

**TANTABIDDI BOATING FACILITY PROJECT,
WESTERN AUSTRALIA
FLORA AND VEGETATION SURVEYS**

MAY 2021

Prepared for the Department of Transport

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Abbreviation	Definition
BAM Act	<i>Biosecurity and Agriculture Management Act 2007</i>
BOM	Bureau of Meteorology
°C	Degrees Celsius
DBCA	Department of Biodiversity, Conservation and Attractions
DoEE	Department of the Environment and Energy
EPA	Environmental Protection Authority
EPBC Act	<i>Environment Protection and Biodiversity Conservation Act 1999</i>
ESA	Environmentally Sensitive Area
GDA94	Geocentric Datum of Australia 1994
GPS	Global Positioning System
ha	hectares
IBRA	Interim Biogeographic Regionalisation for Australia
km	Kilometers
m²	Meters squared
mm	Millimeters
MGA50	Map Grid of Australia
MNES	Matters of National Significance
P	Priority
PEC	Priority Ecological Community
sp.	Species (singular)
subsp.	Subspecies
T	Threatened
TEC	Threatened Ecological Community
WoNS	Weeds of National Significance

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1. INTRODUCTION

1.1 Project Background

The Department of Transport (DoT) proposes to construct a new boating facility (The Tantabiddi Boating Facility Project (TBFP)) in Ningaloo Marine Park, an A Class Marine Reserve which is also located within the Ningaloo Coast World Heritage Area. The proposed development requires robust environmental studies and referral under both the *Environmental Protection Act 1986 WA* and *The Environment Protection and Biodiversity Conservation Act 1999*.

The Department of Transport has engaged Vicki Long and Associates (VLA) to undertake flora and vegetation assessments within the TBFP envelope as indicated on Figure 1.

1.2 Scope and Objectives

The scope of work was to conduct flora and vegetation assessments for the TBFP envelope in accordance with the Department of Transport Survey Environmental Brief and relevant Environmental Protection Authority (EPA) and DBCA technical and regulatory guidance:

- Technical Guidance No 51 - *Flora and Vegetation surveys for Environmental Impact Assessment* (EPA 2016a).
- Environmental Factor Guideline – *Flora and Vegetation* (EPA 2016b)

The scope of work included undertaking a:

- Desktop assessment within a 20km radius of the TBFP, including database searches and a literature review of available resources
- A Reconnaissance flora and vegetation survey within the TBFP envelope including:
 - Verification of information identified by the database searches
 - Composing a species list, including recording locations of any Threatened (Declared Rare) Flora, Priority Flora and introduced flora
 - Vegetation type and vegetation condition with supporting photographs of each vegetation type
 - Discussion of conservation significant vegetation or flora recorded at the survey locations
- Preparation of a final report which addresses the tasks outlined above, relevant contextual information, methodology, timing and limitations.

1.3 Statutory Framework

This environmental assessment was conducted in accordance with the following Commonwealth and State legislation and guidelines:

- Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)
- Western Australian *Environmental Protection Act 1986* (EP Act) (1986)
- Western Australian *Biodiversity Conservation Act 2016* (BC Act)
- Department of Environment Water Heritage and the Arts (DEWHA 2013) Matters of National Environmental Significance. Significant impact guidelines 1.1 - *Environment Protection and Biodiversity Conservation Act 1999*.

As well as those listed above, the assessment complied with EPA requirements for environmental survey and reporting in Western Australia, as outlined in:

- Technical Guidance No 51 - Flora and Vegetation surveys for Environmental Impact Assessment (EPA 2016a).
- Environmental Factor Guideline – Flora and Vegetation (EPA 2016b)

1.3.1 Western Australian *Biodiversity Conservation Act 2016*

The Western Australian BC Act provides for the conservation, protection and ecologically sustainable use of biodiversity and biodiversity components in Western Australia.

Threatened species (both flora and fauna) that meet the categories listed within the BC Act are highly protected and require authorisation by the Minister to take or disturb. These are known as Threatened Flora and Threatened Fauna. The conservation categories of critically endangered, endangered and vulnerable have been aligned with those detailed in the EPBC Act, as below.

Flora and fauna species may be listed as being of special conservation interest if they have a naturally low population, restricted natural range, are subject to or recovering from a significant population decline or reduction of range or are of special interest, and the Minister considers that taking may result in depletion of the species. Migratory species and those subject to international agreement are also listed under the Act. These are known as specially protected species in the BC Act.

Threatened Ecological Communities are also protected under the BC Act and are categorised using the same criteria as threatened species.

1.3.2 Commonwealth *Environment Protection And Biodiversity Conservation Act 1999*

At a Commonwealth level, Threatened taxa are protected under the EPBC Act, which lists species that are considered Critically Endangered, Endangered, Vulnerable, Conservation Dependant, Extinct, or Extinct in the Wild. Detailed descriptions of these categories are summarised in Table A1, Appendix A.

The EPBC Act takes precedence over State legislation.

1.3.3 Threatened and Priority Flora

Conservation significant flora species are those that are listed as Threatened Flora (TF) and (within Western Australia) as Priority Flora (PF). TF species are listed as threatened by the Western Australian DBCA and protected under the provisions of the BC Act (DBCA 2018). Some State-listed TF are provided with additional protection as they are also listed under the Commonwealth EPBC Act.

Flora are listed as PF where populations are geographically restricted or threatened by local processes, or where there is insufficient information to formally assign them to TF categories. Whilst PF are not specifically listed in the BC Act, some may qualify as being of special conservation interest and these have a greater level of protection than unlisted species.

There are eight categories covering State-listed TF and four categories for PF species (DBCA 2019) which are outlined in Table A2 and Table A3, Appendix A (noting that the definitions for TF included in the BC Act have been aligned with those in the EPBC Act). PF for Western Australia are regularly reviewed by the DBCA whenever new information becomes available, with species status altered or removed from the list when data indicates that they no longer meet the requirements outlined in Table A.3, Appendix A.

1.3.4 Other Significant Flora

According to the Flora and Vegetation Technical Guidance (EPA 2016a) other than being listed as Threatened or Priority Flora, a species can be considered as significant if it is:

- locally endemic or in association with a restricted habitat type (e.g., Groundwater Dependent Ecosystems, Sheet Flow Dependent Vegetation)
- a new species or has anomalous features that indicate a potential new species at the extremes of range, recently discovered range extensions (generally considered greater than 100 km or in a different bioregion), or isolated outliers of the main range;
- unusual species, including restricted subspecies, varieties or naturally occurring hybrids;
- relictual status, being representative of taxonomic groups that no longer occur widely in the broader landscape.

1.3.5 Threatened Ecological Communities

1.3.5.1 Nationally Listed Threatened Ecological Communities

Ecological communities are naturally occurring biological assemblages associated with a particular type of habitat. At Commonwealth level, Threatened Ecological Communities (TECs) are protected under the Commonwealth EPBC Act. Criteria for EPBC listed TECs are summarised in Table A4, Appendix A.

1.3.5.2 State Listed Threatened Ecological Communities

The Western Australian DBCA also maintains a list of TECs which are further categorised into three subcategories much like those of the EPBC Act. The full details of DBCA criteria are shown in Table A5 in Appendix A.

1.3.5.3 State Listed Priority Ecological Communities

DBCA maintains a list of Priority Ecological Communities (PECs). PECs include potential TECs that do not meet survey criteria, or that are not adequately defined. Definitions for PECs are summarised in Table A6, Appendix A.

1.3.6 Introduced Flora

Introduced plant species, known as weeds, are plants that are not indigenous to an area and have been introduced either directly or indirectly (unintentionally) through human activity. Species are regarded as introduced if they are listed as ‘alien’ on FloraBase (Western Australian Herbarium [WAH] 1998-2020).

1.3.6.1 Weeds of National Significance

At a national level there are thirty-two weed species listed as Weeds of National Significance (WONS) (Department of Agriculture, Water and the Environment 2020; Weeds Australia 2012). The Commonwealth National Weeds Strategy: A Strategic Approach to Weed Problems of National Significance (2012) describes broad goals and objectives to manage these species.

1.3.6.2 Declared Plants

The Western Australian Organism List (WAOL) details organisms listed as Declared Pests under the *Biosecurity and Agriculture Management Act 2007* (BAM Act). Under the BAM Act, Declared Pests are listed as one of the three categories as summarised in Table A7, Appendix A.

1.3.7 Environmentally Sensitive Areas

There are a number of areas around Western Australia identified as being of environmental significance within which the exemptions to the Native Vegetation Clearing Regulations do not apply. These are referred to as Environmentally Sensitive Areas (ESAs), and are declared under section 51B of the EP Act and described in the Environmental Protection (Environmentally Sensitive Areas) Notice (Government of Western Australia 2005).

1.3.8 Conservation Estate

The National Reserve System is a network of protected areas managed for conservation under international guidelines. The objective of placing areas of bushland into the Conservation Estate is to achieve and maintain a comprehensive, adequate and representative reserve system for Western Australia. The Conservation and Parks Commission is the vesting body for conservation lands, forest and marine reserves that are managed by DBCA.

2. DESKTOP ASSESSMENT OF EXISTING ENVIRONMENT

2.1 Physical Environment

2.1.1 Climate

The climate of the survey area is arid, semi-desert to subtropical with variable summer and winter rainfall. Cyclonic activity can be significant, and cyclonic systems may affect the coast and hinterland annually (Kendrick & Mau 2002).

Figure 2 outlines the rainfall and temperature data for the Survey Area. The closest Bureau of Meteorology (BoM) site recording rainfall is Exmouth Town (Station ID 5051, operating since 1968; BoM 2021), approximately 15 km east of the Survey Area. The mean annual rainfall is 283.3 mm, 78% of which falls in the first 6 months of the year (summer-autumn) period.

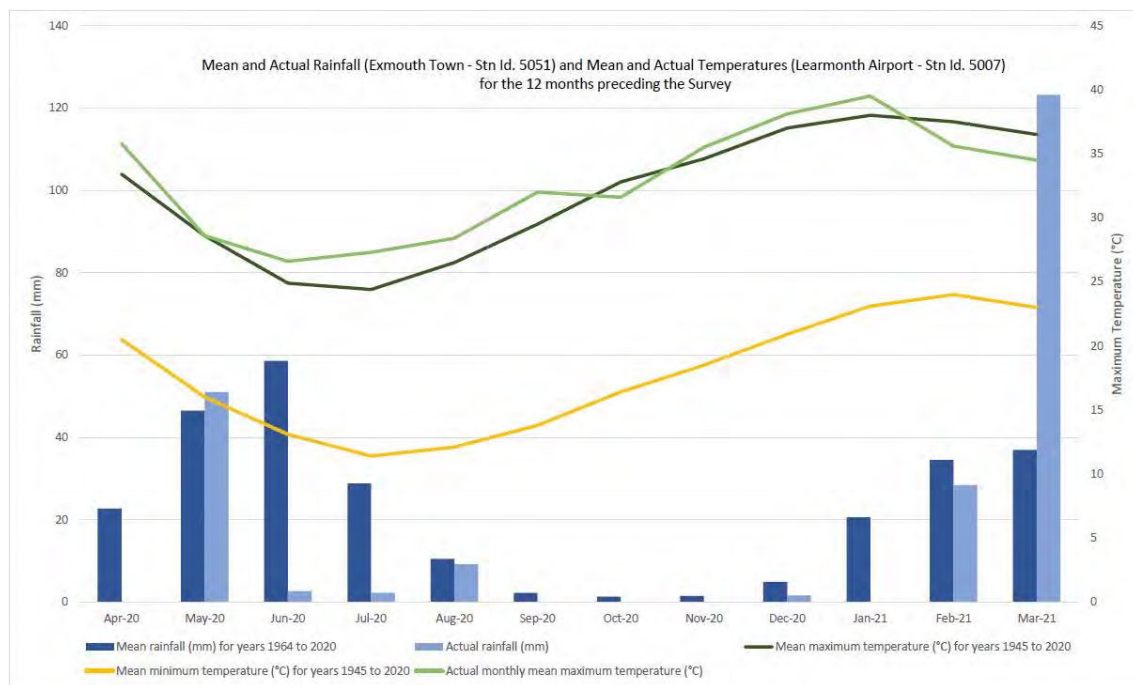


Figure 2. Rainfall (Exmouth Town Stn Id. 5051) and Temperature (Learmonth Airport Stn Id. 5007) Data for the Survey Area

In the six month period prior to the survey being undertaken, a total of 153.2mm of rain had been recorded at the Exmouth Town weather station (Station ID 5051) (BoM 2021). This rainfall is above average for that period due to a significant rainfall event in early March 2021. A further 75 mm of rain, associated with Cyclone Seroja was received in the week prior to the survey being undertaken.

The nearest BoM station recording temperatures is Learmonth Airport (Station ID 5007, operating since 1945), located approximately 38.5 km south-east of the Survey Area. January is the hottest month with a mean maximum temperature of 38°C and mean minimum of 23.1°C, and July is the coldest month with a mean maximum temperature of 24.4°C and mean minimum of 11.4°C (BoM 2021).

Actual mean monthly temperatures during the first couple of months of the summer period (December 2020 and January 2021) were higher than the long-term mean by a couple of degrees,

whilst the two months prior to the survey (February 2021 and March 2021) had actual mean maximum monthly temperatures approximately 2°C lower than the long-term mean (BoM 2021).

2.1.2 Wetlands and Drainage

Tantabiddi Creek flows through the north-eastern section of the survey area. The TBFP will be located outside of the creek boundaries.

The survey area lies within an area described as ‘Cape Range Subterranean Waterways’ wetland, which is included in the Directory of Important Wetlands of Australia (Environment Australia 2001). This wetland listing consists of waterways, sinkholes, general groundwater and artificial wells, with the main ecological feature being entirely subterranean fauna. The Tantabiddi Sinkhole is located approximately 100 m from the proposed development envelope and is a known site for at least one Threatened Stygofauna species. This subterranean fauna aspect will be addressed in a separate report.

2.1.3 Environmentally Sensitive Areas

The survey area falls within an ESA (Landgate 2021). It is unlikely that the ESA refers to any aspects relevant to the flora and vegetation or terrestrial fauna of the survey area and is more likely associated with its proximity to conservation lands (Jurabi Coastal Park and Ningaloo Marine Park) or its proximity to the Cape Range Subterranean Waterways wetland.

2.1.4 Conservation Lands

The survey area lies within the Jurabi Coastal Park and adjacent to the Ningaloo Marine Park. The Cape Range National Park is located approximately 2 km south of the southernmost extent of the survey area.

2.1.5 Land Systems

Land systems of the Carnarvon Basin were mapped and described by the Department of Agriculture (now the Department of Primary Industries and Regional Development (DPIRD)) with comprehensive descriptions of biophysical resources, including soil and vegetation condition. The survey area occurs within the Learmonth land system described as ‘sandy outwash plains marginal to the Cape Range, supporting mainly soft spinifex hummock grasslands with scattered acacia shrubs’ (Payne et al. 1980).

2.1.6 Land Use and Tenure

The survey area is located within the Shire of Exmouth and is located within Unallocated Crown Land (UCL) and Temporary Reserve TR/2614. The areas adjoining the survey location are currently used for recreational activities.

2.2 Biological Environment

2.2.1. Interim Biogeographic Regionalisation of Australia

The Interim Biogeographic Regionalisation for Australia (IBRA version 7) divides the Australian continent into 89 bioregions and 419 subregions (Department of the Environment and Energy 2018). The IBRA regions represent a landscape-based approach to classifying the land surface, including attributes of climate, geomorphology, landform, lithology, and characteristic flora and fauna. The survey area occurs in the Carnarvon bioregion, of which approximately 10% to 15% is represented in the national reserve system (Department of Sustainability, Environment, Water, Population and Communities 2013)

The biodiversity of the 53 subregions recognised in Western Australia was documented as part of a national audit to provide priorities for conservation action (Department of Conservation and Land Management 2002). All of the survey areas fall within the Carnarvon bioregion which is described as “a mosaic of saline alluvial plains with samphire and saltbush low shrublands, Bowgada low woodland on sandy ridges and plains, snakewood scrub on clay flats, and tree to shrub steppe over hummock grasslands on and between red sand dune fields. Limestone strata with *Acacia stuartii** or *A. bivenosa* shrubland outcrop in the north, where extensive tidal flats in sheltered embayments support mangroves (Kendrick and Mau 2002)”.

The TBFP survey area, lies within the Cape Range subregion (CAR01) of the Carnarvon bioregion, described as (Kendrick and Mau, 2002):

The Carnarvon bioregion is composed of quaternary alluvial, aeolian and marine sediments overlying Cretaceous strata. A mosaic of saline alluvial plains with samphire and saltbush low shrublands, Bowgada low woodland on sandy ridges and plains, Snakewood scrub on clay flats, and tree to shrub steppe over hummock grasslands on and between red sand dune fields. Limestone strata with Acacia stuartii or A. bivenosa shrubland outcrop in the north, where extensive tidal flats in sheltered embayments support mangal.

Cape Range and Giralia dunefields form the northern part of Carnarvon Basin. Rugged tertiary limestone ranges and extensive areas of red aeolian dunefield, Quaternary coastal beach dunes and mud flats. Acacia shrublands over Triodia on limestone (Acacia stuartii or A. bivenosa) and red dunefields, Triodia hummock grasslands with sparse Eucalyptus trees and shrubs on the Cape Range. Extensive hummock grasslands (Triodia) on the Cape Range and eastern dunefields. Tidal mudflats of sheltered embayments of Exmouth Gulf support extensive mangroves. Beach dunes with Spinifex communities. An extensive mosaic of saline alluvial plains with samphire and saltbush low shrublands along the eastern hinterland of Exmouth Gulf. Islands of the Muiron, Barrow, Lowendal and Montebello groups are limestone-based. Climate is arid, semi-desert to subtropical climate, with variable summer and winter rainfall. Cyclonic activity can be significant, and cyclonic systems may affect the coast and hinterland annually. Subregional area for CAR1 is 2, 547, 911 ha.

2.2.2 Pre-European Vegetation

The Beard vegetation unit mapped within the survey area is System Association 663 which is described as hummock grassland with scattered shrubs or mallee, *Triodia* spp., *Acacia* spp. *Grevillea* spp. and *Eucalyptus* spp..

The pre-European current extents for Vegetation Association 663 (DBCAs 2019b) are listed in Table 1.

* *Acacia stuartii* does not occur within WA. Maybe this was meant to be *Acacia startii*.

Table 1. Pre-European Current Extents for Vegetation Association 663 (DBCA 2019b).

Region	Original Extent (ha)	Current Extent (ha)	% Remaining	% Current Extent Protected (IUCN I - IV) for Conservation (proportion of Pre-European Extent)
Western Australia	30,474.41	25,976.66	85.24	22.31
IBRA Biogeographic Region (Carnarvon)	29,068.26	25,866.32	88.98	23.29
IBRA Biogeographic Sub-region (Cape Range)	29,068.26	25,866.32	88.98	23.29
LGA (Shire of Exmouth)	30,474.41	25,976.66	85.24	22.31

2.2.3 Threatened and Priority Ecological Communities

A Protected Matters Search Tool (PMST) (DoEE 2021) search was conducted using a 10 km buffer from a central point of the Survey Area. The search did not identify any EPBC-listed TECs within the search area buffer.

A review of the State listed TECs and PECs did not identify any within the Survey Area.

2.2.4 Threatened and Priority Flora

The PMST search did not identify any EPBC listed TF or potentially suitable habitat that may or is likely to occur within the 20 km search buffer area.

Naturemap database search results indicated that no Threatened (T) flora species, eight Priority (P) 2, six P3 and two P4 species have been recorded within 20km of the Survey Area (DBCA 2007-2019).

2.2.4.1 Threatened and Priority Flora Likelihood Assessment

Habitat requirements of conservation significant flora species identified from the database and literature searches were assessed to determine whether suitable habitat was present within the survey locations. Descriptions of criteria utilised by VLA to assess the likelihood of species occurrence within the survey locations are presented in Table 2.

Table 2: Likelihood of occurrence of Priority Flora criteria.

Likelihood of Occurrence	Desktop Criteria
Likely	<ul style="list-style-type: none"> Species has been recorded before in survey area or within 10 km of the Survey Areas Known to be present in the Survey Areas based on site observations (expert advice) Species has been recorded within the same habitat as occurs in the Survey Areas
Potential	<ul style="list-style-type: none"> Species has been recorded within 20 km of the Survey Areas Species reported as known in the Survey Areas by local community Species has been recorded within the same habitat type as occurs in the Survey Areas.

Likelihood of Occurrence	Desktop Criteria
Unlikely	<ul style="list-style-type: none"> • Species has not been recorded within 20 km of the Survey Areas • No suitable habitat occurs in the Survey Areas

Following the surveys, the conservation significant flora species identified during the desktop assessment as having the highest potential to occur within the survey locations, but not recorded during the current surveys, were again assessed to determine their likelihood of occurrence within the survey locations. Post-field survey likelihood was primarily based on validating the presence (and thorough inspection) of suitable habitats within each of the survey locations, combined with life form, habitat and flowering information for each flora species.

Table 3 summarises the Likelihood of Occurrence assessment for the survey area, for the 16 species previously recorded within 20 km of the survey area. The coastal habitat of the Survey Area precludes Priority Flora that are likely to be found 20 km inland on the Range itself, a different geology and habitat.

Table 3. Likelihood of occurrence of Priority Flora within the Survey Area

Species	Conservation Status	Habitat	Likelihood of Occurrence	
			Pre-survey	Post survey
<i>Acacia alexandri</i>	P3	Open or moderately dense, sometimes wispy shrub, 1.5-3 m high. Fl. cream, Jun or Aug to Sep. Limestone. Stony creeks, steep rocky slopes.	Unlikely	Unlikely
<i>Acacia ryaniana</i>	P2	Prostrate, straggly or domed, spinescent shrub, 0.1-0.4 m high. Fl. yellow, Jun to Nov. White or red sand. Coastal sand dunes.	Potential	Unlikely
<i>Acacia startii</i>	P3	Dense, rounded, much-branched shrub, 1-2 m high, to 3 m wide. Fl. green-yellow, Jul to Aug. Calcareous loam with limestone pebbles. Stony hills & watercourses.	Potential	Unlikely
<i>Acanthocarpus rupestris</i>	P2	Rhizomatous, tufted perennial, herb, to 0.5 m high. Fl. white, May to Jun. Red sand, limestone.	Unlikely	Potential
<i>Brachychiton obtusilobus</i>	P4	Tree, 3.5-6 m high. Fl. cream, Aug to Sep. Skeletal soils. Rocky limestone ranges, gorges, occasionally sandplains.	Unlikely	Unlikely
<i>Calandrinia</i> sp. Cape Range (F. Obbens FO 10/18)	P2		Unlikely	Unlikely
<i>Corchorus congener</i>	P3	Spreading shrub, to 0.6 m high. Fl. yellow, Apr to Jun or Aug to Nov. Sand, red sandy loam with limestone. Sand dunes, plains.	Likely	Unlikely

Species	Conservation Status	Habitat	Likelihood of Occurrence	
			Pre-survey	Post survey
<i>Daviesia pleurophylla</i>	P2	Divaricately branched shrub, around 0.7 m high. Occurs on sand dunes.	Likely	Unlikely
<i>Eremophila forrestii</i> subsp. <i>capensis</i>	P3	Sparsely to much-branched shrub, to 1.4 m high. Brown rocky soils, limestone. Ridges.	Unlikely	Unlikely
<i>Eremophila occidens</i>	P2	Shrub, to 1.5 m high. Fl. purple-violet, Aug to Sep. Orange/brown sand. Limestone ranges, dunes.	Unlikely	Unlikely
<i>Eremophila youngii</i> subsp. <i>lepidota</i>	P4	Dense, spreading shrub, (0.2-)1-3 m high. Fl. purple-red-pink, Jan or Mar or Jun or Aug to Sep. Stony red sandy loam. Flats plains, floodplains, sometimes semi-saline, clay flats.	Unlikely	Unlikely
<i>Grevillea calcicola</i>	P3	Small straggly tree or shrub (several-stemmed), to 4 m high. Fl. cream-white, May or Jul to Aug. Limestone hilltops.	Unlikely	Unlikely
<i>Harnieria kempeana</i> subsp. <i>rhadinophylla</i>	P2	Erect or sprawling, spreading, straggly shrub, to 1 m high. Fl. pink/red-purple, May to Sep. Calcareous loam. Amongst limestone rocks, creek banks.	Unlikely	Unlikely
<i>Phyllanthus fuernrohrii</i> (Sand Sponge)	P3		Likely	Unlikely
<i>Tephrosia</i> sp. North West Cape (G. Marsh 81)	P2		Unlikely	Unlikely

Species	Conservation Status	Habitat	Likelihood of Occurrence	
			Pre-survey	Post survey
<i>Tinospora esiangkara</i>	P2	Climber, to 2 m high, large stems with brown, flaky bark. Fl. green, Jul. Pebbly orange-brown calcareous loam. Limestone outcrops or ridges, near creek bank.	Unlikely	Unlikely

2.2.5 Declared Plants and WoNS Weeds

Significant weed species are identified at both the State and National level. At a State level the management of weeds in Western Australia is primarily regulated through the *Biosecurity and Agriculture Management Act 2007* (BAM Act). Species listed under this Act are allocated one of three declared pest categories which define the required level of management (Department of Primary Industries and Regional Development 2019). The Australian Weeds Strategy (Australian Weeds Committee 2012) identifies 'Weeds of National Significance' (WoNS) which have the potential to impact primary industry and/or environmental and social values. The management of weeds in Western Australia is primarily regulated through the *Biosecurity and Agriculture Management Act 2007* (BAM Act). Declared pest categories and listed weed species' priority ratings are presented in Table A.7 (Appendix A).

Forty-eight s22 Declared Pest species were identified in a WAOL search (Department of Primary Industries and Regional Development 2021) for the Shire of Exmouth and 'Whole of State' i.e. they are Declared Pest plants in the Shire of Exmouth. According to NatureMap (DBCA 2007-2019, accessed 15 April 2021), two species, *Lantana camara* and *Parkinsonia aculeata* have been recorded within 20 km of the Survey Area.##

There are 32 WoNS listed for Australia (DoEE 2021). Two species, *Lantana camara* and *Parkinsonia aculeata*, which are also listed as s22 Declared Pests, have been recorded within 20 km of the Survey Area (DBCA 2007-2021, accessed 15 April 2021).

2.3 Literature Review

The following assessments which have been previously conducted in the general vicinity of the survey area were reviewed as part of the desktop assessment:##

- Trudgen M. T., (1994) A Flora and Vegetation Survey of the Conservation Values for Flora and Vegetation in the Area Proposed for the Coral Coast Marina. *Unpublished report in the Public Environmental Review for Marina Development Pty Ltd (1994)*
- GHD (2008a) Material Pit SLK 174 – 175.5 Minilya – Exmouth Road Targeted Flora Survey *unpublished report for Main Roads Western Australia.*
- GHD (2008b) Passing Lanes and Materials Pit Minilya Exmouth Road Targeted Flora Survey unpublished report for Main Roads Western Australia. The report documents a targeted flora survey of several small areas adjacent to the main road 10-28 km south of Exmouth. There were no significant findings during the field survey.
- Astron Environmental Services (2009), Exmouth Wastewater Treatment Plant Land Acquisition Flora, Vegetation and Fauna Survey. The survey of approximately 200 ha adjacent to the town of Exmouth identified 16 vegetation types (none of conservation significance) of varying condition depending on weed density, 79 vascular flora species (two P3 species, *Corchorus congener* and *Gymnanthera cunninghamii*).
- DEC (2009) A priority flora search was conducted in September and October of 2009 in the Cape Range National Park. Five priority listed species were recorded in this survey, *Brachychiton obtusilobus* (Priority 4), *Grevillea calcicola* (Priority 3), *Eremophila forrestii*

subsp. *capensis* (Priority 3), *Corchorus congener* (Priority 3) and *Tinospora esiangkara* (Priority 2).

- Ecoscape (2009), Flora and vegetation survey, Market Street, Exmouth, detailing the flora and vegetation survey of 3.5 ha within the town site of Exmouth. The survey identified a single vegetation type in Completely Degraded or Degraded condition and 35 vascular flora species.
- Meissner (2010a), Biodiversity values of basic raw material sites within Cape Range National Park, reported on the assessment of biodiversity values of eight existing borrow pits and two sites on UCL. This site was dominated by *Acacia bivenosa* and *Senna glutinosa* subsp. *pruinosa* over *Triodia epactia* and *Triodia basedowii*, with *Acanthocarpus humilis*, *Melaleuca cardiophylla* and *Acacia gregorii* on an adjacent limestone ridge. Two priority-listed flora species were recorded from the site; *Eremophila forrestii* subsp. *capensis* and *Corchorus congener*, both P3.
- Meissner (2010b), Biodiversity values of Unallocated Crown Land on Cape Range Peninsula, Western Australia, reported on the natural values of UCL on Cape Range Peninsula including the survey area. The report notes three broad vegetation types; vegetation on limestone hills and ranges, coastal plain vegetation and vegetation of red sand dunes.
- 360 Environmental (2015) conducted a Level 1 Flora and Vegetation Assessment on Truscott Crescent, Exmouth in February 2015. The Survey Area was approximately 23.1 ha in size and was located in the Cape Range biogeographic region of Western Australia. A total of 69 taxa were identified during the survey, with the most commonly occurring families being Fabaceae, Poaceae and Asteraceae (360 Environmental 2015).
- Astron (2016) Exmouth Environmentally Sensitive Area: SLK 185 to 201.02 and 178.69 to 179.51 Biological Survey October 2016 unpublished report for Main Roads Western Australia. The survey identified 178 vascular flora species including five species of conservation significance; *Acacia alexandri* P3, *Corchorus congener* P3, *Gymnanthera cunninghamii* P3, *Stackhousia umbellata* P3 and *Tephrosia* sp. North West Cape (G. Marsh 81) P2. All these species have previously been recorded in the area.
- 360 Environmental (2017), Australian Bundle Site. Detailed Flora and Vegetation Assessment, detailing the investigation of a 535 ha site 35 km south of Exmouth. The survey identified 74 vascular flora taxa including one of conservation significance (*Corchorus congener*, P3) that was considered to be widespread within the survey area and beyond, 10 natural vegetation types and the vegetation was in Very Good to Completely Degraded condition, with Buffel Grass (*Cenchrus ciliaris*) contributing significantly to the vegetation condition.
- VLA (2019) undertook flora and vegetation assessments at seven locations along the Coral Coast, which were being investigated as sites for carparks, roads and other capital works. Vegetation recorded at Maud's Landing was comparable to that mapped by Trudgen (1994), with key component species recorded in the vegetation typical of coastal habitat recorded further north. A couple of species of conservation significance, *Acacia ryaniana* (P2) and *Acacia startii* (P3) were recorded in the coastal locations.
- Ecoscape (2020) was commissioned by Main Roads to undertake a biological survey of an area comprising 42.73 hectares including a detailed flora and vegetation and a basic fauna survey for the diversion of Yardie Creek Road, as part of the redevelopment of the Ningaloo Lighthouse Caravan Park. The field surveys identified 170 vascular flora species including

seven Priority Flora; *Daviesia pleurophylla* (P2), *Tinospora esiangkara* (P2), *Corchorus congener* (P3), *Eremophila forrestii* subsp. *capensis* (P3), *Grevillea calcicola* (P3), *Stackhousia umbellata* (P3), *Brachychiton obtusilobus* (P4). One of potential taxonomic interest (*Alyogyne pinoniana*) and two of potential other significance (*Olax aurantia* as a disjunct population and *Owenia reticulata* as a range extension) were also recorded.

The flora, vegetation and other environmental values identified from these reports were reviewed to put the current survey into a local biological context.

3. METHODOLOGY

3.1 Flora and Vegetation Survey

The reconnaissance flora and vegetation survey was conducted by Principal botanist and ecologist Vicki Long (VLA) (Flora Permit FB62000120; Threatened Flora Permit TFL 29-1920) during the week 19 April 2021 – 21 April 2021.

Vicki has lived and worked in the Pilbara for the past 36 years, establishing Astron Environmental as an arm of Astron Engineering Pty Ltd in 1987, and more recently Vicki Long & Associates. Vicki specialises in north-west coastal environment studies and has conducted coastal surveys from Shark Bay to Derby on the mainland. She has surveyed over 30 sand cays between Exmouth and Dampier, and was the first botanist to survey the Dampier Archipelago Islands. She has considerable experience identifying both native flora and vegetation and introduced flora of the Eremaean zone. The surveys were undertaken in accordance with the requirements outlined in the Scope of Works provided.

Information acquired during the desktop assessment assisted in the design of the field surveys. The survey area was clearly delineated on aerial imagery, produced both as hard paper copies and on a field Trimble. Previously recorded conservation significant flora records and associated habitat preference information assisted in identifying vegetation types and habitats within the survey area that have the potential to support conservation significant flora.

Within the survey area, different vegetation types apparent on the aerial imagery were ground-truthed to roughly define their boundaries. The vegetation and flora were assessed using unmarked 50m x 50m relevés located within the different vegetation types. A minimum of three relevés per vegetation formation, and two within each vegetation type were sampled. Mapping notes were also made to support vegetation description and opportunistic records of flora not found in relevés were also noted. This was considered necessary to provide baseline data against which any future monitoring for revegetation of disturbance may be assessed.

In each vegetation type, the following were recorded:

- Site number
- Date
- Photo number (taken from NW corner of quadrat)
- Approximate size of area
- Location - coordinates measured using a handheld Global Positioning System (GPS) (MGA50, GDA94 at SE and NW corners (approximate))
- Habitat - a broad description of the surrounding landscape based on landform, topography and soil.
- Vegetation description – vegetation types were described according to level 5 of the National Vegetation Information System (ESCAVI 2003). At this level, vegetation is described to ‘association’ where up to three dominant genera for each of the upper, mid and ground strata are categorised based on dominant growth form, cover and height.
- Vegetation condition – assessed according to the vegetation condition classification of Trudgen (1988), as adapted in EPA (2016a) (Table B1, Appendix B).
- Species – vascular plant species present, including weed species.

- Percent Foliar cover – the estimated percentage cover for each flora species.
- Priority flora and the respective GPS location (or any suspected Priority flora)
- Location of any Declared Pests or WoNS.

General notes were made regarding the site ecology and any other issues considered relevant to the results.

Species were identified in the field by the Principal botanist. Any species not able to be identified in the field were collected, labelled and pressed for later identification by Vicki Long (utilising the Pilbara Regional Herbarium) or sent to the WA Herbarium. Priority species identified in the field or any suspected Priority species were located with GPS, photographed and collected for confirmation / identification by the WA Herbarium.

3.2 Limitations

Following completion of the desktop assessment and field surveys, a review of any limitations that may have affected a complete assessment of the data collected was conducted.

Table 4 is based on those suggested as considerations in Section 10.2 of the Technical Guidance – Flora and Vegetation Surveys for Environmental Impact Assessment (EPA 2016a)

Table 4: Statement of limitations

Potential limitation	Statement regarding potential limitations
<p>(i) Sources of information and availability of contextual information Is the region well documented?</p>	<p>Previous biological surveys have been conducted in the broader regional area, and broad-scale information is available from Beard (1975) and Payne et al. (1980). Numerous surveys have been undertaken in the region, however only one study very briefly mentions this part of the coastline. Contextual information is therefore not a limiting factor for this survey but localized information was more so.</p>
<p>(ii) Scope The level of survey and detail required to undertake the survey. Was there adequate time to complete the survey to the desired standard?</p>	<p>There was adequate time to complete the reconnaissance flora and vegetation survey within the survey area. Time was not considered a limiting factor.</p>
<p>(iii) Proportion of flora and fauna identified, recorded and/or collected Was the survey sampling, timing and intensity considered adequate? Was the survey conducted at what was considered an appropriate time of the year for plant identification? Were any taxonomic groups considered to be under-represented?</p>	<p>The flora and vegetation field survey was conducted during mid-April. The region had experienced significant rainfall in early March. Further rainfall, 71 mm associated with Cyclone Seroja Sampling occurred a week prior to the survey but would not had time to affect this survey. Intensity was considered adequate for a wet season survey; the flora taxonomic groups recorded within the survey area were considered well represented for a wet season.</p>

Potential limitation	Statement regarding potential limitations
<p>(iv) Completeness Is there further work which may be required i.e. was the relevant area fully surveyed?</p>	<p>The survey areas were considered adequately surveyed to compile representative lists of species, (including Priority and introduced flora species), as well as describe vegetation at a level appropriate for management decisions.</p> <p>The survey areas were comprehensively surveyed and as such completeness of the reconnaissance survey is not a limiting factor.</p>
<p>(v) Mapping reliability Were the aerial photographs, satellite images and site maps available considered adequate to fully understand the area surveyed? Was the mapping generated considered to have a high degree of reliability?</p>	<p>Colour aerial photography at a scale of 1:10,000 was used to locate the survey areas and to assist in navigation and delineation of vegetation boundaries. The aerial photography was of good resolution and, in general, accurately represented ground conditions. As such mapping reliability was not considered a limiting factor.</p>
<p>(vi) Timing When was the survey conducted in terms of season, rainfall, severe weather events etc. Was the survey conducted at an appropriate time for access, observation of the optimal suite of species and for identification of flowering and fruiting species?</p>	<p>Timing was appropriate to a wet season survey and a comprehensive list of species was recorded accordingly. Annual flora present in the drier third quarter of the year, (eg Asteraceae species, Amaranthaceae etc) were not well represented.</p>
<p>(vii) Disturbance Had the survey area been impacted by any disturbance which may have limited the survey, i.e. fire, flood, accidental human intervention etc.?</p>	<p>Anthropogenic disturbance on the site was historic and not a limitation to the survey. Natural disturbance is expected on coastal dune systems and not considered a limitation.</p>
<p>(viii) Intensity In retrospect, was the intensity considered to be adequate?</p>	<p>The intensity of the survey was considered adequate to compile representative species lists. Intensity was not considered a limiting factor.</p>
<p>(ix) Resources Were the appropriate tools and materials available to complete the task effectively?</p>	<p>Resources were adequate to complete the survey and all appropriate tools and materials required to complete the task were available. Resources were not considered a limiting factor.</p>
<p>(x) Access Were there any factors limiting access to the survey area?</p>	<p>The entire survey area was traversed on foot. As such, access is not considered a limiting factor.</p>
<p>(xi) Experience Were personnel undertaking the field survey and plant identification trained and/or experienced in undertaking the required tasks?</p>	<p>The Principal Botanist responsible for undertaking the field survey has considerable (36 years) experience in conducting vegetation and flora surveys especially on the NW coastline. The identification of specimens brought back from the field was conducted either by the Principal Botanist or by botanists at the WA Herbarium.</p> <p>Personnel experience was not considered a limiting factor.</p>

4. RESULTS

4.1 Flora and Vegetation Survey

A total of 12 relevés were searched (Sites 1-12) and an additional 11 mapping notes (MN-01-MN-11) were made to confirm vegetation types within the survey area (Figure 3). These searches resulted in the identification of eight Broad Floristic Formations (NVIS Level 3) and 14 more detailed Vegetation Types (NVIS Level 5). One further vegetation type, *Cenchrus ciliaris* tussock grassland, bordering road verges was recorded, but no relevé was made. One single Priority 2 species *Cucumis* sp Barrow Island (DW Goodall 1264) was recorded.

4.1.1 Vegetation

The vegetation within the Survey Area was dictated by the six, fine scale, geomorphologic types found there:

- the strandline, beach plateau and seaward side of the primary dune, with loosely consolidated white beach sands containing marine fragments, vegetated by *Spinifex longifolius* tussock grass;
- the distinct broad swale between the primary and secondary dune, with more consolidated pale pink beach sands, marine fragments and limestone fragments, with very open coastal *Eulalia aurea* tussock grass and scattered *Acanthocarpus verticillatus* low shrubs;
- a secondary dune, with pale pinkish/red sands, with *Acacia* spp and mixed coastal shrubs over *Triodia epactia* hummock grass;
- the coastal plain, with pinkish brown silts or loams, sometimes with scattered limestone fragments, broadly a mosaic of *Atriplex bunburyana* low shrubs with areas of *Triodia epactia*/**Cenchrus ciliaris* grassland with open to scattered *Acacia* spp shrubs, or *Frankenia pauciflora* low shrubs over *Sporobolus virginicus* on low, loamy areas of the plain;
- the semi-saline creek mouth and drainage areas, with darker brown sands, with *Frankenia pauciflora*, *Tecticornia* spp and *Sporobolus virginicus* tussock grassland.

The dune system (primary and secondary) and coastal plain within the area currently marked for the development envelope is stable, due to it being well vegetated. This contrasts with the dune habitat further south on the lease and to the north, well beyond the lease. These areas present mobile, eroded, very poorly vegetated dunes and demonstrate the results of impacting dunal habitat.

The condition of the vegetation is variable and some previous impacts including tracks, two small borrow pit/ soil dump areas with associated tracks and road infrastructure have resulted in buffel grass invasion.

Detailed field data sheets and mapping notes are summarised in Appendix C, together with vegetation descriptions for each site.

4.1.1.1 Vegetation Condition

Vegetation condition was assessed using the Trudgen (1988) condition scale, as recommended by the EPA (2016). It is rated predominantly on external factors such as man-made disturbance, fire, clearing, grazing and weeds and does not account for seasonality (dry conditions where flora may be dormant and dry) or the impacts of natural events such as coastal processes and cyclones.

According to this assessment scale, four sites were considered “excellent”, meaning there was no obvious signs of damage caused by human activity. These areas were predominantly vegetation on the coastal plain dominated by *Frankenia pauciflora* over *Sporobolus virginicus* grassland and samphire vegetation around the creek mouth. Three sites were classified as “very good” associated with the coastal beach and dune area (primary and landward side of secondary dune), although these were not weed infested, they showed some signs of anthropogenic disturbance causing aggravation of natural coastal processes and areas of erosion. Two sites were “good” associated with the more naturally disturbed crest of the secondary dune and some subsequent buffel grass invasion, one site was “poor” and one (the road verge) “degraded” due to buffel grass invasion. Two sites were scored “poor-good”, based on patchy localised areas of abundant buffel grass in otherwise good vegetation.

Vegetation condition ratings for each vegetation type identified in the survey area given in Table 5 and shown on Figure 4.

Table 5: Vegetation by Broad Floristic Formation and Vegetation Type according to Habitat within the Survey Area

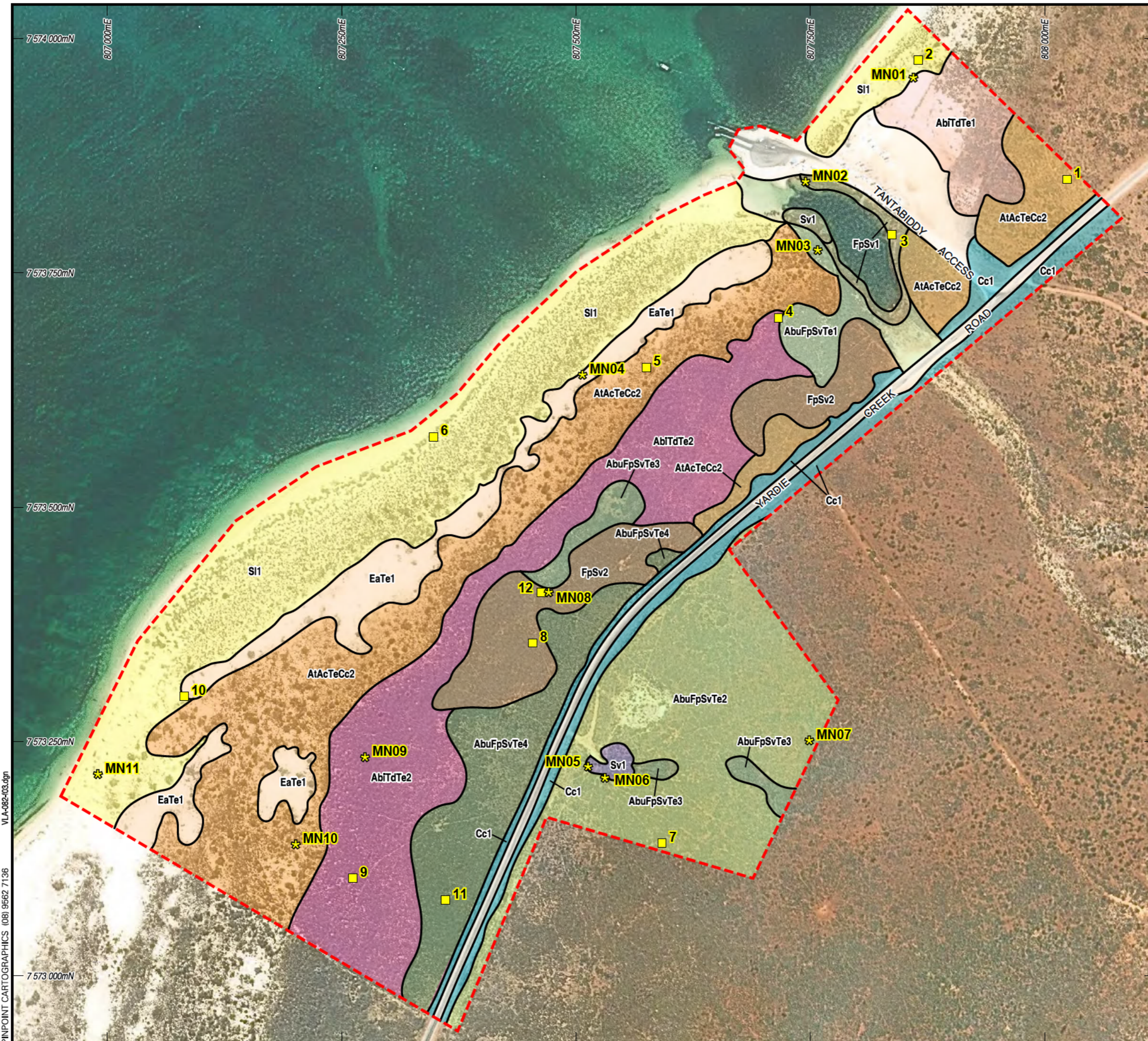
Mapping Code	Vegetation broad floristic formation and Vegetation Types within it.			
AtAcTeCc	Acacia tetragonophylla mixed shrubland over <i>Enchyleana tomentosa</i> low open shrubland over mixed <i>Triodia epactia</i> hummock and *<i>Cenchrus ciliaris</i> tussock grassland			
Vegetation Type	Sites Sampled	Habitat	Vegetation Condition ¹	
AtAcTeCc1	<i>Olearia</i> sp Kennedy Range (G. Byrne 66) with <i>Acacia tetragonophylla</i> open shrubland to low open shrubland over mixed * <i>Cenchrus ciliaris</i> tussock grassland with <i>Triodia epactia</i> hummock grassland with patchy <i>Eriachne obtusa</i>	1 and MN9	Coastal plain extending between beach sands and range with pinkish sands extending to secondary dune ridge	Poor
AtAcTeCc2	<i>Acacia tetragonophylla</i> with <i>Acacia coriacea</i> , <i>Acacia bivenosa</i> and <i>Olearia</i> sp Kennedy Range (G. Byrne 66) open shrubland over <i>Threlkeldia diffusa</i> , <i>Enchylaena tomentosa</i> open low shrubland over low open shrubland over mixed <i>Triodia epactia</i> hummock and * <i>Cenchrus ciliaris</i> tussock with patchy <i>Eriachne obtusa</i> .	Sites 5 and MN 10	Remnant secondary dune fringing coastal swale with fine pale pinkish sands.	Good
AbiTdTe	Acacia bivenosa scattered to open shrubland over <i>Threlkeldia diffusa</i> scattered to open low shrubland over <i>Triodia epactia</i> hummock grassland.			
Vegetation Type	Sites Sampled	Habitat	Vegetation Condition	
AbiTdTe1	<i>Acacia bivenosa</i> shrubland over <i>Threlkeldia diffusa</i> , <i>Neobassia astrocarpa</i> low shrubland over <i>Triodia epactia</i> open hummock grassland.	Site 2 (small disturbed area)	Revegetating disturbed area with old soil stockpiles with pinky silts and gravels.	Good
AbiTdTe2	<i>Acacia bivenosa</i> , <i>Myoporum montanum</i> , <i>Rhagodia preissii</i> subsp <i>obovata</i> open, sometimes scattered shrubland over <i>Triodia epactia</i> hummock grassland with patchy <i>Sporobolus virginicus</i> . Very scattered * <i>Cenchrus ciliaris</i>	Site 9 and MN9	Toe of secondary dune gently inclining to coastal plain with fine pinky sands.	Very Good

Mapping Code	Vegetation broad floristic formation and Vegetation Types within it.			
FpSv	<i>Frankenia pauciflora</i> low closed shrubland over <i>Sporobolus virginicus</i> tussock grassland			
Vegetation Type	Site Sampled	Habitat		
FpSv1	<i>Frankenia pauciflora</i> , <i>Muellerolimon salicorniaceum</i> , closed low shrubland with <i>Tecticornia indica leiostachya</i> over <i>Sporobolus virginicus</i> tussock grassland.	Site 3 MN2	Perimeter of semi-tidal pool, draining from range but impacted by tides.	Excellent
FpSv2	<i>Lawrenca viridigrisea</i> scattered to open shrubland over <i>Frankenia pauciflora</i> closed low shrubland over <i>Sporobolus virginicus</i> tussock grassland.	Site 12 and MN8	Coastal plain low in elevation with soft sodic pinky-brown loams.	Excellent
AbuFpSvTe	<i>Atriplex bunburyana</i> open to closed shrubland with <i>Frankenia pauciflora</i> over mixed <i>Sporobolus virginicus</i>, <i>*Cenchrus ciliaris</i> tussock and <i>Triodia epactia</i> hummock grassland.			
Vegetation Type	Site Sampled	Habitat	Vegetation Condition	
AbuFpSvTe1	<i>Atriplex bunburyana</i> scattered to open low shrubs over <i>Threlkeldia diffusa</i> , <i>Frankenia pauciflora</i> low shrubland over <i>Sporobolus virginicus</i> tussock grassland	Site 4 and MN3	Low coastal area landward of secondary beach dune and outer fringes of tidal pool, pale grey sandy loam	Excellent
AbuFpSvTe2	<i>Pluchea ferdinandi-muelleri</i> , <i>Atriplex bunburyana</i> open, sometimes closed low shrubland over <i>Triodia epactia</i> hummock grassland with <i>*Cenchrus ciliaris</i> , <i>*Cenchrus setigera</i> and <i>Chrysopogon fallax</i> .	Site 7 MN7	Plain with pinky red sands and silty loams.	Good to Poor depending on localised <i>*Cenchrus</i> infestation
AbuFpSvTe3	<i>Atriplex bunburyana</i> low shrubland with <i>Frankenia pauciflora</i> over mixed <i>*Cenchrus ciliaris</i> and <i>Sporobolus virginicus</i> tussock grassland.	Site 8 and MN6	Coastal plain with grey-brown silty loams.	Poor
AbuFpSvTe4	<i>Atriplex bunburyana</i> shrubland to closed shrubland with occasional <i>Acacia bivenosa</i> over <i>Frankenia pauciflora</i> open low shrubland over a mosaic of mixed <i>Sporobolus virginicus</i> , <i>*Cenchrus ciliaris</i> tussock grassland and <i>Triodia epactia</i> hummock grassland.	Site 11	Coastal plain, low in elevation with pale pinky-brown sandy loams with limestone pebbles.	Good to Poor depending on <i>*Cenchrus ciliaris</i> which occurs in patches.

Mapping Code	Vegetation broad floristic formation and Vegetation Types within it.			
Sl	<i>Spinifex longifolius</i> open to closed tussock grassland.			
Vegetation Type	Site Sampled	Habitat	Vegetation Condition	
Sl1	<i>Spinifex longifolius</i> tussock grassland with patchy <i>Whiteochloa airoides</i> , <i>Eulalia aurea</i> . There are <i>Atriplex isitidea</i> shrubs fringing the shoreline. On deeply hummocked mobile sand dunes <i>Spinifex longifolius</i> is scattered to open and can include <i>Eulalia aurea</i>	Site 6 MN1 MN11	Beach plateau and landward side of foredunes with pale beige fine beach sands and fine marine fragments	Very Good
EaTe	<i>Eulalia aurea</i>, <i>Triodia epactia</i> scattered to open grassland			
EaTe1	<i>Eulalia aurea</i> and <i>Triodia epactia</i> scattered grasses over very scattered <i>Acanthocarpus verticillatus</i> .	Site 10 and MN4	Coastal swale between primary and secondary dune with pale beige sands and marine fragments.	Very Good
Sv	<i>Sporobolus virginicus</i> closed tussock grassland, scattered <i>Neobassia astrocarpa</i> low shrubs.			
Sv1	<i>Sporobolus virginicus</i> closed tussock grassland with scattered <i>Neobassia astrocarpa</i> low shrubs.	MN5 (small area only around sink hole)	Perimeter of sink hole with grey silty loams.	Excellent
Cc	*<i>Cenchrus ciliaris</i> tussock grassland with *<i>C. setiger</i>			
Cc1	* <i>Cenchrus ciliaris</i> closed tussock grassland with * <i>C. setiger</i>	Noted	Road verges to 5 m	Degraded

¹ Condition assessment according to Trudgen (EPA 2016a)

² Sent to herbarium for verification





0 50 100 150 200m
SCALE 1 : 4 000 at A3 (MGA zn49)

Legend

- - - Site Boundary
- Cadastral Boundary
- Proposed Development
- Releve Location
- * Mapping Note Location

Vegetation Types

Acacia tetragonophylla mixed shrubland over *Enchyleana tomentosa* low open shrubland over mixed *Triodia epactia* hummock and *Cenchrus ciliaris* tussock grassland

- AtAcTeCc1** - *Olearia* sp Kennedy Range (G. Byrne 66) with *Acacia tetragonophylla* open shrubland to low open shrubland over mixed *Cenchrus ciliaris* tussock grassland with *Triodia epactia* hummock grassland with patchy *Eriachne obtusa*.
- AtAcTeCc2** - *Acacia tetragonophylla* with *Acacia coriacea*, *Acacia bivenosa* and *Olearia* sp Kennedy Range (G. Byrne 66) open shrubland over *Threlkeldia diffusa*, *Enchyleana tomentosa* open low shrubland over low open shrubland over mixed *Triodia epactia* hummock and *Cenchrus ciliaris* tussock with patchy *Eriachne obtusa*.

Acacia bivenosa scattered to open shrubland over *Threlkeldia diffusa* scattered to open low shrubland over *Triodia epactia* hummock grassland

- AbiTdTe1** - *Acacia bivenosa* shrubland over *Threlkeldia diffusa*, *Neobassia astrocarpa* low shrubland over *Triodia epactia* open hummock grassland.
- AbiTdTe2** - *Acacia bivenosa*, *Myoporum montanum*, *Rhagodia preissii* subsp. *obovata* open, sometimes scattered shrubland over *Triodia epactia* hummock grassland with patchy *Sporobolus virginicus*. Very scattered *Cenchrus ciliaris*.

Frankenia pauciflora low closed shrubland over *Sporobolus virginicus* tussock grassland

- FpSv1** - *Frankenia pauciflora*, *Muellerolimon salicorniaceum*, *Sesuvium portulacastrum* closed low shrubland with *Tecticornia indica leiostachya* over *Sporobolus virginicus* tussock grassland.
- FpSv2** - *Lawrenzia viridigrisea* scattered to open shrubland over *Frankenia pauciflora* closed low shrubland over *Sporobolus virginicus* tussock grassland.

Atriplex bunburyana open to closed shrubland with *Frankenia pauciflora* over mixed *Sporobolus virginicus*, *Cenchrus ciliaris* tussock and *Triodia epactia* hummock grassland

- AbuFpSvTe1** - *Atriplex bunburyana* scattered to open low shrubs over *Threlkeldia diffusa*, *Frankenia pauciflora* low shrubland over *Sporobolus virginicus* tussock grassland.
- AbuFpSvTe2** - *Pluchea ferdinandi-muelleri*, *Atriplex bunburyana* open, sometimes closed low shrubland over *Triodia epactia* hummock grassland with *Cenchrus ciliaris*, *Cenchrus setigera* and *Chrysopogon fallax*.
- AbuFpSvTe3** - *Atriplex bunburyana* low shrubland with *Frankenia pauciflora* over mixed *Cenchrus ciliaris* and *Sporobolus virginicus* tussock grassland.
- AbuFpSvTe4** - *Atriplex bunburyana* shrubland to closed shrubland with occasional *Acacia bivenosa* over *Frankenia pauciflora* open low shrubland over a mosaic of mixed *Sporobolus virginicus*, *Cenchrus ciliaris* tussock grassland and *Triodia epactia* hummock grassland.

Spinifex longifolius open to closed tussock grassland

- SI1** - *Spinifex longifolius* tussock grassland with patchy *Whiteochloa airoides*, *Eulalia aurea*. There are *Atriplex istitidea* shrubs fringing the shoreline. On deeply hummocked mobile sand dunes *Spinifex longifolius* is scattered to open and can include *Eulalia aurea*.

Eulalia aurea, Triodia epactia scattered to open grassland

- EaTe1** - *Eulalia aurea* and *Triodia epactia* scattered grasses over very scattered *Acanthocarpus verticillatus*.

Sporobolus virginicus closed tussock grassland, scattered *Neobassia astrocarpa* low shrubs

- Sv1** - *Sporobolus virginicus* closed tussock grassland with scattered *Neobassia astrocarpa* low shrubs.

Cenchrus ciliaris tussock grassland with *C. seriger*

- Cc1** - *Cenchrus ciliaris* closed tussock grassland with *C. seriger*.

CADASTRAL SOURCE: Landgate, April 2021.
AERIAL PHOTOGRAPH SOURCE: ESRI, flown May 2020.
PROPOSED DEVELOPMENT SOURCE: Dept. of Transport, March 2021.

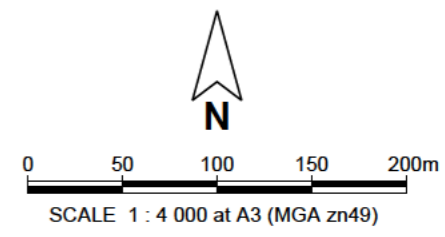


Department of Transport
VEGETATION AND FLORA SURVEY
TANTABIDDI BOATING FACILITY

Date: 4 Nov 2021
Drawn: V. Long

VEGETATION TYPES

Figure 3



- Legend**
- - - Site Boundary
 - Cadastral Boundary
 - Proposed Development
- Vegetation Condition**
- Cleared
 - Degraded
 - Poor
 - Good to Poor
 - Good
 - Very Good
 - Excellent

VLA-082-04.dgn
PINPOINT CARTOGRAPHICS (08) 9562 7136

CADASTRAL SOURCE: Landgate, April 2021.
AERIAL PHOTOGRAPH SOURCE: ESRI, flown May 2020,
PROPOSED DEVELOPMENT SOURCE: Dept. of Transport, March 2021.



Department of Transport
VEGETATION AND FLORA SURVEY
TANTABIDDY BOATING FACILITY

VEGETATION CONDITION

Date: 4 Nov 2021
Drawn: V. Long

Figure 4

4.1.1.2 Conservation Significance of Vegetation

The vegetation types recorded in the survey area are not currently listed TECs or PECs. There is one small area of closed (70-100%) *Sporobolus virginicus* tussock grassland which has the potential to be a PEC, –(in progress). This occurs around the sink hole on the south-eastern side of Yardie Creek Road. This area is not within the development envelope and should not be impacted, especially if the design of the facility incorporates bunding to prevent any leakage of chemicals or fuels towards the sink hole. Incidental visitation from increased tourists due to the close proximity may become an indirect impact.

4.1.2 Flora

A total of 90 taxa representing 33 families were recorded within the survey area. The dominant plant families were Fabaceae, Chenopodiaceae, Poaceae and Asteraceae, with 14, 13, 11 and 7 confirmed species represented, respectively. *Acacia* was the most frequently recorded genus. A matrix indicating species recorded at each site surveyed is presented in Appendix D.

4.1.2.1 Conservation Significant Flora


The desktop review identified a total of 16 Priority species which had the likelihood of occurring within a 20 km radius of the survey locations. Of these species identified, three species are considered as being 'likely to occur' and a further two having the 'potential to occur', in the survey locations. No Priority flora species identified from the database searches were recorded within the survey area.

Post-survey, only one species, *Acanthocarpus rupestris*, was considered as having the 'potential to occur' within the survey area, despite it not being recorded during the survey.

One Priority 2 plant, *Cucumis* sp Barrow Island (DW Goodall 1264), was identified and recorded. It was an opportunistic sighting (ie. not in a releve) between sample sites. The single plant was recorded on the secondary dune towards the southern end of the survey area (and outside the current development footprint). Part of the plant was collected and photographed. The Naturemap search does not list this plant as being within 20 km of the survey area, but the details from Florabase as to where it has been previously recorded, indicate it has been collected from the North West Cape. This specimen was verified at the WA Herbarium.

Table 6 provides the details of the conservation significant flora recorded within the survey area.

Table 6. Conservation significant flora recorded in the survey locations.

Species	Estimated abundance	Vegetation type(s)	Location	Photo
<i>Cucumis</i> sp. Barrow Island (D.W. Goodall 1264) P2	Sparse 1 plant (<2% cover)	AtTeCc2	GPS location [REDACTED]	

4.1.2.2 Introduced Flora (Weeds)

Weed diversity was considered low, with the following four species recorded:

- **Aerva javanica* (kapok) – a single plant was recorded in Mapping Note 1 on the edge of a stockpile near the toilet block
- **Cenchrus ciliaris* (buffel grass) - widespread
- **Cenchrus setiger* (birdwood grass)– less abundant than buffel, but widespread
- **Vachellia farnesiana* (mimosa bush) – found at a single site in low cover (<2%) and is not well recorded on Cape Range.

Most of the survey area is buffel and birdwood grass infested, some vegetation types being more so than others, with the near coastal *Spinifex longifolius* grassland and the *Sporobolus virginicus* samphire shrubland having no weed infestation. A linear corridor bordering Yardie Creek Road and the current Tantabiddi boat ramp access road is heavily infested with **C. ciliaris* and **C. setiger*. The proposed development area is less weed infested, and it is recommended that a weed management plan is prepared and implemented to retain the vegetation in its weed-free state.

The two S22 Declared Pest species, **Lantana camara* and **Parkinsonia aculeata* identified from the desktop assessment as having occurrences within 20 km of the survey area, were assessed post-survey as unlikely to occur within the survey area.

4.1.2.3 Range Extensions and Endemics

Several species recorded during the survey are either endemic to the North West Cape or at the northern or southern extents of their ranges. These are detailed below:

- *Acanthocarpus preissii* and *Maireana polypterygia* are both shown on FloraBase as occurring within the North West Cape, but both are at the northern-most end of their range.
- *Heliotropium ammophilum* is within its range, but has not been previously recorded on the North West Cape.
- *Roebuckiella oncocarpa* is, according to FloraBase collection records, endemic to the North West
- *Launaea sarmentosa* is at the southern end of its range which extends in a northerly direction along the coastline to just south of Karratha.
- *Acacia ligulata* has not previously been recorded on the northern end of the North West Cape.

4.1.3 Dune stability and vegetation

The current proposed footprint extends over a wide foredune berm which is stable and well vegetated with *Spinifex longifolius* grassland (Plate 1). This contrasts with much of the beach and dune area to both the north and south of the area, where the beach berm and the foredunes are eroded and moving sands prevent vegetation establishment (Plate 2). Eroded foredunes occur at the southern end of the survey area and extend southwards for some way. Severely eroded beach dunes occur to the north of the current Tantabiddi boat ramp.



Plate 1. Well vegetated beach berm with *Spinifex longifolius*.



Plate 2. Eroded dunes with isolated *Spinifex longifolius* tussocks – southern end of survey area

5 DISCUSSION

5.1 Vegetation and Flora

According to the desktop review, the vegetation found on the dunes (primary and secondary), the swale and the creek area is typical of that found in the surrounding coastal area.

The *Atriplex bunburyana* shrubland on the coastal plain is less well documented. This species does not appear in the Naturemap search, even at radii of 50 km. Meissner (2010b) however does mention this vegetation and states there are often large tracts of it occurring on the plains. The author observed the vegetation type occurring for a further three kilometres north of the survey area. Additionally, the *Frankenia pauciflora* low shrubland over *Sporobolus virginicus* on the coastal plain is not documented elsewhere, potentially because of a lack of vegetation survey work undertaken in this area. This vegetation type does occur in very small areas on Varanus and Bridled Islands, (V. Long pers obs), two small limestone islands that are part of the Lowendal Island group, some 200 km offshore from the survey area.

The small area of *Sporobolus virginicus* tussock grassland which occurs around the sink hole east of Yardie Creek Road, may in future be classified as a PEC, but the process of verifying the nomination of this grassland type is still in progress. This area is beyond the proposed development envelope and is unlikely to be directly impacted by the development particularly if engineering of the facility ensures no leakage into the area occurs. However, because of the close proximity of the boating facility carpark, it may become indirectly impacted by curious tourists tramping over it to view the sink hole.

The samphire vegetation at the northern end of the survey area is the result of the wide creek mouth and the semi-tidal nature of the pool that occurs there. This feature is relatively unusual on the western side of the Cape. The relocation of the existing Tantabiddi boating facility further south, should help protect this area from future impacts.

Six species (*Acanthocarpus preissii*, *Maireana polypterygia*, *Heliotropium ammophilum*, *Roebuckiella oncocarpa*, *Launaea sarmentosa* and *Acacia ligulata*) recorded during the survey are range extensions, with all, except one (*Heliotropium ammophilum*), having previously been recorded on the North West Cape. *Heliotropium ammophilum*, a relatively short lived annual and potentially only present following sufficient rainfall, is within its range but has not previously recorded on the North West Cape.

The dunal system is well vegetated and relatively stable in the area intended for the boating facility development. This contrasts with the more eroded dunes at the southern end of the survey area and with the extremely eroded and vegetation depauperate dunes, approximately four kilometres north of the area. Generally, the placement of any “hard” development, potentially with a cleared buffer around it, in a dune will cause erosion. Coastal shrubs have an extensive lateral root system which stabilises sand below the dune surface. Removal of these within a cleared area abutting hardstand will result in constant sand movement, scalloping and erosion, which will not allow vegetation to re-establish. The hardstand and surrounding cleared buffer need to be engineered, and potentially stabilising geofabric utilised, to prevent erosion and retain the stable, well vegetated dune system surrounding it.

The Priority 2, *Cucumis* sp Barrow Island (DW Goodall 1264) recorded in the survey area is not listed in the 20 km radius Naturemap search. Three records are listed in Florabase, one on the west side of

the Cape and two on the east side. Only one plant was found during the survey, however a dedicated search of the dunes for further plants was not possible in the time available.

Vegetation condition was excellent on the coastal dunes but varied on the plain, due to the ingress of buffel grass from the road. Buffel grass was particularly prevalent in or near any disturbed sites and tracks on the sandier parts of the plain, but not so abundant where the *Frankenia pauciflora* low shrubland over *Sporobolus virginicus* grassland is dominant. The loamy semi-saline and sodic soils associated with this grass are not preferred by buffel grass. Buffel grass was particularly dense along the 5m wide verge of Yardi Creek Road. The movement of construction traffic through this infested area needs to be addressed in a weed management plan, to ensure vegetation types that are not infested pre-construction, remain that way.

A single kapok plant was recorded in the disturbed area next to the current boat ramp. Kapok has significantly increased on the eastern side of the North West Cape and in Exmouth town site over the past 10 years (V. Long per obs). Every effort should be taken to ensure kapok does not spread in the TBFP area during or post construction.

The weed species, **Vachellia farnesiana* is not well recorded on the North West Cape but can spread quickly. Caution needs to be taken to ensure it is not further spread by development activities. It occurs on the disturbed soil/sand stockpile area immediately adjacent to, and south of, the current boat ramp facility. These weeds must be removed prior to any potential use of the soil for revegetation.

The disturbed area adjacent to, and immediately north of, the current boat ramp facility has been used as a soil / sand stockpile and laydown area. It was included in this survey as it now has some regrowth and provides a good indication of species that will regenerate on disturbed, or possibly even dredged, soils. These species (apart from the two weed species mentioned above) should be noted for revegetation plans for the current boat facility site.

6. EIA CONSIDERATIONS

6.1 Flora and Vegetation Considerations

Considerations for Environmental Impact Assessment (EIA) for the factor Flora and Vegetation (EPA 2016b) include, but are not necessarily limited to:

- application of the mitigation hierarchy to avoid and minimise impacts to flora and vegetation, where possible
- the flora and vegetation affected by the proposal
- the potential impacts and the activities that will cause them, including direct and indirect impacts
- the implications of cumulative impacts
- whether surveys and analyses have been undertaken to a standard consistent with guidance
- the scale at which impacts to flora and vegetation are considered
- the significance of the flora and vegetation, and the risk to the flora and vegetation
- the current state of knowledge of flora and vegetation and the level of confidence underpinning the predicted residual impacts
- whether proposed management and mitigation approaches are technically and practically feasible
- whether the proposal area will be revegetated in a manner that promotes biological diversity and ecological integrity.

Various issues are frequently of significance within the environmental impact assessment process. These issues, and the potential impact from the proposed works, are summarised below.

6.1.1 Vegetation Loss, Degradation and Fragmentation

The pre-European vegetation association 663 found within the survey area has more than 85% of its original extent remaining at State, bioregion, subregion and local government levels (Table 1). Any clearing associated with future development is unlikely to have a significant impact on the remaining extents of this vegetation association. However, it should be noted that the pre-European vegetation association 663 is described at a very broad scale and is not considered by the author, given the very specific coastal context of this project, as an appropriate level to assess habitat loss. Under the NVIS system, the Beard description would be a Level II, Structural Formation description, appropriate for a very broad scale assessment but not at an individual project level.

At a local and regional level, both the *Atriplex bunburyana* shrubland and the *Frankenia pauciflora* low shrubland over *Sporobolus virginicus* on the coastal plain are considered significant at this stage due to a lack of knowledge about their occurrence and extent in the area. The literature study only found one brief reference to the *Atriplex bunburyana* shrubland as being “known to occur as large tracts of the coastal plain” (Meissner 2010b). No other reference to this shrubland was found presumably due to lack of survey effort in this coastal area and Meissner did not elaborate on this comment. The *Frankenia pauciflora* low shrubland over *Sporobolus virginicus* vegetation unit has not previously been documented, again, potentially because of a lack of vegetation survey work undertaken in the area.

The proposed project footprint extends from Yardie Creek Road to the shoreline so vegetation loss and fragmentation will occur, but the area of disturbance is very small and all vegetation types do occur on both sides of the footprint within the survey area. A second survey will confirm further extent of this vegetation beyond the survey area.

There is the potential for degradation through erosion and through significant spread of weeds, especially into currently weed free vegetation types, and the introduction of kapok into the construction area. Only one single kapok plant was found on the north side of the current Tantabiddi boat ramp, but elsewhere in the Exmouth coastal area it has been observed to have increased significantly.

The closing of the existing Tantabiddi boat ramp will provide the opportunity to re-instate landform and vegetation types, thus minimising the small loss of vegetation with the new development.

Only one priority flora species *Cucumis* sp. Barrow Island (DW Goodall 1264) (P2) was recorded as a single plant within the survey area. A targeted search of the dunes within the proposed development envelope should be undertaken to determine the extent of this species within the area.

6.2 Coastal Processes Considerations

The environmental objective of the EPA (2016) factor *Coastal Processes* is “To maintain the geophysical processes that shape coastal morphology so that the environmental values of the coast are protected”. The potential impact that alteration of geophysical processes may have on natural coastal dynamics, ecosystems and other coastal environmental values is the focus of the factor.

The importance of coastal vegetation to the stability of dune systems (which in turn contribute significantly to protection of landform and biodiversity) has been well documented, as has the increasing anthropogenic pressure to which these habitats have been subjected.

The EPA Guidance/Guideline for Coastal Processes (2016) indicates that for the Western Australian coastline, the current state of scientific knowledge for coastal processes and the environmental values they support is “highly variable”. The EPA (2016) also acknowledges that while mathematical models for predicting the effects of coastal development is reasonably well developed for “normal” or “average conditions”, the “ability to predict the impacts under extreme weather events such as cyclones is less well developed”. The severe erosion of other disturbed coastal berms and foredunes in the immediate area serves to demonstrate some of the impacts removal of vegetation have along this coastline.

The current proposed footprint over the well vegetated berm implies there will be significant removal of stabilising vegetation which may result in erosion and the formation of mobile sands. Engineering design of the hardstand area within these sands needs to demonstrate that further erosion will not occur.

7. RECOMMENDATIONS

The results of the survey suggest that the following should be undertaken:

- A brief survey should be conducted during the dry season (September - November) to:
 - capture any Asteraceae species (most were dead or sterile during this survey),
 - capture the *Acacia ligulata* and the *Acanthocarpus* species in seed, to help verification of identification
 - further confirm the occurrence of the *Atriplex bunburyana* shrubland and also the *Frankenia pauciflora/Sporobolus virginicus* vegetation types beyond the project area and
 - target the secondary dunes to determine whether any more *Cucumis* Sp Barrow island (DW Goodall 1264) species are present.
- Discussions should be undertaken with DBCA to protect the Tantabiddi Sinkhole and the potential PEC within the vicinity, by making the area a formal tourist attraction (ie. establish interpretive signage, board walk).
- Prepare and implement a weed management plan specific to the area and the weeds present, prior to construction of the new Tantabiddi boating facility. The plan should include removal of weeds from any soil in the stockpile if it is used for revegetation purposes.
- Prepare a revegetation plan for the current boat ramp area should be prepared, incorporating species identified as growing successfully on the disturbed sand stockpile area adjacent to this area.

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**Appendix A: Conservation Categories for Flora, Fauna and Ecological
Communities, and Categories for Introduced Flora**

Flora and Fauna Protected under the *Environment Protection and Biodiversity Conservation Act 1999*.

Table A.1: Categories and definitions for threatened flora species listed under the *Environment Protection and Biodiversity Conservation Act 1999*.

Conservation category	Definition
Extinct	Taxa with no reasonable doubt that the last member of the species has died.
Extinct in the wild	Taxa known to survive only in cultivation, in captivity or as a naturalized population well outside its past range; or it has not been recorded in its known and/or expected habitat, at appropriated seasons, anywhere in its past range, despite exhaustive surveys over a time frame appropriate to its life cycle and form.
Critically endangered (CR)	Taxa facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with the prescribed criteria.
Endangered (E)	Taxa are not critically endangered; and are facing a very high risk of extinction in the wild in the near future, as determined in accordance with the prescribed criteria.
Vulnerable (V)	Taxa are not critically endangered or endangered; and are facing a high risk of extinction in the wild in the medium-term future, as determined in accordance with the prescribed criteria.
Conservation dependent (CD)	<p>Taxa are the focus of a specific conservation program the cessation of which would result in the species becoming vulnerable, endangered or critically endangered; or the following subparagraphs are satisfied:</p> <ul style="list-style-type: none"> i) the taxa is a species of fish; ii) the taxa is the focus of a management plan that provides management actions necessary to stop the decline of, and support the recovery of, the taxa so that its chances of long term survival in nature are maximised; iii) the management plan is in force under a law of the Commonwealth or of a State or Territory; iv) Cessation of the management plan would adversely affect the conservation status of the taxa <p>Fish includes all taxa of bony fish, sharks, rays, crustaceans, molluscs and other marine organisms, but does not include marine mammals/reptiles.</p>

Flora and Fauna protected under the Biodiversity Conservation Act 2016**Table A.2: Conservation codes for Western Australian flora and fauna under the Biodiversity Conservation Act 2016 (BCA 2016b)**

Code	Conservation category	Definition
Threatened		
CR	Listed as critically endangered under section 19(1)(a) of the BC Act in accordance with the criteria set out in section 20 and the ministerial guidelines. Published under schedule 1 of the Wildlife Conservation (Specially Protected Fauna) Notice 2018 for critically endangered fauna or the Wildlife Conservation (Rare Flora) Notice 2018 for critically endangered flora.	Threatened species considered to be “facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with criteria set out in the ministerial guidelines”
EN	Listed as endangered under section 19(1)(b) of the BC Act in accordance with the criteria set out in section 21 and the ministerial guidelines. Published under schedule 2 of the Wildlife Conservation (Specially Protected Fauna) Notice 2018 for endangered fauna or the Wildlife Conservation (Rare Flora) Notice 2018 for endangered flora.	Threatened species considered to be “facing a very high risk of extinction in the wild in the near future, as determined in accordance with criteria set out in the ministerial guidelines”
VU	Listed as vulnerable under section 19(1)(c) of the BC Act in accordance with the criteria set out in section 22 and the ministerial guidelines. Published under schedule 3 of the Wildlife Conservation (Specially Protected Fauna) Notice 2018 for vulnerable fauna or the Wildlife Conservation (Rare Flora) Notice 2018 for vulnerable flora.	Threatened species considered to be “facing a high risk of extinction in the wild in the medium-term future, as determined in accordance with criteria set out in the ministerial guidelines”
Extinct		
EX	Published as presumed extinct under schedule 4 of the Wildlife Conservation (Specially Protected Fauna) Notice 2018 for extinct fauna or the Wildlife Conservation (Rare Flora) Notice 2018 for extinct flora.	Species where “there is no reasonable doubt that the last member of the species has died”, and listing is otherwise in accordance with the ministerial guidelines (section 24 of the BC Act).
EW	Species that “is known only to survive in cultivation, in captivity or as a naturalised population well outside its past range; and it has not been recorded in its known habitat or expected habitat, at appropriate seasons, anywhere in its past range, despite surveys over a time frame appropriate to its life cycle and form”, and listing is otherwise in accordance with the ministerial guidelines (section 25 of the BC Act).	Currently there are no threatened fauna or threatened flora species listed as extinct in the wild. If listing of a species as extinct in the wild occurs, then a schedule will be added to the applicable notice.
Specially Protected Species		
MI	Published as migratory birds protected under an international agreement under schedule 5 of the Wildlife Conservation (Specially Protected Fauna) Notice 2018	Fauna that periodically or occasionally visit Australia or an external Territory or the exclusive economic zone; or the species is subject of an international agreement that relates to the protection of migratory species and that binds the Commonwealth; and listing is otherwise in accordance with the ministerial guidelines (section 15 of the BC Act).

Code	Conservation category	Definition
CD	Published as conservation dependent fauna under schedule 6 of the Wildlife Conservation (Specially Protected Fauna) Notice 2018.	Fauna of special conservation need being species dependent on ongoing conservation intervention to prevent it becoming eligible for listing as threatened, and listing is otherwise in accordance with the ministerial guidelines (section 14 of the BC Act).
OS	Published as other specially protected fauna under schedule 7 of the Wildlife Conservation (Specially Protected Fauna) Notice 2018.	Fauna otherwise in need of special protection to ensure their conservation, and listing is otherwise in accordance with the ministerial guidelines (section 18 of the BC Act).

Note: Schedules 5, 6, and 7 are only related to conservation significant fauna.

Priority Flora and Fauna

Taxa that have not yet been adequately surveyed to be listed under Schedule 1 or 2 are added to the Priority Flora and Priority Fauna Lists under Priorities 1, 2 or 3. These three categories are ranked in order of priority for survey and evaluation of conservation status so that consideration can be given to their declaration as Threatened flora or fauna. Taxa that are adequately known, are rare but not threatened, or meet criteria for Near Threatened, or that have been recently removed from the threatened list for other than taxonomic reasons, are placed in Priority 4. These taxa require regular monitoring. Conservation dependent species are placed in Priority 5.

Table A.3: Definitions of Categories for Priority species under Western Australian Biodiversity Conservation Act 2016 (DBCA 2019b).

P1: Priority One – Poorly known taxa
Species that are known from one or a few locations (generally five or less) which are potentially at risk. All occurrences are either: very small; or on lands not managed for conservation, e.g. agricultural or pastoral lands, urban areas, road and rail reserves, gravel reserves and active mineral leases; or otherwise under threat of habitat destruction or degradation. Species may be included if they are comparatively well known from one or more locations but do not meet adequacy of survey requirements and appear to be under immediate threat from known threatening processes. Such species are in urgent need of further survey.
P2: Priority Two – Poorly known taxa
Species that are known from one or a few locations (generally five or less), some of which are on lands managed primarily for nature conservation, e.g. national parks, conservation parks, nature reserves and other lands with secure tenure being managed for conservation. Species may be included if they are comparatively well known from one or more locations but do not meet adequacy of survey requirements and appear to be under threat from known threatening processes. Such species are in urgent need of further survey.
P3: Priority Three – Poorly known taxa
Species that are known from several locations, and the species does not appear to be under imminent threat, or from few but widespread locations with either large population size or significant remaining areas of apparently suitable habitat, much of it not under imminent threat. Species may be included if they are comparatively well known from several locations but do not meet adequacy of survey requirements and known threatening processes exist that could affect them. Such species are in need of further survey
P4: Priority Four: Rare, near threatened and other taxa in need of monitoring
(a) Rare. Species that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection but could be if present circumstances change. These species are usually represented on conservation lands. (b) Near Threatened. Species that are considered to have been adequately surveyed and that are close to qualifying for vulnerable but are not listed as Conservation Dependent. (c) Species that have been removed from the list of threatened species during the past five years for reasons other than taxonomy.

Threatened Ecological Communities

Table A.4: Definitions and criteria for threatened ecological communities listed under the *Environment Protection and Biodiversity Conservation Act 1999*.

Categories of ecological communities	
Critically endangered	If, at that time, it is facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with the prescribed criteria.
Endangered	If, at that time, it is not critically endangered and is facing a very high risk of extinction in the wild in the near future, as determined in accordance with the prescribed criteria.
Vulnerable	If, at that time, it is not critically endangered or endangered, and is facing a high risk of extinction in the wild in the medium-term future, as determined in accordance with the prescribed criteria.

Table A.5: Categories for State-listed Threatened Ecological Communities (DEC 2013).

PD: Presumed Totally Destroyed
<p>An ecological community that has been adequately searched for but for which no representative occurrences have been located. The community has been found to be totally destroyed or so extensively modified throughout its range that no occurrence of it is likely to recover its species composition and/or structure in the foreseeable future.</p> <p>An ecological community will be listed as presumed totally destroyed if there are no recent records of the community being extant and either of the following applies (A or B):</p> <p>A) Records within the last 50 years have not been confirmed despite thorough searches of known or likely habitats or</p> <p>B) All occurrences recorded within the last 50 years have since been destroyed.</p>
CR : Critically Endangered
<p>An ecological community that has been adequately surveyed and found to have been subject to a major contraction in area and/or that was originally of limited distribution and is facing severe modification or destruction throughout its range in the immediate future, or is already severely degraded throughout its range but capable of being substantially restored or rehabilitated.</p> <p>An ecological community will be listed as Critically Endangered when it has been adequately surveyed and is found to be facing an extremely high risk of total destruction in the immediate future. This will be determined on the basis of the best available information, by it meeting any one or more of the following criteria (A, B or C):</p> <p>A) The estimated geographic range, and/or total area occupied, and/or number of discrete occurrences since European settlement have been reduced by at least 90% and either or both of the following apply (i or ii):</p> <p>i) geographic range, and/or total area occupied and/or number of discrete occurrences are continuing to decline such that total destruction of the community is imminent (within approximately 10 years);</p> <p>ii) modification throughout its range is continuing such that in the immediate future (within approximately 10 years) the community is unlikely to be capable of being substantially rehabilitated.</p> <p>B) Current distribution is limited, and one or more of the following apply (i, ii or iii):</p> <p>i) geographic range and/or number of discrete occurrences, and/or area occupied is highly restricted and the community is currently subject to known threatening processes which are likely to result in total destruction throughout its range in the immediate future (within approximately 10 years);</p> <p>ii) there are very few occurrences, each of which is small and/or isolated and extremely vulnerable to known threatening processes;</p> <p>iii) there may be many occurrences but total area is very small and each occurrence is small and/or isolated and extremely vulnerable to known threatening processes.</p>

<p>C) The ecological community exists only as highly modified occurrences that may be capable of being rehabilitated if such work begins in the immediate future (within approximately 10 years).</p>
<p>En: Endangered</p>
<p>An ecological community that has been adequately surveyed and found to have been subject to a major contraction in area and/or was originally of limited distribution and is in danger of significant modification throughout its range or severe modification or destruction over most of its range in the near future.</p> <p>An ecological community will be listed as Endangered when it has been adequately surveyed and is not Critically Endangered but is facing a very high risk of total destruction in the near future. This will be determined on the basis of the best available information by it meeting any one or more of the following criteria (A, B, or C):</p> <p>A) The geographic range, and/or total area occupied, and/or number of discrete occurrences have been reduced by at least 70% since European settlement and either or both of the following apply (i or ii):</p> <p>i) the estimated geographic range, and/or total area occupied and/or number of discrete occurrences are continuing to decline such that total destruction of the community is likely in the short term future (within approximately 20 years);</p> <p>ii) modification throughout its range is continuing such that in the short term future (within approximately 20 years) the community is unlikely to be capable of being substantially restored or rehabilitated.</p> <p>B) Current distribution is limited, and one or more of the following apply (i, ii or iii):</p> <p>i) geographic range and/or number of discrete occurrences, and/or area occupied is highly restricted and the community is currently subject to known threatening processes which are likely to result in total destruction throughout its range in the short term future (within approximately 20 years);</p> <p>ii) there are few occurrences, each of which is small and/or isolated and all or most occurrences are very vulnerable to known threatening processes;</p> <p>iii) there may be many occurrences but total area is small and all or most occurrences are small and/or isolated and very vulnerable to known threatening processes.</p> <p>C) The ecological community exists only as very modified occurrences that may be capable of being substantially restored or rehabilitated if such work begins in the short-term future (within approximately 20 years).</p>
<p>VU: Vulnerable</p>
<p>An ecological community that has been adequately surveyed and is found to be declining and/or has declined in distribution and/or condition and whose ultimate security has not yet been assured and/or a community that is still widespread but is believed likely to move into a category of higher threat in the near future if threatening processes continue or begin operating throughout its range.</p> <p>An ecological community will be listed as Vulnerable when it has been adequately surveyed and is not Critically Endangered or Endangered but is facing a high risk of total destruction or significant modification in the medium to long-term future. This will be determined on the basis of the best available information by it meeting any one or more of the following criteria (A, B or C):</p> <p>A) The ecological community exists largely as modified occurrences that are likely to be capable of being substantially restored or rehabilitated.</p> <p>B) The ecological community may already be modified and would be vulnerable to threatening processes, is restricted in area and/or range and/or is only found at a few locations.</p> <p>C) The ecological community may be still widespread but is believed likely to move into a category of higher threat in the medium to long term future because of existing or impending threatening processes.</p>

Priority Ecological Communities

Possible Threatened Ecological Communities that do not meet survey criteria or that are not adequately defined are added to the Priority Ecological Community Lists under Priorities 1, 2 and 3. Ecological communities that are adequately known, and are rare but not threatened or meet criteria for Near Threatened, or that have been recently removed from the threatened list, are placed in Priority 4. These ecological communities require regular monitoring. Conservation Dependent ecological communities are placed in Priority 5 (Table A.6).

Table A.6: Definitions and criteria for Priority Ecological Communities (Department of Parks and Wildlife 2017).

<p>P1: Priority One – Poorly-known ecological communities</p> <p>Ecological communities that are known from very few occurrences with a very restricted distribution (generally ≤ 5 occurrences or a total area of ≤ 100ha). Occurrences are believed to be under threat either due to limited extent, or being on lands under immediate threat (e.g. within agricultural or pastoral lands, urban areas, active mineral leases) or for which current threats exist. May include communities with occurrences on protected lands. Communities may be included if they are comparatively well-known from one or more localities but do not meet adequacy of survey requirements, and/or are not well defined, and appear to be under immediate threat from known threatening processes across their range.</p>
<p>P2: Priority Two – Poorly-known ecological communities</p> <p>Communities that are known from few occurrences with a restricted distribution (generally ≤ 10 occurrences or a total area of ≤ 200ha). At least some occurrences are not believed to be under immediate threat of destruction or degradation. Communities may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements, and/or are not well defined, and appear to be under threat from known threatening processes.</p>
<p>P3: Priority Three – Poorly-known ecological communities</p> <p>(i) Communities that are known from several to many occurrences, a significant number or area of which are not under threat of habitat destruction or degradation or: (ii) communities known from a few widespread occurrences, which are either large or within significant remaining areas of habitat in which other occurrences may occur, much of it not under imminent threat, or; (iii) communities made up of large, and/or widespread occurrences, that may or not be represented in the reserve system, but are under threat of modification across much of their range from processes such as grazing by domestic and/or feral stock, and inappropriate fire regimes.</p> <p>Communities may be included if they are comparatively well known from several localities but do not meet adequacy of survey requirements and/or are not well defined, and known threatening processes exist that could affect them.</p>
<p>P4: Priority Four</p> <p>Ecological communities that are adequately known, rare but not threatened or meet criteria for Near Threatened, or that have been recently removed from the threatened list. These communities require regular monitoring.</p> <p>(i) Rare. Ecological communities known from few occurrences that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection, but could be if present circumstances change. These communities are usually represented on conservation lands.</p> <p>(ii) Near Threatened. Ecological communities that are considered to have been adequately surveyed and that do not qualify for Conservation Dependent, but that are close to qualifying for Vulnerable.</p> <p>(iii) Ecological communities that have been removed from the list of threatened communities during the past five years.</p>
<p>P5: Priority Five – Conservation dependent ecological communities</p> <p>Ecological communities that are not threatened but are subject to a specific conservation program, the cessation of which would result in the community becoming threatened within five years.</p>

The management of introduced flora species in Western Australia is now regulated through the *Biosecurity and Agriculture Management Act 2007* (BAM Act). A list of declared pests, including ‘pest’ plants is provided under the BAM Act, which has been updated to incorporate a number of other Acts that are administered by the Department of Primary Industries and Regional Development (DPIRD 2019). Declared pests can fall into two categories: one that relates to the prevention of introducing the species or eradicating it; and the other relates to managing the species and whether it can be kept (i.e. for scientific purposes, education or other purpose).

As per introduced flora species, the BAM Act seeks to establish a modern biosecurity regulatory scheme to prevent serious animal pests from entering the State and becoming established, and to minimise the spread and impact of any that are already present within the State. Declared animal pests fall into three categories as Gazetted under the *Biosecurity and Agriculture Management Regulations 2013*. These categories are outlined in Table A.7.

Table A.7: Declared pests control categories as gazetted under the *Biosecurity and Agriculture Management Regulations 2013*.

Category	Description
C1 (Exclusion)	Pests will be assigned to this category if they are not established in Western Australia and control measures are to be taken, including border checks, in order to prevent them entering and establishing in the State.
C2 (Eradication)	Pests will be assigned to this category if they are present in Western Australia in low enough numbers or in sufficiently limited areas that their eradication is still a possibility.
C3 (Management)	Pests will be assigned to this category if they are established in Western Australia but it is feasible, or desirable, to manage them in order to limit their damage. Control measures can prevent a C3 pest from increasing in population size or density or moving from an area in which it is established into an area which currently is free of that pest.

The threat and risk posed to site-specific biodiversity values, influences to rehabilitation success, primary production, infrastructure assets or human health will differ depending on the unique characteristics of each site and the associated land management practice or operation. Therefore site or project specific weed assessments and priorities should be reviewed for each project.

Appendix B: Vegetation Condition Rating Scale

Table B.1. Vegetation Condition Scale as adapted from Trudgen (1988). (Environmental Protection Authority 2016a)

Vegetation condition	Condition description
Excellent	Pristine or nearly so, no obvious signs of damage caused by human activities since European settlement.
Very Good	Some relatively slight signs of damage caused by human activities since European settlement. For example, some signs of damage to tree trunks caused by repeated fire, the presence of some relatively non-aggressive weeds, or occasional vehicle tracks.
Good	More obvious signs of damage caused by human activity since European settlement, including some obvious impact on the vegetation structure such as that caused by low levels of grazing or slightly aggressive weeds.
Poor	Still retains basic vegetation structure or ability to regenerate to it after very obvious impacts of human activities since European settlement, such as grazing, partial clearing, frequent fires or aggressive weeds.
Degraded	Severely impacted by grazing, very frequent fires, clearing or a combination of these activities. Scope for some regeneration but not to a state approaching good condition without intensive management. Usually with a number of weed species present including very aggressive species.
Completely Degraded	Areas that are completely or almost completely without native species in the structure of their vegetation; i.e. areas that are cleared or 'parkland cleared' with their flora comprising weed or crop species with isolated native trees or shrubs.

Appendix C: Field Data Sheets, Mapping Notes and Vegetation Descriptions

Site: 1

Type: 50 x 50 Releve

Date: 18/04/2021

MGA Zone: 50

Easting: 808039E

Described by: VL

Northing: 7573869N

Habitat/Landform: Coastal plain extending between beach sands and range.

Soil: Pinkish sands.

Vegetation: *Olearia* sp Kennedy Range (G. Byrne 66) with *Acacia tetragonophylla* open shrubland to low open shrubland over mixed **Cenchrus ciliaris* tussock grassland with *Triodia epactia* hummock grassland with patchy *Eriachne obtusa*.

Veg Condition: Fair

Fire Age: 10 yrs

Species List

Name	Cover (%)
<i>*Cenchrus ciliaris</i>	40
<i>*Cenchrus setiger</i>	10
<i>Acacia bivenosa</i>	<2
<i>Acacia coriacea</i> subsp <i>coriacea</i>	<2
<i>Acacia tetragonophylla</i>	2
<i>Acanthocarpus verticillatus</i>	<2
<i>Bulbostylis barbata</i>	<2
<i>Crotalaria cunninghamii</i>	<2
<i>Cynanchum viminale</i> subsp. <i>australe</i>	<2
<i>Dipteracanthus australasicus</i>	<2
<i>Enchylaena tomentosa</i>	<2
<i>Eragrostis eriopoda</i>	<2
<i>Eriachne obtusa</i>	<2
<i>Euphorbia drummondii</i>	<2
<i>Indigofera boviparda</i> subsp. <i>boviparda</i>	<2
<i>Indigofera colutea</i>	<2
<i>Ipomoea costata</i>	<2
<i>Olearia</i> sp. Kennedy Range (G. Byrne 66)	5-10
<i>Ptilotus obovatus</i>	<2
<i>Rhagodia preissii</i> subsp <i>obovata</i>	<2
<i>Rhynchosia minima</i>	<2
<i>Salsola australis</i>	<2
<i>Sclerolaena uniflora</i>	<2
<i>Senna glutinosa</i> subsp. <i>glutinosa</i>	<2
<i>Solanum lasiophyllum</i>	<2
<i>Stylobasium spathulatum</i>	2
<i>Triodia epactia</i>	15

Site: 2

Type: 100 x 25 Revele

Date: 18/04/2021

MGA Zone: 50

Easting: 807865E

Described by: VL

Northing: 7573977N

Habitat/Landform: Disturbed area with old soil stockpiles and artificial drainage area. with

Soil: Pinky silts and gravels.

Vegetation: *Acacia bivenosa* shrubland over *Threlkeldia diffusa*, *Neobassia astrocarpa* low shrubland over *Triodia epactia* open hummock grassland.

Veg Condition: Good

Fire Age: >10 yrs

Species List

Name	Cover (%)
* <i>Cenchrus ciliaris</i>	5
<i>Acacia bivenosa</i>	10
<i>Acacia coriacea</i> subsp <i>coriacea</i>	<2
<i>Atriplex bunburyana</i>	5
<i>Euphorbia trigonospema</i>	<2
<i>Frankenia pauciflora</i>	<2
<i>Gossypium robinsonii</i>	<2
<i>Myoporum montanum</i>	<2
<i>Neobassia astrocarpa</i>	10
<i>Roepera aurantica</i>	<2
<i>Salsola australis</i>	<2
<i>Sclerolaena uniflora</i>	5
<i>Stylobasium spathulatum</i>	<2
<i>Threlkeldia diffusa</i>	15
<i>Triodia epactia</i>	15
* <i>Vachellia farnesiana</i>	<2

Site: 3

Type: 10 x 150 Revele

Date: 18/04/2021

Described by: VL

MGA Zone: 50

Easting: 807837E

Northing: 7573791N

Habitat/Landform: Perimeter of semi-tidal pool, draining from range but impacted by tides.

Vegetation: *Frankenia pauciflora*, *Muellerolimon salicorniaceum*, closed low shrubland with *Tecticornia indica leiostachya* over *Sporobolus virginicus* tussock grassland.

Veg Condition: Excellent

Fire Age: 10 yrs

Species List

Name	Cover (%)
<i>Enchylaena tomentosa</i>	<2
<i>Frankenia pauciflora</i>	20
<i>Muellerolimon salicorniaceum</i>	35
<i>Neobassia astrocarpa</i>	2
<i>Rhagodia preissii</i> subsp. <i>obovata</i>	<2
<i>Sclerolaena uniflora</i>	<2
<i>Sesuvium portulacastrum</i>	<2
<i>Sporobolus virginicus</i>	35
<i>Tecticornia halocnemoides</i> subsp. <i>tenuis</i>	2
<i>Tecticornia indica</i> subsp. <i>leiostachya</i>	30
<i>Threlkeldia diffusa</i>	2

Site: 4

Type: 50 x 35 Releve

Date: 19/04/2021

MGA Zone: 50

Easting: 807716E

Described by: VL

Northing: 7573702N

Habitat/Landform: Low coastal area landward of secondary beach dune and outer fringes of tidal pool.

Soil: Pinky brown sandy loam

Vegetation: *Atriplex bunburyana* scattered to open low shrubs over *Threlkeldia diffusa*, *Frankenia pauciflora* low shrubland over *Sporobolus virginicus* tussock grassland.

Veg Condition: Good

Fire Age: 10 yrs

Species List

Name	Cover (%)
<i>*Cenchrus ciliaris</i>	2-5
<i>Atriplex bunburyana</i>	2
<i>Enchylaena tomentosa</i>	<2
<i>Euphorbia trigonospema</i>	<2
<i>Frankenia pauciflora</i>	10
<i>Lawrenca viridigrisea</i>	<2
<i>Neobassia astrocarpa</i>	<2
<i>Pluchea ferdinandi-muelleri</i>	<2
<i>Salsola australis</i>	<2
<i>Sporobolus virginicus</i>	65
<i>Swainsona pterostylis</i>	<2
<i>Threlkeldia diffusa</i>	10

Site: 5

Type: 150 x 20 Revele

Date: 19/04/2021

MGA Zone: 50

Easting: 807575E

Described by: VL

Northing: 7573649N

Habitat/Landform: Remnant secondary dune fringing coastal swale

Soil: Fine, pale pinkish sands.

Vegetation: *Acacia tetragonophylla*, *Acacia coriacea*, *Acacia bivenosa* tall shrubland over *Threlkeldia diffusa*, *Enchylaena tomentosa* open low shrubland over *Triodia epactia* hummock grassland. There is very patchy **Cenchrus ciliaris*.

Veg Condition: Good

Fire Age: >10 yrs

Species List

Name	Cover (%)
<i>*Cenchrus ciliaris</i>	5-10
<i>Acacia bivenosa</i>	2
<i>Acacia coriacea</i> subsp <i>coriacea</i>	5
<i>Acacia tetragonophylla</i>	10
<i>Arivela viscosa</i>	<2
<i>Atriplex bunburyana</i>	<2
<i>Boerhavia schomburgkiana</i>	<2
<i>Commicarpus australis</i>	<2
<i>Corynotheca flexuosissima</i>	<2
<i>Enchylaena tomentosa</i>	2
<i>Euphorbia drummondii</i>	2
<i>Euphorbia tannensis</i>	<2
<i>Euphorbia trigonospema</i>	<2
<i>Indigofera colutea</i>	<2
<i>Indigofera linnaei</i>	<2
<i>Myoporum montanum</i>	<2
<i>Olearia</i> sp. Kennedy Range (G. Byrne 66)	<2
<i>Pluchea ferdinandi-muelleri</i>	<2
<i>Rhagodia preissii</i> subsp <i>obovata</i>	2
<i>Rhynchosia minima</i>	2
<i>Roebuckiella oncocarpa</i>	<2
<i>Solanum lasiophyllum</i>	<2
<i>Spinifex longifolius</i>	15
<i>Threlkeldia diffusa</i>	2
<i>Triodia epactia</i>	55
<i>Whiteochloa airoides</i>	<2

Site: 6

Type: 150 x 25 Revele

Date: 19/04/2021

Described by: VL

MGA Zone: 50

Easting: 807348E

Northing: 7573575N

Habitat/Landform: Beach plateau and landward side of foredunes with pale beige fine beach sands and fine marine fragments.

Vegetation: *Spinifex longifolius* tussock grassland with patchy *Whiteochloa airoides*, *Eulalia aurea*. There are *Atriplex isitidea* shrubs fringing the shoreline. On deeply hummocked mobile sand dunes *Spinifex longifolius* is scattered to open and can include *Eulalia aurea*.

Veg Condition: Excellent

Fire Age: >10 yrs

Species List

Name	Cover (%)
<i>Acacia coriacea</i> subsp <i>coriacea</i>	<2
<i>Acanthocarpus preissii</i>	<2
<i>Atriplex isatidea</i>	<2
<i>Launea sarmentosa</i>	<2
<i>Ptilotus villosiflorus</i>	<2
<i>Spinifex longifolius</i>	40-45
<i>Threlkeldia diffusa</i>	<2
<i>Triodia epactia</i>	5
<i>Whiteochloa airoides</i>	10

Site: 7

Type: 50 x 80 Releve

Date: 19/04/2021

MGA Zone: 50

Easting: 807584E

Described by: VL

Northing: 757313N

Habitat/Landform: Plain with pinky red sands and silts.

Vegetation: *Pluchea ferdinandi-muelleri*, *Atriplex bunburyana* open, sometimes closed low shrubland over *Triodia epactia* hummock grassland with **Cenchrus ciliaris*, **Cenchrus setigera* and *Chrysopogon fallax*.

Veg Condition: Good to poor depending on localised **Cenchrus* infestation.

Fire Age: >10 yrs

Species List

Name	Cover (%)
<i>*Cenchrus ciliaris</i>	2
<i>*Cenchrus setigera</i>	10
<i>Acacia bivenosa</i>	2
<i>Acacia tetragonophylla</i>	<2
<i>Atriplex bunburyana</i>	2
<i>Bulbostylis barbata</i>	<2
<i>Chrysopogon fallax</i>	5
<i>Enchylaena tomentosa</i>	<2
<i>Fimbristylis dichotoma</i>	<2
<i>Frankenia pauciflora</i>	<2
<i>Indigofera colutea</i>	<2
<i>Maireana plantifolia</i>	<2
<i>Olearia</i> sp. Kennedy Range (G. Byrne 66)	<2
<i>Phyllanthus erwinii</i>	<2
<i>Pluchea ferdinandi-muelleri</i>	5
<i>Scaevola spinescens</i>	<2
<i>Swainsona pterostylis</i>	<2
<i>Triodia epactia</i>	50

Site: 8

Type: 50 x 50 Releve

Date: 19/04/2021

MGA Zone: 50

Easting: 807454E

Described by: VL

Northing: 7573355N

Habitat/Landform: Coastal plain with reddish brown silty loams.

Vegetation: *Atriplex bunburyana* low shrubland with *Frankenia pauciflora* over mixed **Cenchrus ciliaris* and *Sporobolus virginicus* tussock grassland.

Veg Condition: Poor

Fire Age: >10 yrs

Species List

Name	Cover (%)
<i>*Cenchrus ciliaris</i>	35-40
<i>*Cenchrus setiger</i>	5
<i>Acacia bivenosa</i>	2
<i>Atriplex bunburyana</i>	25
<i>Frankenia pauciflora</i>	25
<i>Maireana tomentosa</i> subsp. <i>tomentosa</i>	<2
<i>Myoporum montanum</i>	<2
<i>Scaevola spinescens</i>	2
<i>Sclerolaena uniflora</i>	<2
<i>Sida fibulifera</i>	<2
<i>Sporobolus virginicus</i>	15
<i>Swainsona pterostylis</i>	<2
<i>Threlkeldia diffusa</i>	<2

Site: 9

Type: 50 x 50 Releve

Date: 19/04/2021

MGA Zone: 50

Easting: 807262E

Described by: VL

Northing: 7573104N

Habitat/Landform: Toe of secondary dune gently inclining to coastal plain with fine pinky sands.

Vegetation: *Acacia bivenosa*, *Myoporum montanum*, *Rhagodia preissii* subsp *obovata* open, sometimes scattered shrubland over *Triodia epactia* hummock grassland with patchy *Sporobolus virginicus*. Very scattered **Cenchrus ciliaris*.

Veg Condition: Excellent.

Fire Age: >10 yrs

Species List

Name	Cover (%)
* <i>Cenchrus ciliaris</i>	5
<i>Acacia bivenosa</i>	2
<i>Acacia tetragonophylla</i>	<2
<i>Atriplex bunburyana</i>	<2
<i>Enchylaena tomentosa</i>	<2
<i>Eriachne obtusa</i>	<2
<i>Euphorbia tannensis</i>	<2
<i>Heliotropium crispatum</i>	<2
<i>Indigofera linnaei</i>	<2
<i>Myoporum montanum</i>	2
<i>Rhagodia preissii</i> subsp <i>obovata</i>	<2
<i>Scaevola cunninghamii</i>	<2
<i>Sida fibulifera</i>	<2
<i>Sida rohlenae</i> subsp. <i>rohlenae</i>	<2
<i>Solanum lasiophyllum</i>	<2
<i>Spinifex longifolius</i>	<2
<i>Sporobolus virginicus</i>	15
<i>Swainsona ?kingii</i> (sterile)	<2
<i>Triodia epactia</i>	55

Site: 10

Type: 150 x 25 Revele

Date: 19/04/2021

MGA Zone: 50

Easting: 807082E

Described by: VL

Northing: 7573298N

Habitat/Landform: Coastal swale between primary and secondary dune with pale beige sands and marine fragments.

Vegetation: *Eulalia aurea* and *Triodia epactia* scattered grasses over very scattered *Acanthocarpus* sp.1

Veg Condition: Good but naturally bare.

Fire Age: >10 yrs

Species List

Name	Cover (%)
<i>Acacia rostellifera (sterile)</i>	<2
<i>Acanthocarpus verticillatus</i>	<2
<i>Corynotheca flexuosissima</i>	<2
<i>Eulalia aurea</i>	2-5
<i>Spinifex longifolius</i>	<2
<i>Triodia epactia</i>	2
<i>Whiteochloa airoides</i>	<2

Site: 11

Type: 30 x 150 Revele

Date: 19/04/2021

MGA Zone: 50

Easting: 807361E

Described by: VL

Northing: 7573081N

Habitat/Landform: Coastal plain, low in elevation with pale pinky-brown sandy loams with limestone pebbles.

Vegetation: *Atriplex bunburyana* shrubland to closed shrubland with occasional *Acacia bivenosa* over *Frankenia pauciflora* open low shrubland over a mosaic of mixed *Sporobolus virginicus*, **Cenchrus ciliaris* tussock grassland and *Triodia epactia* hummock grassland.

Veg Condition: Good to Poor depending on **Cenchrus ciliaris* cover

Fire Age: >10 yrs

Species List

Name	Cover (%)
<i>*Cenchrus ciliaris</i>	10-35
<i>Acacia bivenosa</i>	2
<i>Atriplex bunburyana</i>	15-40
<i>Cyperus bulbosus</i>	<2
<i>Erodium cygnorum</i>	<2
<i>Euphorbia tannensis</i>	<2
<i>Frankenia pauciflora</i>	10-20
<i>Ipomoea costata</i>	<2
<i>Myoporum montanum</i>	<2
<i>Rhynchosia minima</i>	<2
<i>Sclerolaena uniflora</i>	<2
<i>Sida rohlenae</i>	<2
<i>Sporobolus virginicus</i>	5-45
<i>Swainsona ? kingii</i>	<2
<i>Swainsona pterostylis sterile</i>	<2
<i>Threlkeldia diffusa</i>	<2
<i>Triodia epactia</i>	15-35

Site: 12

Type: 50 x 50 Releve

Date: 19/04/2021

MGA Zone: 50

Easting: 807463E

Described by: VL

Northing: 7573409N

Habitat/Landform: Coastal plain low in elevation with soft sodic pinky-brown loams.

Vegetation: *Lawrenia viridigrisea* scattered to open shrubland over *Frankenia pauciflora* closed low shrubland over *Sporobolus virginicus* tussock grassland.

Veg Condition: Excellent

Fire Age: 10 yrs

Species List

Name	Cover (%)
<i>*Cenchrus ciliaris</i>	<2
<i>Acacia bivenosa</i>	<2
<i>Atriplex bunburyana</i>	<2
<i>Frankenia pauciflora</i>	35-40
<i>Lawrenia viridigrisea</i>	2-5
<i>Maireana tomentosa subsp. tomentosa</i>	<2
<i>Muellerolimon salicorniaceum</i>	<2
<i>Pluchea ferdinandi-muelleri</i>	<2
<i>Pluchea dunlopii</i>	<2
<i>Scaevola spinescens</i>	<2
<i>Sclerolaena uniflora</i>	<2
<i>Sporobolus virginicus</i>	35-40

Mapping Notes

Site No	MN-01
GPS Co-Ordinates (Easting Northing)	807860 7873958
Vegetation Description	<i>Spinifex longifolius</i> scattered tussocks with scattered <i>Salsola australis</i> .
Habitat and Soils	Old marine soils and fragment stockpiles
Vegetation Condition	Revegetation -Poor

Site No	MN-02
GPS Co-Ordinates (Easting Northing)	807745 7573847
Vegetation Description	<i>Muellerolimon salicorniaceum</i> , closed low shrubland with <i>Tecticornia ?indica leiostachya</i>
Habitat and Soils	Edge of tidal inlet pool
Vegetation Condition	Excellent

Site No	MN-03
GPS Co-Ordinates (Easting Northing)	807758 7573774
Vegetation Description	<i>Sporobolus virginicus</i> tussock grassland. Scattered <i>Frankenia pauciflora</i> .
Habitat and Soils	Outer fringe of tidal pool – fringes S3
Vegetation Condition	Excellent

Site No	MN-04
GPS Co-Ordinates (Easting Northing)	807507 7573641
Vegetation Description	<i>Triodia epactia</i> and <i>Eulalia aurea</i> very open to scattered grassland. Scattered <i>Acanthocarpus verticillatus</i>
Habitat and Soils	Swale between primary and secondary dunes, pale beige sands with marine fragments
Vegetation Condition	

Site No	MN-05
GPS Co-Ordinates (Easting Northing)	807513 7573223
Vegetation Description	<i>Sporobolus virginicus</i> closed tussock grassland with scattered <i>Neobassia astrocarpa</i> low shrubs.
Habitat and Soils	Perimeter of sink holes
Vegetation Condition	Excellent

Site No	MN-06
GPS Co-Ordinates (Easting Northing)	807531 7573211
Vegetation Description	<i>Atriplex bunburyana</i> low shrubland with <i>Frankenia pauciflora</i> low closed shrubland over mixed <i>*Cenchrus ciliaris</i> and <i>Sporobolus virginicus</i> tussock grassland.

Habitat and Soils	Low plain near sinkhole. Red brown silty soil
Vegetation Condition	25% Buffel

Site No	MN-07
GPS Co-Ordinates (Easting Northing)	807749 7573251
Vegetation Description	<i>Pluchea ferdinandi-muelleri</i> , <i>Atriplex bunburyana</i> open, sometimes closed low shrubland over <i>*Cenchrus setiger</i> tussock grassland with <i>Sporobolus virginicus</i> .
Habitat and Soils	Low area on coastal plain. Reddish, silty loam
Vegetation Condition	Poor – lots of <i>*Cenchrus setiger</i>

Site No	MN-08
GPS Co-Ordinates (Easting Northing)	807471 7573409
Vegetation Description	<i>Frankenia pauciflora</i> dwarf closed shrubland over <i>Sporobolus virginicus</i> tussock grassland.
Habitat and Soils	Low clayey silt (pale pink) area on coastal plain
Vegetation Condition	Excellent

Site No	MN-09
GPS Co-Ordinates (Easting Northing)	807275 7573233
Vegetation Description	<i>Acacia bivenosa</i> , <i>Rhagodia preissii</i> subsp <i>obovata</i> , <i>Myoporum montanum</i> , <i>A. tetragonophylla</i> open to scattered shrubland over mixed <i>Triodia epactia</i> hummock grassland and <i>Sporobolus virginicus</i> tussock grassland with patchy <i>*Cenchrus ciliaris</i> .
Habitat and Soils	Toe and incline to secondary dune
Vegetation Condition	Good

Site No	MN-10
GPS Co-Ordinates (Easting Northing)	807201 7573140
Vegetation Description	<i>Acacia coriacea</i> , <i>Acacia bivenosa</i> , <i>Rhagodia preissii</i> subsp <i>obovata</i> shrubland over over <i>Threlkeldia diffusa</i> , <i>Enchylaena tomentosa</i> open low shrubland over <i>Triodia epactia</i> open hummock grassland. Occasional <i>Spinifex longifolius</i> .
Habitat and Soils	Crest of secondary dune, pinky white beach sand
Vegetation Condition	Excellent

Site No	MN-11
GPS Co-Ordinates (Easting Northing)	806990 7573215
Vegetation Description	Scattered <i>Spinifex longifolius</i> and <i>Eulalea aurea</i>
Habitat and Soils	Very eroded beach dunes
Vegetation Condition	Poor due to natural severe erosion

Table C3. Tantabiddi Vegetation Types

Site	Vegetation Type	Habitat	GPS Eastings Northings NW Corner	Condition ¹
Site 1 MN9	<i>Olearia</i> sp Kennedy Range (G. Byrne 66) with <i>Acacia tetragonaphylla</i> open shrubland to low open shrubland over mixed * <i>Cenchrus ciliaris</i> tussock grassland with <i>Triodia epactia</i> hummock grassland with patchy <i>Eriachne obtusa</i> .	Coastal plain extending between beach sands and range with pinkish sands.	808039E 7573869N	Poor
Site 2	<i>Acacia bivenosa</i> shrubland over <i>Threlkeldia diffusa</i> , <i>Neobassia astrocarpa</i> low shrubland over <i>Triodia epactia</i> open hummock grassland.	Disturbed area with old soil stockpiles and artificial drainage area with pinky silts and gravels.	807865E 7573977N	Poor
Site 3 MN2	<i>Frankenia pauciflora</i> , <i>Muellerolimon salicorniaceum</i> , closed low shrubland with <i>Tecticornia indica leiostachya</i> over <i>Sporobolus virginicus</i> tussock grassland.	Perimeter of semi-tidal pool, draining from range but impacted by tides.	807837E 7573791N	Excellent
Site 4 MN3	<i>Atriplex bunburyana</i> scattered to open low shrubs over <i>Threlkeldia diffusa</i> , <i>Frankenia pauciflora</i> low shrubland over <i>Sporobolus virginicus</i> tussock grassland.	Low coastal area landward of secondary beach dune and outer fringes of tidal pool, pinky brown sandy loam.	807716E 7573702	Good
Site 5 MN10	<i>Acacia tetragonaphylla</i> , <i>Acacia coriacea</i> , <i>Acacia bivenosa</i> tall shrubland over <i>Threlkeldia diffusa</i> , <i>Enchylaena tomentosa</i> open low shrubland over <i>Triodia epactia</i> hummock grassland. There is very patchy * <i>Cenchrus ciliaris</i> .	Remnant secondary dune fringing coastal swale with fine pale pinkish sands.	807575E 7573649N	Good
Site 6 MN1 MN11	<i>Spinifex longifolius</i> tussock grassland with patchy <i>Whiteochloa airoides</i> , <i>Eulalia aurea</i> . There are <i>Atriplex isitidea</i> shrubs fringing the shoreline. On deeply hummocked mobile sand dunes <i>Spinifex longifolius</i> is scattered to open and can include <i>Eulalia aurea</i> .	Beach plateau and landward side of foredunes with pale beige fine beach sands and fine marine fragments.	807348E 7573575N	Excellent

Site	Vegetation Type	Habitat	GPS Eastings Northings NW Corner	Condition ¹
Site 7 MN7	<i>Pluchea ferdinandi-muelleri</i> , <i>Atriplex bunburyana</i> open, sometimes closed low shrubland over <i>Triodia epactia</i> hummock grassland with * <i>Cenchrus ciliaris</i> , * <i>Cenchrus setigera</i> and <i>Chrysopogon fallax</i> .	Plain with pinky red sands and silts.	807584E 757313N	Good to poor depending on localised * <i>Cenchrus</i> infestation.
Site 8 MN6	<i>Atriplex bunburyana</i> low shrubland with <i>Frankenia pauciflora</i> over mixed * <i>Cenchrus ciliaris</i> and <i>Sporobolus virginicus</i> tussock grassland.	Coastal plain with reddish brown silty loams.	807454E 7573355N	Poor
Site 9	<i>Acacia bivenosa</i> , <i>Myoporum montanum</i> , <i>Rhagodia preissii</i> subsp <i>obovata</i> open, sometimes scattered shrubland over <i>Triodia epactia</i> hummock grassland with patchy <i>Sporobolus virginicus</i> . Very scattered * <i>Cenchrus ciliaris</i> .	Toe of secondary dune gently inclining to coastal plain with fine pinky sands.	807262E 7573104N	Excellent
Site 10 MN4	<i>Eulalia aurea</i> and <i>Triodia epactia</i> scattered grasses over very scattered <i>Acanthocarpus verticillatus</i> .	Coastal swale between primary and secondary dune with pale beige sands and marine fragments.	807082E 7573298N	Excellent
Site 11	<i>Atriplex bunburyana</i> shrubland to closed shrubland with occasional <i>Acacia bivenosa</i> over <i>Frankenia pauciflora</i> open low shrubland over a mosaic of mixed <i>Sporobolus virginicus</i> , * <i>Cenchrus ciliaris</i> tussock grassland and <i>Triodia epactia</i> hummock grassland.	Coastal plain, low in elevation with pale pinky-brown sandy loams with limestone pebbles.	807361E 7573081N	Good to Poor depending on buffel which occurs in patches.
Site 12 MN8	<i>Lawrenia viridigrisea</i> scattered to open shrubland over <i>Frankenia pauciflora</i> closed low shrubland over <i>Sporobolus virginicus</i> tussock grassland.	Coastal plain low in elevation with soft sodic pinky-brown loams.	807463E 7573409N	Excellent
MN5	<i>Sporobolus virginicus</i> closed tussock grassland with scattered <i>Neobassia astrocarpa</i> low shrubs.	Perimeter of sink hole with grey silty loams.	807513E 7573223N	Excellent

1. Condition Assessment of from Trudgen and EPA 2016a

Appendix D: Site by Species Matrix

Family	Species name	1	2	3	4	5	6	7	8	9	10	11	12	M N-1	M N-2	M N-3	M N-4	M N-5	M N-6	M N-7	M N-8	M N-9	M N-10	M N-11	Op P
	<i>Indigofera boviparda</i> subsp. <i>boviparda</i>	X																							
	<i>Indigofera colutea</i>	X				X		X																	
	<i>Indigofera linnaei</i>																					X			
	<i>Rhynchosia minima</i>	X				X						X													
	<i>Senna glutinosa</i> subsp. <i>glutinosa</i>	X																							
	<i>Swainsona kingii</i>									X		X													
	<i>Swainsona pterostylis</i>				X			X	X			X											X		
	* <i>Vachellia farnesiana</i>		X																						
Frankeniaceae	<i>Frankenia pauciflora</i>		X	X	X			X	X			X	X			X			X		X	X			
Geraniaceae	<i>Erodium cygnorum</i>											X													
Goodeniaceae	<i>Scaevola cunninghamii</i>									X															
	<i>Scaevola spinescens</i>							X	X				X									X	X		
Hemerocallidaceae	<i>Corynotheca flexuosissima</i>					X					X						X								
Lauraceae	<i>Cassytha aurea</i>																							X	
Malvaceae	<i>Gossypium robinsonii</i>		X																						
	<i>Lawrenca viridigrisea</i>				X								X									X			
	<i>Sida fibulifera</i>								X	X															
	<i>Sida rohlenae</i> subsp. <i>rohlenae</i>									X		X													
Myrtaceae	<i>Thryptomene dampieri</i>																							X	
Nyctaginaceae	<i>Boerhavia schomburgkiana</i>					X																			
	<i>Commicarpus australis</i>					X																	X		
Phyllanthaceae	<i>Phyllanthus erwinii</i>							X																	
Plumbaginaceae	<i>Muellerolimon salicorniaceum</i>			X											X										
Poaceae	* <i>Cenchrus ciliaris</i>	X	X		X	X		X	X	X		X	X	X					X			X	X		
	* <i>Cenchrus setiger</i>	X						X											X	X					
	<i>Chrysopogon fallax</i>							X											X	X					
	<i>Dactyloctenium radulans</i>																		X						

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Family	Species name	1	2	3	4	5	6	7	8	9	10	11	12	M N-1	M N-2	M N-3	M N-4	M N-5	M N-6	M N-7	M N-8	M N-9	M N-10	M N-11	Op P
	<i>Eragrostis eriopoda</i>	X																							
	<i>Eriachne obtusa</i>	X								X															
	<i>Eulalia aurea</i>										X						X						X	X	
	<i>Spinifex longifolius</i>					X	X			X	X			X			X						X	X	
	<i>Sporobolus virginicus</i>			X	X				X	X		X	X		X	X		X	X	X	X	X			
	<i>Triodia epactia</i>	X	X			X	X	X		X	X	X					X					X	X		
	<i>Whiteochloa airoides</i>					X	X				X												X		
Portulacaceae	<i>Portulaca oleraceae</i>																								X
Santalaceae	<i>Exocarpos aphyllus</i>																						X		
Sapindaceae	<i>Alectryon oleifolius</i>																						X		
Scrophulariaceae	<i>Myoporum montanum</i>		X			X			X	X		X											X		
Solanaceae	<i>Solanum lasiophyllum</i>	X				X				X													X		
Surianaceae	<i>Stylobasium spathulatum</i>	X	X																						
Zygophyllaceae	<i>Roepera aurantiaca</i>		X																						
	<i>Roepera fruticulosa</i>																								X
	<i>Tribulus occidentalis</i>																					X			