to become extinct or rare, as critically endangered flora. E: Flora that are considered likely to become extinct or rare, as endangered flora. V: Flora that are considered likely to become extinct or rare, as vulnerable flora.
X	DRF (Declared Rare Flora) -Presumed Extinct Taxa. Taxa which have not been collected, or otherwise verified, over the past 50 years despite thorough searching, or of which all known wild populations have been destroyed more recently.
1	Priority One -Poorly Known Taxa. Taxa, which are known from one or a few (generally <5) populations, which are under threat.
2	Priority Two -Poorly Known Taxa. Taxa which are known from one or a few (generally <5) populations, at least some of which are not believed to be under immediate threat.
3	Priority Three -Poorly Known Taxa. Taxa, which are known from several populations, at least some of which are not believed to be under immediate threat.
4	Priority Four -Rare Taxa. Taxa which are considered to have been adequately surveyed and which whilst being rare, are not currently threatened by any identifiable factors.

Table 1 presents the definitions of Declared Rare and the four Priority Flora ratings under the Wildlife Conservation Act (1950) as extracted from Government Gazette of WA (2015).

Table 2. Threatened and Priority Flora Species List recorded in the selected area with W.A. Government Gazette Threatened Flora code and categories and Priority Flora code and categories listed by the Department of Parks and Wildlife (2016a). Description extracted from FloraBase (Western Australian Herbarium, 2016)

Taxon	Code	Description
Threatened Flora		
<i>Eucalyptus argutifolia</i>	V	(Mallee), 1.5-4 m high, bark smooth. Fl. white, Mar to Apr. Shallow soils over limestone. Slopes or gullies of limestone ridges, outcrops.
<i>Marianthus paralius</i>	CE	Almost prostrate, eventually scandent, woody shrub. Fl. red, Sep to Nov. White sand over limestone. Low coastal cliffs.
Priority Flora		
<i>Acacia benthamii</i>	P2	Shrub, ca 1 m high. Fl. yellow, Aug to Sep. Sand. Typically on limestone breakaways.
<i>Fabronia hampeana</i>	P2	Moss commonly on <i>Macrozamia riedlei</i> trunks.
<i>Lecania turicensis</i> var. <i>turicensis</i>	P2	Lichen
<i>Tetralia</i> sp. Chandala (G.J. Keighery 17055)	P2	No description provided.
<i>Conostylis bracteata</i>	P3	Rhizomatous, tufted or shortly proliferous perennial, grass-like or herb, 0.2-0.45 m high. Fl. yellow, Aug to Sep. Sand, limestone. Consolidated sand dunes.
<i>Hibbertia spicata</i> subsp. <i>leptotheca</i>	P3	Erect or spreading shrub, 0.2-0.5 m high. Fl. yellow, Jul to Oct. Sand. Near-coastal limestone ridges, outcrops & cliffs.
<i>Jacksonia gracillima</i>	P3	No description provided.
<i>Pimelea calcicola</i>	P3	Erect to spreading shrub, 0.2-1 m high. Fl. pink, Sep to Nov. Sand. Coastal limestone ridges.
<i>Sarcozona bicarinata</i>	P3	Shrub, ca 0.1 m high. Fl. white, Aug. White sand.
<i>Jacksonia sericea</i>	P4	Low spreading shrub, to 0.6 m high. Fl. orange, usually Dec or Jan to Feb. Calcareous & sandy soils.

3. METHOD

The site was surveyed using the method set out in the Environmental Protection Authority and Department of Parks and Wildlife (2016). The two proposed roads were walked to ensure a record was made of each vegetation unit, their associated species and any additional species (opportunistic species) recorded outside of the quadrat but within the same vegetation unit. Where a vegetation unit was recorded a temporary 10m x 10m quadrat was set up using a compass and oriented due N,S,E,W. Quadrats were placed to record the variation in the vegetation and associated species. The location of the quadrats is shown in Appendix D Map 1. All species, including weeds were recorded. The vegetation, flora, Threatened and Priority Flora surveys were conducted concurrently. For each quadrat, the following were recorded in the field:

- GPS reading (WGS84, equivalent to Geocentric Datum of Australia 1994 (GDA94)) at NW corner;
- Digital photograph taken at the NW corner;
- Soil type;
- Presence, size and type of any outcropping rocks;
- Topography – eg. ridge, upper slope, middle slope, lower slope, drainage line, minor creek, major creek, wetland;
- Vegetation condition using the scale of Keighery (1994) outlined in Table 5;
- Presence of any Threatened or Priority Flora or other significant flora;
- Additional information including dieback, age since fire, predators, erosion, weeds, grazing, tracks etc.; and
- All species were listed together with their percentage cover within the quadrat and average height.

The area outside of each quadrat was also surveyed to record additional (opportunistic) species for that vegetation unit.

The vegetation units recorded at the site are described using the vegetation classification in Bush Forever (from Government of Western Australia, 2000) as described in Table 3 and the vegetation condition (from Keighery, 1994) as in Table. 4.

Table 3. Vegetation Classification (from Government of Western Australia, 2000)

LIFE FORM / HEIGHT CLASS	Canopy Cover			
	DENSE 70 % - 100%	MID DENSE 30% - 70%	SPARSE 10% - 30%	VERY SPARSE 2% - 10%
Trees over 30 m	Tall Closed Forest	Tall Open Forest	Tall Woodland	Tall Open Woodland
Trees 10 – 30 m	Closed Forest	Open Forest	Woodland	Open Woodland
Trees under 10m	Low Closed Forest	Low Open Forest	Low Woodland	Low Open Woodland
Tree Mallee	Closed Tree Mallee	Tree Mallee	Open Tree Mallee	Very Open Tree Mallee
Shrub Mallee	Closed Shrub Mallee	Shrub Mallee	Open Shrub Mallee	Very Open Shrub Mallee
Shrubs over 2 m	Closed Tall Scrub	Tall Open Scrub	Tall Shrubland	Tall Open Shrubland
Shrubs 1 – 2 m	Closed Heath	Open Heath	Shrubland	Open Shrubland
Shrubs under 1m	Closed Low Heath	Open Low Heath	Low Shrubland	Low Open Shrubland
Grasses	Closed Grassland	Grassland	Open Grassland	Very Open Grassland
Herbs	Closed Herbland	Herbland	Open Herbland	Very Open Herbland
Sedges	Closed Sedgeland	Sedgeland	Open Sedgeland	Very Open Sedgeland

Table 4. Explanation of Vegetation Condition Rating (Keighery, 1994)

Rating	Description	Explanation
1	Pristine	Pristine or nearly so, no obvious signs of disturbance.
2	Excellent	Vegetation structure intact, disturbance affecting individual species and weeds are non-aggressive species.
3	Very Good	Vegetation structure altered, obvious signs of disturbance.
4	Good	Vegetation structure significantly altered by very obvious signs of multiple disturbances. Retains basic vegetation structure or ability to regenerate it.
5	Degraded	Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching good condition without intensive management.
6	Completely Degraded	The structure of the vegetation is no longer intact and the area is completely or almost completely without native species.

4. RESULTS

A botanical survey was undertaken on 17th November 2016 when transects were walked within the proposed roads. Prior to undertaking the field work an overlay on an aerial photograph of the track options was provided on the aerial of the site together with the easting and northing. To ensure the transects walked and the quadrats established were within the proposed development areas, way points were entered into the GPS to be used in the field. This enabled walking from one of the way points to the next ensuring that the transects walked were within the proposed area of disturbance.

By referring to Diagram 1 it can be seen that there is one road nominated from the current development site for a distance before it bifurcates, resulting in two possible road alignments which remain separated but both lead to the same larger area proposed as a car park

A total of four quadrats were surveyed. The locations of these are mapped in Appendix D Map 1, and a full description for each quadrat is provided in Appendix B.

4.1 Vegetation

There were four different vegetation units recorded from the survey area. These were:

1. Open Heath of *Melaleuca cardiophylla* over Very Open Grassland dominated by **Ehrharta longiflora* over Herbland dominated by **Raphanus raphanistrum*, **Crassula glomerata* and **Petrohragia dubia* over Sedgeland dominated by *Lomandra maritima* and *Desmocladius flexuosus*. This was represented by quadrat caq1;
2. Tall Open Scrub of *Acacia rostellifera* and *Spyridium globulosum* over Low Shrubland of *Melaleuca systena* over Open Grassland dominated by **Ehrharta longiflora* over Open Herbland dominated by **Lysimachia arvensis* over Very Open Sedgeland of *Lomandra maritima* and *Desmocladius flexuosus*. This was represented by quadrat caq2;
3. Shrubland of *Acacia rostellifera* over Low Shrubland dominated by *Rhagodia baccata* subsp. *dioica* and *Scaevola crassifolia* over Very Open Grassland dominated by **Ehrharta longiflora* over Open Herbland dominated by *Acanthocarpus preissii*, **Crassula glomerata* and **Trachyandra divaricata* over Sedgeland of *Lepidosperma gladiatum*. This was represented by quadrat caq3; and
4. Low Open Shrubland of *Olearia axillaris*, *Scaevola crassifolia*, **Pelargonium capitatum* and *Rhagodia baccata* subsp. *dioica* over Grassland dominated by *Spinifex longifolius* over Very Open Herbland dominated by **Trachyandra divaricata*. This was represented by quadrat caq4.

The vegetation units are mapped in Appendix D, Map 2. The vegetation changed from the east (quadrat caq1), then further west to quadrat caq2, then quadrat caq3 and near the beach to quadrat caq4. This change was gradual with an overlap of some species. Just above the strand line there was an area up to 5m wide where Marram Grass (**Ammophila arenaria*) was established in amongst the endemic grass *Spinifex longifolius*. The Marram Grass plants were all relatively young so it was uncertain if they had been planted or if rhizomes had come down on the current from Mindarie. Marram Grass has been used a lot to stabilize dunes but it is a weed which has the ability to change the ecosystem of the dunes it invades.

4.2 Vegetation Condition

Bushland has been historically subject to ongoing degradation and is especially susceptible to disturbances arising as a result of indirect impacts from surrounding developments and human activity. Degradation is caused by a wide range of factors, including isolation, edge effects, weed invasion, plant diseases, changes in fire frequency, landscape fragmentation, increased predation on native fauna by feral animals, decrease in species richness and general modification of ecological function. These issues affect the biodiversity rating and ecological viability of areas of remnant vegetation and should be assessed in line with conservation values.

Vegetation condition was rated according to the vegetation condition scale used in Keighery (1994). Table 4 provides the vegetation condition rating and Table 5 the vegetation condition of each of the quadrats.

Table 5. Vegetation Condition Recorded from the quadrats surveyed

Vegetation Condition	Quadrat Number
Very good	caq3
Very good to good	caq1, caq4
Good	caq2
Good to degraded	Some sections in the area of caq4
Degraded	Track through part of northern route

It can be seen from Table 5 that most of the vegetation was in good or better condition. The only area which was degraded was the along the off road vehicle track. The vegetation condition is mapped in Appendix D Map 3.

4.3 Taxa

A total of 31 vascular plant families, 58 genera and 68 taxa were recorded during the survey. All species observed are listed under vascular plant families in Appendix A.

4.4 Significant Taxa

No threatened or priority species were located during the survey.

4.5 Weeds

A total of 26 weeds were recorded from the survey area. All have been determined as weeds by the Western Australian Herbarium (2016) and Department of Parks and Wildlife (2016c). There are several ratings allocated to each weed in the Invasive Plant Prioritisation but only three have been selected to include in this report. These are ecological impacts, invasiveness and current distribution which are shown in Table 8 for each of the non-endemic species recorded. Thirteen of the weeds recorded have a high ecological impact on the natural vegetation.

Weeds that are, or may, become, a problem to agriculture or the environment can be formally classified as Declared Plants under the *Agriculture and Related Resources Protection Act, 1976* (Department of Agriculture and Food, 2016). The Department of Agriculture and Food Western Australia and the Agriculture Protection Board maintain a list of Declared Plants for Western Australia. None of the weeds listed in Table 6 are Declared Plants.

Table 6. Weeds Recorded From the Site

Species	Common Name	Ecological Impacts	Invasiveness	Current Distribution
		Ecological impact L = low impact species M = medium impact species H=high impact species U = unknown impact	Rate of dispersal R=rapid M=moderate S=slow U=unknown	L = limited (localised) M = moderate H = high E = extensive (widespread) U =unknown
* <i>Ammophila arenaria</i>	Marram Grass	U	S	L
* <i>Avena barbata</i>	Bearded Grass	H	R	E
* <i>Briza maxima</i>	Blowfly Grass	U	R	E
* <i>Bromus diandrus</i>	Great Brome	H	R	E
* <i>Crassula glomerata</i>	Stonecrop	U	R	E
* <i>Cuscuta epithymum</i>	Lesser Dodder	M	M	E
* <i>Ehrharta calycina</i>	Perennial Veldt Grass	H	R	E
* <i>Ehrharta longiflora</i>	Annual Veldt Grass	H	R	E
* <i>Euphorbia terracina</i>	Geraldton Carnation Weed	H	R	H
* <i>Heliophila pusilla</i>	Heliophila	H	M	H
* <i>Hordeum leporinum</i>	Barley Grass	H	U	E
* <i>Lactuca serriola</i>	Prickly Lettuce	H	R	H
* <i>Lagurus ovatus</i>	Hare's Tail Grass	H	R	E
* <i>Lolium loliaceum</i>	Stiff Rye Grass	H	R	E
* <i>Lysimachia arvensis</i>	Pimpernel	U	R	E
* <i>Oenothera glazioviana</i>	Evening Primrose	L	M	H
* <i>Pelargonium capitatum</i>	Rose Pelargonium	H	R	E
* <i>Petrorhagia dubia</i>	Velvet Pink	M	R	E
* <i>Raphanus raphanistrum</i>	Wild Radish	U	M	M
* <i>Romulea rosea</i>	Guildford Grass	U	R	E
* <i>Silene gallica</i>	French Catchfly	L	M	E
* <i>Sonchus oleraceus</i>	Common Sowthistle	U	R	E
* <i>Tetragona decumbens</i>	Sea Spinach	H	R	E
* <i>Trachyandra divaricata</i>	Dune Onion Weed	M	R	H
* <i>Urospermum picroides</i>	False Hawkbit	M	R	M
* <i>Vulpia myuros</i>	Rat's Tail Fescue	H	R	H

Thirteen of the weeds listed above are recorded as having a high impact on the environment. The most common weeds listed as having a high impact throughout the site were **Avena barbata*, **Ehrharta longiflora*, **Euphorbia terracina*, **Lagurus ovatus* and **Pelargonium capitatum*.

4.6 Rehabilitation

With the planned development of an access road rehabilitation and weed control will need to be undertaken. It is essential that all species used in rehabilitation are endemic to the particular vegetation unit. Appendix C lists all endemic species together with the quadrat they were recorded. By referring back to Section 4.1 the vegetation unit associated with each quadrat can be determined.

Four species were recorded from all vegetation units; *Acacia cyclops*, *Acanthocarpus preissii*, **Olearia axillaris* and *Spyridium globulosum*. Seed collection should commence immediately and seedlings established before any site works are undertaken. Cuttings especially of *Spinifex longifolius* and *Spinifex hirsutus* should be undertaken in the sections of the car park area proposed for disturbance. The manual prepared by the Department of Planning (2011) provides excellent examples of how to propagate species. For example “the rooted cuttings of grasses (e.g. *Spinifex hirsutus* and *Spinifex longifolius*) that grow on the seaward slope of foredunes have given good results. The roots used for cuttings must be healthy and either yellowish or white in colour and the transplant site should be well moistened”. Successes have been achieved by the methods they outline and *Spinifex* plants must be used along the strand line and foredune in preference to Marram Grass.

Marram Grass has been used a lot to stabilize dunes as it is adapted to sand accretion with the burial promoting leaf elongation and the development of rhizomes from the axillary buds. Florabase (Western Australian Herbarium, 2016) includes a comprehensive description about this species its general biology, notes and general control. In the notes section the following information is provided. “It traps sand and builds dunes at rates much greater than that of the native species, thus out competing the native species. It interferes with the natural dynamics of the dune systems. It out-competes native vegetation and interferes with the natural dynamics of dune systems, including changing topography, adversely affecting long term development of coastal barriers, inhibits transgressive dune development, increases steepness of slopes and restricts movement of sand from beach to interior dunes. Also disrupts structure and reduces diversity of dunal arthropod communities. Harbours symbiotic nitrogen-fixing bacteria within stems and rhizomes that may contribute to its proliferation on nutrient-poor sand. Seed set, viability and survival is low, however viability of buds remains high following submergence in seawater, giving the potential for long-distance vegetative dispersal to other beaches.”

The above information exemplifies why *Spinifex longifolius* and *Spinifex hirsutus* root cuttings should be propagated and used in preference to Marram Grass.

Coastal Planning and Management Manual (Department of Planning, (2011) provides a lot of information including weeds and their management and the selection of species for rehabilitation. In addition it outlines the different methods that can be used in rehabilitation including, direct seeding, use of nursery grown seedlings, seeds and required treatments to break dormancy, cuttings, division, layering as well as the different methods used for planting out. Planting and direct seeding must be undertaken with the onset of the winter rains.

4.7 Management of the Tamala Park Region

Several committees have been established that deal with the management of the coastal area from Mindarie to Burns Beach. These include:

1. The Tamala Park Regional Council (TPRC) is a local government group formed in 2006 specifically to implement the urban development of the Tamala Park Project (marketed as Catalina) with representatives from Town of Cambridge, City of Joondalup, City of Perth, City of Stirling, Town of Victoria Park, City of Vincent and City of Wanneroo. They manage the development of the Tamala Park Local Structure Plan covering residential density and associated requirements.

2. The Community Advisory Committee (set up in 2008 with representatives from the City of Wanneroo and City of Joondalup) was formed to produce a plan for the long term environmental management of the area between Burns Beach and Mindarie. This committee developed the Tamala Conservation Park plan, and includes members from a wide cross section of State and Local Government Agencies and community organisations. One of the many initiatives suggested by the committee is “that funding for comprehensive weed mapping and flora and fauna surveys be provided as a matter of priority for interim management of the area” – which is endorsed by author of tis current survey.
3. In March 2012 a Tamala Conservation Park was proposed and an establishment plan prepared (Western Australian Planning Commission, 2012). The area under consideration is outlined below in Diagram 3 and it can be seen that it includes the current survey area. This was proposed to be managed by the Department of Environment and Conservation (now Department of Parks and Wildlife). The Establishment Plan did not include a timetable for creation of the Conservation Park as it is understand that part of the land covered remains in private ownership. The Tamala Conservation Park has three broad zones of usage, conservation and protection, natural environmental use and recreational use (Western Australian Planning Commission, 2012). With conservation and protection the primary management concern is to ensure no further disturbance to the bushland ensuring that public access is restricted and only via walk paths. Access to the beach has been poorly managed with off road vehicle tracks crossing the bushland.



Diagram 3. Area outlined in red proposed as Tamala Conservation Park.

5. DISCUSSION

The proposed access roads were through remnant bushland with a section of the northern alternative route along an existing off road track. Four different vegetation units were recorded from the survey area. These were:

- 1 Open Heath of *Melaleuca cardiophylla* over Very Open Grassland dominated by **Ehrharta longiflora* over Herbland dominated by **Raphanus raphanistrum*, **Crassula glomerata* and **Petrorhagia dubia* over Sedgeland dominated by *Lomandra maritima* and *Desmocladius flexuosus*;
- 2 Tall Open Scrub of *Acacia rostellifera* and *Spyridium globulosum* over Low Shrubland of *Melaleuca systena* over Open Grassland dominated by **Ehrharta longiflora* over Open Herbland dominated by **Lysimachia arvensis* over Very Open Sedgeland of *Lomandra maritima* and *Desmocladius flexuosus*;
- 3 Shrubland of *Acacia rostellifera* over Low Shrubland dominated by *Rhagodia baccata* subsp. *dioica* and *Scaevola crassifolia* over Very Open Grassland dominated by **Ehrharta longiflora* over Open Herbland dominated by *Acanthocarpus preissii*, **Crassula glomerata* and **Trachyandra divaricata* over Sedgeland of *Lepidosperma gladiatum*; and
4. Low Open Shrubland of *Olearia axillaris*, *Scaevola crassifolia*, **Pelargonium capitatum* and *Rhagodia baccata* subsp. *dioica* over Grassland dominated by *Spinifex longifolius* over Very Open Herbland dominated by **Trachyandra divaricata*.

The vegetation condition varied between very good and good except along the track where it was degraded. Weeds were common throughout the remnant bushland but were very dense along the edges of the track.

A total of 31 vascular plant families, 58 genera and 68 taxa were recorded during the survey, of which 26 taxa were weeds. None of the species were threatened or priority species and none of the weeds were listed as Declared Plants.

Marram grass (**Ammophila arenaria*) was established in amongst *Spinifex longifolius* plants above the strand. The Marram plants were all relatively young so it was uncertain if they had been planted or if they had established from rhizomes which had come down on the current from Mindarie.



Photograph of Marram Grass established above the strand line.

It is important that native species in particular *Spinifex longifolius* and *Spinifex hirsutus* be planted in preference to Marram Grass close to the strand line and in the foredunes.

It is suggested that the northern route be the one selected as some sections of this route are already degraded. The car park area should be fenced off to ensure off road drivers do not continue across the dunes and onto the beach. A fenced off sand track path should be constructed down to the beach from the car park.

The sides of the selected road must be stabilised as both routes traverse steep sided dunes, although this is not such a concern on the northern route as a track has already cut through a section of the area. In some sections the sand may need to have a wall constructed otherwise erosion will cause the sides to collapse and cover the road which could make it impassable. The environment must be conserved. This includes the dune system as well as the vegetation. People must be discouraged from walking through the dunes as this will most likely result in the destruction of some area.

The Community Advisory Committee (set up in 2008 with representatives from the City of Wanneroo and City of Joondalup) recommended that there be fenced, hard stand access from Long Beach Promenade through the reserve to the beach but with no hard stand access through to the beach. Public access to the beach must be managed to protect the environmental values of the area.

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APPENDIX A
Species List

LEGEND

ABBREVIATION	DESCRIPTION
subsp.	subspecies
var.	variety
*	weed

Vascular Plant Family	Taxon
Aizoaceae	
	<i>Carpobrotus virescens</i>
	* <i>Tetragonia decumbens</i>
Asparagaceae	
	<i>Acanthocarpus preissii</i>
	<i>Lomandra maritima</i>
	<i>Thysanotus arenarius</i>
Asphodelaceae	
	* <i>Trachyandra divaricata</i>
Asteraceae	
	* <i>Lactuca serriola</i>
	<i>Olearia axillaris</i>
	<i>Ozothamnus cordatus</i>
	<i>Senecio pinnatifolius</i> var. <i>latilobus</i>
	* <i>Sonchus oleraceus</i>
	* <i>Urospermum picroides</i>
Brassicaceae	
	* <i>Heliophila pusilla</i>
	* <i>Raphanus raphanistrum</i>
Caryophyllaceae	
	* <i>Petrorhagia dubia</i>
	* <i>Silene gallica</i>
Chenopodiaceae	
	<i>Rhagodia baccata</i> subsp. <i>baccata</i>
	<i>Rhagodia baccata</i> subsp. <i>dioica</i>
	<i>Threlkeldia diffusa</i>
Convolvulaceae	
	* <i>Cuscuta epithymum</i>
Crassulaceae	
	<i>Crassula colorata</i>
	* <i>Crassula glomerata</i>
Cyperaceae	
	<i>Isolepis marginata</i>
	<i>Lepidosperma calcicola</i>
	<i>Lepidosperma gladiatum</i>
Ericaceae	
	<i>Leucopogon parviflorus</i>
Euphorbiaceae	
	* <i>Euphorbia terracina</i>
Fabaceae	
	<i>Acacia cyclops</i>
	<i>Acacia rostellifera</i>
	<i>Acacia saligna</i>
	<i>Gompholobium capitatum</i>
	<i>Hardenbergia comptoniana</i>
	<i>Kennedia prostrata</i>

Vascular Plant Family	Taxon
Geraniaceae	
	<i>*Pelargonium capitatum</i>
Goodeniaceae	
	<i>Scaevola crassifolia</i>
	<i>Scaevola globulifera</i>
Haemodoraceae	
	<i>Conostylis aculeata</i> subsp. <i>cygnorum</i>
	<i>Conostylis candicans</i>
Hemerocallidaceae	
	<i>Dianella revoluta</i> var. <i>divaricata</i>
Iridaceae	
	<i>*Romulea rosea</i>
Lamiaceae	
	<i>Hemiandra pungens</i>
Lauraceae	
	<i>Cassytha flava</i>
Myrtaceae	
	<i>Melaleuca cardiophylla</i>
	<i>Melaleuca systema</i>
Onagraceae	
	<i>*Oenothera glazioviana</i>
Phyllanthaceae	
	<i>Phyllanthus calycinus</i>
Poaceae	
	<i>*Ammophila arenaria</i>
	<i>Austrostipa flavescens</i>
	<i>*Avena barbata</i>
	<i>*Briza maxima</i>
	<i>*Bromus diandrus</i>
	<i>*Ehrharta calycina</i>
	<i>*Ehrharta longiflora</i>
	<i>*Hordeum leporinum</i>
	<i>*Lagurus ovatus</i>
	<i>*Lolium loliaceum</i>
	<i>Paspalum vaginatum</i>
	<i>Poa porphyroclados</i>
	<i>Spinifex hirsutus</i>
	<i>Spinifex longifolius</i>
	<i>*Vulpia myuros</i>
Polygalaceae	
	<i>Comesperma integerrimum</i>
Primulaceae	
	<i>*Lysimachia arvensis</i>
Ranunculaceae	
	<i>Clematis linearifolia</i>
Restionaceae	
	<i>Desmocladius flexuosus</i>

Vascular Plant Family	Taxon
Rhamnaceae	
	<i>Spyridium globulosum</i>
Rubiaceae	
	<i>Opercularia vaginata</i>
Santalaceae	
	<i>Exocarpos sparteus</i>

APPENDIX B

Quadrat Data

LEGEND

ABBREVIATION	DESCRIPTION
subsp.	subspecies
var.	variety
*	weed

QUADRAT caq1**GPS (WGS84):** 377775E; 6492000N**Location:** Most eastern section of the proposed road**Topography:** Upper slope to crest of sand dune**Soil:** Grey sand**Litter:** Branches 10%; Leaves 20%**Vegetation Description:** Open Heath of *Melaleuca cardiophylla* over Very Open Grassland dominated by **Ehrharta longiflora* over Herbland dominated by **Raphanus raphanistrum*, **Crassula glomerata* and **Petrorhagia dubia* over Sedgeland dominated by *Lomandra maritima* and *Desmocladius flexuosus***Vegetation Condition:** Good to very good**Notes:** Numerous weeds

SPECIES	HEIGHT (cm)	% COVER
<i>Acacia cyclops</i>	70	1
<i>Acanthocarpus preissii</i>	30	2
<i>Austrostipa flavescens</i>	90	1
* <i>Avena barbata</i>	90	5
* <i>Bromus diandrus</i>	60	<1
<i>Conostylis aculeata</i> subsp. <i>cygnorum</i>	50	12
* <i>Crassula glomerata</i>	5	15

SPECIES	HEIGHT (cm)	% COVER
<i>Desmodcladus flexuosus</i>	50	10
<i>Dianella revoluta</i> subsp. <i>divaricata</i>	70	1
* <i>Ehrharta calycina</i>	90	2
* <i>Ehrharta longiflora</i>	80	20
* <i>Euphorbia terracina</i>	70	5
<i>Hardenbergia comptoniana</i>	twiner	<1
* <i>Lagurus ovatus</i>	30	2
<i>Leucopogon parviflorus</i>	60	1
* <i>Lolium loliaceum</i>	70	<1
<i>Lomandra maritima</i>	60	50
* <i>Lysimachia arvensis</i>	20	5
<i>Melaleuca cardiophylla</i>	200	50
* <i>Petrorhagia dubia</i>	60	15
<i>Phyllanthus calycinus</i>	50	2
* <i>Raphanus raphanistrum</i>	90	20
<i>Rhagodia baccata</i> subsp. <i>baccata</i>	50	2
* <i>Silene gallica</i>	60	10
* <i>Sonchus oleraceus</i>	50	1
<i>Spyridium globulosum</i>	200	5
* <i>Urospermum picroides</i>	60	3
<i>Acacia rostellifera</i>	opportunistic	
<i>Acacia saligna</i>	opportunistic	
<i>Clematis linearifolia</i>	opportunistic	
<i>Comesperma integerrimum</i>	opportunistic	
<i>Exocarpus sparteus</i>	opportunistic	
<i>Gompholobium capitatum</i>	opportunistic	
* <i>Hordeum leporinum</i>	opportunistic	
<i>Isolepis marginata</i>	opportunistic	
<i>Kennedia prostrata</i>	opportunistic	
<i>Lepidosperma calcicola</i>	opportunistic	
<i>Melaleuca systema</i>	opportunistic	
<i>Olearia axillaris</i>	opportunistic	
* <i>Pelargonium capitatum</i>	opportunistic	
<i>Thysanotus arenarius</i>	opportunistic	

QUADRAT caq2**GPS (WGS84):** 377550E; 6491850E**Location:** Southern proposed track**Topography:** Middle slope**Soil:** Grey sand**Litter:** Branches 5%; Leaves 25%**Vegetation Description:** Tall Open Scrub of *Acacia rostellifera* and *Spyridium globulosum* over Low Shrubland of *Melaleuca systena* over Open Grassland dominated by **Ehrharta longiflora* over Open Herbland dominated by **Lysimachia arvensis* over Very Open Sedgeland of *Lomandra maritima* and *Desmocladius flexuosus***Vegetation Condition:** Good**Notes:** Very occasional *Xanthorrhoea preissii* recorded opportunistically

SPECIES	HEIGHT (cm)	% COVER
<i>Acacia rostellifera</i>	300	15
<i>Austrostipa flavescens</i>	90	2
<i>*Briza maxima</i>	50	5
<i>Clematis linearifolia</i>	twiner	2
<i>Conostylis aculeata</i> subsp. <i>cygnorum</i>	30	1
<i>*Crassula glomerata</i>	10	5
<i>Desmocladius flexuosus</i>	40	5
<i>Dianella revoluta</i> subsp. <i>divaricata</i>	70	1

SPECIES	HEIGHT (cm)	% COVER
* <i>Ehrharta calycina</i>	80	5
* <i>Ehrharta longiflora</i>	60	10
* <i>Euphorbia terracina</i>	60	5
<i>Gompholobium capitatum</i>	30	<1
* <i>Lagurus ovatus</i>	50	<1
<i>Lepidosperma calcicola</i>	50	1
* <i>Lolium loliaceum</i>	90	<1
<i>Lomandra maritima</i>	50	5
* <i>Lysimachia arvensis</i>	30	15
<i>Melaleuca systema</i>	80	10
<i>Opercularia vaginata</i>	40	<1
<i>Poa porphyroclados</i>	70	1
* <i>Romulea rosea</i>	40	<1
* <i>Sonchus oleraceus</i>	60	<1
<i>Spyridium globulosum</i>	250	40
<i>Acanthocarpus preissii</i>	opportunistic	
* <i>Bromus diandrus</i>	opportunistic	
<i>Cassytha flava</i>	opportunistic	
<i>Comesperma integerrimum</i>	opportunistic	
<i>Conostylis candicans</i>	opportunistic	
<i>Hardenbergia comptoniana</i>	opportunistic	
<i>Leucopogon parviflorus</i>	opportunistic	
<i>Olearia axillaris</i>	opportunistic	
* <i>Pelargonium capitatum</i>	opportunistic	
<i>Rhagodia baccata</i> subsp. <i>baccata</i>	opportunistic	
<i>Scaevola globulifera</i>	opportunistic	
* <i>Trachyandra divaricata</i>	opportunistic	

QUADRAT caq3

GPS (WGS84): 377425E; 6491800N

Location: Last tall dune before beach

Topography: Upper slope to crest

Soil: Pale grey sand

Litter: Leaves 20%

Vegetation Description:. Shrubland of *Acacia rostellifera* over Low Shrubland dominated by *Rhagodia baccata* subsp. *dioica* and *Scaevola crassifolia* over Very Open Grassland dominated by **Ehrharta longiflora* over Open Herbland dominated by *Acanthocarpus preissii*, **Crassula glomerata* and **Trachyandra divaricata* over Sedgeland of *Lepidosperma gladiatum*

Vegetation Condition: Very Good

Notes: Valleys between the dunes had dense cover (>75%) of *Lepidosperma gladiatum*



SPECIES	HEIGHT (cm)	% COVER
<i>Acacia rostellifera</i>	150	15
<i>Acanthocarpus preissii</i>	30	5
<i>*Bromus diandrus</i>	80	1
<i>*Crassula glomerata</i>	5	10
<i>*Ehrharta longiflora</i>	70	5
<i>Hardenbergia comptoniana</i>	twiner	<1
<i>*Lactuca serriola</i>	10	<1

SPECIES	HEIGHT (cm)	% COVER
<i>Lepidosperma gladiatum</i>	120	40
<i>Olearia axillaris</i>	70	1
* <i>Pelargonium capitatum</i>	50	1
<i>Rhagodia baccata</i> subsp. <i>dioica</i>	100	5
<i>Scaevola crassifolia</i>	80	5
<i>Senecio pinnatifolius</i> var. <i>latilobus</i>	40	1
* <i>Sonchus oleraceus</i>	70	2
* <i>Trachyandra divaricata</i>	60	5
<i>Carpobrotus virescens</i>	opportunistic	
<i>Cassutha flava</i>	opportunistic	
<i>Clematis linearifolia</i>	opportunistic	
* <i>Cuscuta epithymum</i>	opportunistic	
* <i>Heliophila pusilla</i>	opportunistic	
<i>Hemiandra pungens</i>	opportunistic	
* <i>Lagurus ovatus</i>	opportunistic	
<i>Melaleuca systema</i>	opportunistic	
<i>Ozothamnus cordatus</i>	opportunistic	
<i>Poa porphyroclados</i>	opportunistic	
<i>Scaevola globulifera</i>	opportunistic	
<i>Spyridium globulosum</i>	opportunistic	
* <i>Tetragona decumbens</i>	opportunistic	
<i>Threlkeldia diffusa</i>	opportunistic	
<i>Thysanotus arenarius</i>	opportunistic	

QUADRAT caq4**GPS (WGS84):** 377325E; 6491875N**Location:** Just back from the beach**Topography:** Fore dune**Soil:** Pale grey/white sand**Litter:** Leaves 5%**Vegetation Description:.** Low Open Shrubland of *Olearia axillaris*, *Scaevola crassifolia*, **Pelargonium capitatum* and *Rhagodia baccata* subsp. *dioica* over Grassland dominated by *Spinifex longifolius* over Very Open Herbland dominated by **Trachyandra divaricata***Vegetation Condition:** Good to very good**Notes:** Just before the drop down to the water there was a belt about 5m wide where young Marram grass (**Ammophila arenaria*) was dominant and growing between the plants of *Spinifex longifolius*. Many of the plants recorded a dense infestation of the native parasitic twiner *Cassytha flava* If the infestation is very heavy it has the capacity to kill plants

SPECIES	HEIGHT (cm)	% COVER
<i>Acanthocarpus preissii</i>	50	2
<i>*Avena barbata</i>	100	5
<i>Cassytha flava</i>	twiner	30
<i>*Crassula glomerata</i>	10	2
<i>Olearia axillaris</i>	100	3
<i>Ozothamnus cordatus</i>	40	<1

SPECIES	HEIGHT (cm)	% COVER
<i>*Pelargonium capitatum</i>	50	5
<i>Rhagodia baccata</i> subsp. <i>dioica</i>	50	2
<i>Scaevola crassifolia</i>	50	5
<i>*Sonchus oleraceus</i>	70	1
<i>Spinifex longifolius</i>	80	40
<i>*Tetragona decumbens</i>	30	1
<i>*Trachyandra divaricata</i>	60	15
<i>*Vulpia myuros</i>	15	2
<i>Acacia cyclops</i>	opportunistic	
<i>*Ammophila arenaria</i>	opportunistic	
<i>Carpobrotus virescens</i>	opportunistic	
<i>Crassula colorata</i>	opportunistic	
<i>*Oenothera glazioviana</i>	opportunistic	
<i>Paspalum vaginatum</i>	opportunistic	
<i>Spinifex hirsutus</i>	opportunistic	
<i>Spyridium globulosum</i>	opportunistic	
<i>Threlkeldia diffusa</i>	opportunistic	

APPENDIX C**Endemic species recorded from each quadrat (introduced species removed)****LEGEND**

ABBREVIATION	DESCRIPTION
subsp.	subspecies
var.	variety
*	weed
+	species recorded

ENDEMIC SPECIES	QUADRAT NUMBER			
	caq1	caq2	caq3	caq4
<i>Acacia cyclops</i>	+	+	+	+
<i>Acacia rostellifera</i>	+	+	+	
<i>Acacia saligna</i>	+			
<i>Acanthocarpus preissii</i>	+	+	+	+
<i>Ammophila arenaria</i>				+
<i>Austrostipa flavescens</i>	+	+		
<i>Carpobrotus virescens</i>			+	+
<i>Cassutha flava</i>		+	+	+
<i>Clematis linearifolia</i>	+	+	+	
<i>Comesperma integerrimum</i>	+	+		
<i>Conostylis aculeata</i> subsp. <i>cygnorum</i>	+	+		
<i>Conostylis candicans</i>		+		
* <i>Crassula glomerata</i>	+	+	+	+
<i>Desmocladius flexuosus</i>	+	+		
<i>Dianella revoluta</i> subsp. <i>divaricata</i>	+	+		
<i>Exocarpus sparteus</i>	+			
<i>Gompholobium capitatum</i>	+	+		
<i>Hardenbergia comptoniana</i>	+	+	+	
<i>Hemiandra pungens</i>			+	
<i>Isolepis marginata</i>	+			
<i>Kennedia prostrata</i>	+			
<i>Lepidosperma calcicola</i>	+	+		
<i>Lepidosperma gladiatum</i>			+	
<i>Leucopogon parviflorus</i>	+	+		
<i>Lomandra maritima</i>	+	+		
<i>Melaleuca cardiophylla</i>	+			
<i>Melaleuca systema</i>	+	+	+	
<i>Olearia axillaris</i>	+	+	+	+
<i>Opercularia vaginata</i>		+		
<i>Ozothamnus cordatus</i>			+	+
<i>Paspalum vaginatum</i>				+
<i>Phyllanthus calycinus</i>	+			
<i>Poa porphyroclados</i>		+	+	
<i>Rhagodia baccata</i> subsp. <i>baccata</i>	+	+		
<i>Rhagodia baccata</i> subsp. <i>dioica</i>			+	+
<i>Scaevola crassifolia</i>			+	+
<i>Scaevola globulifera</i>		+	+	
<i>Senecio pinnatifolius</i> var. <i>latilobus</i>			+	
<i>Spinifex hirsutus</i>				+
<i>Spinifex longifolius</i>				+

ENDEMIC SPECIES	QUADRAT NUMBER			
	caq1	caq2	caq3	caq4
<i>Spyridium globulosum</i>	+	+	+	+
<i>Threlkeldia diffusa</i>			+	
<i>Thysanotus arenarius</i>	+		+	

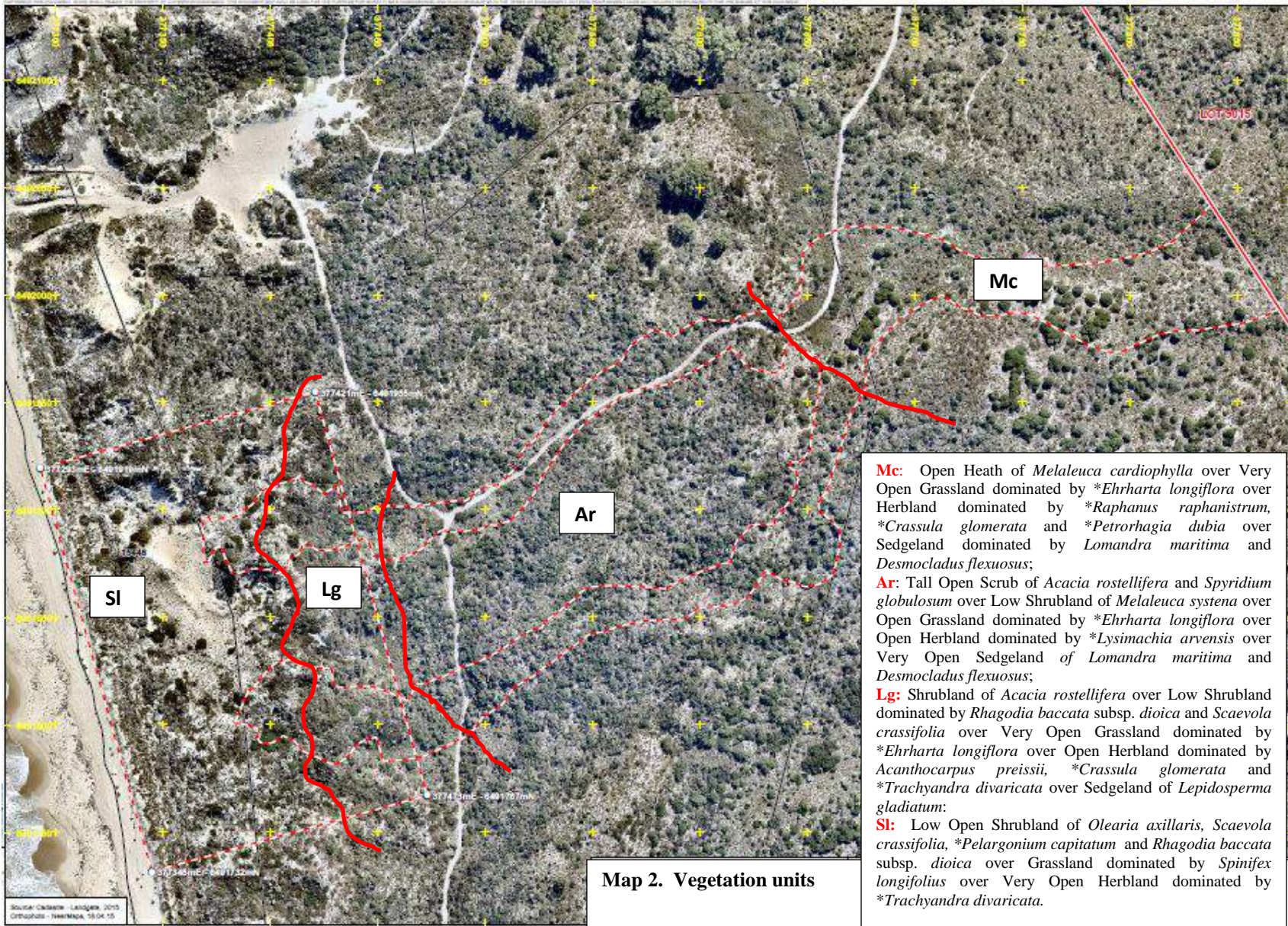
APPENDIX D

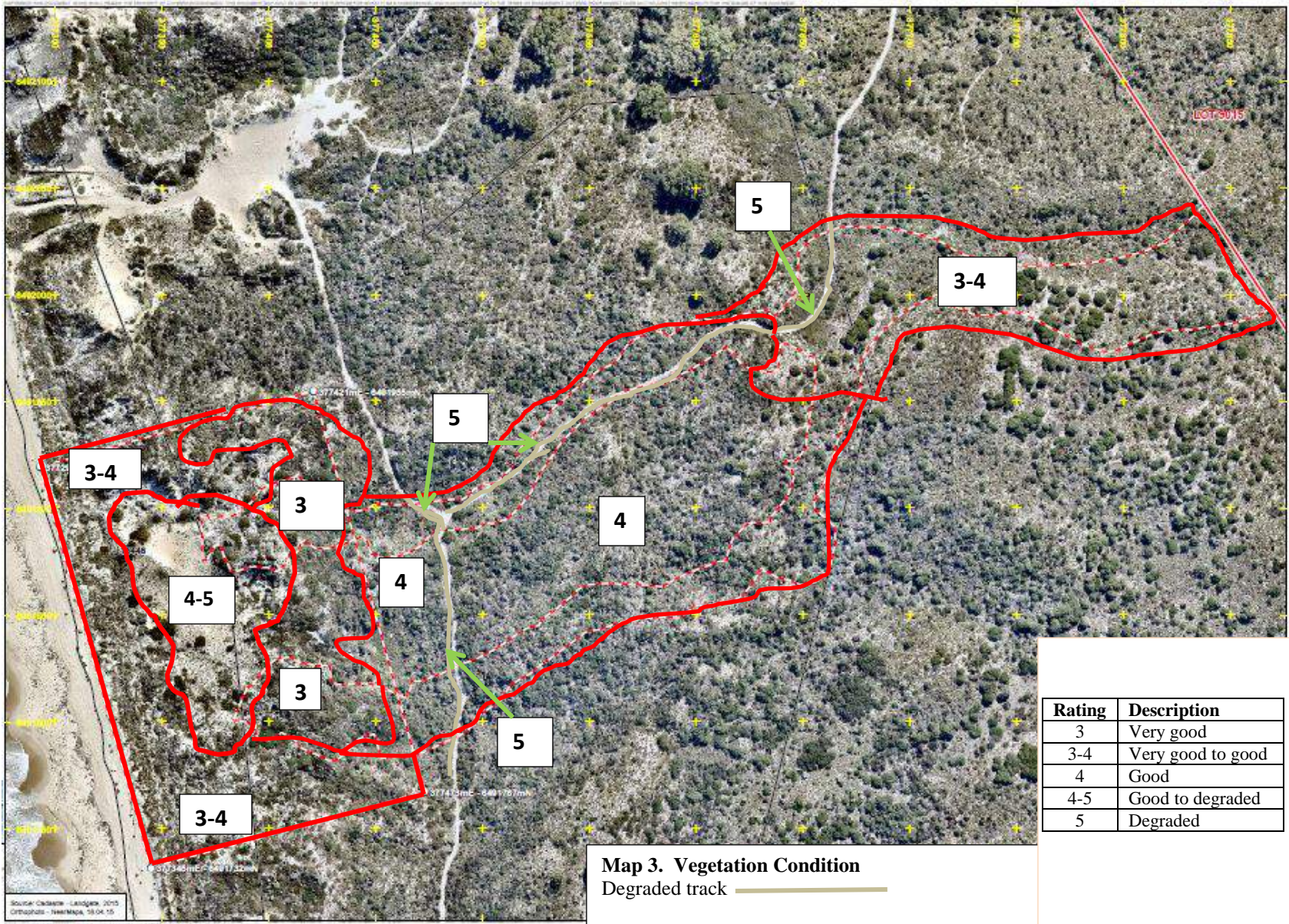
Maps

1. Location of quadrats
2. Vegetation units
3. Vegetation condition



Map 1. Location of quadrats





APPENDIX D – FAUNA SPECIES DATABASE SEARCH RESULTS

NatureMap Species Report

Created By Guest user on 16/01/2017

Current Names Only Yes
Core Datasets Only Yes
Method 'By Circle'
Centre 115° 42' 29" E, 31° 42' 03" S
Buffer 2km
Group By Kingdom

Kingdom	Species	Records
Animalia	61	157
Chromista	4	5
Plantae	19	26
TOTAL	84	188

Name ID	Species Name	Naturalised	Conservation Code	Endemic To Query Area
Animalia				
1.	24260 <i>Acanthiza apicalis</i> (Broad-tailed Thornbill, Inland Thornbill)			
2.	41323 <i>Actitis hypoleucos</i> (Common Sandpiper)		IA	
3.	24991 <i>Aprasia repens</i> (Sand-plain Worm-lizard)			
4.	42381 <i>Brachyrophis semifasciatus</i> (Southern Shovel-nosed Snake)			
5.	24734 <i>Calyptorhynchus latirostris</i> (Carnaby's Cockatoo (short-billed black-cockatoo), Carnaby's Cockatoo)		T	
6.	25335 <i>Caretta caretta</i> (Loggerhead Turtle)		T	
7.	24377 <i>Charadrius ruficapillus</i> (Red-capped Plover)			
8.	25336 <i>Chelonia mydas</i> (Green Turtle)		T	
9.	<i>Chroicocephalus novaehollandiae</i>			
10.	24399 <i>Columba livia</i> (Domestic Pigeon)	Y		
11.	25592 <i>Corvus coronoides</i> (Australian Raven)			
12.	25596 <i>Cracticus torquatus</i> (Grey Butcherbird)			
13.	30893 <i>Cryptoblepharus buchananii</i>			
14.	25027 <i>Ctenotus australis</i>			
15.	25039 <i>Ctenotus fallens</i>			
16.	25087 <i>Cyclodomorphus celatus</i> (Western Slender Blue-tongue)			
17.	24322 <i>Cygnus atratus</i> (Black Swan)			
18.	30908 <i>Diomedea chlororhynchus</i> (Yellow-nosed Albatross)		T	
19.	25100 <i>Egernia napoleonis</i>			
20.	<i>Eolophus roseicapillus</i>			
21.	25622 <i>Falco cenchroides</i> (Australian Kestrel)			
22.	25119 <i>Hemiergis quadrilineata</i>			
23.	24491 <i>Hirundo neoxena</i> (Welcome Swallow)			
24.	25478 <i>Isoodon obesulus</i> (Southern Brown Bandicoot)		P5	
25.	24153 <i>Isoodon obesulus</i> subsp. <i>fusciventer</i> (Quenda, Southern Brown Bandicoot)		P5	
26.	25133 <i>Lerista elegans</i>			
27.	25148 <i>Lerista lineopunctulata</i>			
28.	25165 <i>Lerista praepedita</i>			
29.	25005 <i>Lialis burtonis</i>			
30.	25652 <i>Malurus leucopterus</i> (White-winged Fairy-wren)			
31.	25654 <i>Malurus splendens</i> (Splendid Fairy-wren)			
32.	25184 <i>Menetia greyii</i>			
33.	<i>Microcarbo melanoleucos</i>			
34.	<i>Morus serrator</i>			
35.	24223 <i>Mus musculus</i> (House Mouse)	Y		
36.	25249 <i>Neelaps calonotos</i> (Black-striped Snake)		P3	
37.	<i>Pandion cristatus</i>			
38.	24154 <i>Perameles bougainville</i> subsp. <i>bougainville</i> (Western Barred Bandicoot, Marl (Shark Bay))		T	
39.	24155 <i>Perameles eremiana</i> (Desert Bandicoot)		X	
40.	24156 <i>Petaurus breviceps</i> subsp. <i>ariel</i> (Sugar Glider)			
41.	25697 <i>Phalacrocorax carbo</i> (Great Cormorant)			

Name ID	Species Name	Naturalised	Conservation Code	¹ Endemic To Query Area
42.	24667 <i>Phalacrocorax sulcirostris</i> (Little Black Cormorant)			
43.	25699 <i>Phalacrocorax varius</i> (Pied Cormorant)			
44.	25510 <i>Pogona minor</i> (Dwarf Bearded Dragon)			
45.	25258 <i>Pseudonaja affinis</i> subsp. <i>exilis</i> (Rottnest Dugite)		T	
46.	25008 <i>Pygopus lepidopodus</i> (Common Scaly Foot)			
47.	<i>Raveniella arenacea</i>			
48.	<i>Raveniella peckorum</i>			
49.	25614 <i>Rhipidura leucophrys</i> (Willie Wagtail)			
50.	25534 <i>Sericornis frontalis</i> (White-browed Scrubwren)			
51.	25589 <i>Streptopelia chinensis</i> (Spotted Turtle-Dove)	Y		
52.	25590 <i>Streptopelia senegalensis</i> (Laughing Turtle-Dove)	Y		
53.	25518 <i>Strophurus spinigerus</i>			
54.	33992 <i>Synemon gratiose</i> (Graceful Sunmoth)		P4	
55.	<i>Thalasseus bergii</i>			
56.	25203 <i>Tiliqua occipitalis</i> (Western Bluetongue)			
57.	25204 <i>Tiliqua rugosa</i> subsp. <i>aspera</i>			
58.	24157 <i>Trichosurus vulpecula</i> subsp. <i>arnhemensis</i> (Northern Brushtail Possum)			
59.	24158 <i>Trichosurus vulpecula</i> subsp. <i>vulpecula</i> (Common Brushtail Possum)			
60.	<i>Venator immansueta</i>			
61.	25765 <i>Zosterops lateralis</i> (Grey-breasted White-eye, Silvereye)			

Chromista

62.	26946 <i>Hormophysa cuneiformis</i>			
63.	27238 <i>Sargassum distichum</i>			
64.	27258 <i>Sargassum spinuligerum</i>			
65.	27260 <i>Sargassum tristichum</i>			

Plantae

66.	249 <i>Bromus diandrus</i> (Great Brome)	Y		
67.	2845 <i>Calandrinia brevipedata</i> (Short-stalked Purslane)			
68.	40827 <i>Calandrinia tholiformis</i>			
69.	26535 <i>Callophycus harveyanus</i>			
70.	26536 <i>Callophycus oppositifolius</i>			
71.	3137 <i>Crassula colorata</i> (Dense Stonecrop)			
72.	4332 <i>Erodium botrys</i> (Long Storksbill)	Y		
73.	13091 <i>Eucalyptus argutifolia</i> (Wabbling Hill Mallee)		T	
74.	5649 <i>Eucalyptus foecunda</i> (Narrow-leaved Red Mallee)			
75.	13541 <i>Eucalyptus petrensis</i>			
76.	20162 <i>Fabronia hampeana</i>		P2	
77.	5209 <i>Frankenia pauciflora</i> (Seaheath)			
78.	26850 <i>Gelinaria ulvoidea</i>			
79.	6434 <i>Leucopogon polymorphus</i>			
80.	8682 <i>Lolium loliaceum</i> (Stiff Ryegrass)	Y		
81.	4075 <i>Medicago littoralis</i> (Strand Medic)	Y		
82.	27144 <i>Platoma cyclocolpum</i>			
83.	17543 <i>Sarcozona bicarinata</i>		P3	
84.	17910 <i>Washingtonia filifera</i>	Y		

Conservation Codes

T - Rare or likely to become extinct
X - Presumed extinct
IA - Protected under international agreement
S - Other specially protected fauna
1 - Priority 1
2 - Priority 2
3 - Priority 3
4 - Priority 4
5 - Priority 5

¹ For NatureMap's purposes, species flagged as endemic are those whose records are wholly contained within the search area. Note that only those records complying with the search criterion are included in the calculation. For example, if you limit records to those from a specific datasource, only records from that datasource are used to determine if a species is restricted to the query area.



EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

Information is available about [Environment Assessments](#) and the EPBC Act including significance guidelines, forms and application process details.

Report created: 23/11/16 14:45:04

[Summary](#)

[Details](#)

[Matters of NES](#)

[Other Matters Protected by the EPBC Act](#)

[Extra Information](#)

[Caveat](#)

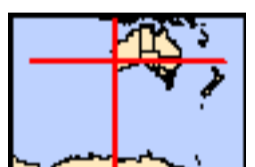
[Acknowledgements](#)



This map may contain data which are ©Commonwealth of Australia (Geoscience Australia), ©PSMA 2010

[Coordinates](#)

Buffer: 2.0Km



Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the [Administrative Guidelines on Significance](#).

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance:	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	1
Listed Threatened Species:	42
Listed Migratory Species:	39

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at <http://www.environment.gov.au/heritage>

A [permit](#) may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Land:	1
Commonwealth Heritage Places:	None
Listed Marine Species:	65
Whales and Other Cetaceans:	13
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Commonwealth Reserves Marine:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

State and Territory Reserves:	None
Regional Forest Agreements:	None
Invasive Species:	35
Nationally Important Wetlands:	None
Key Ecological Features (Marine)	None

Details

Matters of National Environmental Significance

Listed Threatened Ecological Communities

[[Resource Information](#)]

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Name	Status	Type of Presence
Banksia Woodlands of the Swan Coastal Plain	Endangered	Community may occur within area

Listed Threatened Species

[[Resource Information](#)]

Name	Status	Type of Presence
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Birds

Anous tenuirostris melanops Australian Lesser Noddy [26000]	Vulnerable	Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat likely to occur within area
Calyptorhynchus banksii naso Forest Red-tailed Black-Cockatoo, Karrak [67034]	Vulnerable	Species or species habitat likely to occur within area
Calyptorhynchus latirostris Carnaby's Black-Cockatoo, Short-billed Black-Cockatoo [59523]	Endangered	Species or species habitat known to occur within area
Diomedea amsterdamensis Amsterdam Albatross [64405]	Endangered	Species or species habitat may occur within area
Diomedea epomophora (sensu stricto) Southern Royal Albatross [1072]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans (sensu lato) Wandering Albatross [1073]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Halobaena caerulea Blue Petrel [1059]	Vulnerable	Species or species habitat may occur within area
Leipoa ocellata Malleefowl [934]	Vulnerable	Species or species habitat likely to occur within area
Limosa lapponica baueri Bar-tailed Godwit (baueri), Western Alaskan Bar-tailed Godwit [86380]	Vulnerable	Species or species habitat may occur within

Name	Status	Type of Presence area
Limosa lapponica menzbieri Northern Siberian Bar-tailed Godwit, Bar-tailed Godwit (menzbieri) [86432]	Critically Endangered	Species or species habitat may occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Pachyptila turtur subantarctica Fairy Prion (southern) [64445]	Vulnerable	Species or species habitat likely to occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat may occur within area
Pterodroma mollis Soft-plumaged Petrel [1036]	Vulnerable	Species or species habitat may occur within area
Rostratula australis Australian Painted Snipe [77037]	Endangered	Species or species habitat may occur within area
Sternula nereis nereis Australian Fairy Tern [82950]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Thalassarche carteri Indian Yellow-nosed Albatross [64464]	Vulnerable	Foraging, feeding or related behaviour may occur within area
Thalassarche cauta cauta Shy Albatross, Tasmanian Shy Albatross [82345]	Vulnerable	Species or species habitat may occur within area
Thalassarche cauta steadi White-capped Albatross [82344]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area
Mammals		
Balaenoptera musculus Blue Whale [36]	Endangered	Species or species habitat likely to occur within area
Dasyurus geoffroii Chuditch, Western Quoll [330]	Vulnerable	Species or species habitat likely to occur within area
Eubalaena australis Southern Right Whale [40]	Endangered	Breeding known to occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat known to occur within area

Name	Status	Type of Presence
Neophoca cinerea Australian Sea-lion, Australian Sea Lion [22]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Plants		
Caladenia huegelii King Spider-orchid, Grand Spider-orchid, Rusty Spider-orchid [7309]	Endangered	Species or species habitat may occur within area
Diuris micrantha Dwarf Bee-orchid [55082]	Vulnerable	Species or species habitat likely to occur within area
Drakaea elastica Glossy-leaved Hammer Orchid, Glossy-leaved Hammer Orchid, Warty Hammer Orchid [16753]	Endangered	Species or species habitat likely to occur within area
Eucalyptus argutifolia Yanchep Mallee, Wabling Hill Mallee [24263]	Vulnerable	Species or species habitat likely to occur within area
Lepidosperma rostratum Beaked Lepidosperma [14152]	Endangered	Species or species habitat likely to occur within area
Reptiles		
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat known to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Species or species habitat known to occur within area
Sharks		
Carcharias taurus (west coast population) Grey Nurse Shark (west coast population) [68752]	Vulnerable	Species or species habitat known to occur within area
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat known to occur within area
Rhincodon typus Whale Shark [66680]	Vulnerable	Species or species habitat may occur within area
Listed Migratory Species		[Resource Information]
* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.		
Name	Threatened	Type of Presence
Migratory Marine Birds		
Anous stolidus Common Noddy [825]		Species or species habitat may occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Diomedea amsterdamensis Amsterdam Albatross [64405]	Endangered	Species or species habitat may occur within area

Name	Threatened	Type of Presence
Diomedea epomophora (sensu stricto) Southern Royal Albatross [1072]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans (sensu lato) Wandering Albatross [1073]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Phoebastria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat may occur within area
Puffinus carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [1043]		Species or species habitat likely to occur within area
Sterna anaethetus Bridled Tern [814]		Foraging, feeding or related behaviour likely to occur within area
Sterna caspia Caspian Tern [59467]		Foraging, feeding or related behaviour known to occur within area
Sterna dougallii Roseate Tern [817]		Foraging, feeding or related behaviour likely to occur within area
Thalassarche carteri Indian Yellow-nosed Albatross [64464]	Vulnerable	Foraging, feeding or related behaviour may occur within area
Thalassarche cauta (sensu stricto) Shy Albatross, Tasmanian Shy Albatross [64697]	Vulnerable*	Species or species habitat may occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable*	Foraging, feeding or related behaviour likely to occur within area
Migratory Marine Species		
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat may occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Species or species habitat likely to occur within area
Caperea marginata Pygmy Right Whale [39]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat known to occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat known to occur within area
Eubalaena australis Southern Right Whale [40]	Endangered	Breeding known to occur within area
Lagenorhynchus obscurus Dusky Dolphin [43]		Species or species habitat may occur within area
Lamna nasus Porbeagle, Mackerel Shark [83288]		Species or species habitat may occur within area
Manta alfredi Reef Manta Ray, Coastal Manta Ray, Inshore Manta Ray, Prince Alfred's Ray, Resident Manta Ray [84994]		Species or species habitat may occur within area
Manta birostris Giant Manta Ray, Chevron Manta Ray, Pacific Manta Ray, Pelagic Manta Ray, Oceanic Manta Ray [84995]		Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat known to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Species or species habitat known to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
Rhincodon typus Whale Shark [66680]	Vulnerable	Species or species habitat may occur within area
Migratory Terrestrial Species		
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area
Migratory Wetlands Species		
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat likely to occur within area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Pandion haliaetus Osprey [952]		Species or species habitat known to occur within area

Other Matters Protected by the EPBC Act

Commonwealth Land

[\[Resource Information \]](#)

The Commonwealth area listed below may indicate the presence of Commonwealth land in this vicinity. Due to the unreliability of the data source, all proposals should be checked as to whether it impacts on a Commonwealth area, before making a definitive decision. Contact the State or Territory government land department for further information.

Name

Commonwealth Land -

Listed Marine Species

[\[Resource Information \]](#)

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Birds		
Anous stolidus Common Noddy [825]		Species or species habitat may occur within area
Anous tenuirostris melanops Australian Lesser Noddy [26000]	Vulnerable	Species or species habitat may occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardea alba Great Egret, White Egret [59541]		Species or species habitat likely to occur within area
Ardea ibis Cattle Egret [59542]		Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat likely to occur within area
Catharacta skua Great Skua [59472]		Species or species habitat may occur within area
Diomedea amsterdamensis Amsterdam Albatross [64405]	Endangered	Species or species habitat may occur within area
Diomedea epomophora (sensu stricto) Southern Royal Albatross [1072]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans (sensu lato) Wandering Albatross [1073]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat likely to occur within area
Halobaena caerulea Blue Petrel [1059]	Vulnerable	Species or species habitat may occur within area
Larus pacificus Pacific Gull [811]		Foraging, feeding or related behaviour may occur within area

Name	Threatened	Type of Presence
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat may occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Pachyptila turtur Fairy Prion [1066]		Species or species habitat likely to occur within area
Pandion haliaetus Osprey [952]		Species or species habitat known to occur within area
Phoebastria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat may occur within area
Pterodroma mollis Soft-plumaged Petrel [1036]	Vulnerable	Species or species habitat may occur within area
Puffinus assimilis Little Shearwater [59363]		Foraging, feeding or related behaviour known to occur within area
Puffinus carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [1043]		Species or species habitat likely to occur within area
Rostratula benghalensis (sensu lato) Painted Snipe [889]	Endangered*	Species or species habitat may occur within area
Sterna anaethetus Bridled Tern [814]		Foraging, feeding or related behaviour likely to occur within area
Sterna caspia Caspian Tern [59467]		Foraging, feeding or related behaviour known to occur within area
Sterna dougallii Roseate Tern [817]		Foraging, feeding or related behaviour likely to occur within area
Thalassarche carteri Indian Yellow-nosed Albatross [64464]	Vulnerable	Foraging, feeding or related behaviour may occur within area
Thalassarche cauta (sensu stricto) Shy Albatross, Tasmanian Shy Albatross [64697]	Vulnerable*	Species or species habitat may occur within area

Name	Threatened	Type of Presence
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable*	Foraging, feeding or related behaviour likely to occur within area
Fish		
Acentronura australe Southern Pygmy Pipehorse [66185]		Species or species habitat may occur within area
Campichthys galei Gale's Pipefish [66191]		Species or species habitat may occur within area
Choeroichthys suillus Pig-snouted Pipefish [66198]		Species or species habitat may occur within area
Halicampus brocki Brock's Pipefish [66219]		Species or species habitat may occur within area
Hippocampus angustus Western Spiny Seahorse, Narrow-bellied Seahorse [66234]		Species or species habitat may occur within area
Hippocampus breviceps Short-head Seahorse, Short-snouted Seahorse [66235]		Species or species habitat may occur within area
Hippocampus subelongatus West Australian Seahorse [66722]		Species or species habitat may occur within area
Lissocampus fatiloquus Prophet's Pipefish [66250]		Species or species habitat may occur within area
Maroubra perserrata Sawtooth Pipefish [66252]		Species or species habitat may occur within area
Mitotichthys meraculus Western Crested Pipefish [66259]		Species or species habitat may occur within area
Nannocampus subosseus Bonyhead Pipefish, Bony-headed Pipefish [66264]		Species or species habitat may occur within area
Phycodurus eques Leafy Seadragon [66267]		Species or species habitat may occur within area
Phyllopteryx taeniolatus Common Seadragon, Weedy Seadragon [66268]		Species or species habitat may occur within area
Pugnaso curtirostris Pugnose Pipefish, Pug-nosed Pipefish [66269]		Species or species habitat may occur within area
Solegnathus lettiensis Gunther's Pipehorse, Indonesian Pipefish [66273]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Stigmatopora argus Spotted Pipefish, Gulf Pipefish, Peacock Pipefish [66276]		Species or species habitat may occur within area
Stigmatopora nigra Widebody Pipefish, Wide-bodied Pipefish, Black Pipefish [66277]		Species or species habitat may occur within area
Stigmatopora olivacea a pipefish [74966]		Species or species habitat may occur within area
Syngnathoides biaculeatus Double-end Pipehorse, Double-ended Pipehorse, Alligator Pipefish [66279]		Species or species habitat may occur within area
Urocampus carinirostris Hairy Pipefish [66282]		Species or species habitat may occur within area
Vanacampus margaritifer Mother-of-pearl Pipefish [66283]		Species or species habitat may occur within area

Mammals

Arctocephalus forsteri Long-nosed Fur-seal, New Zealand Fur-seal [20]		Species or species habitat may occur within area
Neophoca cinerea Australian Sea-lion, Australian Sea Lion [22]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area

Reptiles

Aipysurus pooleorum Shark Bay Seasnake [66061]		Species or species habitat may occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat known to occur within area
Disteira kingii Spectacled Seasnake [1123]		Species or species habitat may occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Species or species habitat known to occur within area
Pelamis platurus Yellow-bellied Seasnake [1091]		Species or species habitat may occur within area

Whales and other Cetaceans

Name	Status	Type of Presence
[Resource Information]		
Mammals		
Balaenoptera acutorostrata Minke Whale [33]		Species or species habitat may occur within area
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat may occur within

Name	Status	Type of Presence area
Balaenoptera musculus Blue Whale [36]	Endangered	Species or species habitat likely to occur within area
Caperea marginata Pygmy Right Whale [39]		Species or species habitat may occur within area
Delphinus delphis Common Dolphin, Short-beaked Common Dolphin [60]		Species or species habitat may occur within area
Eubalaena australis Southern Right Whale [40]	Endangered	Breeding known to occur within area
Grampus griseus Risso's Dolphin, Grampus [64]		Species or species habitat may occur within area
Lagenorhynchus obscurus Dusky Dolphin [43]		Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat known to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
Stenella attenuata Spotted Dolphin, Pantropical Spotted Dolphin [51]		Species or species habitat may occur within area
Tursiops aduncus Indian Ocean Bottlenose Dolphin, Spotted Bottlenose Dolphin [68418]		Species or species habitat likely to occur within area
Tursiops truncatus s. str. Bottlenose Dolphin [68417]		Species or species habitat may occur within area

Extra Information

Invasive Species [\[Resource Information \]](#)

Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resources Audit, 2001.

Name	Status	Type of Presence
Birds		
Acridotheres tristis Common Myna, Indian Myna [387]		Species or species habitat likely to occur within area
Anas platyrhynchos Mallard [974]		Species or species

Name	Status	Type of Presence
Carduelis carduelis European Goldfinch [403]		habitat likely to occur within area Species or species habitat likely to occur within area
Columba livia Rock Pigeon, Rock Dove, Domestic Pigeon [803]		Species or species habitat likely to occur within area
Passer domesticus House Sparrow [405]		Species or species habitat likely to occur within area
Passer montanus Eurasian Tree Sparrow [406]		Species or species habitat likely to occur within area
Streptopelia chinensis Spotted Turtle-Dove [780]		Species or species habitat likely to occur within area
Streptopelia senegalensis Laughing Turtle-dove, Laughing Dove [781]		Species or species habitat likely to occur within area
Sturnus vulgaris Common Starling [389]		Species or species habitat likely to occur within area
Mammals		
Bos taurus Domestic Cattle [16]		Species or species habitat likely to occur within area
Canis lupus familiaris Domestic Dog [82654]		Species or species habitat likely to occur within area
Felis catus Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
Funambulus pennantii Northern Palm Squirrel, Five-striped Palm Squirrel [129]		Species or species habitat likely to occur within area
Mus musculus House Mouse [120]		Species or species habitat likely to occur within area
Oryctolagus cuniculus Rabbit, European Rabbit [128]		Species or species habitat likely to occur within area
Rattus norvegicus Brown Rat, Norway Rat [83]		Species or species habitat likely to occur within area
Rattus rattus Black Rat, Ship Rat [84]		Species or species habitat likely to occur within area
Vulpes vulpes Red Fox, Fox [18]		Species or species habitat likely to occur within area
Plants		
Asparagus aethiopicus Asparagus Fern, Ground Asparagus, Basket Fern, Sprengi's Fern, Bushy Asparagus, Emerald Asparagus [62425]		Species or species habitat likely to occur within area

Name	Status	Type of Presence
Asparagus asparagoides Bridal Creeper, Bridal Veil Creeper, Smilax, Florist's Smilax, Smilax Asparagus [22473]		Species or species habitat likely to occur within area
Brachiaria mutica Para Grass [5879]		Species or species habitat may occur within area
Cenchrus ciliaris Buffel-grass, Black Buffel-grass [20213]		Species or species habitat may occur within area
Chrysanthemoides monilifera Bitou Bush, Boneseed [18983]		Species or species habitat may occur within area
Chrysanthemoides monilifera subsp. monilifera Boneseed [16905]		Species or species habitat likely to occur within area
Genista sp. X Genista monspessulana Broom [67538]		Species or species habitat may occur within area
Lantana camara Lantana, Common Lantana, Kamara Lantana, Large-leaf Lantana, Pink Flowered Lantana, Red Flowered Lantana, Red-Flowered Sage, White Sage, Wild Sage [10892]		Species or species habitat likely to occur within area
Olea europaea Olive, Common Olive [9160]		Species or species habitat may occur within area
Pinus radiata Radiata Pine Monterey Pine, Insignis Pine, Wilding Pine [20780]		Species or species habitat may occur within area
Protasparagus densiflorus Asparagus Fern, Plume Asparagus [5015]		Species or species habitat likely to occur within area
Rubus fruticosus aggregate Blackberry, European Blackberry [68406]		Species or species habitat likely to occur within area
Salix spp. except S.babylonica, S.x calodendron & S.x reichardtii Willows except Weeping Willow, Pussy Willow and Sterile Pussy Willow [68497]		Species or species habitat likely to occur within area
Salvinia molesta Salvinia, Giant Salvinia, Aquarium Watermoss, Kariba Weed [13665]		Species or species habitat likely to occur within area
Tamarix aphylla Athel Pine, Athel Tree, Tamarisk, Athel Tamarisk, Athel Tamarix, Desert Tamarisk, Flowering Cypress, Salt Cedar [16018]		Species or species habitat likely to occur within area
Reptiles		
Hemidactylus frenatus Asian House Gecko [1708]		Species or species habitat likely to occur within area
Ramphotyphlops braminus Flowerpot Blind Snake, Brahminy Blind Snake, Cacing Besi [1258]		Species or species habitat likely to occur within area

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World and National Heritage properties, Wetlands of International and National Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species distributions have been derived through a variety of methods. Where distributions are well known and if time permits, maps are derived using either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc) together with point locations and described habitat; or environmental modelling (MAXENT or BIOCLIM habitat modelling) using point locations and environmental data layers.

Where very little information is available for species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc). In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More reliable distribution mapping methods are used to update these distributions as time permits.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

Coordinates

-31.698867 115.703128,-31.698721 115.710016,-31.704326 115.711926,-31.705549 115.705167,-31.698958 115.703278,-31.698958 115.703278,-31.698867 115.703128

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

- [-Office of Environment and Heritage, New South Wales](#)
- [-Department of Environment and Primary Industries, Victoria](#)
- [-Department of Primary Industries, Parks, Water and Environment, Tasmania](#)
- [-Department of Environment, Water and Natural Resources, South Australia](#)
- [-Department of Land and Resource Management, Northern Territory](#)
- [-Department of Environmental and Heritage Protection, Queensland](#)
- [-Department of Parks and Wildlife, Western Australia](#)
- [-Environment and Planning Directorate, ACT](#)
- [-Birdlife Australia](#)
- [-Australian Bird and Bat Banding Scheme](#)
- [-Australian National Wildlife Collection](#)
- [-Natural history museums of Australia](#)
- [-Museum Victoria](#)
- [-Australian Museum](#)
- [-South Australian Museum](#)
- [-Queensland Museum](#)
- [-Online Zoological Collections of Australian Museums](#)
- [-Queensland Herbarium](#)
- [-National Herbarium of NSW](#)
- [-Royal Botanic Gardens and National Herbarium of Victoria](#)
- [-Tasmanian Herbarium](#)
- [-State Herbarium of South Australia](#)
- [-Northern Territory Herbarium](#)
- [-Western Australian Herbarium](#)
- [-Australian National Herbarium, Canberra](#)
- [-University of New England](#)
- [-Ocean Biogeographic Information System](#)
- [-Australian Government, Department of Defence Forestry Corporation, NSW](#)
- [-Geoscience Australia](#)
- [-CSIRO](#)
- [-Australian Tropical Herbarium, Cairns](#)
- [-eBird Australia](#)
- [-Australian Government – Australian Antarctic Data Centre](#)
- [-Museum and Art Gallery of the Northern Territory](#)
- [-Australian Government National Environmental Science Program](#)
- [-Australian Institute of Marine Science](#)
- [-Reef Life Survey Australia](#)
- [-American Museum of Natural History](#)
- [-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania](#)
- [-Tasmanian Museum and Art Gallery, Hobart, Tasmania](#)
- [-Other groups and individuals](#)

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

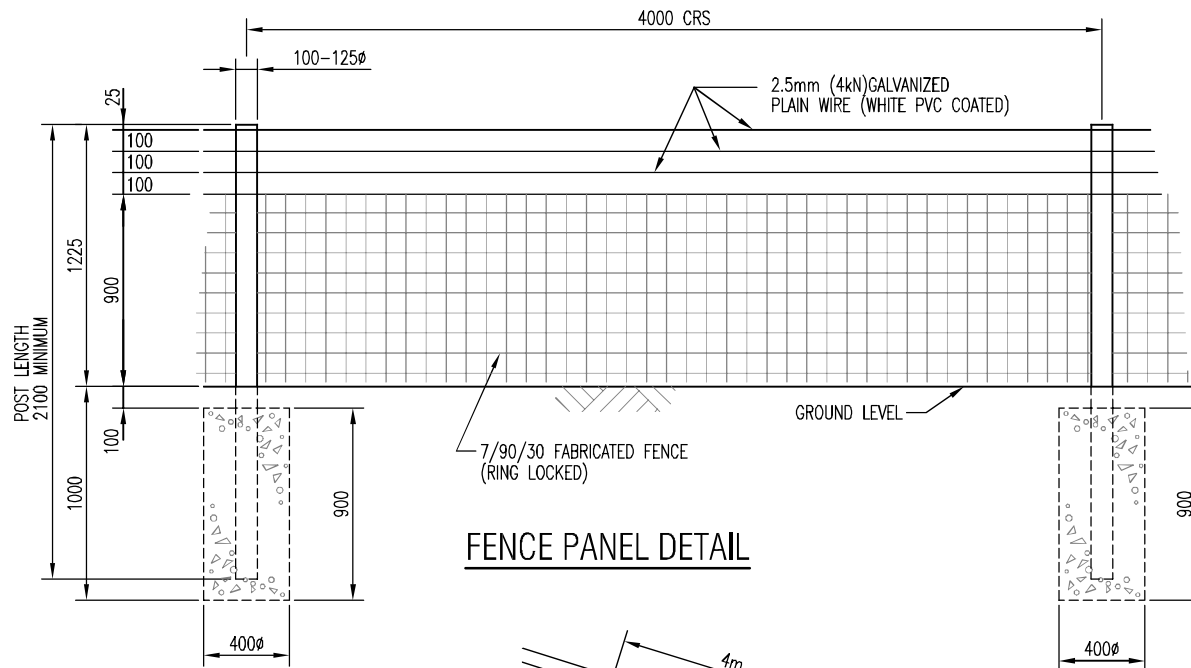
Please feel free to provide feedback via the [Contact Us](#) page.

APPENDIX E – FENCING AND GATE SPECIFICATIONS

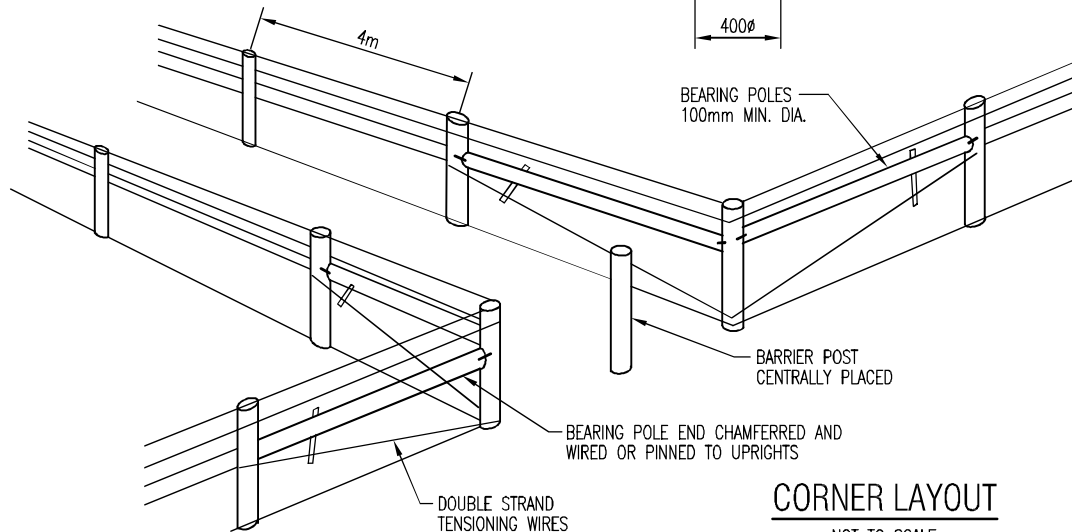
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0.	ISSUED	J.W.T.	8/2001	
1.	NOTE 1 REMOVED	T.T.	3/2006	B.C.
2.	FENCE POST ADJUSTED	P.H.	11/2007	B.C.

NOTES:

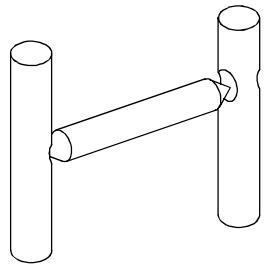
1. OPENINGS BETWEEN CORNER UNITS AND BARRIER POSTS TO BE MAXIMUM OF 1500mm.
2. BEARING POLES TO BE WIRED TO UPRIGHTS WITH 2 STRANDS PLAIN WIRE, END SHARPENED & INSERTED INTO POSTS OR END-DRILLED AND PINNED TO ENSURE SECURED FIXING.
3. MESH TO BE 7/90/30 RINGLOCK FABRICATION FENCING. WIRES TO BE AS SHOWN AND TO BE GALVANIZED ACCORDING TO SPECIFICATIONS.
4. ALL UPRIGHT MEMBERS SHALL BE VERTICAL WITHIN A TOLERANCE OF 1:100.
5. CONCRETE FOOTING SHALL BE MIXED IN THE PROPORTIONS OF (4) PARTS BY WEIGHT OF CLEAN DUST FREE AGGREGATE (NOT EXCEEDING 20mm SIZE) PLUS TWO (2) PARTS BY WEIGHT OF CLEAN DUST FREE SAND PLUS ONE (1) PART BY WEIGHT OF MASONRY CEMENT, WITH WATER CONTENT SUFFICIENT TO ENSURE A SLUMP OF NOT MORE THAN 100mm USING THE AUSTRALIAN STANDARD SLUMP TEST CONE.
6. CONCRETE SHALL ACHIEVE A MINIMUM COMPRESSIVE STRENGTH OF 20MPa AT 28 DAYS.
7. CONCRETE FOOTINGS SHALL BE CURED FOR TWENTY FOUR (24) HOURS BEFORE ERECTION OF WIRES OR MESH TO POSTS.
8. GALVANISED COATINGS FOR ALL FERROUS MATERIALS SHALL HAVE COATINGS OF ZINC IN COMPLIANCE WITH AS 1650. THE COATINGS FOR WIRES SHALL BE TYPE A (HEAVILY GALVANISED).



FENCE PANEL DETAIL



CORNER LAYOUT



POLE FIXING DETAIL

NOT TO SCALE

* INDICATES SIGNATURES ON ORIGINAL ISSUE OF DRAWING.

DATUM: N/A	GRID: N/A	SURVEYOR: N/A	DESIGNED: C.O.W.	APPROVED: * T. QUINN 8/8/2001
SCALE: 1:25 SCALE IN MILLIMETRES			DRAWN: C.O.W.	COORDINATOR: APPROVED:
DESIGN ARCHIVE:			DESIGN CHECKED: DESIGNER	* R. KORENHOF 23/8/2001 MANAGER INFRASTRUCTURE
DRAWING ARCHIVE: *FINAL STANDARD DRAWINGS			STANDARDS/DOCUMENT CONTROL: * J. TRIMMER 8/8/2001 INFRASTRUCTURE TECHNICAL OFFICER	APPROVED: * D. BLAIR 23/8/2001 DIRECTOR TECHNICAL SERVICES

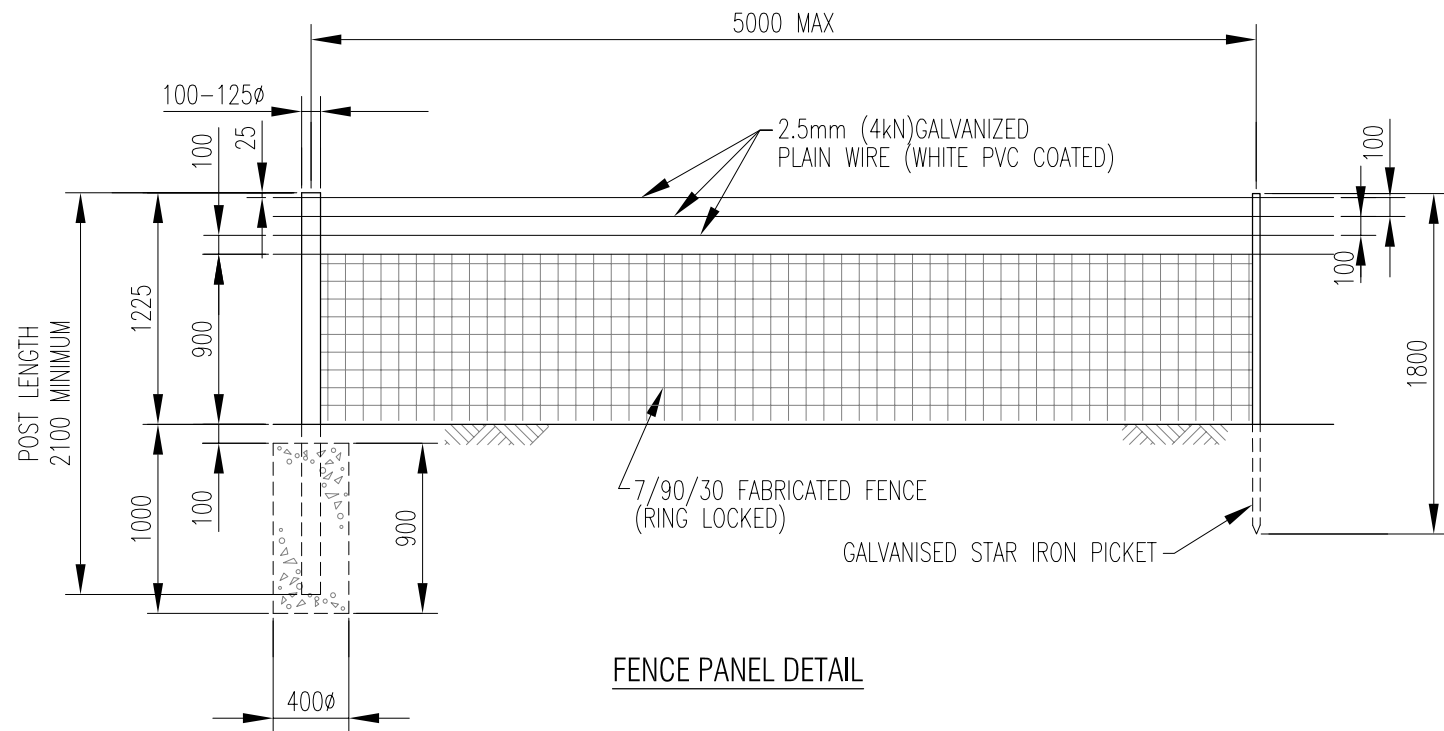
FENCING
COASTAL FORESHORE FENCING
BEACH ACCESSWAY FENCING

LOCALITY

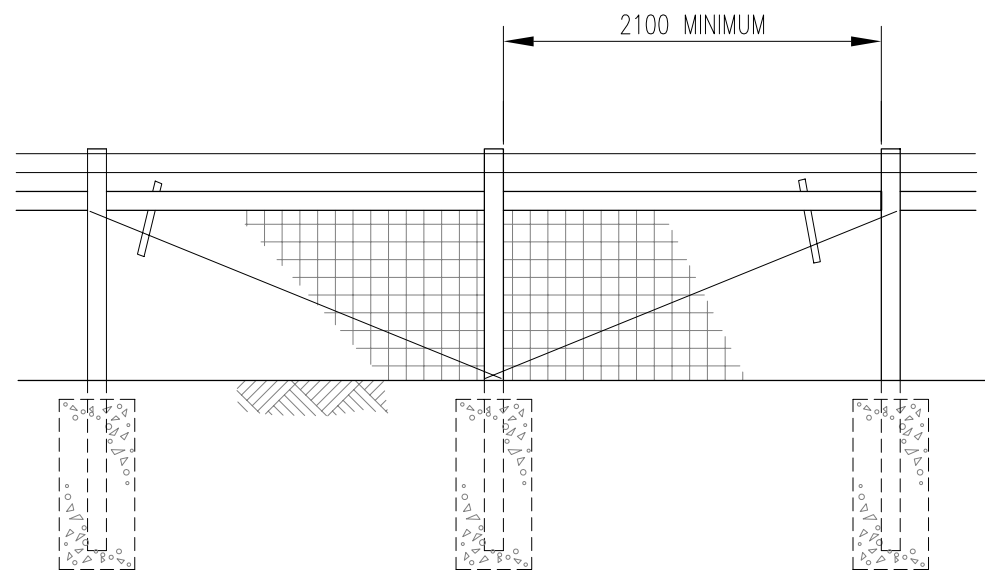
STANDARD

CITY OF WANNEROO				
TECHNICAL SERVICES				
INFRASTRUCTURE SERVICES				
FILE No.	DRAWING No	SHEET	REVISION	ORIGINAL DRG. SIZE
	TS 01 - 4 - 2			A3

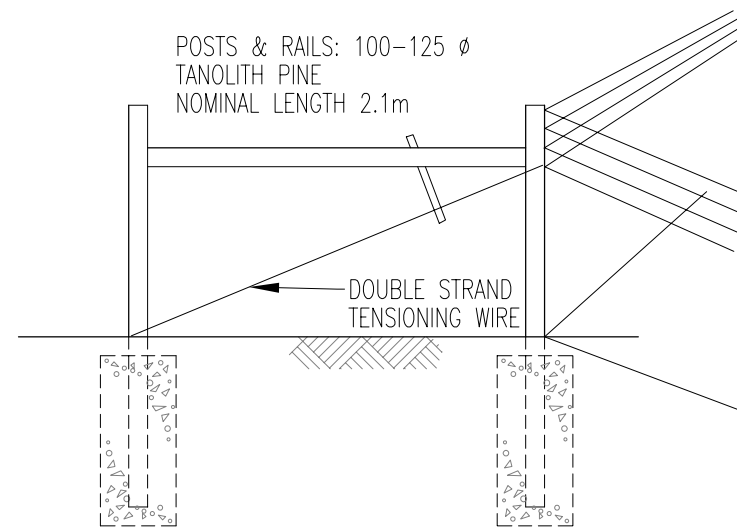
No	REVISION	BY	DATE	AUTH
0.	ISSUED	J.W.T.	8/2001	
1.	NOTES AMENDED	T.T.	3/2006	B.C.



FENCE PANEL DETAIL



INTERMEDIATE BRACING DETAIL



ALIGNMENT BRACING DETAIL

NOTES:

- FOR ROAD FRONTAGE FENCE, POSTS TO BE AT 25m CRS.(MAX.)
- FOR RURAL FENCING POSTS TO BE AT 100m MAX
- ALIGNMENT BRACING TO BE LOCATED AS DIRECTED
- INTERMEDIATE BRACING TO BE SPACED AS DIRECTED (ON STRAIGHT FENCES, MAXIMUM SPACING 125mm.)
- FABRICATED WIRE TO BE 7/90/30 RINGLOCK FENCING.
- WIRES TO BE FIRMLY SECURED TO POSTS AND PICKETS.
- ALL UPRIGHT MEMBERS SHALL BE VERTICAL WITHIN A TOLERANCE OF 1:100.
- THE BASE OF FOOTING HOLES SHALL BE ADEQUATELY COMPACTED BY RAMMING.
- THE DIAMETER OF EACH TIMBER POST OR RAIL SHALL NOT VARY BY MORE THAN 25mm OVER A 2m LENGTH (OR 12.5mm PER METRE LENGTH).
- CONCRETE SHALL BE MIXED IN THE PROPORTIONS OF (4) PARTS BY WEIGHT OF CLEAN DUST FREE AGGREGATE (NOT EXCEEDING 20mm SIZE) PLUS TWO (2) PARTS BY WEIGHT OF CLEAN DUST FREE SAND PLUS ONE (1) PART BY WEIGHT OF MASONRY CEMENT, WITH WATER CONTENT SUFFICIENT TO ENSURE A SLUMP OF NOT MORE THAN 100mm USING THE AUSTRALIAN STANDARD SLUMP TEST CONE.
- CONCRETE SHALL ACHIEVE A MINIMUM COMPRESSIVE STRENGTH OF 20MPa AT 28 DAYS.
- CONCRETE FOOTINGS SHALL BE CURED FOR TWENTY FOUR (24) HOURS BEFORE ERECTION OF WIRES OR MESH TO POSTS AND PICKETS.
- WIRES ARE TO BE FIXED ON THE ROAD PAVEMENT OR PUBLIC ACCESS WAY SIDE OF POSTS AND UPRIGHTS UNLESS ADJACENT TO PRIVATE PROPERTY OR AS INDICATED ON DESIGN DRAWINGS.
- GALVANIZED COATINGS FOR ALL FERROUS MATERIALS SHALL HAVE COATINGS OF ZINC IN COMPLIANCE WITH AS1650 (GALVANIZED COATINGS ON FERROUS ARTICLES). THE COATING FOR WIRE SHALL BE TYPE A (HEAVILY GALVANIZED). THE PVC COATING OR COLOURBOND COATING TO WIRE SHALL BE BLACK, UNLESS OTHERWISE DIRECTED BY THE CITY.
- ALL STAR PICKETS SHALL BE FITTED WITH APPROVED WHITE CAPS.
- TIMBER BEARING POLES/RAILS TO UPRIGHTS WITH 2 STRANDS PLAIN WIRE, END SHARPENED & INSERTED INTO UPRIGHTS OR END-DRILLED AND PINNED TO ENSURE SECURED FIXING. REFER TO TS01-4

* INDICATES SIGNATURES ON ORIGINAL ISSUE OF DRAWING.

DATUM: N/A	GRID: N/A	SURVEYOR: N/A	DESIGNED: C.O.W.	APPROVED: * T. QUINN 8/8/2001
SCALE: 1:40 SCALE IN MILLIMETRES			DRAWN: C.O.W.	COORDINATOR: * R. KORENHOF 23/8/2001
DESIGN ARCHIVE:			DESIGN CHECKED: DESIGNER	APPROVED: * D. BLAIR 23/8/2001
DRAWING ARCHIVE: *\FINAL STANDARD DRAWINGS			STANDARDS/DOCUMENT CONTROL: * J. TRIMMER 8/8/2001	DIRECTOR TECHNICAL SERVICES

FENCING

RURAL CONSERVATION FENCING

LOCALITY STANDARD

CITY OF WANNEROO
TECHNICAL SERVICES

INFRASTRUCTURE SERVICES

FILE No.	DRAWING No	SHEET	REVISION	ORIGINAL DRG. SIZE
	TS 01 - 3 - 1			A3

APPENDIX F – WEED SPECIES LIST

Species	Common Name	Dominance	Priority species for control (Mattiske Pty Ltd, 2000)
* <i>Ammophila arenaria</i>	Marram grass	D	
* <i>Avena barbata</i>	Bearded oat		X
* <i>Briza maxima</i>	Blowfly grass		
* <i>Bromus diandrus</i>	Brome grass		
* <i>Crassula glomerata</i>	Crassula	D	
* <i>Cuscuta epithymum</i>	Dodder		
* <i>Ehrharta calycina</i>	Veldt grass		
* <i>Ehrharta longiflora</i>	Veldt grass	D	
* <i>Euphorbia terracina</i>	Geraldton carnation weed		X
* <i>Heliophila pusilla</i>			
* <i>Hordeum leporinum</i>	Barley grass		
* <i>Lactuca serriola</i>	Prickly lettuce		
* <i>Lagurus ovatus</i>	Hare's tail grass		
* <i>Lolium loliaceum</i>	Rye grass		
* <i>Lysimachia arvensis</i>		D	
* <i>Oenothera glazioviana</i>	Tall evening primrose		
* <i>Pelargonium capitatum</i>	Rose geranium	D	X
* <i>Petrorhagia dubia</i>	Velvet pink	D	
* <i>Raphanus raphanistrum</i>	Wild radish	D	X
* <i>Romulea rosea</i>	Guildford grass		
* <i>Silene gallica</i>	French catchfly		
* <i>Sonchus oleraceus</i>	Sowthistle		
* <i>Tetragonia decumbens</i>	Sea spinach		
* <i>Trachyandra divaricata</i>	Strapweed	D	
* <i>Urospermum picroides</i>	False hawkbit		
* <i>Vulpia myuros</i>	Silver grass		

APPENDIX G – REVEGETATION SPECIES LIST

Coterra Environment Catalina Foreshore - Proposed Species List

Revegetation Notes:

* denotes low representation recommended

** denotes high representation recommended

Blue refers to species requiring 12-18 months lead time for provenance grown seedlings

Orange refers to species observed and additional to the Botanical Assessment

Revegetation Species List

Species	Habit	Mg Zone	Ar Zone	Lg Zone	SI Zone
<i>Acacia cyclops</i>	Shrub	*	*		
<i>Acacia lasiocarpa</i>	Shrub		*	*	
<i>Acacia rostellifera</i>	Shrub		**	*	
<i>Acacia saligna</i>	Shrub	*			
<i>Acanthocarpus preissii</i>	Herb	**	**	**	**
<i>Austrostipa flavescens</i>	Grass	*			
<i>Carpobrotus virescens</i>	Groundcover			*	**
<i>Clematis linearifolia</i>	Climber	**	**	*	*
<i>Conostylis aculeata subsp. cygnorum</i>	Herb	**	*	*	
<i>Conostylis candicans</i>	Herb			*	*
<i>Dianella revoluta var. divaricata</i>	Herb	*			
<i>Ficinia nodosa</i>	Sedge				*
.....				
<i>Hardenbergia comptoniana</i>	Climber	**	**	*	
<i>Hemiandra pungens</i>	Groundcover	*	*		
<i>Kennedia prostrata</i>	Groundcover	*	*	*	
<i>Lepidosperma calcicola</i>	Sedge	*			
<i>Lepidosperma gladiatum</i>	Sedge		**	**	
<i>Melaleuca cardiophylla</i>	Shrub	**	*		
<i>Melaleuca systema</i>	Shrub	**	**	**	
<i>Olearia axillaris</i>	Shrub	*	*	**	**
<i>Pithocarpa cordatus</i>	Shrub			*	*
<i>Phyllanthus calycinus</i>	Herb	*			
<i>Poa porphyroclados</i>	Grass	*			
<i>Rhagodia baccata</i>	Shrub	*	*	**	
<i>Scaevola crassifolia</i>	Shrub			*	**
<i>Scaevola globulifera</i>	Shrub				
<i>Senecio pinnatifolius var. latilobus</i>	Herb				*
<i>Spinifex hirsutus</i>	Grass				*
<i>Spinifex longifolius</i>	Grass			*	**
<i>Spyridium globulosum</i>	Shrub	**	**	**	
<i>Threlkeldia diffusa</i>	Groundcover			*	*
<i>Thysanotus arenarius</i>	Herb	*	*		

Weed Species Notes:

* denotes low density observed

** denotes high density observed

Weed Species Observed

Species	Habit	Mg Zone	Ar Zone	Lg Zone	SI Zone
<i>Ammophila arenaria</i>	Grass				**
<i>Anagallis arvensis var. caerulea</i>	Herb	**			
<i>Arctotheca calendula</i>	Herb		*		
<i>Avena barbata</i>	Grass	*			
<i>Briza maxima</i>	Grass	*			
<i>Bromus diandrus</i>	Grass	*	*		
<i>Cakile maritima</i>	Herb				*
<i>Carpobrotus edulis</i>	Groundcover	*			
<i>Erharta longifolia</i>	Grass	**	**	*	
<i>Euphorbia terracina</i>	Grass	**	*		
<i>Medicago polymorpha</i>	Groundcover	*			
<i>Pelargonium capitatum</i>	Herb	**	**	*	**
<i>Raphanus raphanistrum</i>	Herb	*	*		
<i>Tetragonia decumbens</i>	Groundcover			*	**
<i>Trachyandra divaricata</i>	Herb	*	**	*	**

COTERRA ENVIRONMENT

Level 3, 25 Prowse Street
West Perth WA 6005

T (08) 9381 5513

www.coterra.com.au
info@coterra.com.au

