City of Joondalup

Sorrento Surf Life Saving Club Upgrade Revegetation Plan for Pinnaroo Point

Alternative Formats

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Acknowledgement of Traditional Custodians

The City of Joondalup acknowledges the traditional custodians of this land, the Whadjuk people of the Noongar nation. We recognise the culture of the Noongar people and the unique contribution they make to the Joondalup region and Australia. We pay our respects to their elders past, present and emerging, as well as all Aboriginal and Torres Strait Islander peoples.

Joondalup-ak ngala kaditj Noongar moort nidja Wadjak boodjar-ak kalyakool moondang-ak kaaradj-midi. Ngala Noongar Moort wer baalabang moorditj kaadidjiny koota-djinanginy. Ngala Noongar wer Torres Strait Moort-al dandjoo koorliny kwaba-djinanginy. Koora, yeyi wer kalyakool, ngalak Noongar wer Torres Strait Birdiya wer moort koota-djinanginy.

Contents

Acronyms

Acronym / Abbreviation	Definition
BC Act	*Biodiversity Conservation Act 2016*
DBCA	Department of Biodiversity, Conservation and Attractions
DWER	Department of Water and Environmental Regulation
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
FCT	Floristic Community Type
ha	Hectares
SLSC	Surf Life Saving Club
UXO	Unexploded Ordnance

1.0 Introduction

1.1 Purpose

The Sorrento Surf Life Saving Club (SLSC) Upgrade Revegetation Plan for Pinnaroo Point outlines revegetation works that will be completed within the Hillarys Foreshore Reserve. The revegetation efforts are proposed to offset the residual impact associated with the clearing of native vegetation for the Sorrento SLSC Upgrade. The Revegetation Plan will be included in the City's Native Vegetation Clearing Permit application and is subject to change depending on additional conditions provided by the Department of Water and Environmental Regulation (DWER).

1.2 Project Background

Founded in 1958, the Sorrento SLSC has seen exponential growth in both its memberships, operational needs, and the popularity of Sorrento Beach. As a result of this growth and popularity, the existing club facility is unable to meet the needs of its members and adequately provide for the wider community. The existing club facility is in poor condition and its age makes it unsuitable for simple upgrades and repairs. To provide the Surf Club and the community with a facility which can better suit its needs, the City proposes to demolish the existing Surf Club building and northern toilet block and construct a new facility between the southern and northern car parks.

The Sorrento SLSC Upgrade project includes the development of a new two storey Surf Club (**Attachment 1**) containing a kitchen, training room, gymnasium, tower, toilets, furniture store, and club administration areas on the upper level. The lower level will contain space for club storerooms, a kiosk, first aid room, change rooms and public amenities including changing places, outdoor showers, beach wheelchair store, and user group storerooms. The lower level of the Surf Club accesses a paved forecourt which extends into a vehicle and pedestrian ramp to the beach, with landscaped community use areas and coastal gardens surrounding the club.

The works will include an additional 35 parking bays to facilitate increased usage of the SLSC and popularity of Sorrento Beach, with public amenities to be built next to the northern and southern car parks. A new commercial space (café / restaurant) with kitchen, toilets, and bin store will be located to the south of the new Surf Club, where the original club facility was located. The development of the public amenities, parking facilities, and commercial space will not require the clearing of native vegetation however the proposed SLSC facility partially intrudes into the current coastal vegetation. The clearing of 0.15ha of vegetation is required to allow for a safe and accessible space for the club, pedestrians, and vehicles. To facilitate this, the City is applying for a Native Vegetation Clearing Permit to be authorised by DWER. The Revegetation Plan is to be included in the City's application.

1.3 Qualifications and Experience

The Sorrento SLSC Upgrade Revegetation Plan for Pinnaroo Point was developed by the following City of Joondalup staff members:

- Danielle Bowler, Environmental Development Coordinator, Postgraduate Certificate in Policy Studies specialising in Ecologically Sustainable Development, 18 years environmental experience.
- Georgia Davis, Environmental Approvals Officer, Bachelor of Science, 5 years environmental experience.

The City engages a variety of suitably qualified environmental consultants to assist with revegetation works and monitoring of revegetation offsets. Environmental management and monitoring of the offset site will be conducted by suitably qualified environmental consultants. The contractors engaged for the environmental works and monitoring detailed in this plan will be contracted based on the Revegetation Plan and requirements of the Sorrento SLSC Upgrade Clearing Permit.

1.4 Native Vegetation Clearing Details

The Native Vegetation Clearing Permit application submitted by the City of Joondalup for the Sorrento SLSC Upgrade requests the approval for 1,499.8m^2 (0.15ha) of native vegetation clearing. Clearing is required to facilitate the development of a new SLSC in response to the poor condition of the existing facilities and the increasing needs of the Sorrento SLSC and the wider community. The proposed clearing will allow for the construction of the new Surf Club, a public amenity building, and beach access path for Surf Club vehicles and pedestrians.

The clearing is proposed to occur within the following parcels of land:

- Lot 15444 on Deposited Plan 40340. Reserve 47831
- Lot 300 on Deposited Plan 48930. Reserve 27732

The native vegetation communities to be cleared for the Sorrento SLSC upgrade includes:

- Grassland to open grassland of *Spinifex longifolius* with scattered shrubs *Olearia axillaris* and *Scaevola crassifolia* (430.7m^2)

- Heathland to low open heathland *Scaevola crassifolia* with scattered shrubs *Olearia axillaris* over scattered grassland *Spinifex longifolius* over scattered herbs *Acanthocarpus preissii* (1069.1m^2)

Of the 1,499.8m^2 of clearing area, 1061.5m^2 is noted to be of the State listed Priority 3 Ecological Community, Coastal shrublands on shallow sands represented as Floristic Community Type 29a (FCT 29a).

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Sorrento Surf Life Saving Club
Proposed Clearing Extent
Total Area 1499.8sqm

1.5 Revegetation Offset

A suitable revegetation offset has been identified within the Hillarys Foreshore Reserve in Lot 15445 on Deposited Plan 40340, Reserve 47831. The proposed revegetation site is located at Pinnaroo Point, just northwest of John Wilkie Tarn.

The size of the revegetation offset is 4,800m^2 (0.48ha) and is noted to have been calculated using the WA Environmental Offset Calculator in line with guidance from DWER and the Environmental Offset Policy and Environmental Offset Guidelines. The revegetation site is of the same floristic community type as the clearing area (FCT 29a Coastal shrublands on shallow sands, Priority 3), making its location suitable to address the residual impact for this project.

Table 1: Offset calculator rationale and proposed offset area from Environmental Offset Calculator.

Environmental Offset Factors	Scoring and Rationale
Priority Ecological Community	Application area contains native vegetation that represents FCT 29a Coastal shrublands on shallow sands (PEC) in very good condition.
Landscape-level value impacted	Yes - mapped within the Perth regional ecological linkage.
Description	Clearing of native vegetation that represents FCT 29a Coastal shrublands on shallow sands (PEC) in very good condition.
Significant Impact (ha)	0.11ha – Clearing of 0.1062 ha of vegetation representative of FCT 29a: Coastal shrublands on shallow sands (PEC) in very good condition.
Quality	8 – Condition of the vegetation to be cleared is in very good condition.
Rehabilitation Credit	None proposed.
Offset Description	Assumed offset based on the preliminary information provided; to be used as a guide only.
Proposed Offset Area	0.48ha – The area required based on the information provided. Please note this may change based on the final application and offset site.
Current Quality of Offset Site	5 – Assuming the offset site is in good condition and contains environmental values similar to the impact site.
Future Quality Without Offset	5 – Assuming the condition of the offset site will not change with no management measures proposed.
Future Quality With Offset	7 – Assuming that with appropriate management measures and revegetation, following specified completion criteria by a revegetation specialist, the site can be improved to very good condition.
Time Until Ecological Benefit	12 years – The time it would take for the proposed improvements to the native vegetation to occur.
Confidence in Offset Result	80% – Moderate to high level of confidence that the proposed offset will be successful.
Duration of Offset Implementation	20 years – Assumed the offset site will be conserved in perpetuity.
Time Until Offset Secured	2 years – Assuming the revegetation offset will commence within two years of clearing.
Risk of Future Loss Without Offset	10% – The proposed offset site (Sorrento Foreshore Reserve) is zoned as Parks and Recreation and as such the risk of loss is considered low.
Risk of Future Loss With Offset	5% –The proposed offset site is highly unlikely to be developed once it has been designated as revegetation site. .

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Sorrento SLSC Upgrade Revegetation Offset

Pinnaroo Point, Hillarys 6025

2.0 Background of Revegetation Site

2.1 Planning Context

The proposed revegetation site within Hillarys Foreshore Reserve is Crown land managed by the City of Joondalup (Lot 15445 on Deposited Plan 40340). Hillarys Foreshore Reserve is a Major Conservation Area in Bush Forever site 325 that will continue to be managed as a natural area under the Hillarys - Kallaroo Coastal Foreshore Management Plan.

The City of Joondalup is the primary interest holder for the management care and control of the above parcel of land in accordance with the relevant management orders. As such the City is authorised to conduct rehabilitation works within these areas.

The zoning of Pinnaroo Point is noted to be for Parks and Recreation, as listed under the Metropolitan Region Scheme. The area has historically been used by the community and spent many years covered with Beach shacks built in 1925 from timber and Kerosene tins, until they fell into disrepair and were demolished in 1972 as part of the residential development within the surrounding area. In 2000 the area of coastline from Burns Beach to Hillarys, was identified and endorsed as Bush Forever site 325 by State Government and has been protected by the City of Joondalup as a major conservation area within the Hillarys Foreshore Reserve.

2.2 Existing Environment

2.2.1 Climate

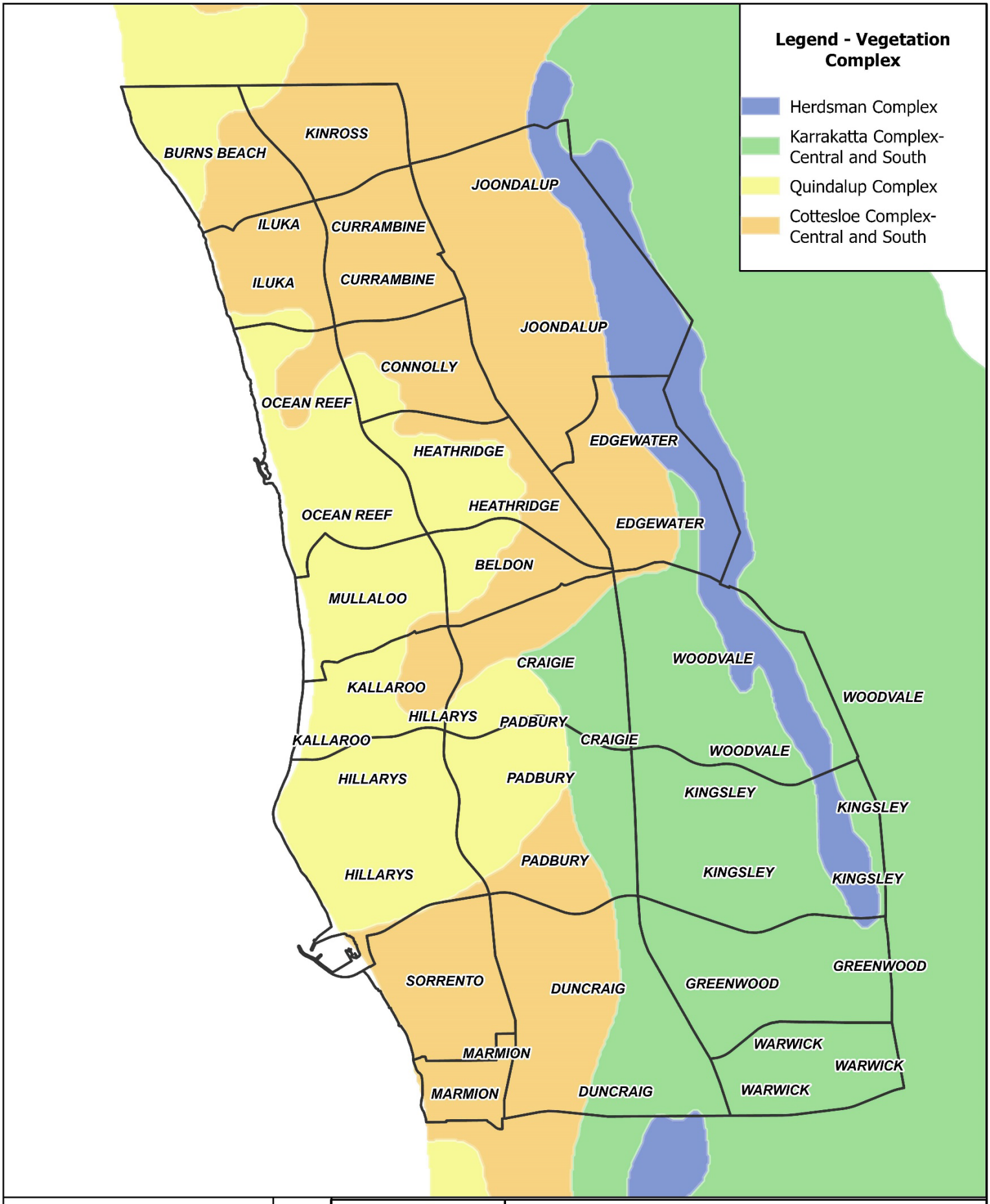
The revegetation site is located within the south-west of Western Australia, which experiences hot, dry summers and cool, wet winters. Data from the Bureau of Meteorology notes the average annual rainfall for the Perth Metro area is 727mm (1994-2024) with approximately 80% falling between May and September. The best time to establish plants in the revegetation site is late autumn to early winter to coincide with seasonal rainfall.

2.2.2 Geomorphology

The revegetation site is located within the Swan Coastal Plain which is broadly characterised as including areas of Jarrah and Banksia woodlands on sandy soils in a series of sand dunes. The site is located on the youngest formation, the Quindalup Dune System, and consists of calcareous deep sands.

2.2.3 Hydrology and Drainage

The City of Joondalup is located on the Gnangara Groundwater System (Gnangara Mound) which is known to be Perth's largest source of groundwater. The Hillarys Foreshore Reserve has one small natural water body present at the southern end of the reserve (Hillarys Marina Lake); however, this water body is a considerable distance from the proposed revegetation site and is unlikely to be impacted by the offset or provide direct drainage. The Hillarys-Kallaroo Foreshore Reserve Management Plan details the depth to groundwater across the reserve to be 0 - 21m above sea level which is consistent with coastal regions.



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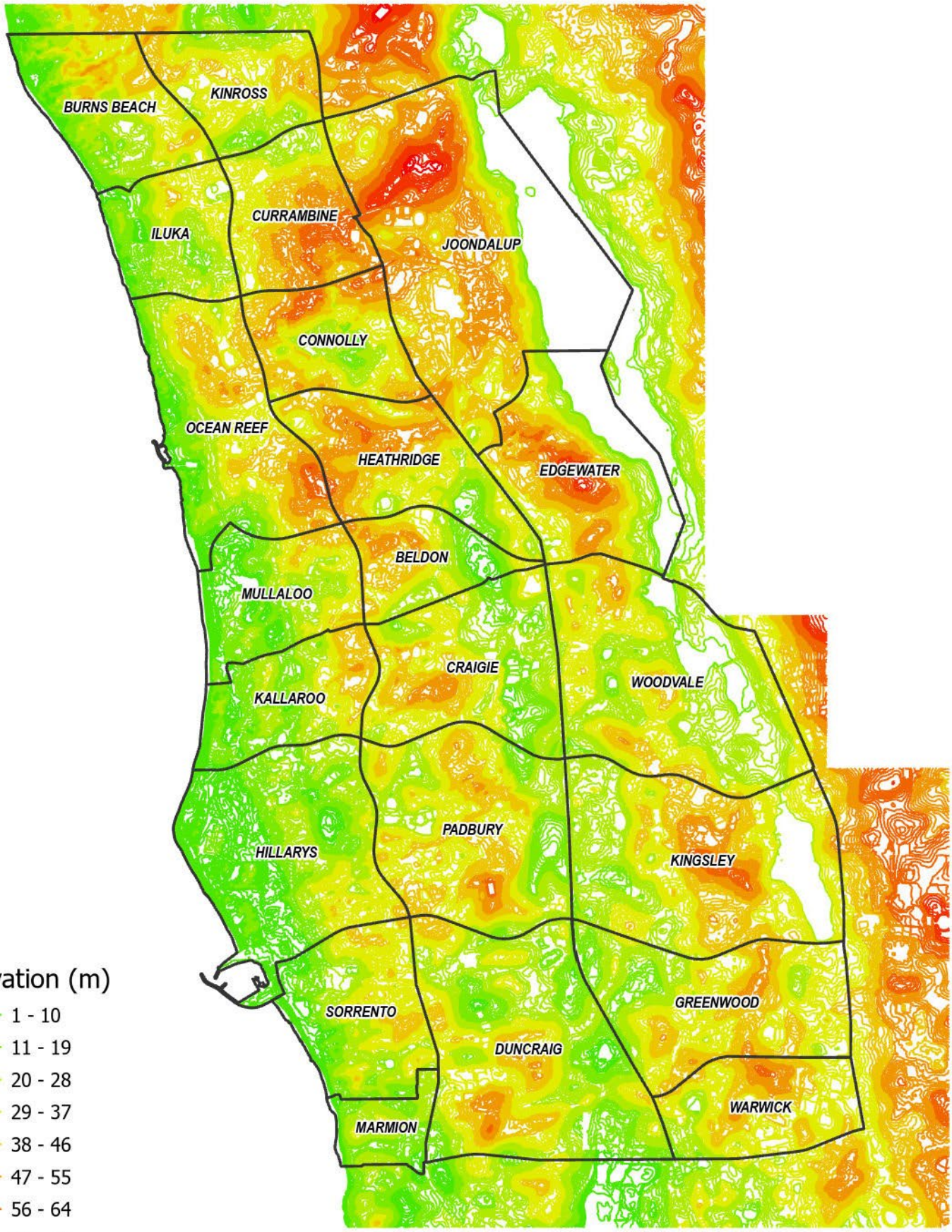
Author: G. Davis

Scale: 1:70,000

Date: 11/03/2025

City of Joondalup Vegetation Complexes

0 0.5 1 2 3 Kilometers



Elevation (m)

- 1 - 10
- 11 - 19
- 20 - 28
- 29 - 37
- 38 - 46
- 47 - 55
- 56 - 64
- 65 - 73
- 74 - 82

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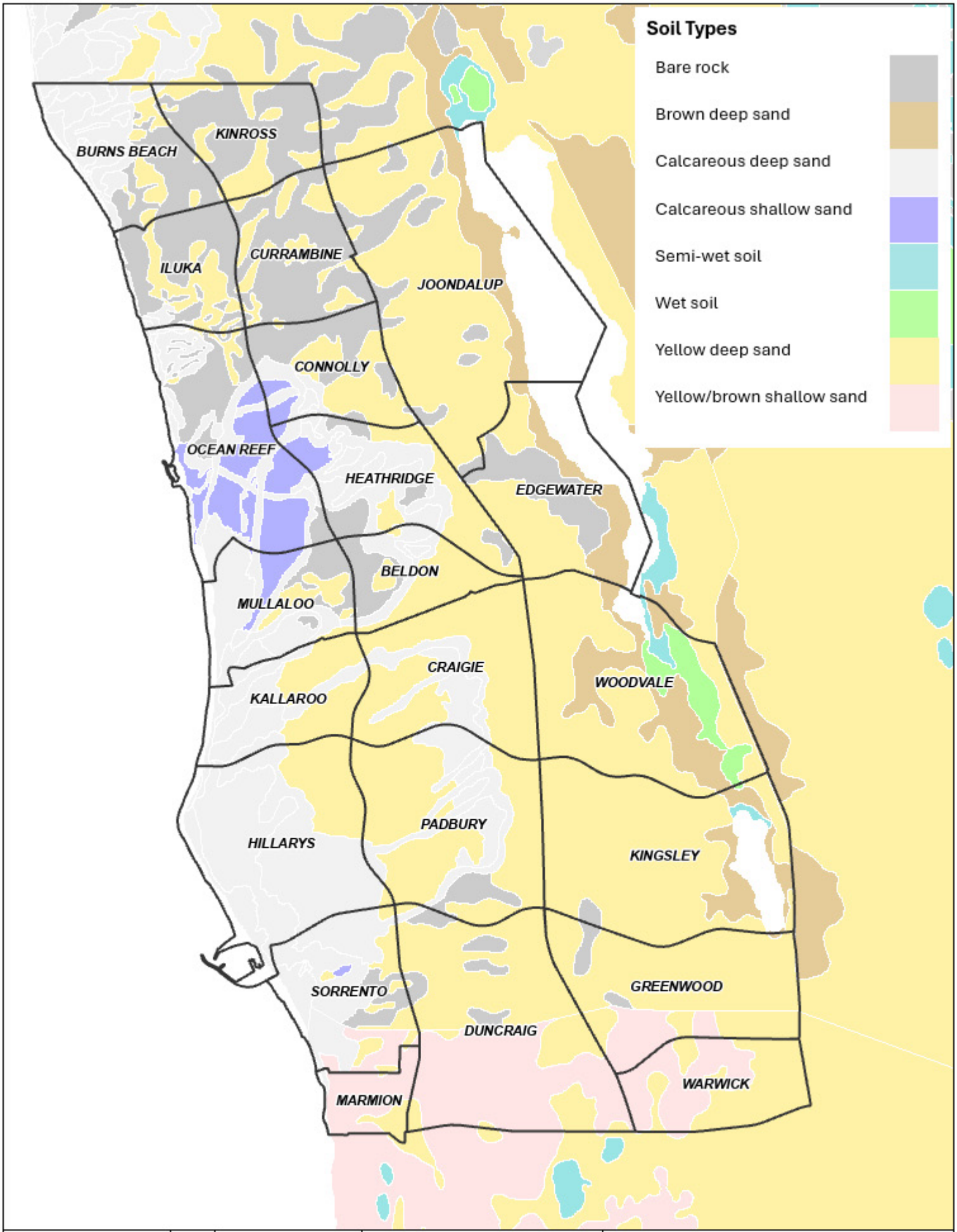
Topographical Contours City of Joondalup



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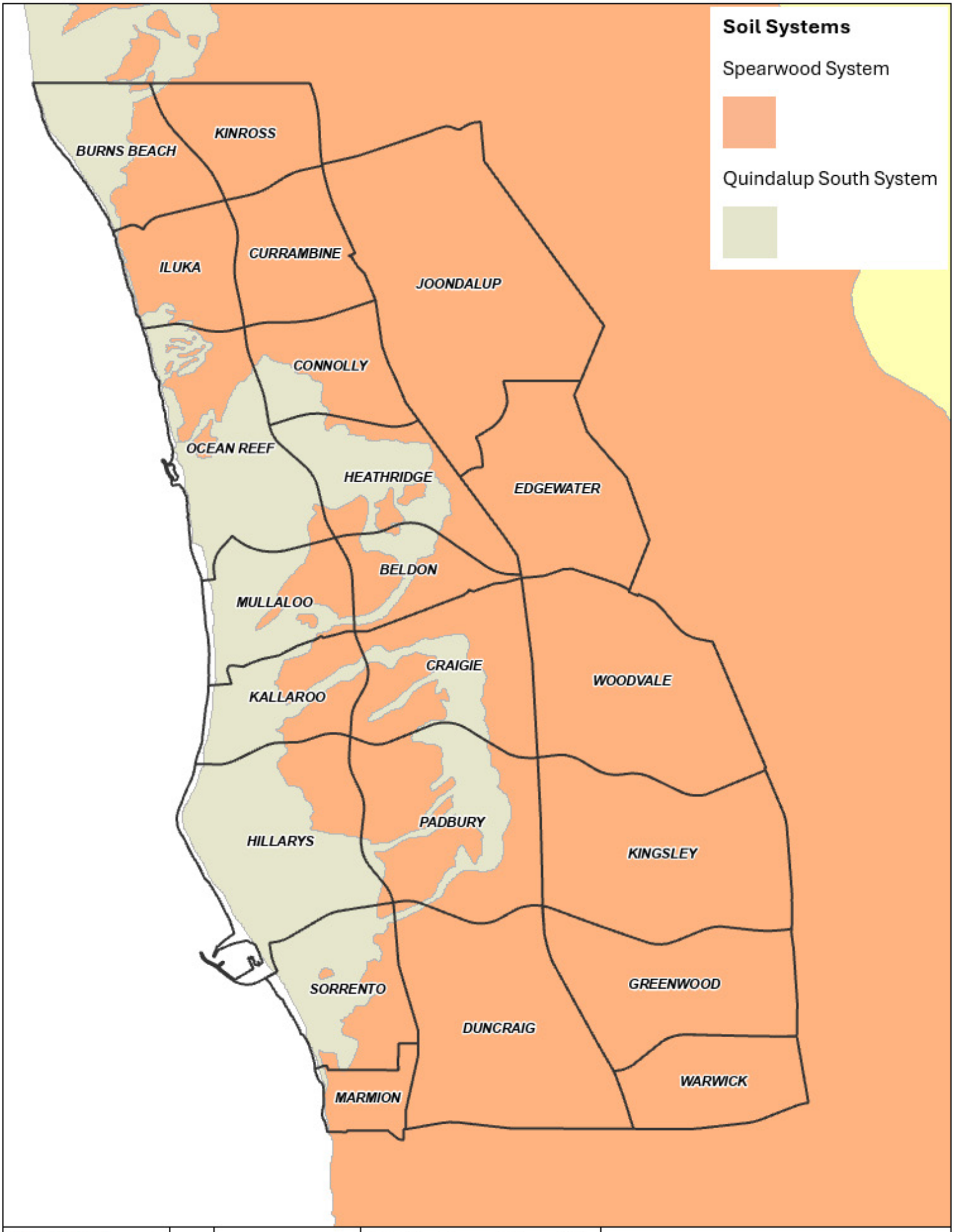
925 462.5 0 925 1,850
Metres

Created by: G. Davis

Date: 29/10/2024

Soil Types City of Joondalup



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Metres

Created by:G. Davis

Date: 29/10/2024

Soil Systems City of Joondalup

2.2.4 Floristic Community and Vegetation Complexes

Regional scale mapping indicates that the revegetation site is located within the Quindalup Vegetation Complex on Quindalup Dunes. The Quindalup Complex is a coastal dune complex consisting mainly of two alliances:

1. The strand and foredune alliance.
2. The mobile and stable dune alliance.

Eco Logical Australia conducted a Flora Survey and Vegetation Condition Assessment of the Hillarys – Kallaroo Foreshore Reserve in 2021 (**Attachment 2**). This survey mapped the local vegetation condition, threatened or priority ecological communities, and local vegetation communities across the two foreshore reserves, including the location proposed for the revegetation offset for the Sorrento SLSC Upgrade.

The Pinnaroo Point revegetation site is 4,800m^2 (0.48ha) of Good condition vegetation associated with the Coastal shrublands on shallow sands Priority Ecological Community (Priority 3) which aligns with FCT 29a. This is the same FCT noted to be associated with the clearing works of the Sorrento SLSC.

The local vegetation communities occurring within the revegetation site include:

- 1,707m^2 OaApRbLOS – *Olearia axillaris, Acanthocarpus preissii* and *Rhagodia baccata* subsp. *baccata* low shrubland over *Spinifex hirsutus* very open grassland (0.17ha).
- 3,093m^2 ArAcTOS - *Acacia rostellifera* and *Acacia cyclops* tall open shrubland over *Spyridium globulosum* and *Olearia axillaris* shrubland to open shrubland over *Melaleuca systena*, *Rhagodia baccata* subsp. *baccata* and *Acanthocarpus preissii* low shrubland over *Lepidosperma gladiatum* open sedgeland (0.31ha).

The mapping of floristic data, vegetation conditions, and vegetation communities may contain minor variances due to the geometric nature of the flora survey and revegetation offset site boundaries, and inherent limitations in GPS technology. Where environmental data is incomplete it has been assumed to correlate to its closest vegetation community and condition area.

Photographs of the revegetation site have been provided in **Attachment 3**.

Vegetation Condition

- VERY GOOD
- GOOD

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Sorrento SLSC Upgrade Revegetation Offset Vegetation Condition

Pinnaroo Point, Hillarys 6025

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Sorrento SLSC Upgrade Revegetation Offset Vegetation Communities

Pinnaroo Point, Hillarys 6025

Threatened and Priority Vegetation Community

FCT 29a: Coastal shrublands on shallow sands (P3)

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Sorrento SLSC Upgrade Revegetation Offset Threatened and Priority Vegetation Communities

Pinnaroo Point, Hillarys 6025

2.2.5 Existing Evidence of Fauna

In 2021, during floristic surveys of the Hillarys and Kallaroo Foreshore Reserves a total of 25 fauna species were identified from observational sightings. A total of 20 native species, two naturalised species, and three pest species were identified. Many of these observations were of direct sightings within the survey area, however some bird species may have been identified flying overhead or via their calls.

Two conservation significant species were identified within the survey including the Forest Red-tailed Black Cockatoo (*Calyptorhynchus banksii naso*), listed as Vulnerable under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and *Biodiversity Conservation Act 2016* (BC Act), and Quenda (*Isoodon fusciventer*) is listed as Priority 4 by the Department of Biodiversity, Conservation and Attractions (DBCA).

Table 2: List of species identified in the flora survey conducted in the Hillary's and Kallaroo Foreshore Reserves by Eco Logical Australia (2021)

Type	Species	Common name	Observation type
Bird	*Anthochaera carunculata*	Red Wattlebird	Directly observed
Bird	*Artamus cinereus*	Black-faced Woodswallow	Directly observed
Bird	*Cacatua sanguinea*	Little Corella	Directly observed
Bird	*Calyptorhynchus banksii naso* (V)	Forest Red-tailed Black Cockatoo	Heard, observed flying overhead
Bird	*Coracina novaehollandiae*	Black-faced Cuckooshrike	Heard
Bird	*Corvus coronoides*	Australian Raven	Directly observed
Bird	*^Dacelo novaeguineae*	Laughing Kookaburra	Directly observed
Bird	*Eolophus roseicapilla*	Galah	Directly observed
Bird	*Gymnorhina tibicen*	Australian Magpie	Directly observed
Bird	*Lichenostomus virescens*	Singing Honeyeater	Directly observed
Bird	*Malurus lamberti*	Variegated Fairywren	Directly observed
Bird	*Ocyphaps lophotes*	Crested Pigeon	Directly observed
Bird	*Pandion haliatus*	Osprey	Directly observed
Bird	*Phylidonyris novaehollandiae*	New Holland Honeyeater	Directly observed
Bird	*Rhipidura leucophrys*	Willie Wagtail	Directly observed
Bird	*^Spilopelia senegalensis*	Laughing Dove	Directly observed
Bird	*Zosterops lateralis*	Silvereye	Directly observed
Insect	**Ischnura heterosticta*	Common Bluetail Dragonfly	Directly observed
Insect	**Mamestra brassicae*	Cabbage Moth	Directly observed
Insect	*Nephila edulis*	Australian Golden Orb-Weaving Spider	Directly observed
Insect	**Ommatoiulus moreleti*	Portuguese Millipede	Directly observed
Mammal	*Isoodon fusciventer* (Priority 4)	Quenda, Southern Brown Bandicoot	Directly observed
Reptile	*Ctenotus fallens*	West-coast Laterite Ctenotus	Directly observed
Reptile	*Egernia kingii*	King's skink	Directly observed
Reptile	*Pseudonaja affinis*	Dugite	Directly observed

Note: * refers to a pest species; ^ refers to a naturalised exotic species

2.2.6 Previous Works

The City supports ongoing revegetation works in degraded coastal areas through annually providing native plants to the Friends of Sorrento Beach and Marmion Foreshore, Friends of Hillarys and Kallaroo Foreshore, Mullaloo Beach Community Group, and the Friends of North Ocean Reef / Iluka Foreshore, as well as implementing the annual Adopt a Coastline / Bushland interactive bushland management program with schools. For example, Mullaloo Heights Primary School conducted revegetation in Pinnaroo Point in June 2024 as part of the City's Adopt a Coastline program.

Native plants are often grown in the City's nursery from seed stock collected on site and used for revegetation works in degraded areas or as part of community planting days. In 2024, a total of 5,430 native plants were provided to coastal friends group by the City. This consisted of 1,100 native plants provided to the Friends of Sorrento Beach and Marmion Foreshore, 2,280 to the Friends of Hillarys and Kallaroo Foreshore, 1,600 to the Mullaloo Beach Community Group, and 450 native plants provided to the Friends of North Ocean Reef / Iluka Foreshore. The City will continue to support the community to undergo coastal revegetation works as well as also conducting revegetation works.

2.3 Existing site disturbances

Unmanaged access
The movement of people and domestic animals over the revegetated area may result in erosion, damage to plants and limit revegetation outcomes. Restricting access to the revegetation site may be required during restoration and over the long-term management of the site. There are existing signs of unmanaged access at the proposed site through patches of open sand along the western side of the dune. Revegetating these areas and using temporary fencing and signage as required will limit access to the area.

Waste and rubbish
The site contains small amounts of litter which have blown in from the beach front and nearby park. General maintenance at the site will include the removal of rubbish. If significant rubbish or dumping is identified within the site, additional measures will be taken to prevent access to the site and to promote the responsible disposal of rubbish while using the beach and park.

2.4 Physical site factors

Erosion and dust generation
Surface water is likely to drain freely across the site due to the permeable sands present. Therefore, water erosion from surface runoff would occur infrequently, if at all, and only in response to intense events. Wind erosion and sand drift have the potential to impact revegetation due to ground disturbance low vegetation cover and the prevailing coastal winds. Although revegetation will stabilise the site and reduce the potential for dust and erosion, management actions will be undertaken prior to planting and as required during ongoing monitoring of the site.

Unexploded Ordnance
The Pinnaroo Point revegetation site falls within an unexploded ordnance (UXO) area of 'other potential' and was used by allied aircraft for gunnery and bombing practice during WWII. No specific UXO contaminated site has been identified in the area and no UXO has been recovered from the site, however a possibility still exists that UXO may be found within the area. It is considered that the possible risks from UXO within this area are minimal, however

a level of risk remains. The City's 'Finding Unexploded Ordnance Items' process will be implemented during the revegetation works, if required.

2.5 Biological site conditions

Weeds
Weeds can degrade native vegetation by competing for space and resources. An increase in weed presence could therefore limit revegetation outcomes. There is the potential for the cover and/or diversity of weeds to be increased through ground disturbance and by introducing new weeds on vehicles or equipment. Good hygiene practices and regular weed management are required to limit weed introduction and control weeds within the site.

Non-native Fauna
Non-native herbivorous fauna can directly limit the outcomes of revegetation by damaging or destroying plants. It is possible that herbivores like rabbits could pose a risk to site revegetation. Rabbit and other non-herbivorous fauna management will be required if impacts are recorded, particularly in initial periods when plants are small.

Plant pathogens
Pathogen sampling was conducted at Hillarys Foreshore Reserve in 2013/14 and 2016/17. No pathogens have been identified within the Pinnaroo Point revegetation site or directly adjacent, however only a small number of samples were taken. A large range of native species are susceptible to pathogens which are spread through movement of contaminated soil and mud, especially by vehicles, equipment, and footwear. There is no practical large-scale cure for Phytophthora and Pythium pathogens and therefore prevention and containment is the primary management solution. While pathogens are not expected to be a critical issue within the site, good hygiene practices will be applied to limit the potential spread or introduction of plant pathogens. The City's Pathogen Hygiene Procedure will be implemented during the works (**Attachment 4**), as well as staff and contractors being required to be Green Card qualified.

2.6 Management

The City's coastal zone is managed under the Coastal Foreshore Management Plan with major conservation areas managed for conservation purposes under reserve specific management plans. The vegetation in and around the development area for the Sorrento SLSC upgrade is managed under the Sorrento Coastal Foreshore Reserve Management Plan, with the revegetation area proposed at Pinnaroo Point managed under the Hillarys - Kallaroo Coastal Foreshore Management Plan.

The City regularly conducts works within its bushland reserves including weed monitoring every six months to identify priority weeds and establish their distributions, weed control, seed collection, revegetation, erosion control, and feral pest management. These works are conducted either by City personnel or by contractors. Natural bushland regeneration is encouraged through weed management and the use of conservation fencing, with revegetation typically undertaken as required. Community Landcare activities including revegetation and weed control have been conducted along the Hillarys Foreshore by the Friends of Hillarys and Kallaroo Foreshore Reserve which has improved the vegetation quality and biodiversity of the Hillarys Foreshore. In addition to this ongoing management of the City's reserves, the revegetation site will be regularly monitored to ensure compliance with the City's completion criteria. Additional measures to ensure the success of the revegetation will be conducted as needed including weed control, watering, erosion control, and infill planting.

3.0 Revegetation Commitments

3.1 Goals and Objectives

The overarching goal for revegetation is to stabilise, revegetate, and improve the condition of the vegetation within the revegetation site.

The following objectives are proposed to guide the revegetation and ensure that the overarching goal has been met:

- Landforms within revegetated areas are stable and not actively eroding such that native shrub and herb species can be established.
- Revegetated areas have a minimum of 2 plants per metre squared.
- Revegetated areas have a minimum diversity of at least 7 appropriate locally native species.
- Weed cover does not exceed 10% of revegetated areas.
- Pinnaroo Point site improves from good condition to a minimum of very good condition.

3.2 Targets and Completion Criteria

Assessment of the revegetation areas will include statistical analysis of the survival rate, plant density, species diversity, and weed load. The completion criteria meet the SMART principles by being: specific and providing exact numbers for species diversity, density, and weed control; measurable by being qualities that can be assessed during floristic surveys and site inspections; achievable by being based upon previous targets set by DWER for revegetation; relevant by their ability to improve the condition and diversity of the revegetation site; and time-bound by the criteria requiring the City to meet these targets within 3 years. The revegetation completion targets and criteria are outlined in Table 3. The revegetation site will be monitored annually against completion targets and criteria through floristic and vegetation condition assessments with remedial actions undertaken until the completion criteria are met.

Table 3: Revegetation completion targets and criteria for the Pinnaroo Point revegetation site.

Measure	Completion targets	Completion criteria	Monitoring
Native diversity	Minimum of 60% of native species returned	A minimum of 7 native species per 10m by 10m quadrat	Native diversity will be counted annually in years 1, 2 and 3 and as required thereafter
Weed density	Weed cover at the site is 10% or less (minor non-competitive weeds)	Weed cover is to be 10% or less of minor non-competitive weeds	Weed cover percentage will be assessed annually in years 1, 2 and 3 and as required thereafter
Native density	Survival rate of 2 plant / m^2	A survival rate of 2 plant / m^2 is to be achieved after 3 years. Non-surviving species will be replanted within 12 months and monitored for a further 2 years.	The number of surviving plants will be counted annually in years 1, 2 and 3. Further monitoring will be conducted if replanting is required
Watering	Watering of tubestock over summer months	Watering to be conducted 5 times over the summer months each year for 3 years	Watering of tubestock to be conducted 5 times in years 1, 2 and 3 and as required thereafter
Weed control	Quarterly weed control events with the first event to be undertaken prior to planting	Weed control events to be conducted quarterly each year for 3 years	Quarterly weed control events to be conducted in years 1, 2 and 3

3.3 Reference Sites

Floristic surveys are regularly scheduled in the City's coastal reserves to provide accurate data regarding floristic communities and vegetation conditions. These flora surveys provide the City with quadrat data as part of the vegetation analysis which are used by the City as reference sites for developing revegetation species lists and to guide long term monitoring.

The reference sites used by the City are identifiable by GPS coordinates for use in future surveys and monitoring, and include vegetation of good to excellent condition, with excellent condition being favoured where available. The reference quadrats are of the same Priority 3 ecological community (FCT 29a Coastal shrublands on shallow sands), and local vegetation community as the areas being revegetated to ensure the species used in rehabilitation works are suitable given the surrounding vegetation, soil type, and geology. The floristic data from the relevant surveys from which the reference quadrats have been sourced can be found in **Attachment 2.**

Hillarys Foreshore Reserve Revegetation Site

Five reference sites from the Hillarys-Kallaroo Coastal Foreshore Reserve Flora Survey and Vegetation Condition Assessment (2021), were used to develop the revegetation species list and will be used to guide the long-term rehabilitation at the site. The selected reference sites are all reflective of the Priority 3 ecological community (FCT 29a Coastal shrublands on shallow sands). Two Very Good condition reference sites have been selected from the local vegetation community ArAcTOS and three Good condition reference quadrats have been selected for local vegetation community OaApRbLOS. Additional infill planting and revegetation may include alternative species identified from within the reference quadrats.

Hillarys-Kallaroo Coastal Foreshore Reserve Flora Survey (2021)

- WN New Q2 – Good Condition – OaApRbLOS
- WN New Q3 – Good Condition – OaApRbLOS
- WN Q6 – Very God – ArAcTOS
- WN Q8 – Good Condition – OaApRbLOS
- WN Q12 – Very Good Condition – ArAcTOS

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N

Scale (A4): 1:9,965	Date: 6/03/2025	Compiled: A.Gilbert
Path: E:\GIS Projects\SSLC\SSLC.aprx		

Sorrento SLSC Upgrade Revegetation Offset Reference Sites

Pinnaroo Point, Hillarys 6025

3.4 Revegetation Species

The City will engage a contractor to propagate and grow revegetation species as listed below, using local provenance seed collected from site where possible. The City will also consider the collection of cuttings and seeds from the native vegetation clearing to grow local provenance species in the City's nursery for its revegetation projects which will be conducted as required depending on the species to be collected. The City adopts a local provenance approach for revegetation projects within the City and works closely with the local Friends Groups in revegetation efforts.

Reference sites in good to excellent condition have been used to develop the revegetation species list representative of the current and adjacent ecological communities including species from FCT29a, the Coastal shrublands on shallow sands Priority Ecological Community (Priority 3).

Scientific Name	**Number of plants***
Acanthocarpus preissii	500
Carpobrotus virescens	100
Ficinia nodosa	100
Myoporum insulare	300
Olearia axillaris	750
Rhagodia baccata subsp. *Baccata*	650
Scaevola crassifolia	650
Spinifex hirsutus	350
Spinifex longifolius	1000
Spyridium globulosum	500
Threlkeldia diffusa	100

Total number of plants: 5,000

Additional species may be used during the initial planting and any subsequent infill events depending on availability. The species selected will be suitable for the local floristic region and vegetation communities within the revegetation site. The number of plants selected has been identified from the size of the revegetation site, completion criteria, and the existing vegetation density, diversity, and distribution. The number of plants may vary due to availability and progress towards the completion criteria.

3.5 Revegetation Techniques

Revegetation of the City's coastal reserves is completed through a variety of different activities depending on existing site conditions and the time of year. During the revegetation process the City will keep records relating to any works conducted including their outcome, method and timing.

3.5.1 Site Preparations

Prior to the revegetation works commencing, the City will ensure the site is adequately prepared. Preparations may include the clearing of non-native vegetation, chemical weed control, pest management techniques, and erosion control such as coir matting and sand trap fencing. Seed collection may be conducted around the revegetation areas to facilitate the propagation of local provenance tubestock to be used in the revegetation works.

3.5.2 Plantings

Tubestock seedlings will be planted in winter due to favourable weather conditions promoting effective revegetation. Tubestock will be planted once the winter rains have started, and the ground is sufficiently moist. Species will be planted in a mixed pattern so that diversity is maintained across the revegetation site. Tree guards may be used across the revegetation site to prevent damage from grazing and improve the survival rate of planted tubestock. Tubestock will be installed using a deep planting method where possible. Supplementary plantings will be undertaken in years 2 and 3 if the native diversity and density criteria is not met.

3.5.3 Pathogen and Weed Hygiene

Pathogen and weed hygiene protocols will be adhered to prior to entering and leaving the site, including implementation of the City's Pathogen Hygiene Procedure as shown in **Attachment 4**. Seedlings will be obtained from either a Nursery Industry Accreditation Scheme Australia (NIASA) certified nursery, or from the City's nursery implementing our pathogen hygiene procedures to ensure the plants are obtained from pathogen free sources.

3.5.4 Weed Control

Weed control will occur at the revegetation site prior to planting to reduce competition pressures for the planted tubestock. Following the winter planting, quarterly weed control events will be scheduled including hand weeding and spot spraying with additional weed control conducted as required.

3.5.5 Pest Management

Pest control methods for foxes and rabbits will be conducted if required at the revegetation site prior to revegetation works to prevent damage to revegetation and to improve the condition of the existing vegetation.

3.5.6 Watering

Tubestock will be watered 5 times over summer months as required for the first 3 years or until completion criteria are met.

3.5.7 Site Protections

The Pinnaroo Point revegetation site is to have temporary fencing installed to prevent pedestrian access to the dunes along the beach and beach access pathway. In the case of disruptions to the revegetation site, additional fencing measure will be employed. Temporary signage indicating that the site contains revegetation and is not to be disturbed will be installed. Temporary fencing will be inspected every 6 months and repairs undertaken as required.

3.5.8 Remedial Action

Annual monitoring will be conducted by an environmental specialist within the revegetation areas to ensure the completion criteria are met. If monitoring results indicate the revegetation site is not predicted to meet the requirements of the completion criteria, additional plantings will be conducted until the species diversity and plant density are met. Remedial actions will

also be conducted if weed coverage is greater than 10%, there is continued evidence of erosion, or signs of feral pests.

4.0 Schedule

Table 4: Proposed schedule of works for the Pinnaroo Point revegetation site

Year	Timing	Responsible	Task
Year 0	As Required	Contractor	Seed collection from within the Hillarys - Kallaroo Foreshore Reserves
	After permit granted	Contractor	Clearing completed
	July	City Staff	Order revegetation tubestock for planting
Year 1	As Required	Contractor	Seed collection from within the Hillarys - Kallaroo Foreshore Reserves
	Mar - May	Contractor	Weed and erosion control, at revegetation site prior to planting
	Jun - Aug	Contractor	Plant tubestock seedlings at revegetation site
	After planting is completed	Contractor	Install temporary fencing if required and signage around revegetation site
	Every six months after fencing is installed	City Staff	Inspect fencing and signage and make repairs if required
	Quarterly after planting	City Staff / Contractor	Weed control at revegetation site after planting
	Sept - Nov	Contractor	Inspect revegetation survival rates and determine vegetation condition, density, diversity, and composition. Determine number of new plants required to be planted in following year to meet targets and assessment criteria
	Sept - Nov	City Staff	Order plants for supplementary planting in following year (if required)
	Summer	City Staff / Contractor	Water revegetation plants over summer – five times
Year 2	As Required	Contractor	Seed collection from within the Hillarys - Kallaroo Foreshore Reserves
	Every six months	City Staff	Inspect fencing and signage and make repairs if required
	Quarterly	City Staff / Contractor	Weed control at revegetation site

Year	Timing	Responsible	Task
Year 2	Sept - Nov	Contractor	Monitoring and assessment against targets and completion criteria and to assess vegetation condition, density, diversity, and composition
	Sept - Nov	City Staff	Order plants for supplementary planting in following year (if required)
	Summer	City Staff / Contractor	Water revegetation plants over summer – five times
Year 3	As Required	Contractor	Seed collection from within the Hillarys - Kallaroo Foreshore Reserves
	Every six months	City Staff	Inspect fencing and signage and make repairs if required
	Quarterly	City Staff / Contractor	Weed control at revegetation site
	Sept - Nov	Contractor	Monitoring and assessment against targets and completion criteria and to assess vegetation condition, density, diversity, and composition – Determine if further management / monitoring required.
	Sept - Nov	City Staff	Order plants for supplementary planting in following year (if required)
	Summer	City Staff / Contractor	Water revegetation plants over summer – five times

5.0 References

Australian Government Bureau of Meteorology 2024, *Monthly Rainfall Perth Metro*, https://reg.bom.gov.au/jsp/ncc/cdio/weatherData/av?p_nccObsCode=139&p_display_type=dataFile&p_startYear=&p_c=&p_stn_num=009225

Department of Planning Lands and Heritage 2022, *Bush Forever Audit 2021*, Western Australian Planning Commission, Perth WA.

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Natural Area Consulting 2014, *Coastal Foreshore Management Plan 2014 – 2024*. Prepared for the City of Joondalup

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Pratt S., *City of Joondalup / City of Wanneroo Snapshot*, History Teachers Association of Western Australia. https://htawa.net.au/WA-100-years/files/community/City-of-Joondalup-and-Wanneroo-snaphot-e.pdf

6.0 Attachments

Attachment 1: Sorrento Surf Life Saving Club Designs – Hodge Collard Preston

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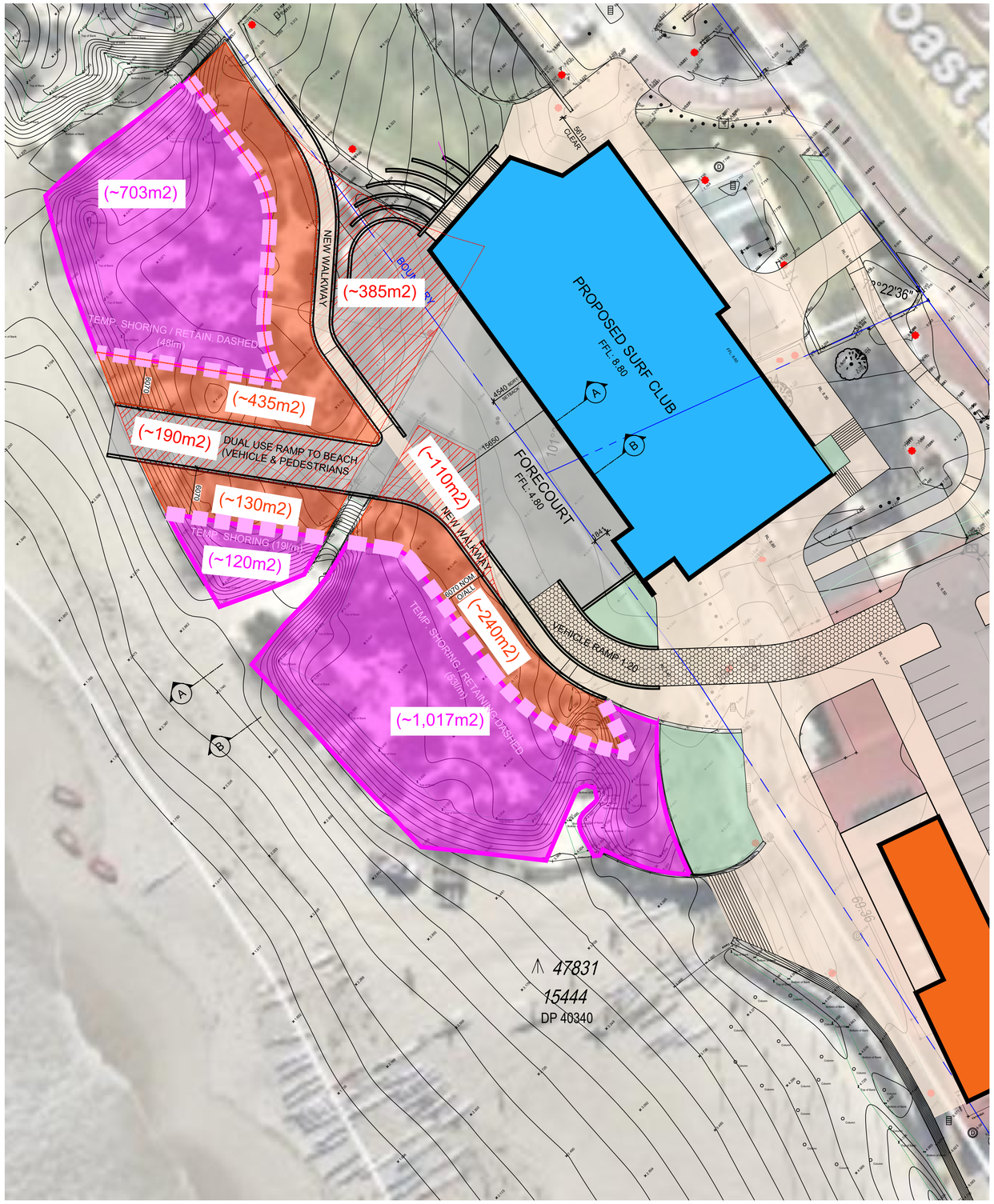

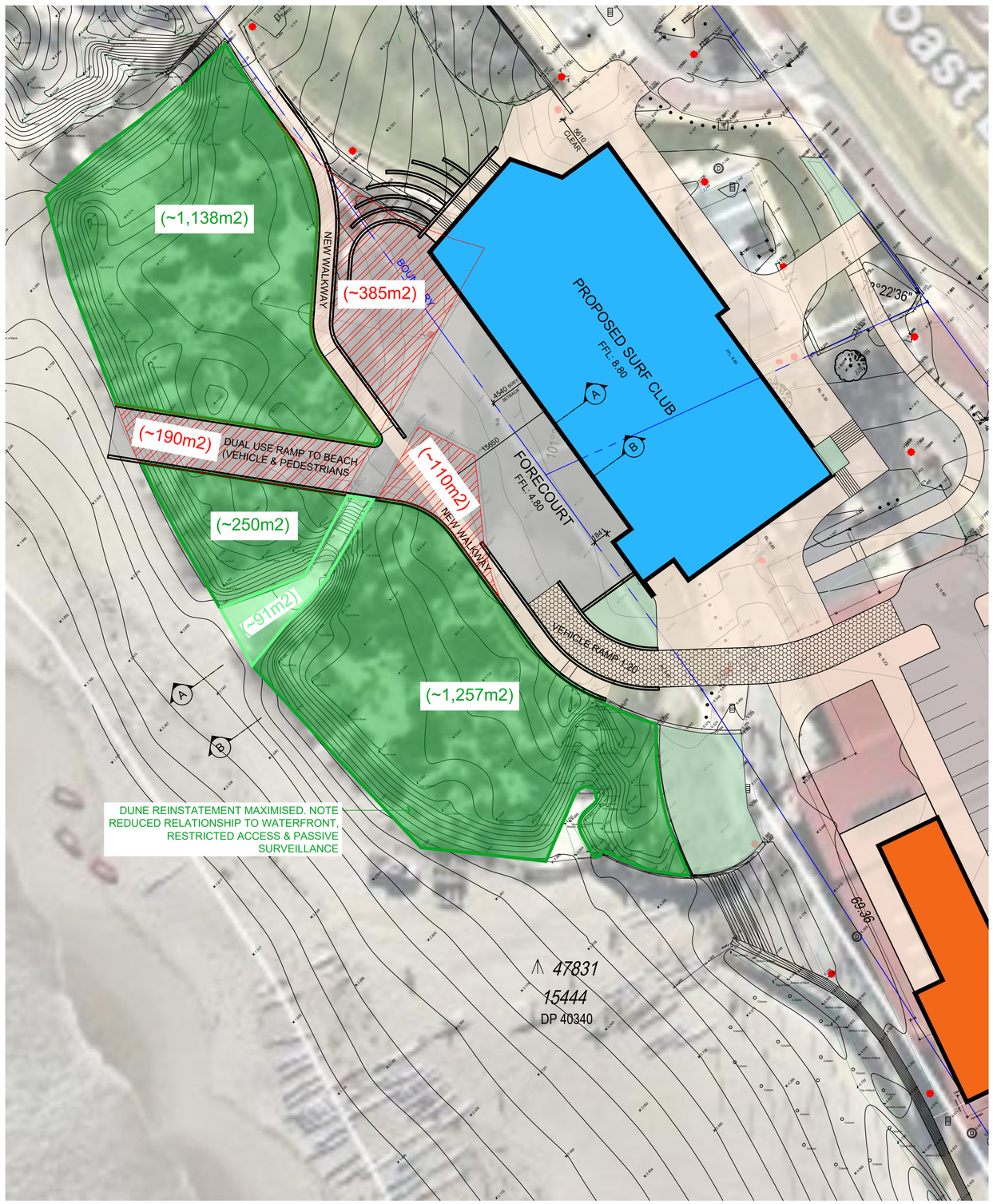

1 / - SITE PLAN - DUNE IMPACTS
SCALE 1:300 @ A1

TOTAL EXISTING DUNE AREA: 3,330m2

- DUNES RETAINED DURING CONSTRUCTION 1,840m2 (APPROX)
- DUNES DEMOLISHED TO FACILITATE CONSTRUCTION 805m2 (APPROX)
- DUNES PERMANENTLY DEMOLISHED FOR NEW SLSC, TO BE REINSTATED ELSEWHERE 685m2
- DUNE REINSTATEMENT 2,645m2 (APPROX)
- DUNE - NEW AREAS 91m2 (APPROX)

2 / - SITE PLAN - DUNE REINSTATEMENT
SCALE 1:300 @ A1

revision/ issue	description	drawn	checked	date
C	ISSUED FOR REVIEW & COMMENT – SITE LAYOUT UPDATED	JC	NP	28.11.2024
B	ISSUED FOR REVIEW & COMMENT – TEMP SHORING / RETAINING ADDED	JC	NP	19.09.2024
A	ISSUED FOR REVIEW & COMMENT	JC	NP	09.09.2024

project: SORRENTO SLSC FACILITY REDEVELOPMENT PROJECT
location: 187 WEST COAST DRIVE, SORRENTO WA 6020
drawn: JC
checked: NP
description: PROPOSED SLSC SITE & DUNE IMPACTS
scale: 1:300 @A1
date: 09/09/2024
project no: 78.24
dwg no: SK06
rev: C

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PO Box 743, West Perth, WA 6872
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Fax: (08) 9322 5740
Email: admin@hcparch.com

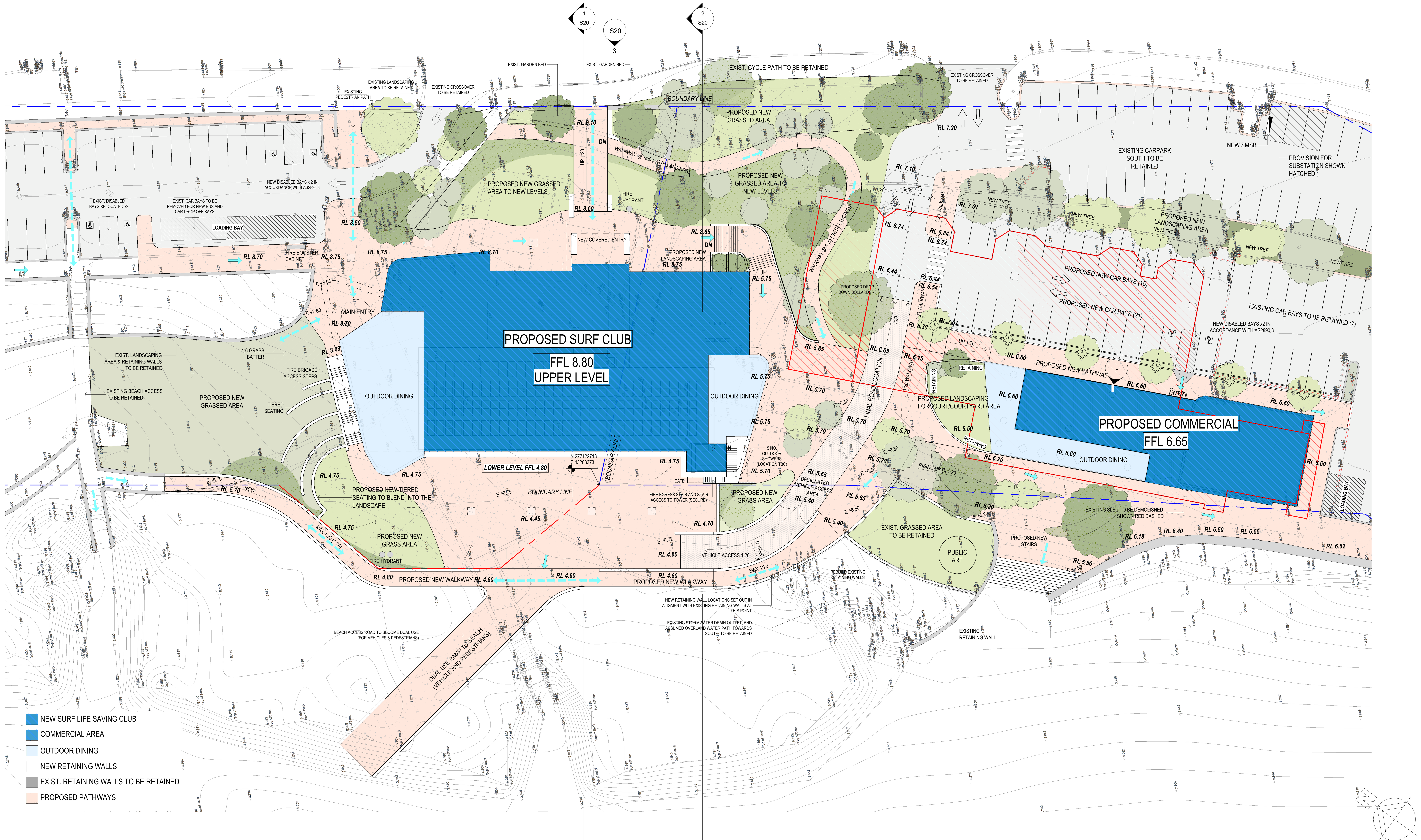
1 - SLSC - LOCATION PLAN
1 : 650

PROPOSED SLSC LOCATION PLAN

S01

SORRENTO SLSC FACILITY REDEVELOPMENT
189 WEST COAST DR, SORRENTO WA 6020
REVISION E PROJECT NO. 78.24 DATE 14/02/2025

Hodge Collard Preston ARCHITECTS



1 SLSC - SITE PLAN
1 : 250

PROPOSED SLSC SITE PLAN

S02

SORRENTO SLSC FACILITY REDEVELOPMENT
189 WEST COAST DR, SORRENTO WA 6020
REVISION H PROJECT NO. 78.24 DATE 14/02/2025

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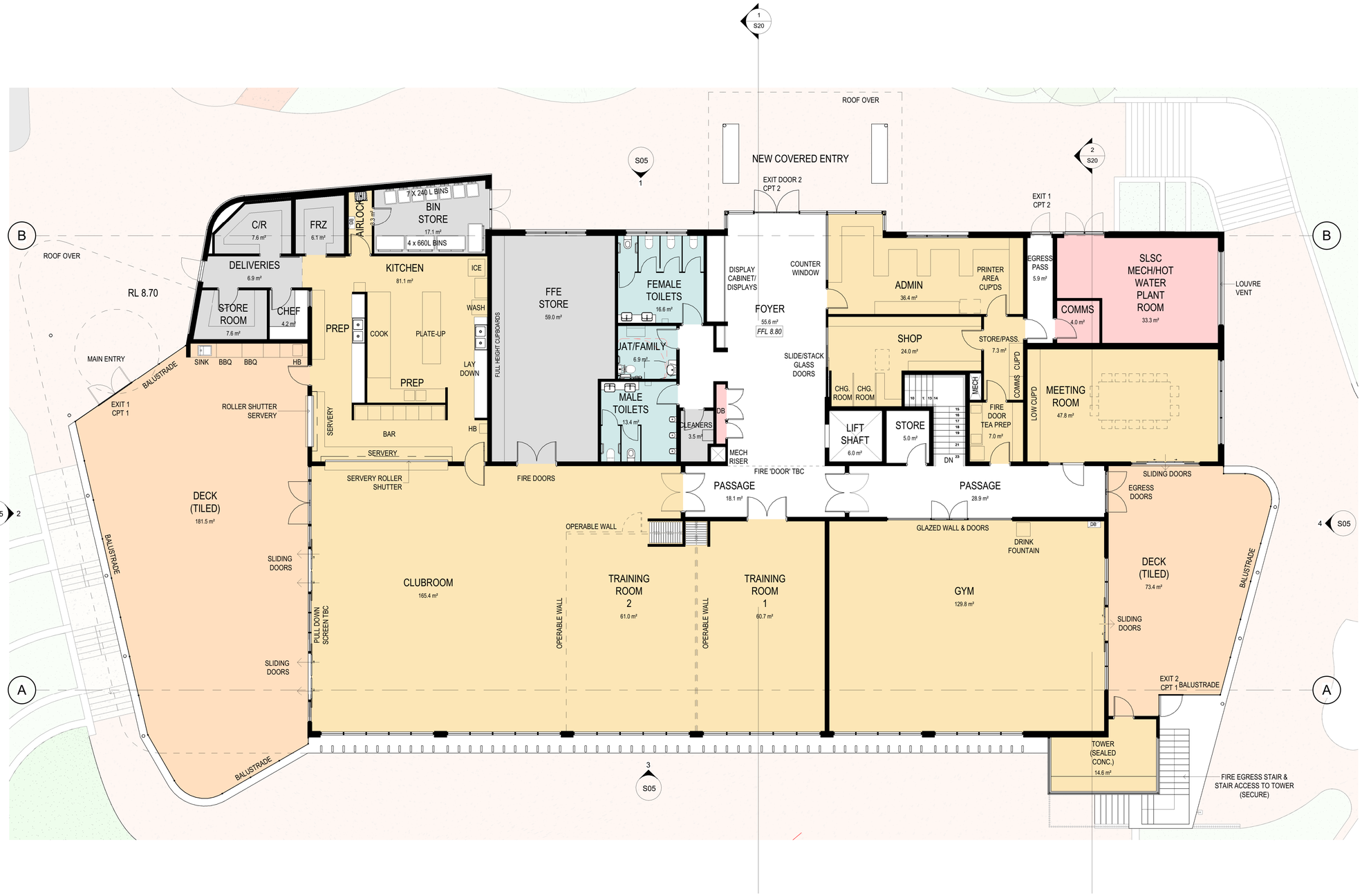


- CLUB (MAIN AREAS)
- CLUB AMENITIES
- CLUB DECK
- CLUB SERVICES
- CLUB STORAGE
- PUBLIC AMENITIES

ROOM SCHEDULE

Name	Area
UAT/FAMILY	7 m²
FEMALE TOILETS	17 m²
MALE TOILETS	13 m²
KITCHEN	81 m²
BIN STORE	17 m²
AIRLOCK	3 m²
DB	1 m²
CLEANERS	3 m²
EGRESS PASS	6 m²
FFE STORE	59 m²
LIFT SHAFT	6 m²
FRZ	6 m²
C/R	8 m²
CHEF	4 m²
STORE ROOM	8 m²
ADMIN	36 m²
MEETING ROOM	48 m²
TRAINING ROOM 2	61 m²
TRAINING ROOM 1	61 m²
GYM	130 m²
SLSC MECH/HOT WATER PLANT ROOM	33 m²
STORE	5 m²
SHOP	24 m²
STORE/PASS.	7 m²
TEA PREP	7 m²
DECK (TILED)	73 m²
TOWER (SEALED CONC.)	15 m²
CLUBROOM	165 m²
DECK (TILED)	182 m²
FOYER	56 m²
PASSAGE	29 m²
STAIRS	9 m²
PASSAGE	18 m²
COMMS	4 m²
DELIVERIES	7 m²

PROPOSED SLSC UPPER FLOOR PLAN

S03

SORRENTO SLSC FACILITY REDEVELOPMENT

189 WEST COAST DR, SORRENTO WA 6020

REVISION I PROJECT NO. 78.24 DATE 14/02/2025

Hodge Collard Preston ARCHITECTS

- CLUB (MAIN AREAS)
- CLUB AMENITIES
- CLUB DECK
- CLUB SERVICES
- CLUB STORAGE
- PUBLIC AMENITIES

ROOM SCHEDULE

Name	Area
IRB REPAIR	30 m²
STORE	3 m²
KIOSK	25 m²
FEMALE CHANGEROOMS	77 m²
MENS CHANGEROOM	74 m²
UAT/SHR	8 m²
UAT/SHR	8 m²
STORE CLEANER	4 m²
UAT/SHR	12 m²
USER GROUP STORE #1	11 m²
USER GROUP STORE #2	11 m²
STORE (BEACH WHEELCHAIR)	14 m²
CHANGING PLACES	16 m²
GEAR	62 m²
BOARDS	84 m²
SKI	62 m²
SKI	90 m²
BOATS	90 m²
VEHICLE	91 m²
GEAR	72 m²
FIRST AID	25 m²
STORE/CLNR	3 m²
MALE PUBLIC AMENITIES	36 m²
FEMALE PUBLIC AMENITIES	35 m²
JET SKI STORAGE	26 m²
PASSAGE	42 m²
LIFT	6 m²
STAIRS	10 m²

PROPOSED SLSC LOWER FLOOR PLAN

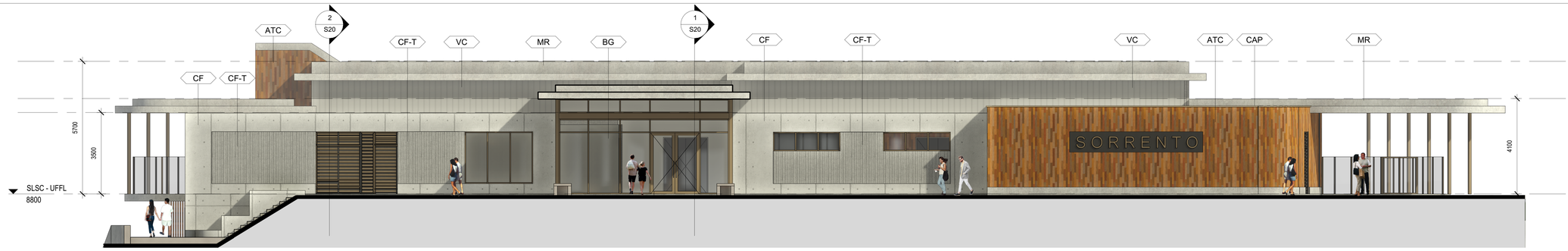
S04

SORRENTO SLSC FACILITY REDEVELOPMENT

189 WEST COAST DR, SORRENTO WA 6020

REVISION I PROJECT NO. 78.24 DATE 14/02/2025

Hodge Collard Preston ARCHITECTS



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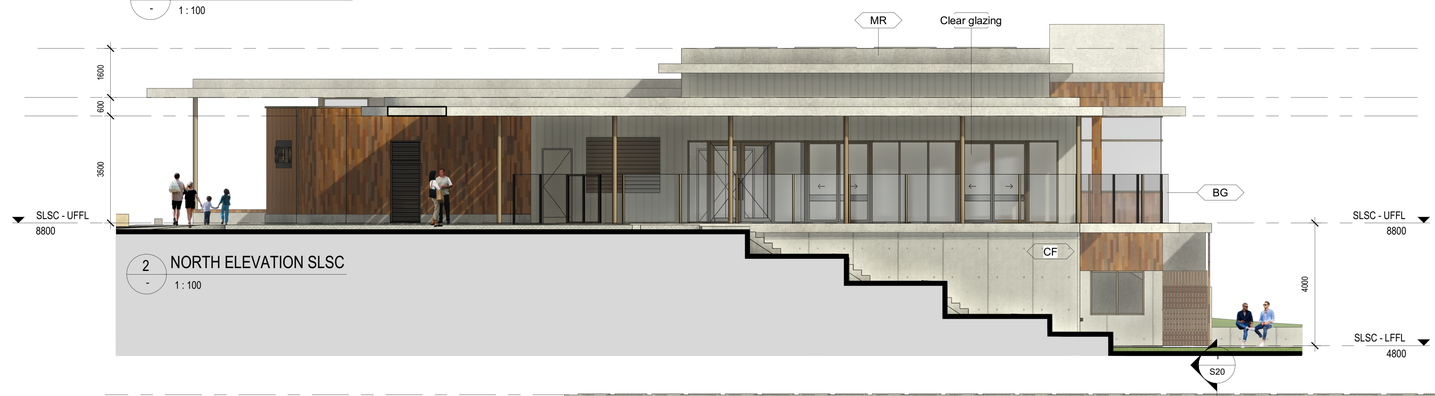

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3 - WEST ELEVATION SLSC
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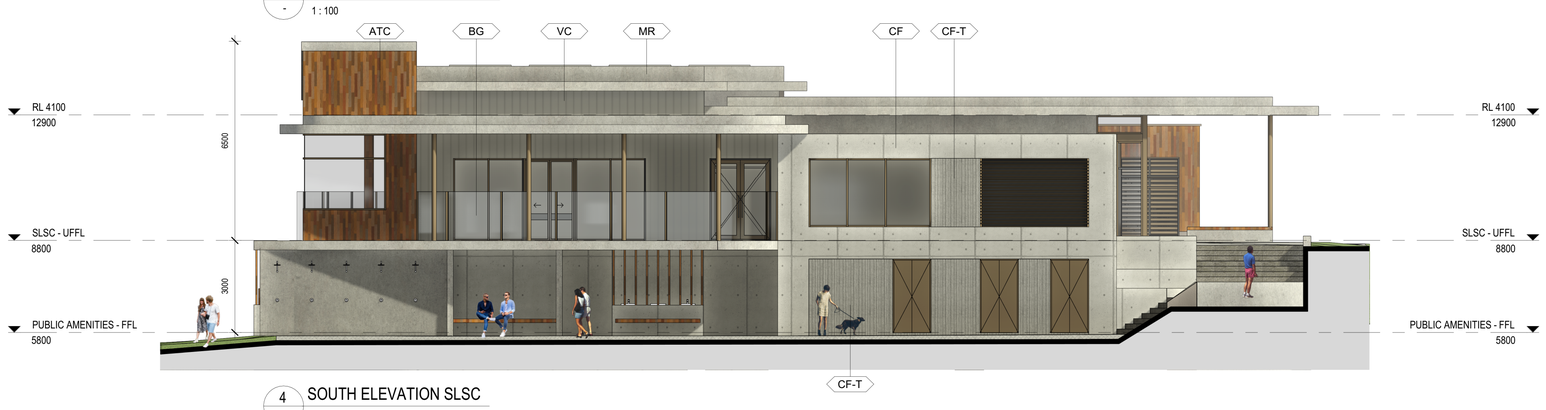


4 - SOUTH ELEVATION SLSC
1 : 100

EXTERNAL FINISHES LEGEND

ATC	ALUMINIUM TIMBER LOOK CLADDING
CAP	PRESSED METAL CAPPING
CF	OFF FORM CONCRETE
CF-T	TEXTURED CONCRETE
LVR	LOUVRES, CONTINUOUS & TREATED.
MR	MEMBRANE ROOF
VC	VERTICAL CLADDING

0 1 2 3 4 5 10
GRAPHIC SCALE: 1:100

SLSC ELEVATIONS

S05

SORRENTO SLSC FACILITY REDEVELOPMENT
189 WEST COAST DR, SORRENTO WA 6020
REVISION D PROJECT NO. 78.24 DATE 14/02/2025

Hodge Collard Preston
ARCHITECTS

NORTHERN ENTRY PERSPECTIVE

SOUTH EAST PERSPECTIVE

SLSC - LOWER SOUTH PERSPECTIVE

S08

SORRENTO SLSC FACILITY REDEVELOPMENT

189 WEST COAST DR, SORRENTO WA 6020

REVISION B PROJECT NO. 78.24 DATE 14/02/2025

Hodge Collard Preston ARCHITECTS

SLSC - LOWER NORTH PERSPECTIVE

S09

SORRENTO SLSC FACILITY REDEVELOPMENT
189 WEST COAST DR, SORRENTO WA 6020
REVISION B PROJECT NO. 78.24 DATE 14/02/2025

Hodge Collard Preston
ARCHITECTS

COMMERCIAL AMENITIES
COMMERCIAL INDOOR DINING
COMMERCIAL KITCHEN
COMMERCIAL OUTDOOR DINING
COMMERCIAL SERVERY
COMMERCIAL SERVICES
COMMERCIAL STORAGE

ROOM SCHEDULE

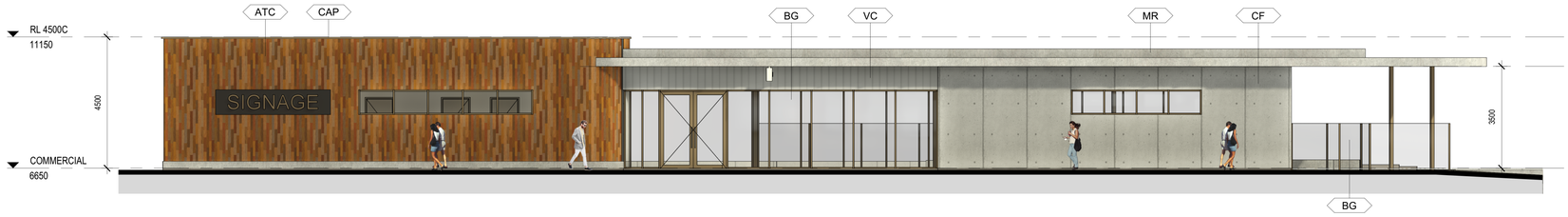
Name	Area
KITCHEN	60 m²
MALE	13 m²
CLNR	4 m²
UNISEX UAT	7 m²
FEMALE	20 m²
FRZ	4 m²
C/R	4 m²
BIN STORE	11 m²
DELIVERIES	5 m²
DRY STORE	4 m²
INDOOR DINING	191 m²
OUTDOOR DINING	114 m²
STORE	4 m²
SERVERY	20 m²

PROPOSED COMMERCIAL FLOOR PLAN

S10

SORRENTO SLSC FACILITY REDEVELOPMENT
189 WEST COAST DR, SORRENTO WA 6020
REVISION E PROJECT NO. 78.24 DATE 14/02/2025

Hodge Collard Preston ARCHITECTS



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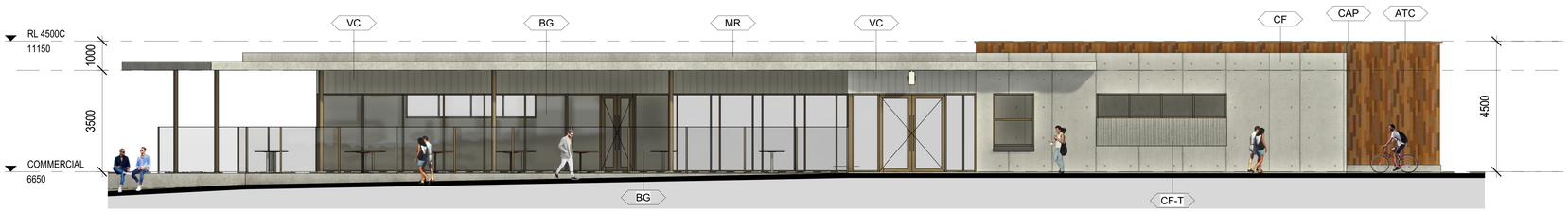
1 : 100

2 - NORTHERN ELEVATION - COMMERCIAL

1 : 100



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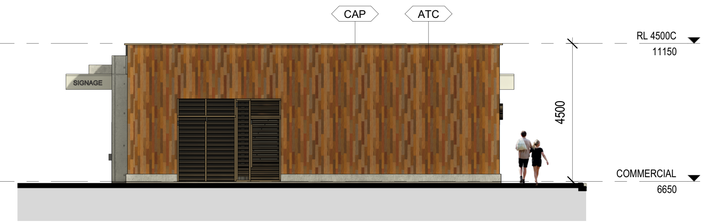

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EXTERNAL FINISHES LEGEND

ATC	ALUMINIUM TIMBER LOOK CLADDING
CAP	PRESSED METAL CAPPING
CF	OFF FORM CONCRETE
CF-T	TEXTURED CONCRETE
LVR	LOUVRES, CONTINUOUS & TREATED.
MR	MEMBRANE ROOF
VC	VERTICAL CLADDING

0 1 2 3 4 5 10

GRAPHIC SCALE: 1:100

COMMERCIAL - EASTERN PERSPECTIVE

S12

SORRENTO SLSC FACILITY REDEVELOPMENT
189 WEST COAST DR, SORRENTO WA 6020
REVISION B PROJECT NO. 78.24 DATE 14/02/2025

Hodge Collard Preston
ARCHITECTS

COMMERCIAL - SOUTHERN PERSPECTIVE

S13

SORRENTO SLSC FACILITY REDEVELOPMENT

189 WEST COAST DR, SORRENTO WA 6020

REVISION B PROJECT NO. 78.24 DATE 14/02/2025

Hodge Collard Preston ARCHITECTS

COMMERCIAL - NORTHERN PERSPECTIVE

S14

SORRENTO SLSC FACILITY REDEVELOPMENT

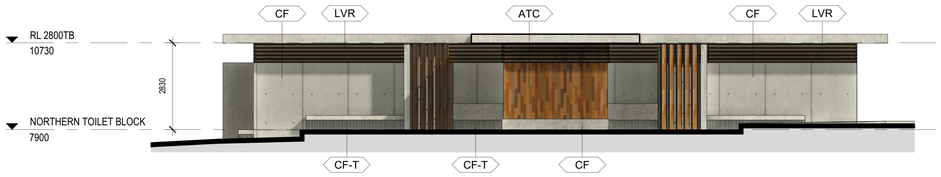
189 WEST COAST DR, SORRENTO WA 6020

REVISION B PROJECT NO. 78.24 DATE 14/02/2025

Hodge Collard Preston ARCHITECTS

ROOM SCHEDULE	
Name	Area
MALE PUBLIC AMENITIES	46 m²
FEMALE PUBLIC AMENITIES	46 m²
UAT/SHR	14 m²
DUCT/CLNR	6 m²

1 NORTHERN TOILET BLOCK
1 : 100



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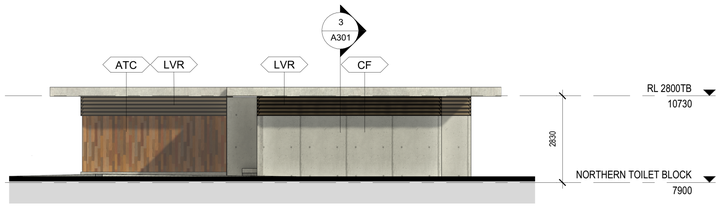
1 : 100



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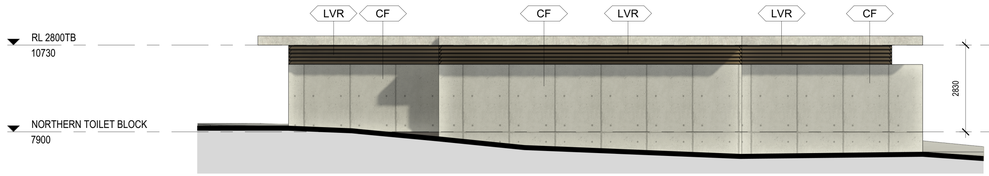
1 : 100



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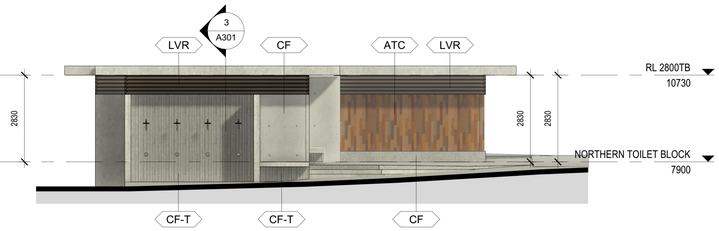

4 - SOUTH ELEVATION - NORTHERN TOILET BLOCK

1 : 100

SOUTHERN PERSPECTIVE

NORTHERN PERSPECTIVE

EXTERNAL FINISHES LEGEND

ATC	ALUMINIUM TIMBER LOOK CLADDING
CF	OFF FORM CONCRETE
CF-T	TEXTURED CONCRETE
LVR	LOUVRES, CONTINUOUS & TREATED.

0 1 2 3 4 5 10

GRAPHIC SCALE: 1:100

NORTHERN TOILET BLOCK ELEVATIONS & SECTION

S17

SORRENTO SLSC FACILITY REDEVELOPMENT

189 WEST COAST DR, SORRENTO WA 6020

REVISION D PROJECT NO. 78.24 DATE 14/02/2025

Hodge Collard Preston ARCHITECTS

Attachment 2: Flora Survey for the Hillarys-Kallaroo Foreshore Reserve (2021)

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Please See Attached Document

Hillarys-Kallaroo Coastal Foreshore Reserve Flora Survey and Vegetation Condition Assessment

City of Joondalup

ecological AUSTRALIA
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DOCUMENT TRACKING

Project Name	Hillarys-Kallaroo Coastal Foreshore Reserve Flora Survey and Vegetation Condition Assessment
Project Number	19876
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Reviewed by	Jeff Cargill
Approved by	Jeff Cargill
Status	**Final**
Version Number	**v2**
Last saved on	**1 February 2022**

This report should be cited as 'Eco Logical Australia 2022. *Hillarys-Kallaroo Coastal Foreshore Reserve Flora Survey and Vegetation Condition Assessment*. Prepared for City of Joondalup.'

ACKNOWLEDGEMENTS

This document has been prepared by Eco Logical Australia Pty Ltd with support from the City of Joondalup.

Template 2.8.1

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Abbreviations

Abbreviation	Description
BAM Act	State *Biosecurity and Agriculture Management Act 2007*
BC Act	State *Biodiversity Conservation Act 2016*
BoM	Bureau of Meteorology
CLUSTER	Hierarchical Clustering
CR	Critically Endangered
DAWE	Department of Agriculture, Water and the Environment
DBCA	Department of Biodiversity, Conservation and Attractions
DEC	Department of Environment and Conservation
DotEE	Department of Environment and Energy
DPIRD	Department of Primary Industries and Regional Development
DWER	Department of Water and Environmental Regulation
ELA	Eco Logical Australia
EN	Endangered
EPA	Environmental Protection Authority
EPBC Act	Commonwealth *Environment Protection and Biodiversity Act 1999*
ESA	Environmentally Sensitive Area
FCT	Floristic Community Type
ha	hectare
IBRA	Interim Biogeographical Regionalisation for Australia
km	kilometre
KPI	Key Performance Indicator
m	metre
MDS	Multi-Dimensional Scaling
P	Priority
PEC	Priority Ecological Community
PMST	Protected Matters Search Tool
PRIMER	Plymouth Routines in Multivariate Ecological Research v6
SIMPER	Similarity Percentages
TEC	Threatened Ecological Community
the City	City of Joondalup
TSSC	Threatened Species Scientific Committee
VU	Vulnerable
WA	Western Australia

Abbreviation	Description
WAH	Western Australian Herbarium
WAM	Western Australian Museum
WAOL	Western Australian Organism List
WoNS	Weed of National Significance

Executive Summary

Eco Logical Australia (ELA) was engaged by the City of Joondalup to undertake a Detailed and Targeted flora survey and vegetation condition assessment of Hillarys-Kallaroo Coastal Foreshore Reserve, an area of bushland approximately 94 hectares in size, located in the suburbs of Hillarys and Kallaroo, Western Australia. The information provided from the current assessment will be used to report on the change in vegetation condition in accordance with the City's endorsed Natural Area Key Performance Indicators, and to inform a review and update of the existing Hillarys-Kallaroo Coastal Foreshore Reserve Management Plan.

The field survey was conducted in Spring from 27 to 30 September 2021 in accordance with the Environmental Protection Authority *Technical Guidance*: *Flora and Vegetation Surveys for Environmental Impact Assessment* (2016).

Vegetation communities were described through the establishment and survey of eleven 10 x 10 metre quadrats, eight of which were previously established by ELA in 2015. A Targeted flora survey was conducted to record occurrences of any conservation significant flora species and/or communities listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*, the State *Biodiversity Conservation Act 2016* or by the Department of Biodiversity, Conservation and Attractions. Opportunistic flora species were also recorded across the survey area.

A Targeted weed survey was conducted to record weed species within the survey area, including mapping of City of Joondalup pest plant (Caltrop), City of Joondalup priority weed species and species listed as a Weed of National Significance or as a Declared Pest under the State *Biosecurity and Agriculture Management Act 2007*.

A total of 117 flora taxa (68 native and 49 introduced) were recorded within the survey area from quadrats and opportunistic collections, representing an increase in species recorded from the 2015 survey (79 species total; 51 native and 28 introduced). No Threatened (Declared Rare), Priority listed flora species by the Department of Biodiversity, Conservation and Attractions or Bush Forever significant species for 'Site 325: Coastal Strip from Burns Beach to Hillarys' were recorded within the survey area.

A total of three vegetation communities were delineated and mapped within the survey area, consistent with those originally described and mapped by Eco Logical Australia in 2015 (Eco Logical Australia 2016):

- ArAcTOS – *Acacia rostellifera* and *Acacia cyclops* tall open shrubland;
- SgOaS – *Spyridium globulosum* and *Olearia axillaris* shrubland to open shrubland; and
- OaApRbLOS – *Olearia axillaris*, *Acanthocarpus preissii* and *Rhagodia baccata* subsp. *baccata* low shrubland.

Intact vegetation within the survey area comprised 65.7 hectares (69.9% of the survey area), with the remaining 28.3 hectares (30.1% of the survey area) comprising revegetation, tracks, parkland and cleared areas, and open beach. Vegetation Community ArAcTOS was the most widespread vegetation community recorded, covering 54.4% (51.1 hectares) of the survey area.

Results of the multivariate analysis showed that quadrats within vegetation community ArAcTOS had a strong affiliation with Floristic Community Type 29a and, to a lesser extent, to Floristic Community Type

29b and Floristic Community Type 30a (**Table 9**). This community, covering a total area of 51.1 hectares (54.4% of the survey area), was considered to represent floristic aspects of Floristic Community Type 29a. Floristic Community Type 29a, described as 'coastal shrublands on shallow sands, mostly heaths on shallow sands over limestone close to the coast' is listed as a Priority 3 ecological community.

Quadrats within vegetation community OaApRbLOS had a strong affiliation with Floristic Community Type 29a. This community, covering a total area of 6.4 hectares (6.8% of the survey area), is considered as representing floristic aspects of the Floristic Community Type 29a Priority 3 ecological community.

Quadrats within vegetation community SgOaS had a strong affiliation to Floristic Community Type 29b and, to a lesser extent, to Floristic Community Type 29a. This community, covering a total area of 8.1 hectares (8.6% of the survey area), is considered as representing floristic aspects of Floristic Community Type 29b. Floristic Community Type 29b, described as 'Acacia shrublands on taller dunes, dominated by Acacia shrublands or mixed heaths on the larger dunes', is listed as a Priority 3 ecological community.

Vegetation was also assessed against the key diagnostic characteristics outlined in the Department of Environment and Energy '*Approved Conservation Advice (incorporating listing advice) for the Tuart (Eucalyptus gomphocephala) woodlands and forests of the Swan Coastal Plain ecological community*'. A total of 5.23 hectares (5.6% of the survey area) of vegetation within the survey area was assessed as being likely to represent floristic and structural aspects of this Threatened and Priority Ecological Community.

Vegetation within the survey area ranged from Degraded to Excellent condition, based on the Keighery (1994) vegetation scale, as outlined in the Environmental Protection Authority *Technical Guidance*: *Flora and Vegetation Surveys for Environmental Impact Assessment* 2016. The majority of the survey area was observed to be in Very Good and Excellent condition (29.7 hectares; 31.6% of the survey area and 23.8 hectares; 25.3% of the survey area, respectively). Disturbances within the survey area included the presence of weeds, grazing and rubbish dumping.

No fungi species were recorded during the field survey. A total of 25 fauna species (20 native; two naturalised exotic and three pests) were recorded opportunistically within the survey area, comprising 17 birds, four insects, three reptiles and one mammal. Of these, the Forest Red-tailed Black Cockatoo (*Calyptorhynchus banksii naso*) is listed as Vulnerable under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* and the State *Biodiversity Conservation Act 2016*, and Quenda (*Isoodon fusciventer*) is listed as Priority 4 by the Department of Biodiversity, Conservation and Attractions. The Forest Red-tailed Black Cockatoo was recorded from calls and was observed flying overhead, while the Quenda were directly observed within the survey area.

A total of five introduced fauna species were recorded during the field survey. These comprised two birds listed as naturalised exotic in Western Australia, namely **Dacelo novaeguineae* (Laughing Kookaburra) and **Spilopelia senegalensis* (Laughing Dove; Western Australian Museum 2021) and three invertebrates listed as pest species namely **Ischnura heterosticta* (Common Bluetail Dragonfly) **Mamestra brassicae* (Cabbage Moth) and **Ommatoiulus moreleti* (Portuguese Millipede; Department of Primary Industries and Regional Development 2021c).

Based on results of the current survey, the following recommendations have been made to assist in the conservation of native flora, vegetation and environmental values present within Hillarys-Kallaroo Coastal Foreshore Reserve:

- Continue long-term monitoring of weed populations within the survey area. Implement weed control, particularly for the Declared Pest species **Moraea flaccida* (One-leaf Cape Tulip), the Weed of National Significance **Asparagus asparagoides* (Bridal Creeper) and for City of Joondalup priority weeds. Concentrate weed control activities along track edges and boundaries between remnant bushland and cleared areas.
- Prioritise maintenance of the vegetation at Hillarys-Kallaroo Coastal Foreshore Reserve due to the presence of the Tuart (*Eucalyptus gomphocephala*) Threatened Ecological Community and the Floristic Community Type 29a and Floristic Community Type 29b Priority Ecological Communities.
- It is recommended to continue monitoring for evidence of dieback and other pathogens, and to maintain correct hygiene practices within the survey area.
- Ensure that access is restricted to defined tracks/paths only to prevent habitat degradation and weed spread and consider installation of fencing or formal signage to prevent use of unauthorised walking tracks and rubbish dumping within the survey area, particularly in the dune/foreshore areas.

1. Introduction

1.1 Project background

Eco Logical Australia (ELA) was engaged by the City of Joondalup (the City) to undertake a Detailed and Targeted flora survey and vegetation condition assessment of Hillarys-Kallaroo Coastal Foreshore Reserve, an area of approximately 94 hectares (ha) in size located in the suburbs of Hillarys and Kallaroo[1], approximately 20 kilometres (km) northwest of Perth, Western Australia (WA; **Figure 1**: Survey area location).

Hillarys-Kallaroo Coastal Foreshore Reserve is a major conservation area within the City, with high biodiversity values and is vested with, and managed by, the City. The bushland contains regionally significant plant communities and has been recognised for its regional environmental significance by being designated as a Bush Forever site (325) by the Western Australian Planning Commission (Government of Western Australia 2000).

Information provided from the current assessment will be used to report on the change in vegetation condition in accordance with the City's endorsed Natural Area Key Performance Indicators (KPIs), and to inform an update of the existing Hillarys-Kallaroo Coastal Foreshore Reserve Management Plan. The most recent ecological survey was undertaken by ELA in 2015 to collect baseline information on ecological values to be utilised in the development of a Whitfords Nodes Foreshore Management Plan (ELA 2016).

More specifically, the objectives of this survey include:

- An assessment of flora and vegetation communities in accordance with the Environmental Protection Authority (EPA) *Technical Guidance: Flora and Vegetation Surveys for Environmental Impact Assessment* (EPA 2016);
- Undertake a vegetation condition assessment using the Keighery vegetation condition scale (1994; EPA 2016);
- A Targeted survey for State, Federal and/or Department of Biodiversity, Conservation and Attractions (DBCA) conservation significant flora, including Bush Forever significant flora and/or vegetation;
- An assessment to verify if the vegetation meets the requirements specified in the Commonwealth *Environment Protection and Biodiversity Act 1999* (EPBC Act) 'Approved Conservation Advice (incorporating listing advice) for the Banksia Woodlands of the Swan Coastal Plain ecological community', using the four-stage assessment process itemised in the Approved Conservation Advice (Threatened Species Scientific Committee [TSSC] 2016);
- An assessment to verify if the vegetation meets the requirement specified in the Department of Environment and Energy (DotEE) 'Approved Conservation Advice (incorporating listing advice) for the Tuart (*Eucalyptus gomphocephala*) woodlands and forests of the Swan Coastal Plain ecological community' using the assessment process outlines in the Conservation Advice (DotEE 2019a);

1 The northernmost point of Hillarys-Kallaroo Coastal Foreshore Reserve occurs in the suburb of Mullaloo, however for the purpose of this assessment and to maintain consistency with the Hillarys Kallaroo Coastal Foreshore Management Plan, the survey area boundary aligns with the Kallaroo suburb boundary.

- Record and mapping of all weed species encountered including State, Federal (Weed of National Significance [WoNS], Declared Pests listed under the State *Biosecurity and Agriculture Management Act 2007* [BAM Act]), City of Joondalup pest plant and/or priority weeds in the City of Joondalup (priority species list provided by the City); and
- Record opportunistic sightings of fauna (including invertebrates) and fungi during the flora survey, in particular fauna species of State or Federal conservation significance.
- Make recommendations to conserve biodiversity values.

Figure 1: Survey area location

Survey Area

N

0 290 580 1,160

Metres

Datum/Projection:
GCS WGS 1984

Project: 19876-DD Date: 24/01/2022

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2. Environmental setting

2.1 Regional context

Broad environmental values for the region relevant to the survey area are presented in **Table 1**.

Table 1: Environmental values of the region

Existing environmental attributes	Survey area
Interim Biogeographical Regionalisation for Australia (IBRA) Bioregion (Department of Agriculture, Water and the Environment [DAWE] 2021a)	Swan Coastal Plain (SWA).
IBRA Subregion (DAWE 2021a)	Perth (SWA02).
Geology, landform and soils (Department of Primary Industries and Regional Development [DPIRD] 2021a)	**Quindalup South System**: Coastal dunes, of the Swan Coastal Plain, with calcareous deep sands and yellow sands. Coastal scrub.
FCTs inferred within Bush Forever Site 325 (Government of Western Australia 2000) *Not sampled; types inferred	**Supergroup 2**: Seasonal Wetlands - ***FCT16**: Highly saline seasonal wetlands (*Frankenia pauciflora* Low Shrubland on Tamala Limestone Cliffs) **Supergroup 4**: Uplands centred on Spearwood and Quindalup dunes. - **FCT27**: Species-poor mallees and shrublands on limestone. - **FCT29a**: Coastal shrublands on shallow sands. - ***FCT29b**: Acacia shrublands on taller dunes. - ***FCT S11**: Northern *Acacia rostellifera – Melaleuca acerosa* shrublands. - ***FCT S13**: Northern *Olearia axillaris – Scaevola crassifolia* shrublands. - ***FCT S14**: *Spinifex longifolius* grassland and low shrublands.
Bush Forever (Government of Western Australia 2000)	Bush Forever Site 325.
Beard's (1975) vegetation mapping	**Guilderton 1007**: Mosaic: Shrublands; *Acacia lasiocarpa* & *Melaleuca acerosa* heath / Shrublands; *Acacia rostellifera* & *Acacia cyclops* thicket.

3. Methodology

3.1 Desktop review

3.1.1 Database searches and literature review

The following Commonwealth and State databases were searched for information relating to conservation listed flora and ecological communities in order to compile and summarise existing data to inform the field survey. Database searches undertaken around the central coordinate 379806 metres (m) E; 6480579m S are presented in **Table 2**. Applied buffers below are considered suitable based on flora and fauna assemblages expected to occur within the survey area.

Table 2: Database searches undertaken for the survey area

Database	Reference	Buffer (km)
EPBC Act Protected Matters Search Tool (PMST) for Threatened species and communities listed under the EPBC Act.	DAWE 2021b	10
DBCA and Western Australian Museum (WAM) NatureMap online database.	DBCA 2007-2021	10
DAFWA Western Australian Organism List (WAOL)	DPIRD 2021b	-
Department of Water and Environmental Regulation (DWER) Environmentally Sensitive Area (ESA) Database	DWER 2021	-

In addition, the following documents were also reviewed:

- City of Joondalup. 2016. *Hillarys-Kallaroo Coastal Foreshore Reserve Management Plan*;
- Eco Logical Australia (ELA). 2016. *Whitfords Nodes Foreshore Flora, Fauna and Fungi Survey*; and
- City of Joondalup Priority Weed List for Hillarys-Kallaroo Coastal Foreshore Reserve.

3.2 Field survey

3.2.1 Survey team and timing

A Detailed and Targeted flora and vegetation survey was conducted by Jeff Cargill (Senior Botanist), Jeni Morris (Ecologist) and Maitland Ely (Graduate Ecologist) from 27 to 30 September 2021. The survey team's relevant qualifications, experience and licences are provided in **Table 3** below.

A total of 7.4 millimetres (mm) of rainfall was recorded during the field survey from the nearby Wanneroo Bureau of Meteorology (BoM) weather station (station number 9105, located approximately 8 km to the northwest of the survey area; BoM 2021).

In the three months prior to the field survey (June to August), a total of 455mm of rainfall was recorded in the region (BoM 2021). This is slightly higher than the long-term average for the same period (446mm; BoM 2021). Survey conditions during the field survey were considered suitable, with most species in various stages of reproduction (e.g., flowering, seeding, fruiting), allowing for positive identification of both common and cryptic species.

Table 3: Survey team

Name	Qualification	Relevant experience	Licenses
Dr. Jeffry Cargill	BSc. Hons. PhD Environmental Sciences	Jeff has extensive experience in botanical and ecological studies throughout Western Australia including baseline vegetation studies (Reconnaissance and Detailed surveys), Targeted threatened and priority flora surveys, fauna and black cockatoo surveys, MNES surveys and rehabilitation and vegetation monitoring programs.	Flora Taking (Biological Assessment) Licence number: FB62000138 Authorisation to Take Threatened Flora: Herbarium Specimens number: TFL 48-1920
Jeni Morris	BSc. Conservation and Wildlife Biology	Jeni has completed several flora and vegetation surveys on the Swan Coastal Plain and within the City of Joondalup including at Shepherd's Bush Reserve, Iluka-Burns Beach Coastal Reserve, Warwick Open Space, Craigie Bushland Reserve and Yellagonga Regional Park.	Flora Taking (Biological Assessment) Licence number: FB62000070 Authorisation to Take Threatened Flora: Herbarium Specimens number: TFL 13-1920
Maitland Ely	BSc. Conservation Biology and Botany	Maitland joined ELA as a Graduate Environmental Scientist in 2020. He has experience undertaking Baseline and Targeted flora and vegetation survey and Basic and Detailed fauna survey in Western Australia.	N/A
Daniel Brassington	BSc Environmental Science (Hons)	Daniel has over 10 years' experience in botanical surveys and environmental services throughout Western Australia. This includes baseline vegetation studies (reconnaissance and detailed surveys), threatened and priority flora surveys, rehabilitation and vegetation monitoring, targeted species surveys, weed control, seed collection and processing, nursery operations and revegetation operations.	Flora Taking (Biological Assessment) Licence number: FB62000196 Authorisation to Take Threatened Flora: Herbarium Specimens number: TFL 15-1920

3.3 Flora and vegetation survey

A Detailed and Targeted flora and vegetation survey was conducted in accordance with the EPA *Technical Guidance: Flora and Vegetation Surveys for Environmental Impact Assessment* (EPA 2016). A

total of eight existing quadrats originally established by ELA in 2015 (ELA 2016) were re-sampled during the current survey, with an additional three quadrats established in 2021 (eleven quadrats total; **Figure 2**).

Stainless steel fence droppers were used to permanently mark the north-west corner of each quadrat. Dominant vegetation communities were described, with respect to dominant species, structure and overall condition. The survey involved the use of 10 x 10m quadrats as recommended for the Swan Coastal Plain bioregion (EPA 2016). Opportunistic sampling of species not recorded within the quadrats was undertaken to supplement the existing list of species recorded from within the survey area.

Where possible, photos were taken from the same position as those undertaken in 2015 (ELA 2016). Otherwise, photos were taken from the northwest corner of each quadrat facing south-east. The following data was recorded within each quadrat:

- Site details (site name, site number, observers, date and location);
- Environmental information including landform, soil type and colour, bare ground and leaf litter cover, rock outcropping and time since last fire event; and
- Biological information including vegetation structure, vegetation condition in accordance with Keighery (1994), degree of disturbance, species present and species percentage cover.

A Targeted survey was completed within the survey area to identify any conservation significant flora or communities potentially occurring, including:

- Threatened flora or Threatened Ecological Communities (TECs) listed under the EPBC Act;
- Threatened (Declared Rare) Flora listed under the latest WA Wildlife Conservation (Rare Flora) Notice under the BC Act;
- Priority Ecological Communities (PECs) endorsed by the Western Australian Minister for the Environment;
- Priority (P) flora recognised by DBCA; and
- Bush Forever significant flora (Government of Western Australia 2000).

The survey methodology involved personnel walking transects across the survey area, with transects spaced (on average) 5-30m apart depending on factors such as habitat type, disturbance (e.g., tracks) and landform. Locations of survey transects are shown in **Figure 2** below. Flora species able to be identified in the field were recorded, and voucher specimens of unfamiliar species were collected for later identification. All collections were assigned a unique collecting number. For conservation significant flora species identified in the field, the following was recorded:

- A colour photograph;
- GPS location;
- Population size estimate;
- Location of population boundaries;
- Associated habitat/landscape element;
- Time and date observed;
- Observer details; and
- A voucher specimen suitable for use as a reference specimen (if appropriate to do so for conservation significant flora).

3.4 Weed survey and mapping

The survey area was surveyed and mapped for State, Federal and/or Priority weeds as specified by the City of Joondalup, including all WoNS, Declared Pests listed under the BAM Act and City of Joondalup declared pest plants. The City of Joondalup priority weed list is provided in **Table 4**.

For each priority weed species, including WoNS and/or Declared Pest species encountered, a GPS location coordinate was recorded using points for individual plants or polygons for populations. Weed data was collected in accordance with the DBCA (previously Department of Environment and Conservation [DEC]) Standard Operating Procedure 22.1 *Techniques for mapping weed distribution and cover in bushland and wetlands* (DEC 2011).

Table 4: City of Joondalup Priority weed species list for Hillarys-Kallaroo Coastal Foreshore Reserve

Species (Common Name)	Ranking
**Agave americana* (Agave)	-
**Arctotis* sp. (Arctotis)	-
**Asparagus asparagoides* (Bridal Creeper)	WoNS
**Avena fatua* (Wild Oats)	-
**Cakile maritima* (Sea Rocket)	-
**Carpobrotus edulis* (Pigface)	-
**Cenchrus clandestinum* (Kikuyu grass)	-
**Chamelaucium uncinatum* (Geraldton Wax)	-
**Conyza* sp. (Fleabane)	-
**Cynodon dactylon* (Couch grass)	-
**Dimorphotheca ecklonis* (Veldt Daisy)	-
**Ehrharta calycina* (Perennial Veldt)	-
**Ehrharta longiflora* (Annual Veldt)	-
**Euphorbia paralias* (Sea Spurge)	-
**Euphorbia terra*cina (Geraldton Carnation Weed)	-
**Fumaria* sp. (Fumitory)	-
**Gazania linearis* (Gazania)	-
**Ipomoea indica* (Morning Glory)	-
**Lactuca serriola* (Prickle Lettuce)	-
**Moraea flaccida* (One-leaf Cape Tulip)	Declared Pest - s22(2) under the BAM Act
**Oxalis pes-caprae* (Soursob)	-
**Pelargonium capitatum* (Rose Pelargonium)	-
**Raphanus* sp. (Wild Radish)	-
**Schinus terebinthifolia* (Japanese Pepper)	-
**Tetragonia decumbens* (Sea Spinach)	-
**Thinopyrum distichum* (Sea Wheatgrass)	-
**Trachyandra divaricata* (Onion Weed)	-
**Tropaeolum* sp. (Nasturtium)	-

Species (Common Name)	Ranking
**Urospermum picroides* (False Hawkbit)	-
**Yucca* sp. (Yucca)	-

Note: * refers to an introduced species.

3.5 Data analysis

3.5.1 Flora species accumulation curve

A flora species accumulation curve was undertaken to indicate adequacy of the survey effort (Clarke and Gorley 2006). As the number of survey sites increases, and correspondingly the size of the area surveyed increases, there should be a diminishing number of new species recorded. At some point, the number of new species recorded becomes essentially asymptotic. The asymptotic value was determined using Michaelis-Menten modelling and provided an incidence-based coverage estimator of species richness. When the number of new species being recorded for survey effort expended approaches this asymptotic value, the survey effort can be considered adequate.

3.5.2 Vegetation communities

Plymouth Routines in Multivariate Ecological Research v6 (PRIMER) statistical analysis software was used to analyse species-by-site data and discriminate survey sites based on their species composition (Clarke and Gorley 2006). A presence/absence transformation was applied to the dataset to align with Gibson *et al.* (1994). Introduced species (weeds), specimens not identified to species level and singletons (species recorded at a single quadrat and not forming a dominant structural component) were excluded from the data set prior to analysis. Computation of similarity matrices was based on the Bray-Curtis similarity measure. Data were analysed using a series of multivariate analysis routines including Hierarchical Clustering (CLUSTER) and Similarity Percentages (SIMPER). Results were used to inform and support interpretation of aerial photography and delineation of individual plant communities.

Previously assigned vegetation mapping codes and descriptions (ELA 2016) were retained during the current assessment to maintain consistency between survey periods.

A Threatened and Priority Ecological Community (TEC/PEC) Occurrence Report Form was completed and submitted for all TECs and PECs identified within the survey area.

3.5.2.1 FCT analysis

Species within the Gibson *et al*. (1994) data set were updated to align with current names as specified by FloraBase (DBCA and Western Australian Herbarium [WAH] 2021). Using current records, several species in the Gibson *et al*. (1994) data set were shown to be significant range extensions from the Swan Coastal Plain, where appropriate such cases were removed. In addition, excluded and misapplied names were removed from the data set and infra-specific names were reduced. The merged dataset was analysed using a combination of pre-treatments such as the inclusion and/or removal of introduced species and singletons. The removal of singletons from the merged dataset, an accepted pre-treatment for such analysis, produced the best results (e.g., stronger correlations; Clarke and Gorley 2006). Inclusion of such data merely served to confound the dataset by introducing stochastic and 'site' artefact data. Transformed data were analysed using a combination of multivariate analysis routines including Bray-Curtis Similarity Matrices, single insertion Cluster Analysis (Flexible Beta) and Multi-Dimensional Scaling (MDS).

To identify potential TECs and PECs in the survey area, ELA quadrats and vegetation communities were compared to Floristic Community Types (FCTs) defined by Gibson *et al*. (1994). To identify the presence of FCT's appropriate multivariate analyses comparing current data to that of Gibson *et al*. (1994) species by quadrat data, and inferences based on dominant species and geomorphology were used. Given the nature of the data (e.g., spatial and temporal differences), results and subsequent extrapolations, assigned FCT's within the survey area were inferred and not absolute, i.e., a vegetation code assigned to an FCT was inferred to comprise, to varying degrees, floristic aspects of that FCT as defined by Gibson *et al*. (1994). These FCTs were subsequently compared with vegetation communities delineated by ELA (2016).

3.5.2.2 Assessment of diagnostics to assess presence of Threatened Ecological Communities

The 'Banksia Woodlands of the Swan Coastal Plain' TEC is listed as Endangered under the EPBC Act (TSSC 2016). For information to assist in referral, environmental assessment and compliance issues, it has been recommended to refer to the Listing Advice and/or Conservation Advice and Recovery Plan on the DotEE Species Profile and Threats Database (TSSC 2016). The Listing Advice and/or Conservation Advice defines the national ecological community and includes key diagnostic characteristics, condition thresholds and additional considerations (TSSC 2016).

In order to determine whether the 'Banksia Woodlands of the Swan Coastal Plain' TEC is present in the survey area key diagnostic characteristics must be met under Section 2 of the Conservation Advice (TSSC 2016). As no *Banksia* species were identified as occurring within the survey area, the four-stage assessment identified by DotEE to ascertain the presence of the Banksia Woodlands endangered ecological community within the site was not undertaken by ELA following the field survey.

The 'Tuart (*Eucalyptus gomphocephala*) woodlands and forests of the Swan Coastal Plain' ecological community is listed as Critically Endangered under the EPBC Act (DotEE 2019). For information to assist in referral, environmental assessment and compliance issues, it has been recommended to refer to the Listing Advice and/or Conservation Advice on the DotEE Species Profile and Threats Database (DotEE 2019). The Listing Advice and/or Conservation Advice defines the national ecological community and includes key diagnostic characteristics, condition thresholds and additional considerations (DotEE 2019a).

In order to determine whether the 'Tuart (*Eucalyptus gomphocephala*) woodlands and forests of the Swan Coastal Plain' TEC is present in the survey area key diagnostic characteristics must be met under Section 3.2 of the Conservation Advice (DotEE 2019). The assessment identified by DotEE to ascertain the presence of the Tuart (*Eucalyptus gomphocephala*) Woodlands endangered ecological community within the site was undertaken by ELA following the field survey.

3.6 Flora identification and nomenclature

Flora specimen identification was undertaken by ELA Botanist Daniel Brassington. Species identification utilised taxonomic literature and keys and where required specimens were confirmed using the WAH collection. Where considered appropriate, specimens that meet WAH specimen lodgement requirements (e.g., Threatened and Priority Flora, range extensions), will be submitted along with Threatened and Priority Report forms to DBCA. Nomenclature used for the flora species within this report follows the WA Plant Census as available on FloraBase (DBCA and WAH 2021).

3.7 Limitations

The EPA *Technical Guide – Flora and Vegetation Surveys for Environmental Impact Assessment* (EPA 2016) recommends including discussion of the constraints and limitations of the survey methods used. Constraints and limitations for the Detailed and Targeted flora and vegetation for the survey area are summarised in **Table 5** below. No constraints were identified.

Table 5: Survey limitations

Constraint	Limitations
Sources of information	**Not a constraint**: The Swan Coastal Plain has been well surveyed, with increasing survey work occurring due to the ongoing urban development of the Perth metropolitan area. A number of flora surveys have been undertaken in the survey area which have been utilised for the purposes of this survey. Gibson *et al*. 1994 was a primary source for determination of methods, analysis and results for assessing FCTs. Broad-scale vegetation mapping at a scale of 1:1,000,000 was available. Land system mapping at a scale of 1:2,000,000 and soil and landform mapping was also available. The information which was available was sufficient and as such sources of information were not considered a major limitation.
Scope of work	**Not a constraint:** The survey requirement for a Detailed and Targeted flora and vegetation survey in accordance with the EPA *Technical Guidance: Flora and Vegetation Surveys for Environmental Impact Assessment* (EPA 2016) was adequately met.
Completeness of survey	**Not a constraint:** The area was surveyed to the satisfaction of the scope and a Detailed and Targeted flora and vegetation survey as per relevant guidelines.
Intensity of survey	**Not a constraint:** Survey effort was considered adequate to meet objectives of the scope. The area was surveyed for conservation significant flora species and vegetation communities by field staff undertaking transects across the survey area spaced 5-20 m apart on average. This method provided an accurate assessment of habitat characteristics and likelihood of conservation significant species. The number of quadrats established was sufficient to determine the vegetation communities present and to identify any vegetation of conservation significance. Adequacy of the current sampling effort was tested via a species accumulation curve; approximately 78.6% of the flora potentially present within the survey area was recorded, not including the additional 18 species collected opportunistically during the field survey.
Timing, weather, season, cycle	**Not a constraint:** The survey area is located in the Swan Coastal Plain bioregion of Western Australia. Recommended survey timing for this region is in spring (September – November; EPA 2016). The field survey was undertaken at the beginning of September, with greater than average rainfall recorded in the three months preceding the field survey (BoM 2021). Many flora species were flowering at the time of the field survey or had sufficient material (fruit) available to identify the dominant and target species. The timing was appropriate for conducting this level of survey.
Disturbances	**Not a constraint:** Disturbances within the survey area included the presence of weeds, unauthorised access (walk trails and bike tracks) and edge effects. These disturbances did not negatively impact the ability to meet objectives outlined in the scope of works.
Resources	**Not a constraint:** The personnel conducting this field survey were suitably qualified to identify specimens, having previously undertaken flora and vegetation assessments on the Swan Coastal Plain, including in several reserves for the City of Joondalup.
Accessibility	**Not a constraint:** All relevant areas of the survey area were easily accessed and able to be surveyed.

Figure 2: Survey effort

Survey Area
Quadrats
Transect

0 50 100 200
Metres

Datum/Projection:
GDA 1994 MGA Zone 50

Project: 19876-DD Date: 24/01/2022

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4. Results

4.1 Desktop review

4.1.1 Conservation significant flora species and ecological communities

A PMST search (DAWE 2021b) and Naturemap search (DBCA 2007-2021) were undertaken to identify conservation significant species and communities recorded within, or nearby to, the survey area (current and historic). Additional documents reviewed included:

- City of Joondalup. 2016. *Hillarys-Kallaroo Coastal Foreshore Reserve Management Plan*. Perth, WA; and
- Eco Logical Australia (ELA). 2016. *Whitfords Nodes Foreshore Flora, Fauna and Fungi Survey*. Prepared for the City of Joondalup.

A total of 22 flora species of conservation significance were identified as possible occurring within the survey area, including nine species listed under the EPBC Act and BC Act as either Endangered (EN) or Vulnerable (VU), and 13 species listed as Priority (P) by DBCA. Of these, none have been previously recorded within the survey area (ELA 2016).

Two TECs were identified as possibly occurring within the survey area, namely 'Banksia Woodlands of the Swan Coastal Plain ecological community', listed as Endangered under the EPBC Act (DAWE 2021b) and 'Tuart (*Eucalyptus gomphocephala*) Woodlands and Forests of the Swan Coastal Plain ecological community', listed as Critically Endangered under the EPBC Act (DAWE 2021b).

Conservation codes, categories and criteria for flora and fauna protected under the EPBC Act and the State *Biodiversity Conservation Act 2016* (BC Act) are provided in **Appendix A**.

4.1.2 Expected flora assemblages

A summary of the number of flora species (native and introduced) previously recorded from within Hillarys-Kallaroo Coastal Foreshore Reserve is provided in **Table 6** below.

Table 6: Summary of flora species and conservation significant species recorded within Hillarys-Kallaroo Coastal Foreshore Reserve from previous studies

Study	Number of species			Number of quadrats established	Conservation significant species/communities recorded
	Native	Introduced	Total		
ELA (2016)	51	28	79	8	Nil

4.2 Flora and vegetation

4.2.1 Flora overview

A total of 117 taxa (68 native and 49 introduced taxa) from 105 genera and 49 families were recorded across 11 quadrats established within the survey area and from opportunistic collections. Average species richness per quadrat was 31.3 species, ranging from a low of 21 species at WN Q8 and WN New Q2 to a high of 43 species at WN Q14. Families with the highest number of species included Fabaceae (13 species), Poaceae (12 species) and Asteraceae (9 species). *Acacia* was the best represented genera throughout the survey area with 6 taxa recorded. No orchid species were recorded within the survey area. A flora species list is provided in **Appendix B** and a site by species matrix is provided in **Appendix C**. Quadrat site data is presented in **Appendix D**.

4.2.2 Accumulated species – site surveyed (species-area curve)

A species accumulation curve (**Figure 3**) was used to evaluate the adequacy of sampling (Clarke and Gorley 2006). Only species data recorded from defined quadrats were used; no opportunistic flora collections were included. The asymptotic value was determined using Michaelis Menten modelling. Using this analysis, the incidence-based coverage estimator of species richness was calculated to be 93.68. Based on this value, and the total of 79 species recorded within quadrats, approximately 85.4% of the flora species potentially present within the survey area were recorded. This result, in addition to a total of 39 opportunistic collections, indicates that the majority of flora potentially present within the survey area were recorded.

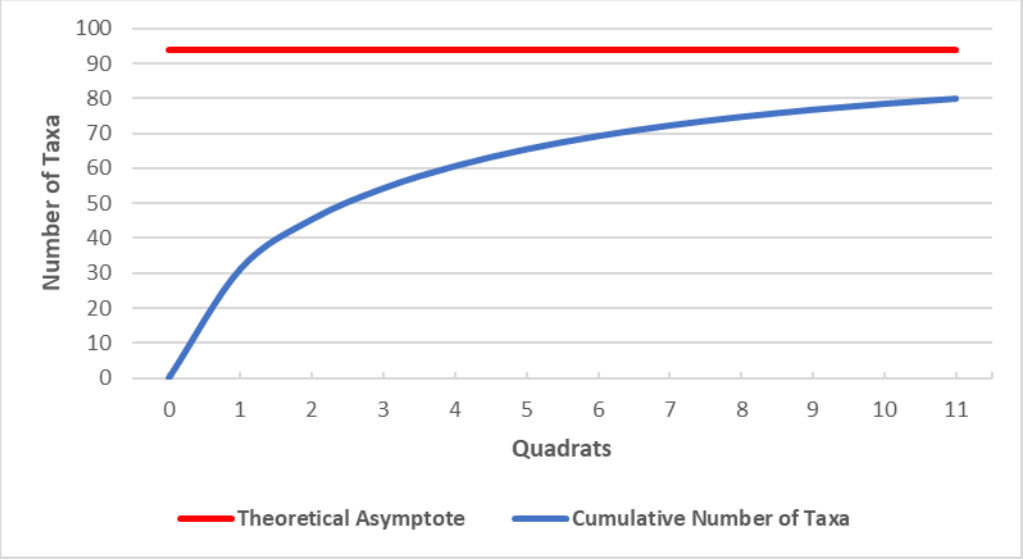

Figure 3: Average randomised species accumulation curve

4.2.3 Conservation and Bush Forever significant flora

No Threatened or Priority flora species listed under the EPBC Act, the BC Act or by DBCA were recorded within the survey area. No Bush Forever significant species were recorded within the survey area.

4.2.4 Introduced flora

A total of 48 introduced (weed) species were recorded within the survey area, representing 40.7% of the total species recorded. Of these, **Asparagus asparagoides* (Bridal Creeper) is listed as a WoNS and **Moraea flaccida* (One-leaf Cape Tulip) is listed as a Declared Pest under the BAM Act, categorised as s22(2) (exempt; **Plate 1**). Declared Pests "must satisfy any applicable import requirements when imported and may be subject to an import permit if they are potential carriers of high-risk organisms. They may also be subject to control and keeping requirements once within Western Australia" (DPIRD 2021b).

Asparagus asparagoides* (Bridal Creeper) was observed within Hillarys Foreshore reserve, with a small patch of <5% cover recorded in the south of Kallaroo Foreshore Reserve (Appendix E**). **Moraea flaccida* was observed within Kallaroo Foreshore Reserve along the northern and western boundaries (**Appendix E**). Neither of these introduced flora species were recorded in the survey area by ELA in 2015 (ELA 2016).

Of the 48 introduced (weed) species recorded, 24 are listed on the City of Joondalup priority weed list for Hillarys-Kallaroo Coastal Foreshore Reserve. The City's declared pest plant, **Tribulus terrestris* (Caltrop), was not recorded during the current survey. A list of all City of Joondalup priority weeds, Declared Pests and WoNS recorded within the survey area are listed in **Table 7** and presented in **Appendix E**.

Plate 1: Left: *Asparagus asparagoides* (Bridal Creeper; listed as a WoNS) and Right:*Moraea flaccida* (One-leaf Cape Tulip; listed as a Declared Pest) recorded within the survey area

Table 7: CoJ Priority weed species, Declared Pests or WoNS recorded within Hillarys-Kallaroo Coastal Foreshore Reserve

Species (Common Name)	Ranking
**Agave americana* (Agave)	-
**Arctotis* sp. (Arctotis)	-
**Asparagus asparagoides* (Bridal Creeper)	WoNS
**Avena fatua* (Wild Oats)	-
**Cakile maritima* (Sea Rocket)	-
**Carpobrotus edulis* (Pigface)	-
**Cenchrus clandestinum* (Kikuyu grass)	-
**Cynodon dactylon* (Couch grass)	-
**Dimorphotheca ecklonis* (Veldt Daisy)	-
**Ehrharta calycina* (Perennial Veldt)	-
**Ehrharta longiflora* (Annual Veldt)	-
**Euphorbia paralias* (Sea Spurge)	-
**Euphorbia terra*cina (Geraldton Carnation Weed)	-
**Fumaria* sp. (Fumitory)	-
**Gazania linearis* (Gazania)	-
**Moraea flaccida* (One-leaf Cape Tulip)	Declared Pest - s22(2) under the BAM Act
**Oxalis pes-caprae* (Soursob)	-
**Pelargonium capitatum* (Rose Pelargonium)	-
**Raphanus* sp. (Wild Radish)	-
**Schinus terebinthifolia* (Japanese Pepper)	-
**Tetragonia decumbens* (Sea Spinach)	-
**Trachyandra divaricata* (Onion Weed)	-
**Tropaeolum* sp. (Nasturtium)	-
**Yucca* sp. (Yucca)	-

4.2.5 Vegetation communities

A total of three vegetation communities were delineated and mapped within the survey area (**Appendix F**). Vegetation codes previously assigned by ELA (2016) were validated during the current analysis and subsequently retained for consistency purposes. Vegetation community boundaries mapped by ELA (2016) were ground-truthed during the current survey and were considered accurate. These were:

- ArAcTOS – *Acacia rostellifera* and *Acacia cyclops* tall open shrubland;
- SgOaS – *Spyridium globulosum* and *Olearia axillaris* shrubland to open shrubland; and
- OaApRbLOS – *Olearia axillaris*, *Acanthocarpus preissii* and *Rhagodia baccata* subsp. *baccata* low shrubland.

Vegetation communities are described in **Table 8** and presented in **Figure 4** below. Intact vegetation within the survey area comprised 65.7 hectares (69.9% of the survey area), with the remaining 28.3 hectares (30.1%) comprising revegetation, tracks, parkland and cleared areas, and open beach.

Table 8: Vegetation communities recorded within the survey area

Image	Vegetation community	Vegetation description	Quadrats	Extent within the survey area (ha)	Proportion of the survey area (%)
	ArAcTOS	*Acacia rostellifera* and *Acacia cyclops* tall open shrubland over *Spyridium globulosum* and *Olearia axillaris* shrubland to open shrubland over *Melaleuca systena*, *Rhagodia baccata* subsp. *baccata* and *Acanthocarpus preissii* low shrubland over *Lepidosperma gladiatum* open sedgeland.	WN Q2, WN Q4, WN Q6, WN Q10, WN Q12	51.1	54.4
	SgOaS	*Spyridium globulosum* and *Olearia axillaris* shrubland to open shrubland over *Melaleuca systena*, *Acacia lasiocarpa* var. *lasiocarpa* and *Acanthocarpus preissii* low shrubland over *Lomandra maritima* open herbland.	WN Q14, WN Q16, WN New Q1	8.1	8.6

Image	Vegetation community	Vegetation description	Quadrats	Extent within the survey area (ha)	Proportion of the survey area (%)
	OaApRbLOS	*Olearia axillaris*, *Acanthocarpus preissii* and *Rhagodia baccata* subsp. *baccata* low shrubland over *Spinifex hirsutus* very open grassland.	WN Q8, WN New Q2, WN New Q3	6.4	6.8
		Revegetation	N/A	0.3	0.4
		Tracks/parkland/cleared areas	N/A	11.9	12.7
		Open beach	N/A	16.1	17.1
		Total		94	100

4.2.6 Conservation significant ecological communities

To identify potential TECs and PECs in the survey area, ELA quadrats and vegetation communities were compared to FCTs defined by Gibson *et al*. (1994). Results of this analysis are shown below in **Table 9**.

Results of the multivariate analysis showed that quadrats within vegetation community ArAcTOS had a strong affiliation with FCT 29a and, to a lesser extent to FCT 29b and FCT 30a (**Table 9**). This community, covering a total area of 51.1ha (54.4% of the survey area), was considered to represent floristic aspects of FCT 29a. FCT 29a, described as 'coastal shrublands on shallow sands, mostly heaths on shallow sands over limestone close to the coast' is listed as a Priority 3 ecological community (DBCA 2021).

FCT 30a (SCP 30a), described as '*Callitris preissii* (or *Melaleuca lanceolata*) forests and woodlands, Swan Coastal Plain', is listed as a TEC under the EPBC Act. Although one quadrat within vegetation community ArAcTOS (WN Q2) showed a weak affiliation with FCT 30a, this vegetation community is, however, not considered as representing this TEC as it doesn't comprise key floristic and structural aspects of the FCT i.e., overarching *C. preissii* and/or *M. lanceolata* forest or woodland.

Quadrats within vegetation community OaApRbLOS had a strong affiliation with FCT 29a. This community, covering a total area of 6.4 ha (6.8% of the survey area), is considered as representing floristic aspects of the FCT 29a which is listed as a P3 ecological community by DBCA.

Quadrats within vegetation community SgOaS had a strong affiliation with FCT 29b and, to a lesser extent, FCT 29a. This community, covering a total area of 8.1 ha (8.6% of the survey area), is considered as representing floristic aspects of FCT 29b. FCT 29b, described as 'Acacia shrublands on taller dunes, dominated by Acacia shrublands or mixed heaths on the larger dunes', is listed as a Priority 3 ecological community (DBCA 2021).

A graphical representation of relationships between ELA vegetation communities and Floristic Community Types (FCTs) defined by Gibson *et al.* (1994) is shown in **Appendix G**.

Table 9: Relationships between ELA vegetation communities and FCTs defined by Gibson *et al.* (1994)

FCT	Vegetation community	Hillarys-Kallaroo quadrat number	Closest affiliated site(s) (Gibson *et al*. 1994)
29a	ArAcTOS	WN Q2, WN Q6	TRIG-2
29a	ArAcTOS	WN Q4, WN Q10	TRIG-2, BURN-2
29a	ArAcTOS	WN Q12	BURN-2, TRIG-2, PRES-1, NAVB-2, BURN-1, SEAB-8, SEAB-4, SEAB-5
29a	OaApRbLOS	WN Q8	TRIG-2, BURN-2, PRES-1, NAVB-2, BURN-1, SEAB-8
29a	OaApRbLOS	WN New Q2, WN New Q3	TRIG-2, BURN-2
29a	SgOaS	WN Q14	BURN-2, TRIG-2, GARDEN-2

FCT	Vegetation community	Hillarys-Kallaroo quadrat number	Closest affiliated site(s) (Gibson *et al*. 1994)
29a	SgOaS	WN Q16, WN New Q1	TRIG-2, GARDEN-2
29b	ArAcTOS	WN Q10, WN Q6	TRIG-1
29b	SgOaS	WN Q14, WN New Q1	TRIG-1, PB-4, PB-2, PB-3, PB-5, WHILL-2, WHILL-1, NPRES-1
29b	SgOaS	WN Q16	TRIG-1, PB-2, PB-3, PB-5, WHILL-2, WHILL-1, NPRES-1
30a	ArAcTOS	WN Q2	WOODP-2, GARDEN-4, WOODP-1, GARDEN-3, GARDEN-1

4.2.6.1 Banksia Woodlands of the Swan Coastal Plain TEC diagnostic

Vegetation within the survey area is not considered as having the potential to represent the Banksia Woodlands of the Swan Coastal Plain TEC due to there being no *Banksia* spp. individuals recorded within the survey area. As such, the full four-stage assessment for this TEC, as outlined in the approved conservation advice (TSSC 2016), was not completed for the survey area.

4.2.6.2 Tuart (Eucalyptus gomphocephala) woodlands and forests of the Swan Coastal Plain TEC diagnostic

Vegetation within the survey area was assessed against key diagnostic characteristics outlined in the 'Tuart (*Eucalyptus gomphocephala*) Woodlands and Forests of the Swan Coastal Plain TEC' approved conservation advice (DotEE 2019) in order to determine the presence of the TEC within the survey area. Several of these diagnostic characteristics were met by patches of vegetation within vegetation communities ArAcTOS and OaApRbLOS, including:

- **Location/landform** – the survey area is located on the Swan Coastal Plain and occurs on the Quindalup South Dune System.
- **Structure and composition** – Tuart (*Eucalyptus gomphocephala*) is present in the upper canopy layer (scattered large trees), with an understory of native plants present including herbs and shrubs listed in Section 2.3.3 of the approved conservation advice (DotEE 2019).
- **Defining a patch of the ecological community** – on applying a 30 m patch boundary beyond the outer canopy of established Tuart trees, three patches of vegetation within the survey area were identified as meeting key diagnostic characteristics and condition thresholds outlined in the approved conservation advice (DotEE 2019) for the Tuart TEC:
  - Patch 1: 0.91ha
  - Patch 2: 0.98ha
  - Patch 3: 3.34ha.

Each of these patches was assessed as likely to represent the Tuart (*Eucalyptus gomphocephala*) Woodlands and Forests of the Swan Coastal Plain TEC, totalling 5.23ha. The full assessment against the key diagnostic characteristics for this TEC are presented in **Appendix H**.

4.2.7 Vegetation condition

Vegetation within the survey area ranged from Degraded to Excellent condition, based on the Keighery (1994) vegetation scale provided in the EPA *Technical Guidance: Flora and Vegetation Surveys for Environmental Impact Assessment* (2016). Majority of the survey area was observed to be in Very Good or Excellent condition (29.7ha; 31.6% of the survey area and 23.8ha; 25.3% of the survey area, respectively). A small area of Degraded condition (0.3ha; 0.4% of the survey area) was identified adjacent to Northshore Drive on the eastern boundary of Kallaroo Coastal Foreshore Reserve. Disturbances within the survey area included the presence of weeds, grazing and rubbish dumping.

Comparisons in vegetation condition between the current survey and that recorded by ELA in 2015 (ELA 2016) is presented in **Table 10**. Vegetation condition within the survey area is presented in **Figure 6** below. Vegetation condition per vegetation community is presented in **Table 11** and **Figure 7**.

Table 10: Vegetation condition within the survey area in 2021 compared to vegetation condition recorded in 2015 (ELA 2016)

Vegetation condition	ELA 2016		Current assessment (2021)	
	Total area (ha)	Proportion of the survey area (%)	Total area (ha)	Proportion of the survey area (%)
Pristine	0	0	0	0
Excellent	22.3	28.2	23.8	25.3
Very Good	29.3	37.1	29.7	31.6
Good	14.2	18.0	11.8	12.5
Degraded	0	0	0.39	0.4
Completely Degraded	1.3	1.6	0	0
Tracks / paths / car parks	6.4	8.2	11.9	12.7
Parkland	4.8	6.2	0	0
Revegetation	0.4	0.5	0.3	0.4
Open beach	0	0	16.1	17.1
Total	**79**	**100**	**94**	**100**

*Completely Degraded vegetation condition previously included tracks and cleared areas however they have been separated for the current assessment

Table 11: Vegetation condition per vegetation community within the survey area

Vegetation community	Vegetation Condition ha (% of total of vegetation community)						
	Pristine	Excellent	Very Good	Good	Degraded	Completely Degraded	Total ha (%)
ArAcTOS	0 (0)	14.9 (29.2)	25.8 (50.5)	10.0 (19.5)	0.4 (0.8)	0 (0)	51.1 (100)
OaApRbLOS	0 (0)	0.9 (14.2)	3.7 (58.0)	1.8 (27.8)	0 (0)	0 (0)	6.4 (100)
SgOaS	0 (0)	7.9 (98.0)	0.2 (2.0)	0 (0)	0 (0)	0 (0)	8.1 (100)

*Totals are subject to rounding errors of 0.01-0.1

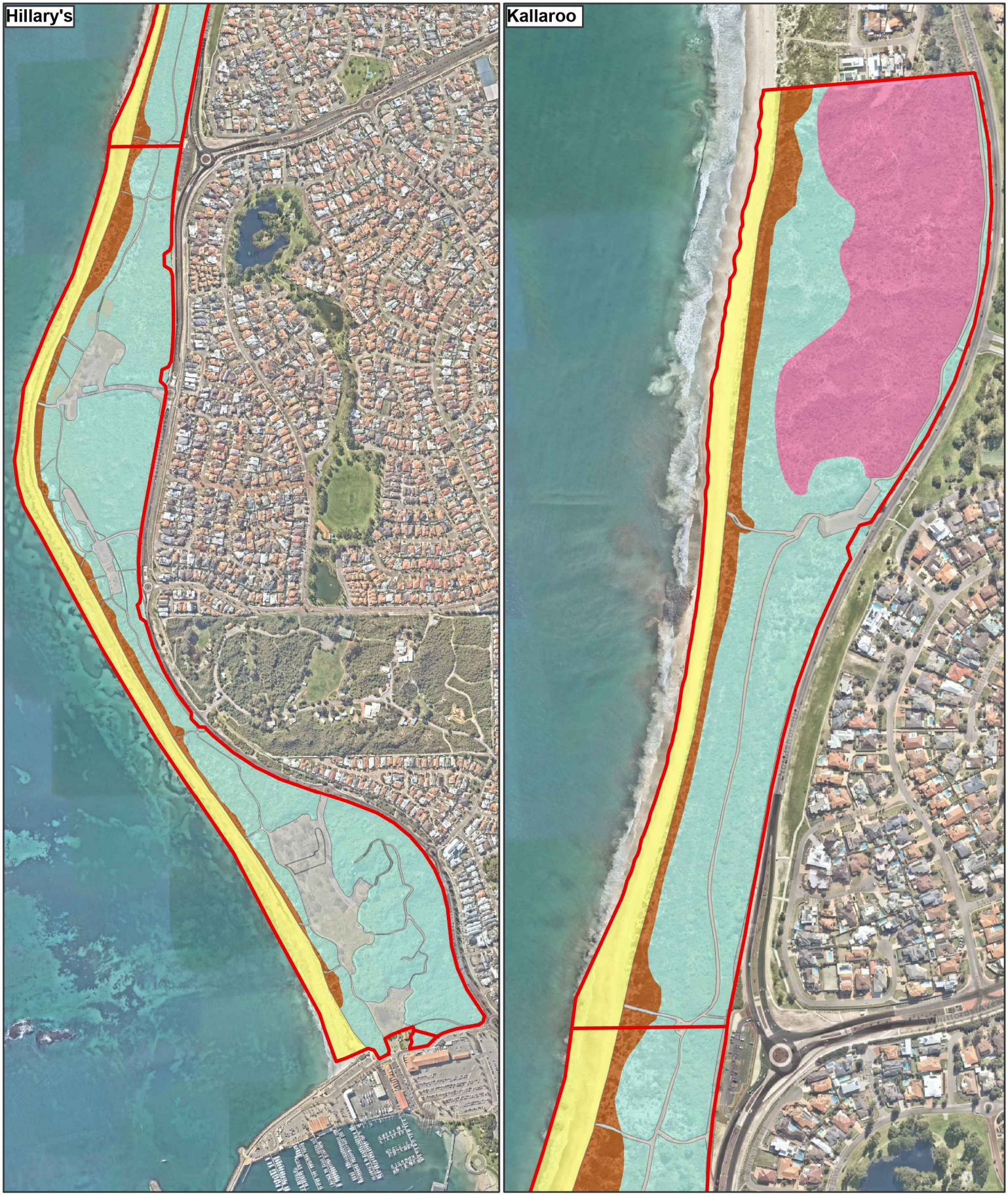

Figure 4: Vegetation communities recorded within the survey area

Survey Area
Revegetation
Cleared
Open Beach

Vegetation Communities

ArAcTOS
OaApRbLOS
SgOaS

0 55 110 220
Metres

Datum/Projection:
GDA 1994 MGA Zone 50

Project: 19876-DD Date: 24/01/2022

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Figure 5: Conservation significant vegetation communities recorded within the survey area (1 of 2)

Tuart Woodlands TEC

0 35 70 140

Metres

Datum/Projection:
GDA 1994 MGA Zone 50

Project: 19876-DD Date: 24/01/2022

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Figure 5: Conservation significant vegetation communities recorded within the survey area (2 of 2)

Cleared
Open Beach

Conservation Significant Vegetation Communities

FCT 29a: Coastal shrublands on shallow sands (P3)
FCT 29b: Acacia shrublands on taller dunes (P3)

0 50 100 200
Metres

Datum/Projection:
GDA 1994 MGA Zone 50

Project: 19876-DD Date: 24/01/2022

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Figure 6: Vegetation condition recorded within the survey area

Survey Area

Vegetation Condition

- Excellent
- Very Good
- Good
- Degraded

0 50 100 200

Metres

Datum/Projection:
GDA 1994 MGA Zone 50

Project: 19876-DD Date: 24/01/2022

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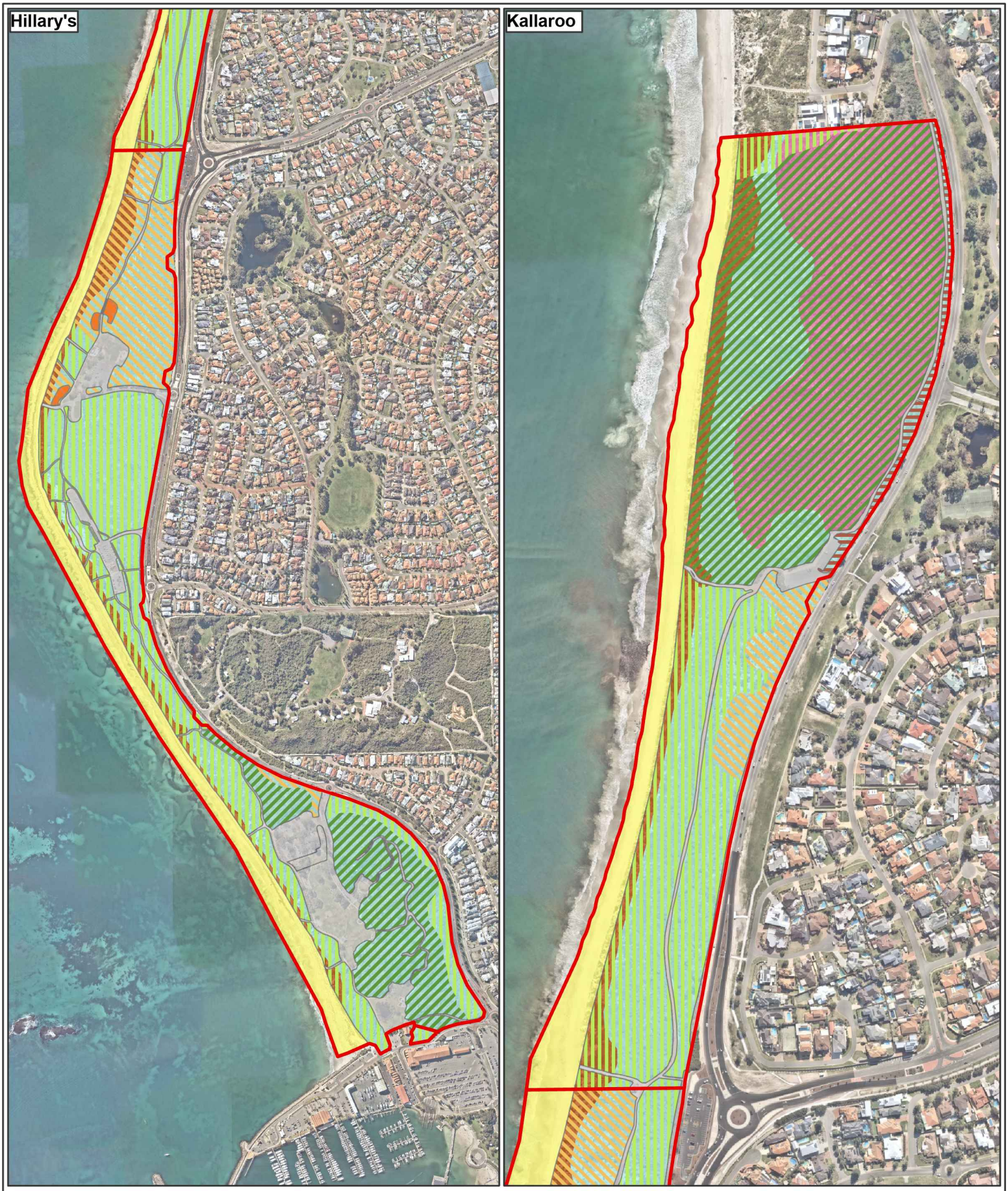

Figure 7: Vegetation condition per community within the survey area

Survey Area
Revegetation
Cleared
Open Beach

Vegetation Unit
ArAcTOS
OaApRbLOS
SgOaS

Vegetation Condition
Degraded
Good
Very Good
Excellent

0 50 100 200
Metres

Datum/Projection:
GDA 1994 MGA Zone 50

Project: 19876-DD Date: 24/01/2022

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4.3 Fungi

No fungi species were recorded within the survey area.

4.4 Fauna

A total of 25 fauna species (20 native; two naturalised exotic and three pests) were recorded opportunistically within the survey area, comprising 17 birds, four insects, three reptiles and one mammal (**Table 12**). Of these, the Forest Red-tailed Black Cockatoo (*Calyptorhynchus banksii naso*) is listed as Vulnerable under the EPBC Act and BC Act, and Quenda (*Isoodon fusciventer*) is listed as P4 by DBCA. The Forest Red-tailed Black Cockatoo was recorded from calls and was observed flying overhead, while Quenda was directly observed within the survey area.

A total of five introduced fauna species were recorded during the field survey. These comprised two birds listed as naturalised exotic in Western Australia, namely **Dacelo novaeguineae* (Laughing Kookaburra) and **Spilopelia senegalensis* (Laughing Dove; Western Australian Museum 2021) and three invertebrates listed as pest species namely **Ischnura heterosticta* (Common Bluetail Dragonfly) **Mamestra brassicae* (Cabbage Moth) and **Ommatoiulus moreleti* (Portuguese Millipede; DPIRD 2021c).

Table 12: Fauna species recorded opportunistically within the survey area

Type	Species	Common name	Observation type
Bird	*Anthochaera carunculata*	Red Wattlebird	Directly observed
Bird	*Artamus cinereus*	Black-faced Woodswallow	Directly observed
Bird	*Cacatua sanguinea*	Little Corella	Directly observed
Bird	*Calyptorhynchus banksii naso*	Forest Red-tailed Black Cockatoo	Heard, observed flying overhead
Bird	*Coracina novaehollandiae*	Black-faced Cuckooshrike	Heard
Bird	*Corvus coronoides*	Australian Raven	Directly observed
Bird	*^Dacelo novaeguineae*	Laughing Kookaburra	Directly observed
Bird	*Eolophus roseicapilla*	Galah	Directly observed
Bird	*Gymnorhina tibicen*	Australian Magpie	Directly observed
Bird	*Lichenostomus virescens*	Singing Honeyeater	Directly observed
Bird	*Malurus lamberti*	Variegated Fairywren	Directly observed
Bird	*Ocyphaps lophotes*	Crested Pigeon	Directly observed
Bird	*Pandion haliatus*	Osprey	Directly observed
Bird	*Phylidonyris novaehollandiae*	New Holland Honeyeater	Directly observed
Bird	*Rhipidura leucophrys*	Willie Wagtail	Directly observed
Bird	*^Spilopelia senegalensis*	Laughing Dove	Directly observed
Bird	*Zosterops lateralis*	Silvereye	Directly observed
Insect	**Ischnura heterosticta*	Common Bluetail Dragonfly	Directly observed
Insect	**Mamestra brassicae*	Cabbage Moth	Directly observed
Insect	*Nephila edulis*	Australian Golden Orb-Weaving Spider	Directly observed

Type	Species	Common name	Observation type
Insect	**Ommatoiulus moreleti*	Portuguese Millipede	Directly observed
Mammal	*Isoodon fusciventer*	Quenda, Southern Brown Bandicoot	Directly observed
Reptile	*Ctenotus fallens*	West-coast Laterite Ctenotus	Directly observed
Reptile	*Egernia kingii*	King's skink	Directly observed
Reptile	*Pseudonaja affinis*	Dugite	Directly observed

Note: * refers to a pest species; ^ refers to a naturalised exotic species

5. Discussion and recommendations

5.1 Flora

A total of 117 taxa (68 native and 49 introduced taxa) from 105 genera and 49 families were recorded across 11 quadrats established within the survey area and from opportunistic collections. This number is an increase from the number of species recorded by ELA in 2015 (79 species; 51 native and 28 introduced; ELA 2016), likely due to the increased survey effort (11 quadrats established over four days in 2021 compared to eight quadrats established over two days by ELA in 2015). The number of species recorded from the current survey is comparable to the number of species recorded from the nearby Burns Beach-Iluka Foreshore Reserve, located approximately 6km north of the survey area, by ELA in 2020 (121 species; 74 native and 47 introduced; ELA 2021).

Average flora species richness per quadrat was 31.3 species, (range 21 to 43 species per quadrat). This is higher than recorded by ELA in 2016, where an average species richness of 23 species (range 12-31 species) was recorded, and higher than recorded by ELA at Burns Beach-Iluka Foreshore Reserve in 2021 (25.62 species; range 17 to 40 species).

A species accumulation curve determined that approximately 85.4% of the flora species potentially present within the survey area were recorded from quadrats (79 species). This result, in addition to flora species recorded opportunistically (39 species), indicates that the majority of flora potentially present within the survey area were recorded. This figure suggests that a comprehensive flora inventory of the survey area has been compiled.

No Threatened or Priority flora listed under the EPBC Act, the BC Act or by DBCA were recorded within the survey area. No Bush Forever significant species for the Bush Forever site 325: Coastal Strip from Burns Beach to Hillarys were recorded within the survey area; a result consistent with ELA (2016).

Weed species comprised 40.7% (48 species) of the total flora taxa recorded. This result, in comparison to ELA (2016), represents an overall increase in the number of weed species (28 introduced species recorded) and percentage of weed species compared to native species (increased from 35.4% in 2015; ELA 2016). An increase in the number of weed species recorded could potentially be attributed to several factors including seasonal differences, natural fluctuations in occurrence and increased search effort undertaken during the current assessment.

Of the 48 weed species recorded, **Asparagus asparagoides* (Bridal Creeper) is listed as a WoNS and **Moraea flaccida* (One-leaf Cape Tulip) is listed as a Declared Pest under the BAM Act. Neither of these species was recorded during the 2015 assessment (ELA 2016).

Asparagus asparagoides* (Bridal Creeper) is a rhizomatous and tuberous perennial herb / climber, 1-5m high with white flowers from August to September which grows in sand, loam, clay and granite (DBCA and WAH 2021). This species is regarded as one of the worst weeds in Australia because of its invasiveness and environmental impacts which include smothering native species, dominating the lower layers of vegetation, forming dense underground tubers which impede the root growth of other plants, reducing soil moisture available to other plants and preventing seedling establishment (Weeds of Australia 2021a). Within the survey area, **A. asparagoides* was recorded from a small patch in the southeast corner of Kallaroo Coastal Foreshore Reserve and from multiple point and polygon locations within Hillarys Coastal Foreshore Reserve (Appendix E**).

*_Moraea flaccida_ is a perennial herb to 70 centimetres with orange to salmon pink flowers from September to November, underground bulbs and a single large, strap-like leaf (DBCA and WAH 2021; Weeds of Australis 2021b). It grows in white sand and grey sandy loam over limestone, laterite, clay and gravel in seasonally wet sites, along creeklines, hilltops, pastures and on disturbed land (DBCA and WAH 2021). This species was originally introduced as a garden plant in the 19th century and is extremely toxic to livestock (Weeds of Australia 2021). *_M. flaccida_ has a legal status of S22(2) and "may be subject to control and keeping requirements once within Western Australia" (DPIRD 2021). Within the survey area, *_M. flaccida_ (One-leaf Cape Tulip) was recorded within Kallaroo Coastal Foreshore Reserve from three-point locations and a polygon of <5% cover along the northern and eastern boundaries of the survey area (**Appendix E**).

5.2 Vegetation

A total of three vegetation communities were delineated and mapped within the survey area. Quadrats previously established by ELA (2016) were re-surveyed (eight in total), with three additional quadrats established, ensuring a minimum of three quadrats established per vegetation community, as specified in the EPA *Technical Guidance: Flora and Vegetation Surveys for Environmental Impact Assessment* (EPA 2016). Following ground-truthing, there were no substantial changes to the type or extent of vegetation communities between survey periods. The vegetation code previously assigned by ELA (2016) remained valid between the two survey periods and as such was retained for consistency:

- ArAcTOS – *Acacia rostellifera* and *Acacia cyclops* tall open shrubland;
- SgOaS – *Spyridium globulosum* and *Olearia axillaris* shrubland to open shrubland; and
- OaApRbLOS – *Olearia axillaris*, *Acanthocarpus preissii* and *Rhagodia baccata* subsp. *baccata* low shrubland.

To identify potential TECs and PECs in the survey area, ELA quadrats and vegetation communities were compared to FCTs defined by Gibson *et al*. (1994).

Results of the multivariate analysis showed that quadrats within vegetation communities ArAcTOS and OaApRbLOS had strong affiliations with FCT 29a. These communities, covering a total of 51.1ha and 6.4ha, respectively, (57.5ha total; 61.2% of the survey area) are considered to represent floristic aspects of FCT 29a, described as 'coastal shrublands on shallow sands, mostly heaths on shallow sands over limestone close to the coast'. Common species recorded include *Acanthocarpus preissii*, *Daucus glochidiatus*, *Hardenbergia comptoniana*, *Leucopogon parviflorus*, *Rhagodia baccata*, *Spyridium globulosum*, **Bromus diandrus*, **Lysimachia arvensis* and *Trachymene pilosa* (Gibson *et al*. 1994). This community is listed as a Priority 3 ecological community by DBCA. This FCT aligns with those stated as occurring within Bush Forever site 303 (Government of Western Australia 2000).

One quadrat within vegetation community ArAcTOS showed a weak affiliation to FCT 30a. FCT 30a (SCP 30a), described as '*Callitris preissii* (or *Melaleuca lanceolata*) forests and woodlands, Swan Coastal Plain', is listed as a TEC under the EPBC Act. Although one quadrat (WN Q2) within this community showed a weak affiliation with FCT 30a, vegetation community ArAcTOS is not considered as representing this TEC as it does not represent floristic aspects of this TEC (e.g., species composition, forest or woodland structure).

Quadrats within vegetation community SgOaS had a strong affiliation to FCT 29b and, to a lesser extent, to FCT 29a. This community, covering a total area of 8.1ha (8.6% of the survey area), is considered as

representing floristic aspects of FCT 29b. FCT 29b, described as 'Acacia shrublands on taller dunes, dominated by Acacia shrublands or mixed heaths on the larger dunes', is listed as a Priority 3 ecological community (DBCA 2021). Common species recorded include *Acacia lasiocarpa*, *Acanthocarpus preissii*, *Daucus glochidiatus*, *Gompholobium tomentosum*, *Hemiandra pungens, Lomandra maritima*, *Opercularia vaginata, Trachymene pilosa* and *Rhagodia baccata* (Gibson *et al.* 1994). This FCT aligns with those stated as occurring within Bush Forever site 303 (Government of Western Australia 2000).

Vegetation within the survey area is not considered to represent the Banksia Woodlands of the Swan Coastal Plain TEC due to there being no key diagnostic *Banksia* species present within the survey area (e.g., *Banksia attenuata*, *B. menziesii*, B. *prionotes*, *B. ilicifolia*; TSSC 2016). As such, the full four-stage assessment for this TEC, as outlined in the approved conservation advice (TSSC 2016), was not completed for the survey area.

Vegetation within the survey area was assessed against key diagnostic characteristics outlined in the 'Tuart (*Eucalyptus gomphocephala*) Woodlands and Forests of the Swan Coastal Plain TEC' approved conservation advice (DotEE 2019) in order to determine the presence of the TEC within the survey area. Key steps to identify patches of the TEC as outlined in the approved conservation advice were followed with the following outcomes:

- **Key diagnostic characteristics** were met, including:
  - **Location/landform** – the survey area is located on the Swan Coastal Plain and occurs on the Quindalup South Dune System.
  - **Structure and composition** – Tuart (*Eucalyptus gomphocephala*) is present in the upper canopy layer (scattered large trees) of areas within vegetation communities ArAcTOS and OaApRbLOS, with an understory of native plants present including herbs and shrubs listed in Section 2.3.3 of the approved conservation advice (DotEE 2019).
- **Defining a patch of the ecological community**: The approved conservation advice for the Tuart TEC defines a patch as a discrete and mostly continuous area of vegetation that meets the key diagnostic characteristics (DotEE 2019). Patches may vary in structural or biological complexity, and may include small areas without understorey vegetation, such as bare ground, as well as waterbodies or hardscape (e.g., roads, paths, car parks, or buildings) that do not significantly alter the overall function of the ecological community (DotEE 2019). Patches within the survey area were defined by applying a 30m buffer beyond the outer canopy of established Tuart trees (DotEE 2019) and removing areas considered to significantly alter the overall function of the community, including parkland cleared areas and roads/tracks. A patch was considered continuous if occurring within <30m of another buffered Tuart canopy. Upon following information provided in the approved conservation advice, three patches of vegetation meeting key diagnostic characteristics (above) were identified:
  - Patch 1: 0.91ha
  - Patch 2: 0.98ha
  - Patch 3: 3.34ha.

- **Condition thresholds and categories**: Confirmed patches of the ecological community identified within the survey area between 0.5ha and 5ha require on-ground surveys to determine which condition category applies (DotEE 2019). Patches were assessed as being in Moderate condition (DotEE 2019), based on vegetation condition mapping undertaken within the survey area. In

addition, patches of the community were considered as having an important landscape role (occurring within <100m of native vegetation) and an important habitat role (>2 very large trees present per 0.5ha), as defined in the approved conservation advice (DotEE 2019).

All three patches of the ecological community identified above are considered as likely to represent the Tuart Woodlands and Forests of the Swan Coastal Plain TEC, totalling 5.23ha (5.6% of the survey area). Majority of individual Tuart trees within the survey area occur in parkland cleared areas or directly adjacent to roads, with Tuart observed within native vegetation occurring as small, isolated canopies or isolated individual trees. As such, the TEC identified above is not considered to represent a distinct vegetation community in addition to those identified from the broader assessment.

Vegetation condition within the survey area ranged from Degraded to Excellent condition, based on the Keighery (1994) vegetation scale provided in the EPA *Technical Guidance: Flora and Vegetation Surveys for Environmental Impact Assessment* (2016). Majority of the survey area was observed to be in Very Good and Excellent condition (29.7ha; 31.6% of the survey area and 23.8ha; 25.3% of the survey area, respectively). Vegetation condition within the survey area has remained fairly consistent since 2016, with areas of Excellent and Very Good condition increasing slightly between survey periods. Subtle differences of areas classed as Good and Degraded were recorded between 2015 and 2021, which would most likely be attributed to refining condition boundaries and other factors including seasonal changes, weed control and observer differences. Areas of vegetation previously classed as being in Completely Degraded condition in 2016 were reclassified under 'Tracks/cleared areas' during the current assessment. Disturbances within the survey area included the presence of weeds, grazing and rubbish dumping.

5.3 Recommendations

Based on results of the current survey, the following recommendations have been made to assist in the conservation of native flora, vegetation and environmental values present within Hillarys-Kallaroo Coastal Foreshore Reserve:

- Continue long-term monitoring of weed populations within the survey area. Implement weed control, particularly for the Declared Pest species **Moraea flaccida* (One-leaf Cape Tulip), the WoNS **Asparagus asparagoides* (Bridal Creeper) and for City of Joondalup priority weeds. Concentrate weed control activities along track edges and boundaries between remnant bushland and cleared areas.
- Prioritise maintenance of the vegetation at Hillarys-Kallaroo Coastal Foreshore Reserve due to the presence of the Tuart (*Eucalyptus gomphocephala*) TEC and the FCT29a and FCT 29b PECs.
- It is recommended to continue monitoring for evidence of dieback and other pathogens, and to maintain correct hygiene practices within the survey area.
- Ensure that access is restricted to defined tracks/paths only to prevent habitat degradation and weed spread and consider installation of fencing or formal signage (particularly in dune areas of Kallaroo Foreshore Reserve) to prevent use of unauthorised walking tracks and rubbish dumping within the survey area, particularly in the dune/foreshore areas.

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Appendix A Framework for conservation significant flora and fauna ranking

CATEGORIES OF THREATENED SPECIES UNDER THE ENVIRONMENT PROTECTION AND BIODIVERSITY CONSERVATION ACT 1999 (EPBC ACT)

Threatened fauna and flora may be listed in any one of the following categories as defined in Section 179 of the EPBC Act. Species listed as 'conservation dependent' and 'extinct' are not Matters of National Environmental Significance and therefore do not trigger the EPBC Act.

Category	Definition
Extinct (EX)	There is no reasonable doubt that the last member of the species has died.
Extinct in the Wild (EW)	Taxa known to survive only in captivity or as a naturalised population well outside its past range; or taxa has not been recorded in its known and/or expected habitat at appropriate seasons, anywhere in its past range, despite exhaustive surveys over a time frame appropriate to its life cycle and form.
Critically Endangered (CE)	Taxa considered to be facing an extremely high risk of extinction in the wild.
Endangered (EN)	Taxa considered to be facing a very high risk of extinction in the wild.
Vulnerable (VU)	Taxa considered to be facing a high risk of extinction in the wild.
Near Threatened (NT)	Taxa has been evaluated against the criteria but does not qualify for Critically Endangered, Endangered or Vulnerable now, but is close to qualifying for or is likely to qualify for a threatened category in the near future.
Least Concern (LC)	Taxa has been evaluated against the criteria and does not qualify for Critically Endangered, Endangered, Vulnerable or Near Threatened. Widespread and abundant taxa are included in this category.
Data Deficient (DD)	There is inadequate information to make a direct, or indirect, assessment of taxa's risk extinction based on its distribution and/or population status.
Not Evaluated (NE)	Taxa has not yet been evaluated against the criteria.
Migratory (M)	Not an IUCN category. Species are defined as migratory if they are listed in an international agreement approved by the Commonwealth Environment Minister, including: • the Bonn Convention (Convention on the Conservation of Migratory Species of Wild Animal) for which Australia is a range state; • the agreement between the Government of Australian and the Government of the People's Republic of China for the Protection of Migratory Birds and their environment (CAMBA); • the agreement between the Government of Japan and the Government of Australia for the Protection of Migratory Birds and Birds in Danger of Extinction and their Environment (JAMBA); or • the agreement between Australia and the Republic of Korea to develop a bilateral migratory bird agreement similar to the JAMBA and CAMBA in respect to migratory bird conservation and provides a basis for collaboration on the protection of migratory shorebirds and their habitat (ROKAMBA).

CONSERVATION CODES FOR WESTERN AUSTRALIA FLORA AND FAUNA

The Wildlife Conservation (Specially Protected Fauna) Notice 2018 and the Wildlife Conservation (Rare Flora) Notice 2018 have been transitioned under regulations 170, 171 and 172 of the Biodiversity Conservation Regulations 2018 to be the lists of Threatened, Extinct and Specially Protected species under Part 2 of the *Biodiversity Conservation Act 2016*.

Specially protected fauna or flora are species which have been adequately searched for and are deemed to be, in the wild, threatened, extinct or in need of special protection, and have been gazetted as such.

Threatened species (T)
Listed by order of the Minister as Threatened in the category of critically endangered, endangered or vulnerable under section 19(1), or is a rediscovered species to be regarded as threatened species under section 26(2) of the *Biodiversity Conservation Act 2016* (BC Act).

Threatened fauna is that subset of 'Specially Protected Fauna' listed under schedules 1 to 3 of the Wildlife Conservation (Specially Protected Fauna) Notice 2018 for Threatened Fauna.

Threatened flora is that subset of 'Rare Flora' listed under schedules 1 to 3 of the Wildlife Conservation (Rare Flora) Notice 2018 for Threatened Flora.

The assessment of the conservation status of these species is based on their national extent and ranked according to their level of threat using IUCN Red List categories and criteria as detailed below.

Category	Code	Description
Critically Endangered species	CR	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". 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.
Endangered species	EN	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". 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.

Category	Code	Description
Vulnerable species	VU	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". 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.

Extinct species

Listed by order of the Minister as extinct under section 23(1) of the BC Act as extinct or extinct in the wild, as follows:

Category	Code	Description
Extinct species	EX	Species which have been adequately searched for and there is no reasonable doubt that the last individual has died. Published as Specially Protected under the *Wildlife Conservation Act 1950*, in Schedule 4 of the Wildlife Conservation (Specially Protected Fauna) Notice for Presumed Extinct Fauna and Wildlife Conservation (Rare Flora) Notice for Presumed Extinct Flora.
Extinct in the wild species	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

Listed by order of the Minister as specially protected under section 13(1) of the BC Act. Meeting one or more of the following categories: species of special conservation interest; migratory species; cetaceans; species subject to international agreement; or species otherwise in need of special protection.

Species that are listed as threatened species (critically endangered, endangered or vulnerable) or extinct species under the BC Act cannot also be listed as Specially Protected species.

Categories are detailed below.

Category	Code	Description
Migratory species	M	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). Includes birds that are subject to an agreement between the government of Australia and the governments of Japan (JAMBA), China (CAMBA) and The Republic of Korea (ROKAMBA), and fauna subject to the Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention), an environmental treaty under the United Nations Environment Program. Migratory species listed under the BC Act are a subset of the migratory animals that are known to visit Western Australia, protected under the international agreements or treaties, excluding species that are listed as Threatened species. Published as migratory birds protected under an international agreement under schedule 5 of the Wildlife Conservation (Specially Protected Fauna) Notice 2018.
Species of special conservation interest (conservation dependent fauna)	CD	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). Published as conservation dependent fauna under schedule 6 of the Wildlife Conservation (Specially Protected Fauna) Notice 2018.
Other specially protected species	OS	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). Published as other specially protected fauna under schedule 7 of the Wildlife Conservation (Specially Protected Fauna) Notice 2018.

Priority species (P)

Possibly threatened species that do not meet survey criteria, or are otherwise data deficient, are added to the Priority Fauna or Priority Flora 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 fauna or flora.

Species that are adequately known, are rare but not threatened, or meet criteria for near threatened, or that have been recently removed from the threatened species or other specially protected fauna lists for other than taxonomic reasons, are placed in Priority 4. These species require regular monitoring.

Assessment of Priority codes is based on the Western Australian distribution of the species, unless the distribution in WA is part of a contiguous population extending into adjacent States, as defined by the known spread of locations.

Category	Code	Definition
Priority 1	P1	*Poorly-known species* 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.
Priority 2	P2	*Poorly-known species* 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.
Priority 3	P3	*Poorly-known species* 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.
Priority 4	P4	*Rare, Near Threatened and other species 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.

Appendix B Flora species list

Family	Species name	Common name	Conservation status	2016	2021
Aizoaceae	**Carpobrotus edulis*	Hottentot Fig	-		X
Aizoaceae	**Tetragonia decumbens*	Sea Spinach	-	X	X
Aizoaceae	*Carpobrotus virescens*	Coastal Pigface	-	X	X
Anacardiaceae	**Schinus terebinthifolia*	Japanese Pepper	-		X
Apiaceae	*Daucus glochidiatus*	Australian Carrot	-	X	X
Araliaceae	*Trachymene pilosa*	Native Parsnip	-		X
Asparagaceae	**Agave americana*	Century Plant	-	X	X
Asparagaceae	**Asparagus asparagoides*	Bridal Creeper	-		X
Asparagaceae	**Yucca* sp.		-		X
Asparagaceae	*Acanthocarpus preissii*		-	X	X
Asparagaceae	*Lomandra maritima*		-	X	X
Asparagaceae	*Thysanotus patersonii*		-		X
Asphodelaceae	**Asphodelus fistulosus*	Onion Weed	-	X	
Asphodelaceae	**Trachyandra divaricata*	Onion Weed	-		X
Asteraceae	**Arctotheca calendula*	Cape Weed	-	X	X
Asteraceae	**Arctotis* sp.		-		X
Asteraceae	**Gazania linearis*	Gazania	-	X	X
Asteraceae	**Lactuca serriola*	Prickly Lettuce	-	X	
Asteraceae	**Osteospermum ecklonis*	Cape Marguerite	-		X
Asteraceae	**Sonchus oleraceus*	Common Sowthistle	-	X	X
Asteraceae	*Asteraceae* sp.		-		X
Asteraceae	*Olearia axillaris*	Coastal Daisybush	-	X	X
Asteraceae	*Pithocarpa cordata*		-	X	X
Asteraceae	*Senecio pinnatifolius*		-	X	X
Brassicaceae	**Brassica tournefortii*	Mediterranean Turnip	-	X	X
Brassicaceae	**Cakile maritima*	Sea Rocket	-	X	X
Brassicaceae	**Heliophila pusilla*		-		X
Brassicaceae	**Raphanus* sp.		-		X
Caprifoliaceae	**Centranthus macrosiphon*		-		X
Caryophyllaceae	**Cerastium glomeratum*	Mouse Ear Chickweed	-		X
Caryophyllaceae	**Stellaria media*	Chickweed	-		X
Casuarinaceae	*Allocasuarina lehmanniana*	Dune Sheoak	-	X	X
Celastraceae	*Stackhousia monogyna*		-		X
Chenopodiaceae	**Chenopodium murale*	Nettle-leaf Goosefoot	-		X
Chenopodiaceae	*Atriplex* aff *cinerea*		-		X
Chenopodiaceae	*Rhagodia baccata subsp. baccata*		-	X	X
Chenopodiaceae	*Threlkeldia diffusa*	Coast Bonefruit	-	X	X
Convolvulaceae	**Cuscuta epithymum*	Lesser Dodder	-	X	X
Crassulaceae	**Crassula glomerata*		-	X	

Family	Species name	Common name	Conservation status	2016	2021
Crassulaceae	*Crassula colorata*	Dense Stonecrop	-		X
Crassulaceae	*Crassula glomerata*		-		X
Cupressaceae	*Callitris preissii*	Rottnest Island Pine	-	X	X
Cyperaceae	**Cyperus tenellus*	Tiny Flatsedge	-	X	X
Cyperaceae	*Ammothryon grandiflorum*	Large Flowered Bog-rush	-	X	X
Cyperaceae	*Ficinia nodosa*	Knotted Club Rush	-	X	X
Cyperaceae	*Lepidosperma gladiatum*	Coast Sword-sedge	-	X	X
Cyperaceae	*Lepidosperma squamatum*		-	X	X
Cyperaceae	*Schoenus clandestinus*		-	X	
Cyperaceae	*Schoenus* sp.		-		X
Dilleniaceae	*Hibbertia subvaginata*		-	X	X
Ericaceae	*Acrotriche cordata*	Coast Ground Berry	-		X
Ericaceae	*Leucopogon parviflorus*	Coast Beard-heath	-	X	X
Ericaceae	*Leucopogon* sp.		-	X	
Euphorbiaceae	**Euphorbia paralias*	Sea Spurge	-	X	X
Euphorbiaceae	**Euphorbia peplus*	Petty Spurge	-		X
Euphorbiaceae	**Euphorbia terracina*	Geraldton Carnation Weed	-	X	X
Fabaceae	**Lupinus cosentinii*	Sandplain Lupin	-		X
Fabaceae	**Medicago littoralis*	Strand Medic	-	X	
Fabaceae	**Trifolium campestre*	Hop Clover	-		X
Fabaceae	*Acacia cochlearis*	Rigid Wattle	-	X	X
Fabaceae	*Acacia cyclops*	Coastal Wattle	-	X	X
Fabaceae	*Acacia lasiocarpa* var. *lasiocarpa*	Panjang	-	X	X
Fabaceae	*Acacia rostellifera*	Summer-scented Wattle	-	X	X
Fabaceae	*Acacia saligna*	Orange Wattle	-	X	X
Fabaceae	*Acacia truncata*		-	X	X
Fabaceae	*Gastrolobium capitatum*		-	X	X
Fabaceae	*Gastrolobium nervosum*		-		X
Fabaceae	*Gompholobium tomentosum*	Hairy Yellow Pea	-		X
Fabaceae	*Hardenbergia comptoniana*	Native Wisteria	-	X	X
Fabaceae	*Templetonia retusa*	Cockies Tongues	-	X	X
Geraniaceae	**Erodium botrys*	Long Storksbill	-		X
Geraniaceae	**Geranium molle*	Dove's Foot Cranesbill	-		X
Geraniaceae	**Pelargonium capitatum*	Rose Pelargonium	-	X	X
Goodeniaceae	*Scaevola crassifolia*	Thick-leaved Fan-flower	-	X	X
Gyrostemonaceae	*Tersonia cyathiflora*	Button Creeper	-	X	
Haemodoraceae	*Conostylis candicans*	Grey Cottonhead	-	X	X
Hemerocallidaceae	*Dianella revoluta*	Blueberry Lily	-	X	X
Iridaceae	**Moraea flaccida*	One-leaf Cape Tulip	-		X
Iridaceae	**Romulea rosea*	Guildford Grass	-		X

Family	Species name	Common name	Conservation status	2016	2021
Lamiaceae	*Hemiandra glabra*		-	X	X
Lamiaceae	*Hemiandra pungens*	Snakebush	-		X
Lauraceae	*Cassytha flava*	Dodder Laurel	-	X	X
Montiaceae	*Calandrinia calyptrata*	Pink Purslane	-	X	X
Montiaceae	*Calandrinia corrigioloides*	Strap Purslane	-		X
Myrtaceae	**Leptospermum laevigatum*	Coast Teatree	-		X
Myrtaceae	*Agonis flexuosa*	Peppermint	-	X	X
Myrtaceae	*Eucalyptus gomphocephala*	Tuart	-	X	X
Myrtaceae	*Eucalyptus utilis*	Coastal Moort	-	X	X
Myrtaceae	*Melaleuca huegelii*	Chenille Honeymyrtle	-		X
Myrtaceae	*Melaleuca lanceolata*	Rottnest Teatree	-	X	X
Myrtaceae	*Melaleuca systena*		-	X	X
Onagraceae	**Oenothera drummondii*	Beach Evening Primrose	-	X	X
Oxalidaceae	**Oxalis corniculata*	Yellow Wood Sorrel	-		X
Oxalidaceae	**Oxalis pes-caprae*	Soursob	-		X
Papaveraceae	**Fumaria capreolata*	Whiteflower Fumitory	-	X	X
Phyllanthaceae	*Phyllanthus calycinus*	False Boronia	-		X
Poaceae	**Avena barbata*	Bearded Oat	-	X	
Poaceae	**Avena fatua*	Wild Oats	-		X
Poaceae	**Briza maxima*	Blowfly Grass	-	X	
Poaceae	**Bromus diandrus*	Great Brome	-	X	X
Poaceae	**Cenchrus clandestinus*	Kikuyu Grass	-		X
Poaceae	**Cynodon dactylon*	Couch	-		X
Poaceae	**Ehrharta calycina*	Perennial Veldt Grass	-		X
Poaceae	**Ehrharta longiflora*	Annual Veldt Grass	-	X	X
Poaceae	**Lagurus ovatus*	Hare's Tail Grass	-	X	X
Poaceae	**Lolium perenne*	Perennial Ryegrass	-	X	X
Poaceae	*Austrostipa flavescens*		-	X	X
Poaceae	*Poa poiformis*	Coastal Poa	-	X	X
Poaceae	*Spinifex hirsutus*	Hairy Spinifex	-	X	X
Poaceae	*Spinifex longifolius*	Beach Spinifex	-		X
Primulaceae	**Lysimachia arvensis*	Pimpernel	-	X	X
Ranunculaceae	*Clematis pubescens*	Common Clematis	-	X	X
Restionaceae	*Desmocladus asper*		-		X
Rhamnaceae	*Spyridium globulosum*	Basket Bush	-	X	X
Rhamnaceae	*Trymalium ledifolium* var. *ledifolium*		-		X
Rubiaceae	**Galium murale*	Small Goosegrass	-	X	X
Rubiaceae	*Opercularia vaginata*	Dog Weed	-	X	X
Santalaceae	*Exocarpos sparteus*	Broom Ballart	-	X	X
Santalaceae	*Santalum acuminatum*	Quandong	-	X	X
Scrophulariaceae	**Dischisma arenarium*		-		X
Scrophulariaceae	*Eremophila glabra*		-		X

Family	Species name	Common name	Conservation status	2016	2021
Scrophulariaceae	*Myoporum insulare*	Blueberry Tree	-	X	X
Solanaceae	**Solanum nigrum*	Black Berry Nightshade	-	X	
Stylidiaceae	*Stylidium hesperium*		-		X
Thymelaeaceae	*Pimelea ferruginea*		-	X	X
Tropaeolaceae	**Tropaeolum* sp.		-		X
Urticaceae	*Parietaria cardiostegia*		-	X	X
Verbenaceae	**Verbena rigida* var. *rigida*		-	X	

Appendix C Species by site matrix

Family	Species name	WN Q2	WN Q4	WN Q6	WN Q8	WN Q10	WN Q12	WN Q14	WN Q16	WN New Q1	WN New Q2	WN New Q3
Aizoaceae	**Carpobrotus edulis*											
Aizoaceae	**Tetragonia decumbens*				X	X					X	X
Aizoaceae	*Carpobrotus virescens*				X						X	X
Anacardiaceae	**Schinus terebinthifolia*											
Apiaceae	*Daucus glochidiatus*					X		X	X	X		
Araliaceae	*Trachymene pilosa*		X			X	X	X	X	X		
Asparagaceae	**Agave americana*											
Asparagaceae	**Asparagus asparagoides*											
Asparagaceae	**Yucca* sp.											
Asparagaceae	*Acanthocarpus preissii*	X	X	X	X	X	X	X	X	X	X	X
Asparagaceae	*Lomandra maritima*							X	X	X		
Asparagaceae	*Thysanotus patersonii*								X			
Asphodelaceae	**Trachyandra divaricata*		X	X	X		X	X		X	X	X
Asteraceae	**Arctotheca calendula*											
Asteraceae	**Arctotis* sp.											
Asteraceae	**Dimorphotheca ecklonis*											
Asteraceae	**Gazania linearis*											
Asteraceae	**Sonchus oleraceus*	X	X	X	X	X	X	X	X	X	X	X
Asteraceae	*Asteraceae* sp.											
Asteraceae	*Olearia axillaris*	X	X		X	X	X	X	X	X	X	X
Asteraceae	*Pithocarpa cordata*	X	X			X	X					

Family	Species name	WN Q2	WN Q4	WN Q6	WN Q8	WN Q10	WN Q12	WN Q14	WN Q16	WN New Q1	WN New Q2	WN New Q3
Asteraceae	*Senecio pinnatifolius*		X				X				X	
Brassicaceae	**Brassica tournefortii*		X	X		X	X	X	X	X		
Brassicaceae	**Cakile maritima*											X
Brassicaceae	**Heliophila pusilla*							X	X	X		
Brassicaceae	**Raphanus* sp.											
Caprifoliaceae	**Centranthus macrosiphon*	X	X	X		X			X			
Caryophyllaceae	**Cerastium glomeratum*	X										
Caryophyllaceae	**Stellaria media*	X		X								
Casuarinaceae	*Allocasuarina lehmanniana*											
Celastraceae	*Stackhousia monogyna*							X	X	X		
Chenopodiaceae	**Chenopodium murale*	X	X			X						
Chenopodiaceae	*Atriplex aff cinerea*											
Chenopodiaceae	*Rhagodia baccata* subsp. *baccata*	X	X	X	X	X	X	X	X	X	X	X
Chenopodiaceae	*Threlkeldia diffusa*		X	X		X	X				X	X
Convolvulaceae	**Cuscuta epithymum*					X	X			X	X	X
Crassulaceae	*Crassula colorata*											
Crassulaceae	*Crassula glomerata*		X	X	X	X	X	X	X	X	X	X
Cupressaceae	*Callitris preissii*											
Cyperaceae	**Cyperus tenellus*	X	X		X	X	X	X	X	X		X
Cyperaceae	*Ammothryon grandiflorum*											
Cyperaceae	*Ficinia nodosa*				X						X	X
Cyperaceae	*Lepidosperma gladiatum*	X	X	X			X				X	X

Family	Species name	WN Q2	WN Q4	WN Q6	WN Q8	WN Q10	WN Q12	WN Q14	WN Q16	WN New Q1	WN New Q2	WN New Q3
Cyperaceae	*Lepidosperma squamatum*							X	X			
Cyperaceae	*Schoenus* sp.											
Dilleniaceae	*Hibbertia subvaginata*		X					X	X	X		
Ericaceae	*Acrotriche cordata*			X					X	X		
Ericaceae	*Leucopogon parviflorus*	X	X	X		X	X	X	X	X		
Euphorbiaceae	**Euphorbia paralias*				X						X	X
Euphorbiaceae	**Euphorbia peplus*								X			
Euphorbiaceae	**Euphorbia terracina*	X	X	X	X	X	X		X	X	X	
Fabaceae	**Lupinus cosentinii*											
Fabaceae	**Trifolium campestre*											
Fabaceae	*Acacia cochlearis*							X				
Fabaceae	*Acacia cyclops*			X				X	X	X		
Fabaceae	*Acacia lasiocarpa* var. *lasiocarpa*		X	X		X		X	X	X		
Fabaceae	*Acacia rostellifera*	X	X	X		X						
Fabaceae	*Acacia saligna*											
Fabaceae	*Acacia truncata*		X	X			X					
Fabaceae	*Gastrolobium capitatum*							X	X			
Fabaceae	*Gastrolobium nervosum*											
Fabaceae	*Gompholobium tomentosum*							X	X			
Fabaceae	*Hardenbergia comptoniana*	X	X	X		X	X	X	X	X		
Fabaceae	*Templetonia retusa*		X									
Geraniaceae	**Erodium botrys*											

Family	Species name	WN Q2	WN Q4	WN Q6	WN Q8	WN Q10	WN Q12	WN Q14	WN Q16	WN New Q1	WN New Q2	WN New Q3
Geraniaceae	**Geranium molle*											
Geraniaceae	**Pelargonium capitatum*		X	X	X	X	X	X	X	X	X	X
Goodeniaceae	*Scaevola crassifolia*		X		X	X					X	X
Haemodoraceae	*Conostylis candicans*	X	X	X		X	X	X	X	X		
Hemerocallidaceae	*Dianella revoluta*											
Iridaceae	**Moraea flaccida*											
Iridaceae	**Romulea rosea*											X
Lamiaceae	*Hemiandra glabra*		X									
Lamiaceae	*Hemiandra pungens*							X		X		
Lauraceae	*Cassytha flava*		X	X	X			X		X		
Montiaceae	*Calandrinia calyptrata*		X									
Montiaceae	*Calandrinia corrigioloides*						X	X				
Myrtaceae	**Leptospermum laevigatum*											
Myrtaceae	*Agonis flexuosa*											
Myrtaceae	*Eucalyptus gomphocephala*											
Myrtaceae	*Eucalyptus utilis*											
Myrtaceae	*Melaleuca huegelii*											
Myrtaceae	*Melaleuca lanceolata*											
Myrtaceae	*Melaleuca systena*	X	X	X		X		X	X	X		
Onagraceae	**Oenothera drummondii*				X							
Oxalidaceae	**Oxalis corniculata*											
Oxalidaceae	**Oxalis pes-caprae*											

Family	Species name	WN Q2	WN Q4	WN Q6	WN Q8	WN Q10	WN Q12	WN Q14	WN Q16	WN New Q1	WN New Q2	WN New Q3
Papaveraceae	**Fumaria capreolata*											
Phyllanthaceae	*Phyllanthus calycinus*					X		X	X	X		
Poaceae	**Avena fatua*				X							
Poaceae	**Bromus diandrus*	X	X	X	X	X		X	X	X	X	X
Poaceae	**Cenchrus clandestinus*											
Poaceae	**Cynodon dactylon*											
Poaceae	**Ehrharta calycina*											
Poaceae	**Ehrharta longiflora*	X	X	X	X	X	X	X	X	X		
Poaceae	**Lagurus ovatus*			X			X	X	X	X		X
Poaceae	**Lolium perene*	X				X						
Poaceae	*Austrostipa flavescens*		X			X		X		X		
Poaceae	*Poa poiformis*		X	X	X	X	X	X	X	X		
Poaceae	*Spinifex hirsutus*				X							
Poaceae	*Spinifex longifolius*										X	X
Primulaceae	**Lysimachia arvensis*	X		X		X	X	X	X	X		
Ranunculaceae	*Clematis pubescens*		X	X		X	X	X	X	X		
Restionaceae	*Desmocladus asper*							X		X		
Rhamnaceae	*Spyridium globulosum*	X	X	X		X	X	X	X	X	X	X
Rhamnaceae	*Trymalium ledifolium* var. *ledifolium*							X		X		
Rubiaceae	**Galium murale*	X	X	X		X			X	X		
Rubiaceae	*Opercularia vaginata*							X	X			
Santalaceae	*Exocarpos sparteus*	X										

Family	Species name	WN Q2	WN Q4	WN Q6	WN Q8	WN Q10	WN Q12	WN Q14	WN Q16	WN New Q1	WN New Q2	WN New Q3
Santalaceae	*Santalum acuminatum*							X	X	X		
Scrophulariaceae	**Dischisma arenarium*		X				X		X	X		
Scrophulariaceae	*Eremophila glabra*											
Scrophulariaceae	*Myoporum insulare*						X				X	
Stylidiaceae	*Stylidium hesperium*							X	X			
Thymelaeaceae	*Pimelea ferruginea*							X				
Tropaeolaceae	**Tropaeolum* sp.											
Urticaceae	*Parietaria cardiostegia*					X						

Appendix D Quadrat data

Quadrat	Date	Site type	Observer
WN Q2	44467	Quadrat 10 x 10m	JC
Condition	**Disturbances**	**Fire history**	**Vegetation community**
Excellent	Weeds	Old (>20 years)	ArAcTOS
Soil description	**Leaf litter**	**Bare ground**	**Coarse woody debris**
Light grey/white sand	2	5	0.5
Aspect / slope (°)	**Landform**	**Easting**	**Northing**
West, 0.2	Dune Slope	380703	6478986

Species	Cover (%)	Stratum (U=Upper, M=Middle, G=Ground)	Sub-Stratum
Acacia rostellifera	60	M	Shrubs >2m
Spyridium globulosum	5	M	Shrubs 1-2m
Exocarpos sparteus	0.5	M	Shrubs 1-2m
Rhagodia baccata subsp. *baccata*	1.5	M	Shrubs <1m
Melaleuca systena	0.5	M	Shrubs <1m
Leucopogon parviflorus	0.2	M	Shrubs <1m
**Chenopodium murale*	0.1	M	Shrubs <1m
Olearia axillaris	0.1	M	Shrubs <1m
Pithocarpa cordata	0.1	M	Shrubs <1m
Lepidosperma gladiatum	25	G	Sedges
**Cyperus tenellus*	0.02	G	Sedges

Species	Cover (%)	Stratum (U=Upper, M=Middle, G=Ground)	Sub-Stratum
**Ehrharta longiflora*	2	G	Grasses
**Bromus diandrus*	0.1	G	Grasses
**Lolium perene*	0.05	G	Grasses
Acanthocarpus preissii	2	G	Herbs
**Centranthus macrosiphon*	0.5	G	Herbs
**Euphorbia terracina*	0.2	G	Herbs
**Cerastium glomeratum*	0.1	G	Herbs
**Galium murale*	0.1	G	Herbs
**Lysimachia arvensis*	0.1	G	Herbs
**Stellaria media*	0.1	G	Herbs
Conostylis candicans	0.1	G	Herbs
Hardenbergia comptoniana	0.1	G	Herbs
**Sonchus oleraceus*	0.05	G	Herbs

Quadrat	Date	Site type	Observer
WN Q4	44467	Quadrat 10 x 10m	JC
Condition	**Disturbances**	**Fire history**	**Vegetation community**
Excellent	Weeds	Old (>20 years)	ArAcTOS
Soil description	**Leaf litter**	**Bare ground**	**Coarse woody debris**
Light grey/white sand	2	5	1
Aspect / slope (°)	**Landform**	**Easting**	**Northing**
West, 10	Dune Slope	380585	6479142

Species	Cover (%)	Stratum (U=Upper, M=Middle, G=Ground)	Sub-Stratum
Acacia rostellifera	60	M	Shrubs >2m
Templetonia retusa	2.5	M	Shrubs 1-2m
Olearia axillaris	0.5	M	Shrubs 1-2m
Spyridium globulosum	0.5	M	Shrubs 1-2m
Melaleuca systena	8	M	Shrubs <1m
Rhagodia baccata subsp. *baccata*	0.5	M	Shrubs <1m
Scaevola crassifolia	0.5	M	Shrubs <1m
**Chenopodium murale*	0.2	M	Shrubs <1m
Acacia lasiocarpa var. *lasiocarpa*	0.2	M	Shrubs <1m
Acacia truncata	0.2	M	Shrubs <1m
Leucopogon parviflorus	0.2	M	Shrubs <1m

Species	Cover (%)	Stratum (U=Upper, M=Middle, G=Ground)	Sub-Stratum
Hemiandra glabra	0.1	M	Shrubs <1m
Hibbertia subvaginata	0.1	M	Shrubs <1m
Pithocarpa cordata	0.05	M	Shrubs <1m
Lepidosperma gladiatum	5	G	Sedges
**Cyperus tenellus*	0.05	G	Sedges
**Ehrharta longiflora*	0.5	G	Grasses
Poa poiformis	0.2	G	Grasses
**Bromus diandrus*	0.1	G	Grasses
Austrostipa flavescens	0.02	G	Grasses
Acanthocarpus preissii	4	G	Herbs
**Pelargonium capitatum*	2	G	Herbs
**Centranthus macrosiphon*	1	G	Herbs
**Trachyandra divaricata*	0.5	G	Herbs
Threlkeldia diffusa	0.3	G	Herbs
**Euphorbia terracina*	0.2	G	Herbs
Clematis pubescens	0.2	G	Herbs
**Brassica tournefortii*	0.1	G	Herbs
**Galium murale*	0.1	G	Herbs
**Sonchus oleraceus*	0.1	G	Herbs
Calandrinia calyptrata	0.1	G	Herbs
Cassytha flava	0.1	G	Herbs
Conostylis candicans	0.1	G	Herbs
Crassula glomerata	0.1	G	Herbs
Hardenbergia comptoniana	0.1	G	Herbs
**Dischisma arenarium*	0.05	G	Herbs
Senecio pinnatifolius	0.05	G	Herbs
Senecio pinnatifolius	0.05	G	Herbs
Trachymene pilosa	0.05	G	Herbs

Quadrat	Date	Site type	Observer
WN Q6	44467	Quadrat 10 x 10m	JC
Condition	**Disturbances**	**Fire history**	**Vegetation community**
Very Good	Weeds	Old (>20 years)	ArAcTOS
Soil description	**Leaf litter**	**Bare ground**	**Coarse woody debris**
Light grey/white sand	10	5	2
Aspect / slope (°)	**Landform**	**Easting**	**Northing**
West, 2	Dune Slope	379793	6480328

Species	Cover (%)	Stratum (U=Upper, M=Middle, G=Ground)	Sub-Stratum
Melaleuca systena	10	M	Shrubs 1-2m
Acacia cyclops	5	M	Shrubs 1-2m
Spyridium globulosum	5	M	Shrubs 1-2m
Rhagodia baccata subsp. *baccata*	2	M	Shrubs <1m
Acacia lasiocarpa var. *lasiocarpa*	1	M	Shrubs <1m
Acrotriche cordata	1	M	Shrubs <1m
Acacia truncata	0.5	M	Shrubs <1m
Acacia rostellifera	0.2	M	Shrubs <1m
Leucopogon parviflorus	0.1	M	Shrubs <1m
Lepidosperma gladiatum	5	G	Sedges
**Ehrharta longiflora*	0.5	G	Grasses

Species	Cover (%)	Stratum (U=Upper, M=Middle, G=Ground)	Sub-Stratum
**Bromus diandrus*	0.2	G	Grasses
Poa poiformis	0.1	G	Grasses
**Lagurus ovatus*	0.05	G	Grasses
**Pelargonium capitatum*	5	G	Herbs
Acanthocarpus preissii	3	G	Herbs
**Centranthus macrosiphon*	0.8	G	Herbs
Threlkeldia diffusa	0.5	G	Herbs
**Euphorbia terracina*	0.2	G	Herbs
Cassytha flava	0.2	G	Herbs
Hardenbergia comptoniana	0.2	G	Herbs
**Brassica tournefortii*	0.1	G	Herbs
**Galium murale*	0.1	G	Herbs
**Lysimachia arvensis*	0.1	G	Herbs
**Sonchus oleraceus*	0.1	G	Herbs
**Stellaria media*	0.1	G	Herbs
**Trachyandra divaricata*	0.1	G	Herbs
Clematis pubescens	0.1	G	Herbs
Conostylis candicans	0.1	G	Herbs
Crassula glomerata	0.1	G	Herbs

Quadrat	Date	Site type	Observer
WN Q8	44467	Quadrat 10 x 10m	JC
Condition	**Disturbances**	**Fire history**	**Vegetation community**
Good	Weeds	Old (>20 years)	OaApRbLOS
Soil description	**Leaf litter**	**Bare ground**	**Coarse woody debris**
Light grey/white sand	45	0.5	0.5
Aspect / slope (°)	**Landform**	**Easting**	**Northing**
N/A	N/A	379829	6480845

Species	Cover (%)	Stratum (U=Upper, M=Middle, G=Ground)	Sub-Stratum
Olearia axillaris	10	M	Shrubs <1m
Rhagodia baccata subsp. *baccata*	2.5	M	Shrubs <1m
**Tetragonia decumbens*	2	M	Shrubs <1m
Scaevola crassifolia	2	M	Shrubs <1m
Ficinia nodosa	0.1	G	Sedges
**Cyperus tenellus*	0.05	G	Sedges
Spinifex hirsutus	2.5	G	Grasses
**Ehrharta longiflora*	0.2	G	Grasses
**Avena fatua*	0.1	G	Grasses
**Bromus diandrus*	0.1	G	Grasses
Poa poiformis	0.1	G	Grasses

Species	Cover (%)	Stratum (U=Upper, M=Middle, G=Ground)	Sub-Stratum
Acanthocarpus preissii	5	G	Herbs
**Trachyandra divaricata*	1.5	G	Herbs
**Pelargonium capitatum*	1	G	Herbs
**Euphorbia terracina*	0.2	G	Herbs
**Oenothera drummondii*	0.2	G	Herbs
Carpobrotus virescens	0.2	G	Herbs
Crassula glomerata	0.2	G	Herbs
**Sonchus oleraceus*	0.1	G	Herbs
Cassytha flava	0.1	G	Herbs
**Euphorbia paralias*	0.05	G	Herbs

Quadrat	Date	Site type	Observer
WN Q10	44467	Quadrat 10 x 10m	JC
Condition	**Disturbances**	**Fire history**	**Vegetation community**
Good	Weeds	Old (>20 years)	ArAcTOS
Soil description	**Leaf litter**	**Bare ground**	**Coarse woody debris**
Light grey/white sand	5	2	0.5
Aspect / slope (°)	**Landform**	**Easting**	**Northing**
West, 0.5	Dune Slope	380245	6479491

Species	Cover (%)	Stratum (U=Upper, M=Middle, G=Ground)	Sub-Stratum
Spyridium globulosum	20	M	Shrubs 1-2m
Acacia rostellifera	5	M	Shrubs 1-2m
Olearia axillaris	0.5	M	Shrubs 1-2m
Scaevola crassifolia	12	M	Shrubs <1m
Rhagodia baccata subsp. *baccata*	1	M	Shrubs <1m
Leucopogon parviflorus	0.2	M	Shrubs <1m
**Chenopodium murale*	0.1	M	Shrubs <1m
**Tetragonia decumbens*	0.1	M	Shrubs <1m
Acacia lasiocarpa var. *lasiocarpa*	0.1	M	Shrubs <1m
Melaleuca systena	0.1	M	Shrubs <1m
Phyllanthus calycinus	0.1	M	Shrubs <1m

Species	Cover (%)	Stratum (U=Upper, M=Middle, G=Ground)	Sub-Stratum
Pithocarpa cordata	0.1	M	Shrubs <1m
**Cyperus tenellus*	0.1	G	Sedges
**Ehrharta longiflora*	5	G	Grasses
**Bromus diandrus*	2.5	G	Grasses
**Lolium perene*	0.2	G	Grasses
Austrostipa flavescens	0.1	G	Grasses
Poa poiformis	0.05	G	Grasses
Acanthocarpus preissii	6	G	Herbs
**Centranthus macrosiphon*	2	G	Herbs
**Pelargonium capitatum*	1	G	Herbs
**Euphorbia terracina*	0.5	G	Herbs
Clematis pubescens	0.5	G	Herbs
**Brassica tournefortii*	0.2	G	Herbs
**Lysimachia arvensis*	0.2	G	Herbs
Hardenbergia comptoniana	0.2	G	Herbs
Threlkeldia diffusa	0.2	G	Herbs
**Cuscuta epithymum*	0.1	G	Herbs
**Sonchus oleraceus*	0.1	G	Herbs
Conostylis candicans	0.1	G	Herbs
Crassula glomerata	0.1	G	Herbs
Daucus glochidiatus	0.1	G	Herbs
Parietaria cardiostegia	0.1	G	Herbs
Trachymene pilosa	0.1	G	Herbs
**Galium murale*	0.05	G	Herbs

Quadrat	Date	Site type	Observer
WN Q12	44467	Quadrat 10 x 10m	JC
Condition	**Disturbances**	**Fire history**	**Vegetation community**
Very Good	Weeds	Old (>20 years)	ArAcTOS
Soil description	**Leaf litter**	**Bare ground**	**Coarse woody debris**
Light grey/white sand	20	50	0.5
Aspect / slope (°)	**Landform**	**Easting**	**Northing**
West, 0.5	Dune Slope	380103	6479538

Species	Cover (%)	Stratum (U=Upper, M=Middle, G=Ground)	Sub-Stratum
Spyridium globulosum	8	M	Shrubs 1-2m
Olearia axillaris	0.5	M	Shrubs 1-2m
Pithocarpa cordata	0.2	M	Shrubs 1-2m
Myoporum insulare	5	M	Shrubs <1m
Acacia truncata	2.5	M	Shrubs <1m
Rhagodia baccata subsp. *baccata*	0.5	M	Shrubs <1m
Leucopogon parviflorus	0.2	M	Shrubs <1m
Lepidosperma gladiatum	5	G	Sedges
**Cyperus tenellus*	0.01	G	Sedges
**Ehrharta longiflora*	0.2	G	Grasses
**Lagurus ovatus*	0.1	G	Grasses

Poa poiformis	0.05	G	Grasses
Acanthocarpus preissii	10	G	Herbs
**Pelargonium capitatum*	1	G	Herbs
**Brassica tournefortii*	0.2	G	Herbs
**Lysimachia arvensis*	0.2	G	Herbs
**Trachyandra divaricata*	0.2	G	Herbs
Hardenbergia comptoniana	0.2	G	Herbs
Threlkeldia diffusa	0.2	G	Herbs
**Cuscuta epithymum*	0.1	G	Herbs
**Euphorbia terracina*	0.1	G	Herbs
**Sonchus oleraceus*	0.1	G	Herbs
Calandrinia corrigioloides	0.1	G	Herbs
Clematis pubescens	0.1	G	Herbs
Conostylis candicans	0.1	G	Herbs
Crassula glomerata	0.1	G	Herbs
Trachymene pilosa	0.1	G	Herbs
Senecio pinnatifolius	0.05	G	Herbs
**Dischisma arenarium*	0.01	G	Herbs

Quadrat	Date	Site type	Observer
WN Q14	44467	Quadrat 10 x 10m	JC
Condition	**Disturbances**	**Fire history**	**Vegetation community**
Excellent	Weeds	Old (>20 years)	SgOaS
Soil description	**Leaf litter**	**Bare ground**	**Coarse woody debris**
Light grey/white sand	30	2	0.1
Aspect / slope (º)	**Landform**	**Easting**	**Northing**
West, 4	Dune Slope	380213	6481893

Species	Cover (%)	Stratum (U=Upper, M=Middle, G=Ground)	Sub-Stratum
Spyridium globulosum	5	M	Shrubs 1-2m
Acacia lasiocarpa var. *lasiocarpa*	3	M	Shrubs <1m
Olearia axillaris	2	M	Shrubs <1m
Hibbertia subvaginata	1.5	M	Shrubs <1m
Melaleuca systena	1	M	Shrubs <1m
Santalum acuminatum	1	M	Shrubs <1m
Acacia cochlearis	0.5	M	Shrubs <1m
Acacia cyclops	0.5	M	Shrubs <1m
Gastrolobium capitatum	0.5	M	Shrubs <1m
Hemiandra pungens	0.5	M	Shrubs <1m
Rhagodia baccata subsp. *baccata*	0.5	M	Shrubs <1m

Species	Cover (%)	Stratum (U=Upper, M=Middle, G=Ground)	Sub-Stratum
Gompholobium tomentosum	0.2	M	Shrubs <1m
Leucopogon parviflorus	0.2	M	Shrubs <1m
Desmocladus asper	0.1	M	Shrubs <1m
Pimelea ferruginea	0.1	M	Shrubs <1m
Trymalium ledifolium var. *ledifolium*	0.1	M	Shrubs <1m
Phyllanthus calycinus	0.05	M	Shrubs <1m
Lepidosperma squamatum	0.1	G	Sedges
**Cyperus tenellus*	0.05	G	Sedges
**Ehrharta longiflora*	0.2	G	Grasses
**Lagurus ovatus*	0.2	G	Grasses
**Bromus diandrus*	0.1	G	Grasses
Austrostipa flavescens	0.05	G	Grasses
Poa poiformis	0.05	G	Grasses
Lomandra maritima	8	G	Herbs
Acanthocarpus preissii	5	G	Herbs
**Pelargonium capitatum*	0.5	G	Herbs
**Brassica tournefortii*	0.2	G	Herbs
**Lysimachia arvensis*	0.2	G	Herbs
**Sonchus oleraceus*	0.2	G	Herbs
Conostylis candicans	0.2	G	Herbs
**Trachyandra divaricata*	0.1	G	Herbs
Clematis pubescens	0.1	G	Herbs
Crassula glomerata	0.1	G	Herbs
Daucus glochidiatus	0.1	G	Herbs
Hardenbergia comptoniana	0.1	G	Herbs
Opercularia vaginata	0.1	G	Herbs
Trachymene pilosa	0.1	G	Herbs
Calandrinia corrigioloides	0.05	G	Herbs
Cassytha flava	0.05	G	Herbs
Stylidium hesperium	0.02	G	Herbs

Species	Cover (%)	Stratum (U=Upper, M=Middle, G=Ground)	Sub-Stratum
**Heliophila pusilla*	0.01	G	Herbs
Stackhousia monogyna	0.01	G	Herbs

Quadrat	Date	Site type	Observer
WN Q16	44467	Quadrat 10 x 10m	JC
Condition	**Disturbances**	**Fire history**	**Vegetation community**
Excellent	Weeds	Old (>20 years)	SgOaS
Soil description	**Leaf litter**	**Bare ground**	**Coarse woody debris**
Light grey/white sand	1	15	0.5
Aspect / slope (°)	**Landform**	**Easting**	**Northing**
West, 2	Dune Slope	380200	6482166

Species	Cover (%)	Stratum (U=Upper, M=Middle, G=Ground)	Sub-Stratum
Spyridium globulosum	30	M	Shrubs 1-2m
Acacia cyclops	2.5	M	Shrubs 1-2m
Olearia axillaris	2	M	Shrubs 1-2m
Santalum acuminatum	0.5	M	Shrubs 1-2m
Melaleuca systena	5	M	Shrubs <1m
Acrotriche cordata	2.5	M	Shrubs <1m
Rhagodia baccata subsp. *baccata*	1	M	Shrubs <1m
Acacia lasiocarpa var. *lasiocarpa*	0.5	M	Shrubs <1m
Leucopogon parviflorus	0.5	M	Shrubs <1m
Hibbertia subvaginata	0.3	M	Shrubs <1m
Gastrolobium capitatum	0.2	M	Shrubs <1m

Species	Cover (%)	Stratum (U=Upper, M=Middle, G=Ground)	Sub-Stratum
Gompholobium tomentosum	0.05	M	Shrubs <1m
Phyllanthus calycinus	0.05	M	Shrubs <1m
Lepidosperma squamatum	0.1	G	Sedges
**Cyperus tenellus*	0.05	G	Sedges
**Ehrharta longiflora*	0.5	G	Grasses
**Lagurus ovatus*	0.2	G	Grasses
**Bromus diandrus*	0.05	G	Grasses
Poa poiformis	0.05	G	Grasses
Lomandra maritima	10	G	Herbs
**Lysimachia arvensis*	0.5	G	Herbs
**Pelargonium capitatum*	0.5	G	Herbs
**Sonchus oleraceus*	0.5	G	Herbs
**Centranthus macrosiphon*	0.2	G	Herbs
**Euphorbia peplus*	0.2	G	Herbs
**Euphorbia terracina*	0.1	G	Herbs
**Galium murale*	0.1	G	Herbs
Acanthocarpus preissii	0.1	G	Herbs
Clematis pubescens	0.1	G	Herbs
Conostylis candicans	0.1	G	Herbs
Crassula glomerata	0.1	G	Herbs
Daucus glochidiatus	0.1	G	Herbs
Hardenbergia comptoniana	0.1	G	Herbs
Stackhousia monogyna	0.1	G	Herbs
**Brassica tournefortii*	0.05	G	Herbs
Opercularia vaginata	0.05	G	Herbs
Stylidium hesperium	0.05	G	Herbs
Trachymene pilosa	0.05	G	Herbs
Thysanotus patersonii	0.02	G	Herbs
**Dischisma arenarium*	0.01	G	Herbs
**Heliophila pusilla*	0.01	G	Herbs

Quadrat	Date	Site type	Observer
WN New Q1	44468	Quadrat 10 x 10m	JC
Condition	**Disturbances**	**Fire history**	**Vegetation community**
Excellent	Weeds	Old (>20 years)	SgOaS
Soil description	**Leaf litter**	**Bare ground**	**Coarse woody debris**
Light grey/white sand	20	1	1.5
Aspect / slope (°)	**Landform**	**Easting**	**Northing**
Southwest, 2	Dune Slope	380231	6482082

Species	Cover (%)	Stratum (U=Upper, M=Middle, G=Ground)	Sub-Stratum
Spyridium globulosum	15	M	Shrubs 1-2m
Olearia axillaris	5	M	Shrubs 1-2m
Acacia lasiocarpa var. *lasiocarpa*	2	M	Shrubs <1m
Hibbertia subvaginata	1.5	M	Shrubs <1m
Melaleuca systena	1.5	M	Shrubs <1m
Leucopogon parviflorus	1	M	Shrubs <1m
Acrotriche cordata	0.5	M	Shrubs <1m
Santalum acuminatum	0.5	M	Shrubs <1m
Phyllanthus calycinus	0.3	M	Shrubs <1m
Acacia cyclops	0.2	M	Shrubs <1m
Hemiandra pungens	0.2	M	Shrubs <1m

Species	Cover (%)	Stratum (U=Upper, M=Middle, G=Ground)	Sub-Stratum
Rhagodia baccata subsp. *baccata*	0.2	M	Shrubs <1m
Trymalium ledifolium var. *ledifolium*	0.2	M	Shrubs <1m
Desmocladus asper	0.1	M	Shrubs <1m
**Cyperus tenellus*	0.05	G	Sedges
**Lagurus ovatus*	0.2	G	Grasses
**Bromus diandrus*	0.1	G	Grasses
**Ehrharta longiflora*	0.1	G	Grasses
Austrostipa flavescens	0.1	G	Grasses
Poa poiformis	0.1	G	Grasses
Lomandra maritima	20	G	Herbs
Acanthocarpus preissii	2.5	G	Herbs
**Pelargonium capitatum*	0.5	G	Herbs
Hardenbergia comptoniana	0.2	G	Herbs
**Brassica tournefortii*	0.1	G	Herbs
**Euphorbia terracina*	0.1	G	Herbs
**Lysimachia arvensis*	0.1	G	Herbs
**Sonchus oleraceus*	0.1	G	Herbs
**Trachyandra divaricata*	0.1	G	Herbs
Cassytha flava	0.1	G	Herbs
Clematis pubescens	0.1	G	Herbs
Conostylis candicans	0.1	G	Herbs
Crassula glomerata	0.1	G	Herbs
Cuscuta epithymum	0.1	G	Herbs
Daucus glochidiatus	0.1	G	Herbs
**Dischisma arenarium*	0.05	G	Herbs
**Galium murale*	0.05	G	Herbs
**Heliophila pusilla*	0.05	G	Herbs
Trachymene pilosa	0.05	G	Herbs
Stackhousia monogyna	0.02	G	Herbs

Quadrat	Date	Site type	Observer
WN New Q2	44468	Quadrat 10 x 10m	JC
Condition	**Disturbances**	**Fire history**	**Vegetation community**
Good	Weeds	Old (>20 years)	OaApRbLOS
Soil description	**Leaf litter**	**Bare ground**	**Coarse woody debris**
Light grey/white sand	40	0.5	0.5
Aspect / slope (°)	**Landform**	**Easting**	**Northing**
West, 1	Dune Slope	380040	6481822

Species	Cover (%)	Stratum (U=Upper, M=Middle, G=Ground)	Sub-Stratum
Olearia axillaris	2	M	Shrubs 1-2m
**Tetragonia decumbens*	5	M	Shrubs <1m
Scaevola crassifolia	5	M	Shrubs <1m
Rhagodia baccata subsp. *baccata*	2.5	M	Shrubs <1m
Myoporum insulare	0.5	M	Shrubs <1m
Spyridium globulosum	0.5	M	Shrubs <1m
Lepidosperma gladiatum	0.5	G	Sedges
Ficinia nodosa	0.3	G	Sedges
Spinifex longifolius	30	G	Grasses
**Bromus diandrus*	2	G	Grasses
**Trachyandra divaricata*	4.5	G	Herbs

Species	Cover (%)	Stratum (U=Upper, M=Middle, G=Ground)	Sub-Stratum
**Pelargonium capitatum*	1.5	G	Herbs
Acanthocarpus preissii	0.5	G	Herbs
**Euphorbia paralias*	0.4	G	Herbs
**Euphorbia terracina*	0.2	G	Herbs
Threlkeldia diffusa	0.2	G	Herbs
**Sonchus oleraceus*	0.1	G	Herbs
Carpobrotus virescens	0.1	G	Herbs
Crassula glomerata	0.1	G	Herbs
Cuscuta epithymum	0.1	G	Herbs
Senecio pinnatifolius	0.05	G	Herbs

Quadrat	Date	Site type	Observer
WN New Q3	44468	Quadrat 10 x 10m	JC
Condition	**Disturbances**	**Fire history**	**Vegetation community**
Good	Weeds	Old (>20 years)	OaApRbLOS
Soil description	**Leaf litter**	**Bare ground**	**Coarse woody debris**
Light grey/white sand	40	0.5	0.5
Aspect / slope (°)	**Landform**	**Easting**	**Northing**
West, 0.5	Dune Slope	379949	6481302

Species	Cover (%)	Stratum (U=Upper, M=Middle, G=Ground)	Sub-Stratum
Olearia axillaris	8	M	Shrubs 1-2m
Scaevola crassifolia	15	M	Shrubs <1m
Rhagodia baccata subsp. *baccata*	4	M	Shrubs <1m
**Tetragonia decumbens*	3	M	Shrubs <1m
Spyridium globulosum	0.5	M	Shrubs <1m
Ficinia nodosa	0.3	G	Sedges
Lepidosperma gladiatum	0.2	G	Sedges
**Cyperus tenellus*	0.02	G	Sedges
Spinifex longifolius	10	G	Grasses
**Bromus diandrus*	5	G	Grasses
**Lagurus ovatus*	0.1	G	Grasses

Species	Cover (%)	Stratum (U=Upper, M=Middle, G=Ground)	Sub-Stratum
**Pelargonium capitatum*	5	G	Herbs
**Trachyandra divaricata*	2.5	G	Herbs
Acanthocarpus preissii	2	G	Herbs
Carpobrotus virescens	0.2	G	Herbs
**Euphorbia paralias*	0.1	G	Herbs
Crassula glomerata	0.1	G	Herbs
Cuscuta epithymum	0.1	G	Herbs
Threlkeldia diffusa	0.1	G	Herbs
**Cakile maritima*	0.05	G	Herbs
**Sonchus oleraceus*	0.05	G	Herbs
**Romulea rosea*	0.02	G	Herbs

Appendix E Weed mapping

***Agave americana* (Agave)**

Hillarys Coastal Foreshore Reserve

Kallaroo Coastal Foreshore Reserve

Weed location

0 50 100 200

Metres

Datum/Projection:
GDA 1994 MGA Zone 50

Project: 19876-SM Date: 10/12/2021

N

eco logical AUSTRALIA
A TETRA TECH COMPANY

***Arctotis* sp. (Arctotis)**

Hillarys Coastal Foreshore Reserve

Kallaroo Coastal Foreshore Reserve

Weed location

Weed Coverage (%)

6-75%

0 50 100 200

Metres

Datum/Projection:
GDA 1994 MGA Zone 50

Project: 19876-SM Date: 10/12/2021

N

eco logical AUSTRALIA
A TETRA TECH COMPANY

***Arctotis* sp. (Arctotis)**

Hillarys Coastal Foreshore Reserve

Kallaroo Coastal Foreshore Reserve

Weed Coverage (%)

<5%

76-100%

0 100 200 400

Metres

Datum/Projection:
GDA 1994 MGA Zone 50

Project: 19876-SM Date: 10/12/2021

N

eco logical AUSTRALIA
A TETRA TECH COMPANY

***Asparagus asparagoides* (Bridal Creeper)**

Hillarys Coastal Foreshore Reserve

Kallaroo Coastal Foreshore Reserve

Weed Coverage (%)

<5%

0 50 100 200

Metres

Datum/Projection:
GDA 1994 MGA Zone 50

Project: 19876-SM Date: 10/12/2021

N

eco logical AUSTRALIA
A TETRA TECH COMPANY

***Asparagus asparagoides* (Bridal Creeper)**

Hillarys Coastal Foreshore Reserve

Kallaroo Coastal Foreshore Reserve

Weed location

Weed Coverage (%)

<5%

0 100 200 400

Metres

Datum/Projection:
GDA 1994 MGA Zone 50

Project: 19876-SM Date: 10/12/2021

N

eco logical AUSTRALIA
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***Avena fatua* (Wild Oats)**

Hillarys Coastal Foreshore Reserve

Kallaroo Coastal Foreshore Reserve

Weed location

Weed Coverage (%)

<5%

6-75%

0 50 100 200

Metres

Datum/Projection:
GDA 1994 MGA Zone 50

Project: 19876-SM Date: 10/12/2021

N

eco logical AUSTRALIA
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***Avena fatua* (Wild Oats)**

Hillarys Coastal Foreshore Reserve

Kallaroo Coastal Foreshore Reserve

Weed location

Weed Coverage (%)

<5%

6-75%

0 100 200 400

Metres

Datum/Projection:
GDA 1994 MGA Zone 50

Project: 19876-SM Date: 10/12/2021

N

eco logical AUSTRALIA
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***Cakile maritima* (Sea Rocket)**

Hillarys Coastal Foreshore Reserve

Kallaroo Coastal Foreshore Reserve

Weed location

0 50 100 200

Metres

Datum/Projection:
GDA 1994 MGA Zone 50

Project: 19876-SM Date: 10/12/2021

N

eco logical AUSTRALIA
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***Cakile maritima* (Sea Rocket)**

Hillarys Coastal Foreshore Reserve

Kallaroo Coastal Foreshore Reserve

Weed location

Weed Coverage (%)

<5%

6-75%

0 100 200 400

Metres

Datum/Projection:
GDA 1994 MGA Zone 50

Project: 19876-SM Date: 10/12/2021

N

eco logical AUSTRALIA
A TETRA TECH COMPANY

***Carpobrotus edulis* (Pigface)**

Hillarys Coastal Foreshore Reserve

Kallaroo Coastal Foreshore Reserve

Weed location

Weed Coverage (%)

<5%

0 50 100 200

Metres

Datum/Projection:
GDA 1994 MGA Zone 50

Project: 19876-SM Date: 10/12/2021

N

eco logical AUSTRALIA
A TETRA TECH COMPANY

***Carpobrotus edulis* (Pigface)**

Hillarys Coastal Foreshore Reserve

Kallaroo Coastal Foreshore Reserve

Weed location

Weed Coverage (%)

<5%

6-75%

0 100 200 400

Metres

Datum/Projection:
GDA 1994 MGA Zone 50

Project: 19876-SM Date: 10/12/2021

N

eco logical AUSTRALIA
A TETRA TECH COMPANY

***Cenchrus clandestinus* (Kikuyu Grass)**

Hillarys Coastal Foreshore Reserve

Kallaroo Coastal Foreshore Reserve

Weed location

0 50 100 200

Metres

Datum/Projection:
GDA 1994 MGA Zone 50

Project: 19876-SM Date: 10/12/2021

N

eco logical AUSTRALIA
A TETRA TECH COMPANY

***Cenchrus clandestinus* (Kikuyu Grass)**

Hillarys Coastal Foreshore Reserve

Kallaroo Coastal Foreshore Reserve

Weed location

Weed Coverage (%)

6-75%

0 100 200 400

Metres

Datum/Projection:
GDA 1994 MGA Zone 50

Project: 19876-SM Date: 10/12/2021

N

eco logical AUSTRALIA
A TETRA TECH COMPANY

***Cynodon dactylon* (Couch Grass)**

Hillarys Coastal Foreshore Reserve

Kallaroo Coastal Foreshore Reserve

Weed Coverage (%)

<5%

0 100 200 400

Metres

Datum/Projection:
GDA 1994 MGA Zone 50

Project: 19876-SM Date: 10/12/2021

N

eco logical AUSTRALIA
A TETRA TECH COMPANY

***Dimorphotheca ecklonis* (Veldt Daisy)**

Hillarys Coastal Foreshore Reserve

Kallaroo Coastal Foreshore Reserve

Weed location

Weed Coverage (%)

<5%

0 100 200 400

Metres

Datum/Projection:
GDA 1994 MGA Zone 50

Project: 19876-SM Date: 10/12/2021

N

eco logical AUSTRALIA
A TETRA TECH COMPANY

***Ehrharta calycina* (Perennial Veldt)**

Hillarys Coastal Foreshore Reserve

Kallaroo Coastal Foreshore Reserve

Weed location

Weed Coverage (%)

<5%

0 50 100 200

Metres

Datum/Projection:
GDA 1994 MGA Zone 50

Project: 19876-SM Date: 10/12/2021

N

eco logical AUSTRALIA
A TETRA TECH COMPANY

***Ehrharta calycina* (Perennial Veldt)**

Hillarys Coastal Foreshore Reserve

Kallaroo Coastal Foreshore Reserve

Weed location

Weed Coverage (%)

<5%

0 100 200 400

Metres

Datum/Projection:
GDA 1994 MGA Zone 50

Project: 19876-SM Date: 10/12/2021

N

eco logical AUSTRALIA
A TETRA TECH COMPANY

***Ehrharta longiflora* (Annual Veldt)**

Hillarys Coastal Foreshore Reserve

Kallaroo Coastal Foreshore Reserve

Weed location

Weed Coverage (%)

<5%

6-75%

0 50 100 200

Metres

Datum/Projection:
GDA 1994 MGA Zone 50

Project: 19876-SM Date: 10/12/2021

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***Ehrharta longiflora* (Annual Veldt)**

Hillarys Coastal Foreshore Reserve

Kallaroo Coastal Foreshore Reserve

Weed location

Weed Coverage (%)

<5%

6-75%

0 100 200 400

Metres

Datum/Projection:
GDA 1994 MGA Zone 50

Project: 19876-SM Date: 10/12/2021

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***Euphorbia paralias* (Sea Spurge)**

Hillarys Coastal Foreshore Reserve

Kallaroo Coastal Foreshore Reserve

Weed Coverage (%)

<5%

0 50 100 200

Metres

Datum/Projection:
GDA 1994 MGA Zone 50

Project: 19876-SM Date: 10/12/2021

N

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***Euphorbia paralias* (Sea Spurge)**

Hillarys Coastal Foreshore Reserve

Kallaroo Coastal Foreshore Reserve

Weed Coverage (%)

<5%

0 100 200 400

Metres

Datum/Projection:
GDA 1994 MGA Zone 50

Project: 19876-SM Date: 10/12/2021

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***Euphorbia terracina* (Geraldton Carnation Weed)**

Hillarys Coastal Foreshore Reserve

Kallaroo Coastal Foreshore Reserve

Weed location

Weed Coverage (%)

<5%

6-75%

0 50 100 200

Metres

Datum/Projection:
GDA 1994 MGA Zone 50

Project: 19876-SM Date: 10/12/2021

N

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***Euphorbia terracina* (Geraldton Carnation Weed)**

Hillarys Coastal Foreshore Reserve

Kallaroo Coastal Foreshore Reserve

Weed location

Weed Coverage (%)

<5%

6-75%

0 100 200 400

Metres

Datum/Projection:
GDA 1994 MGA Zone 50

Project: 19876-SM Date: 10/12/2021

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***Fumaria* sp.(Fumitory)**

Hillarys Coastal Foreshore Reserve

Kallaroo Coastal Foreshore Reserve

Weed location

Weed Coverage (%)

<5%

6-75%

0 50 100 200

Metres

Datum/Projection:
GDA 1994 MGA Zone 50

Project: 19876-SM Date: 10/12/2021

N

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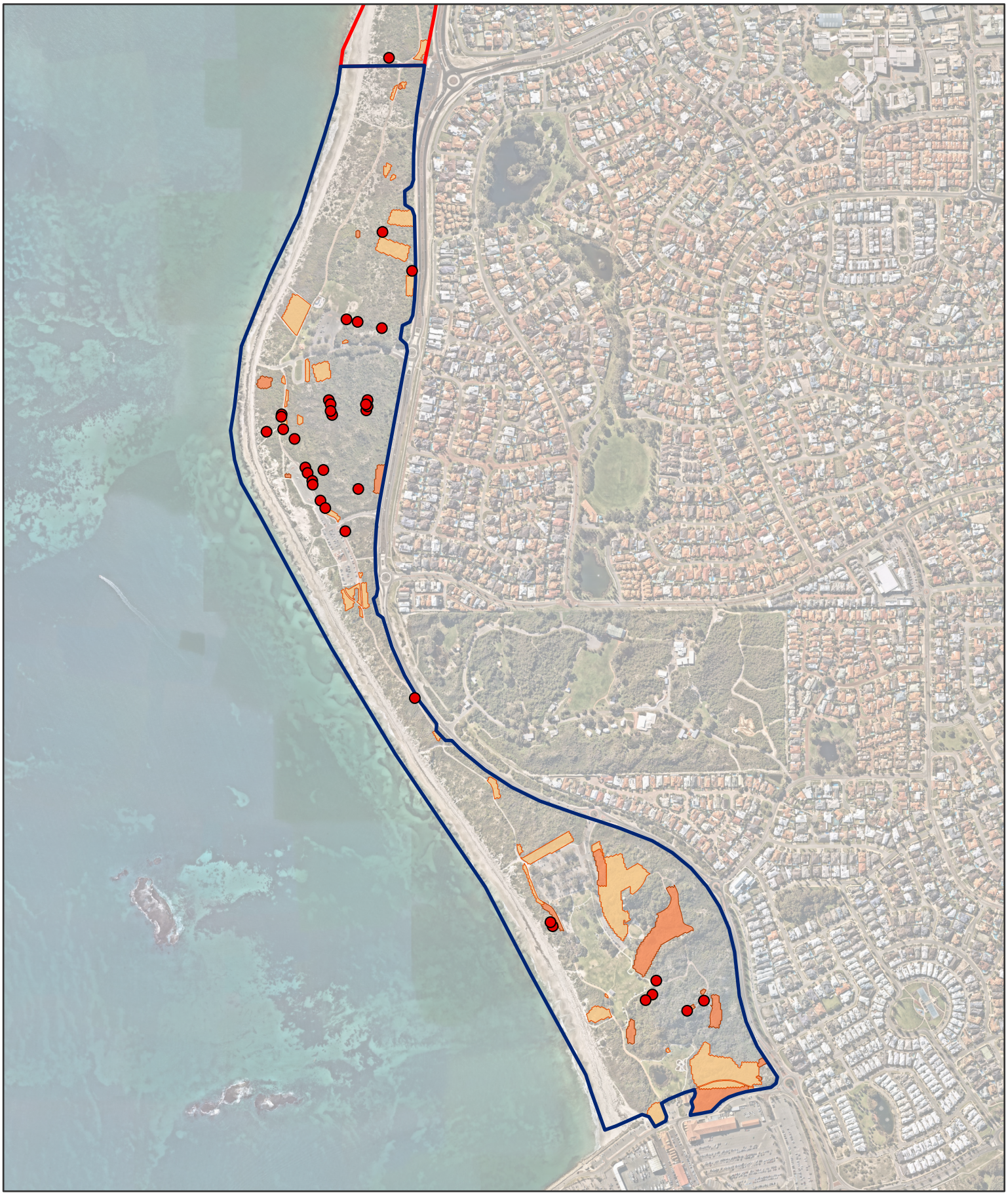

***Fumaria* sp. (Fumitory)**

Hillarys Coastal Foreshore Reserve

Kallaroo Coastal Foreshore Reserve

Weed location

Weed Coverage (%)

<5%

6-75%

0 100 200 400

Metres

Datum/Projection:
GDA 1994 MGA Zone 50

Project: 19876-SM Date: 10/12/2021

N

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***Gazania linearis* (Gazania)**

Hillarys Coastal Foreshore Reserve

Kallaroo Coastal Foreshore Reserve

Weed location

Weed Coverage (%)

<5%

0 50 100 200

Metres

Datum/Projection:
GDA 1994 MGA Zone 50

Project: 19876-SM Date: 10/12/2021

N

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***Gazania linearis* (Gazania)**

Hillarys Coastal Foreshore Reserve

Kallaroo Coastal Foreshore Reserve

Weed location

Weed Coverage (%)

<5%

0 100 200 400

Metres

Datum/Projection:
GDA 1994 MGA Zone 50

Project: 19876-SM Date: 10/12/2021

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***Moraea flaccida* (One-leaf Cape Tulip)**

Hillarys Coastal Foreshore Reserve

Kallaroo Coastal Foreshore Reserve

Weed location

Weed Coverage (%)

<5%

0 50 100 200

Metres

Datum/Projection:
GDA 1994 MGA Zone 50

Project: 19876-SM Date: 10/12/2021

N

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***Oxalis pes-caprae* (Soursob)**

Hillarys Coastal Foreshore Reserve

Kallaroo Coastal Foreshore Reserve

Weed location

Weed Coverage (%)

<5%

6-75%

0 50 100 200

Metres

Datum/Projection:
GDA 1994 MGA Zone 50

Project: 19876-SM Date: 10/12/2021

N

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***Oxalis pes-caprae* (Soursob)**

Hillarys Coastal Foreshore Reserve

Kallaroo Coastal Foreshore Reserve

Weed location

Weed Coverage (%)

<5%

6-75%

0 100 200 400

Metres

Datum/Projection:
GDA 1994 MGA Zone 50

Project: 19876-SM Date: 10/12/2021

N

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***Pelargonium capitatum* (Rose Pelargonium)**

Hillarys Coastal Foreshore Reserve

Kallaroo Coastal Foreshore Reserve

Weed location

Weed Coverage (%)

<5%

6-75%

0 50 100 200

Metres

Datum/Projection:
GDA 1994 MGA Zone 50

Project: 19876-SM Date: 10/12/2021

N

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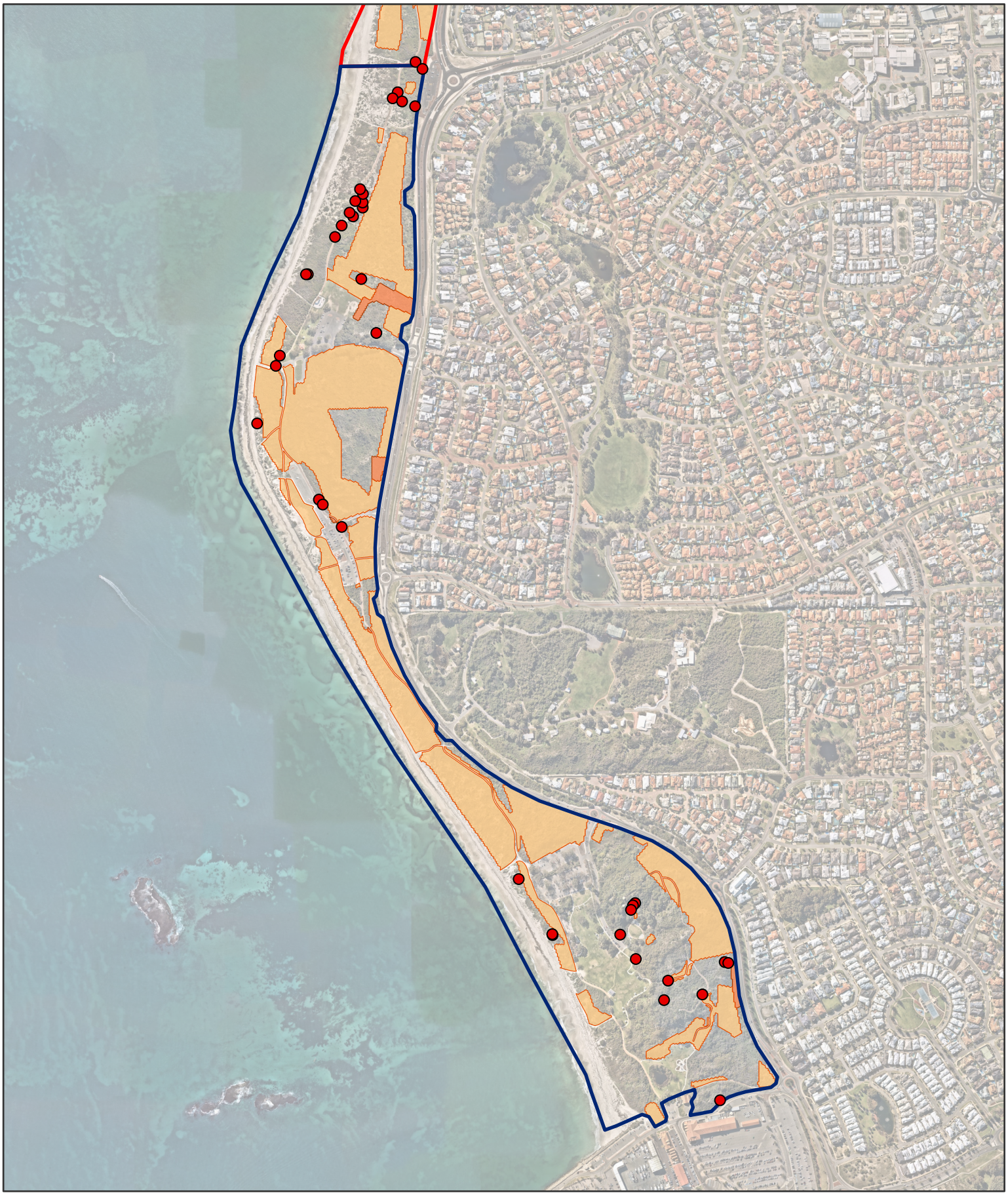

***Pelargonium capitatum* (Rose Pelargonium)**

Hillarys Coastal Foreshore Reserve

Kallaroo Coastal Foreshore Reserve

Weed location

Weed Coverage (%)

<5%

6-75%

0 100 200 400

Metres

Datum/Projection:
GDA 1994 MGA Zone 50

Project: 19876-SM Date: 10/12/2021

N

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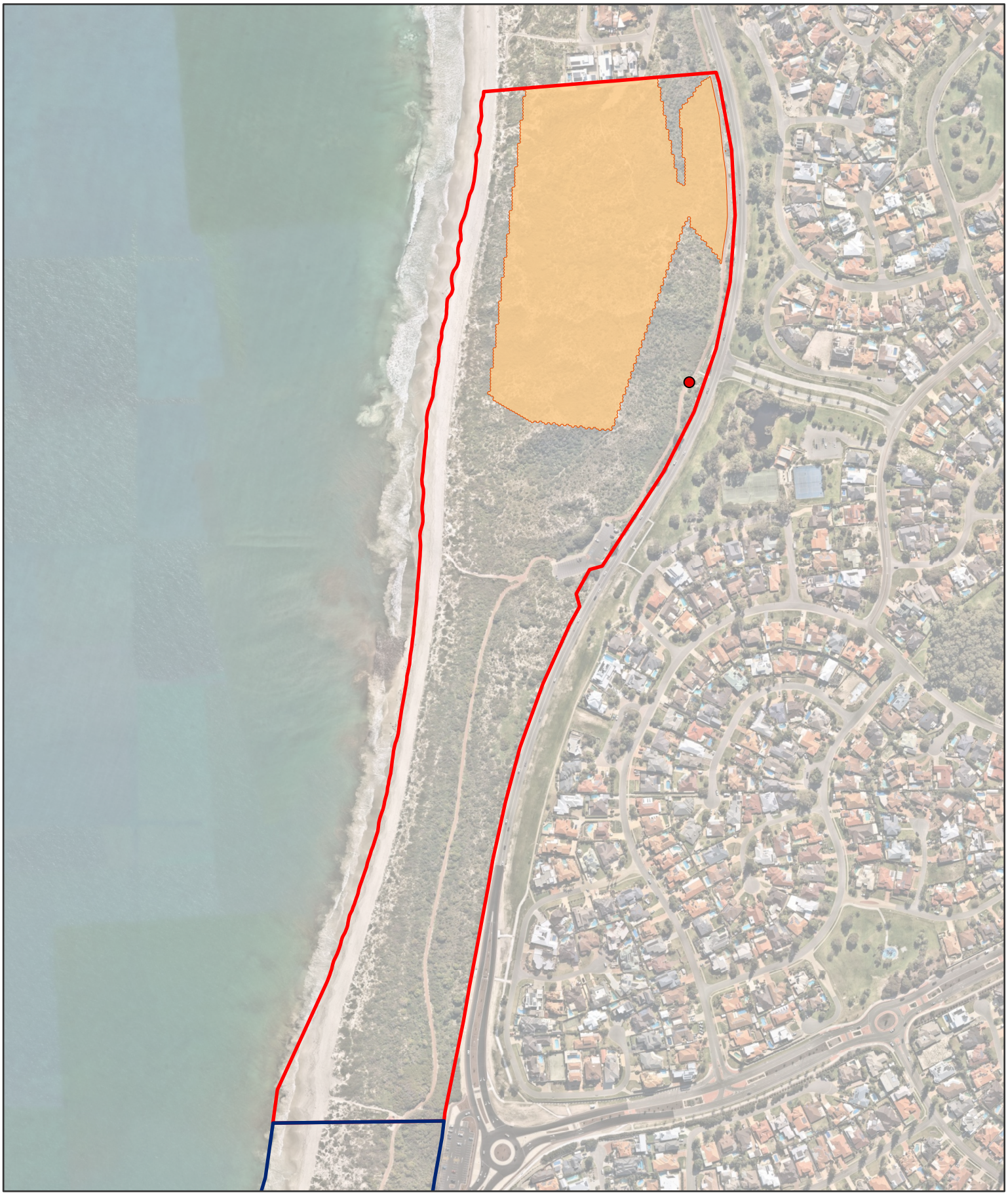

***Raphanus* sp. (Wild Radish)**

Hillarys Coastal Foreshore Reserve

Kallaroo Coastal Foreshore Reserve

Weed location

Weed Coverage (%)

<5%

0 50 100 200

Metres

Datum/Projection:
GDA 1994 MGA Zone 50

Project: 19876-SM Date: 10/12/2021

N

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***Schinus terebinthifolia* (Japanese Pepper)**

Hillarys Coastal Foreshore Reserve

Kallaroo Coastal Foreshore Reserve

Weed location

0 100 200 400

Metres

Datum/Projection:
GDA 1994 MGA Zone 50

Project: 19876-SM Date: 10/12/2021

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***Tetragonia decumbens* (Sea Spinach)**

Hillarys Coastal Foreshore Reserve

Kallaroo Coastal Foreshore Reserve

Weed location

Weed Coverage (%)

<5%

6-75%

0 50 100 200

Metres

Datum/Projection:
GDA 1994 MGA Zone 50

Project: 19876-SM Date: 10/12/2021

N

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***Tetragonia decumbens* (Sea Spinach)**

Hillarys Coastal Foreshore Reserve

Kallaroo Coastal Foreshore Reserve

Weed location

Weed Coverage (%)

<5%

6-75%

0 100 200 400

Metres

Datum/Projection:
GDA 1994 MGA Zone 50

Project: 19876-SM Date: 10/12/2021

N

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***Trachyandra divaricata* (Onion Weed)**

Hillarys Coastal Foreshore Reserve

Kallaroo Coastal Foreshore Reserve

Weed location

Weed Coverage (%)

<5%

6-75%

0 50 100 200

Metres

Datum/Projection:
GDA 1994 MGA Zone 50

Project: 19876-SM Date: 10/12/2021

N

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***Trachyandra divaricata* (Onion Weed)**

Hillarys Coastal Foreshore Reserve

Kallaroo Coastal Foreshore Reserve

Weed location

Weed Coverage (%)

<5%

6-75%

0 100 200 400

Metres

Datum/Projection:
GDA 1994 MGA Zone 50

Project: 19876-SM Date: 10/12/2021

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***Tropaeolum* sp. (Nasturtium)**

Hillarys Coastal Foreshore Reserve

Kallaroo Coastal Foreshore Reserve

Weed location

0 100 200 400

Metres

Datum/Projection:
GDA 1994 MGA Zone 50

Project: 19876-SM Date: 10/12/2021

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***Yucca* sp. (Yucca)**

Hillarys Coastal Foreshore Reserve

Kallaroo Coastal Foreshore Reserve

Weed Coverage (%)

6-75%

0 50 100 200

Metres

Datum/Projection:
GDA 1994 MGA Zone 50

Project: 19876-SM Date: 10/12/2021

N

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***Yucca* sp. (Yucca)**

Hillarys Coastal Foreshore Reserve

Kallaroo Coastal Foreshore Reserve

Weed location

Weed Coverage (%)

6-75%

0 100 200 400

Metres

Datum/Projection:
GDA 1994 MGA Zone 50

Project: 19876-SM Date: 10/12/2021

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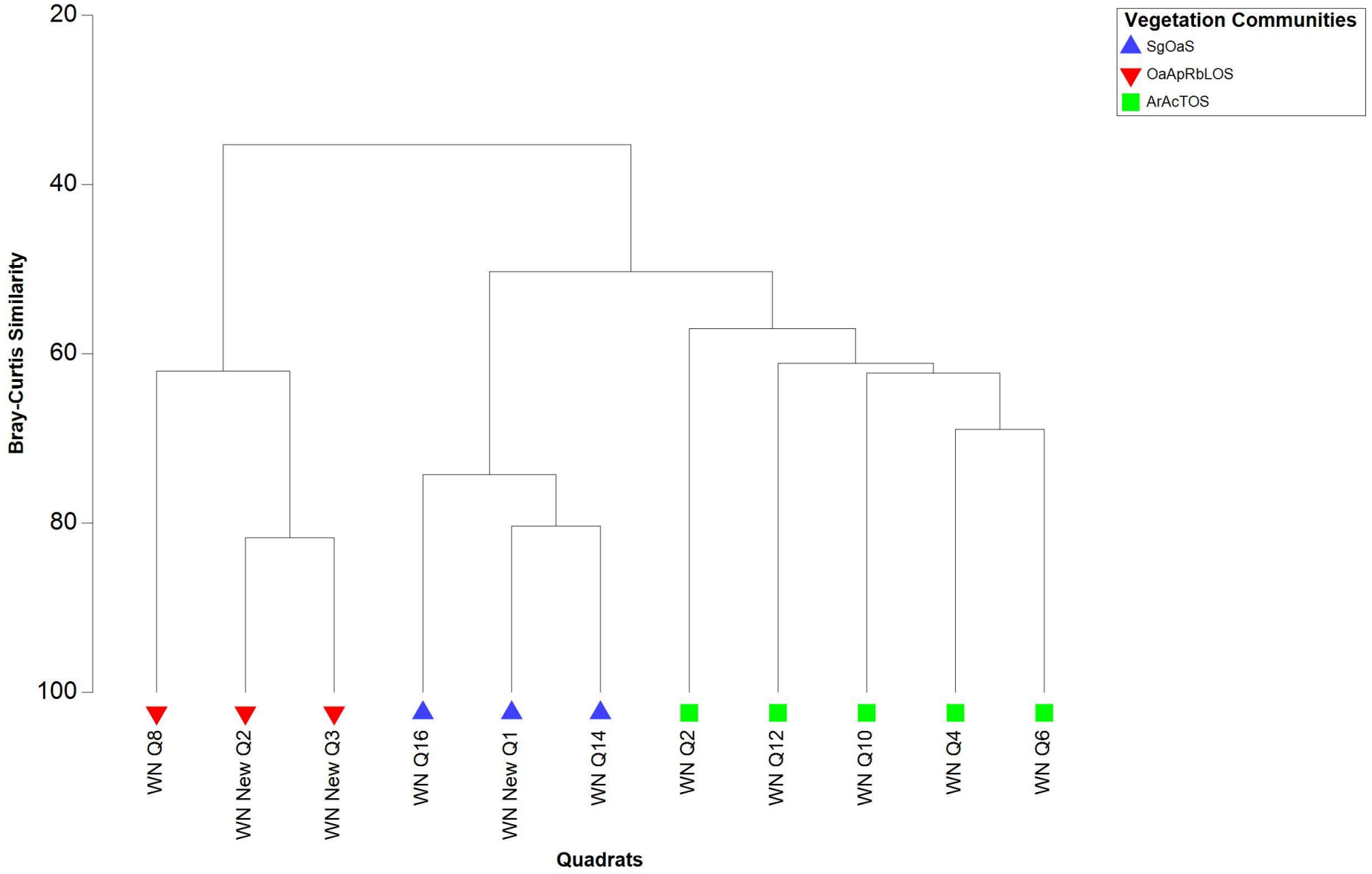
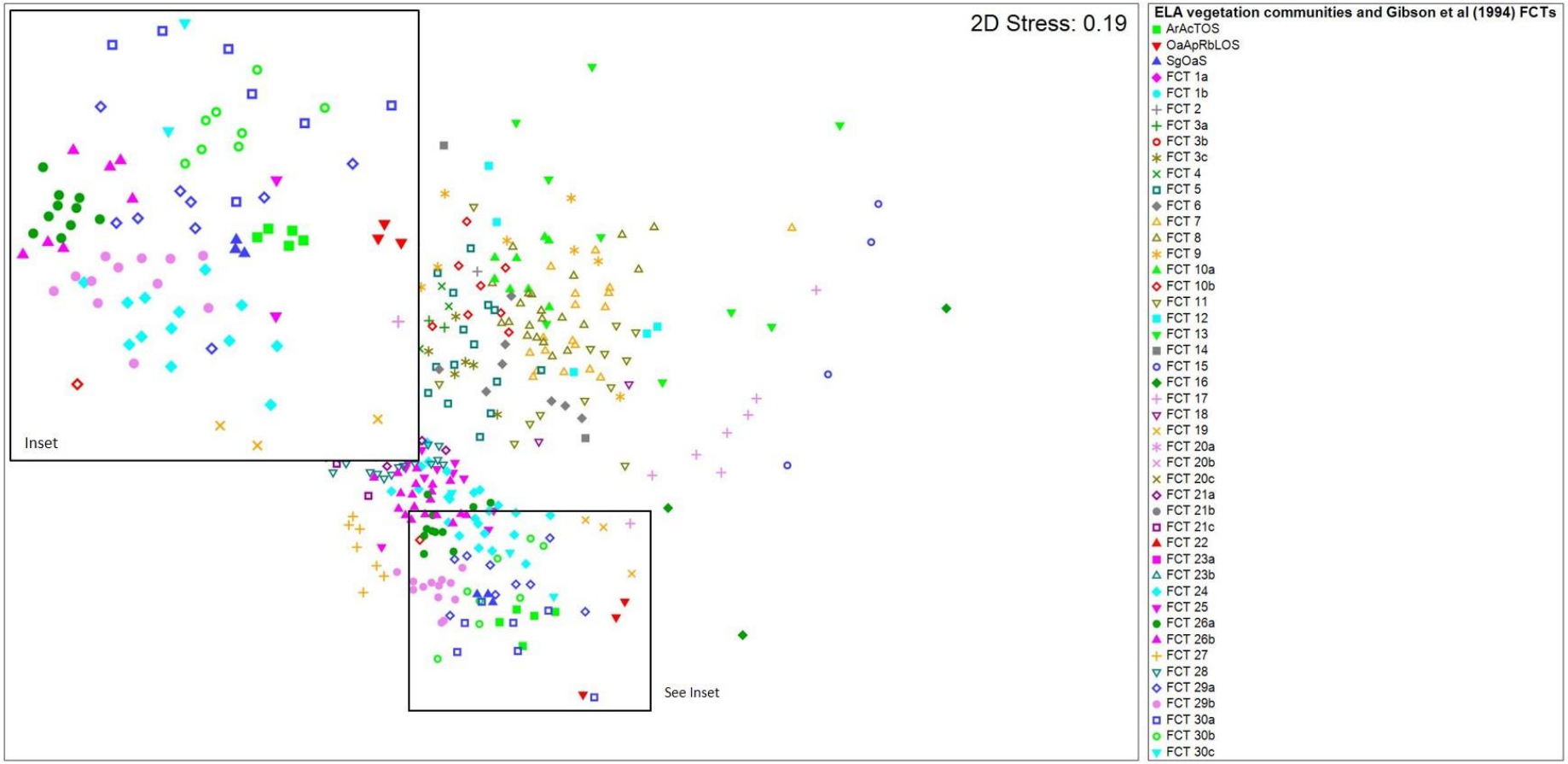
Appendix F Hierarchical clustering dendrogram


Vegetation Communities
SgOaS
OaApRbLOS
ArAcTOS
Bray-Curtis Similarity
20
40
60
80
100
WN Q8
WN New Q2
WN New Q3
WN Q16
WN New Q1
WN Q14
WN Q2
WN Q12
WN Q10
WN Q4
WN Q6
Quadrats

Appendix G MDS: Relationships between ELA vegetation communities and Floristic Community Types (FCTs) defined by Gibson et al. (1994)


2D Stress: 0.19
Inset
See Inset
ELA vegetation communities and Gibson et al (1994) FCTs
ArAcTOS
OaApRbLOS
SgOaS
FCT 1a
FCT 1b
FCT 2
FCT 3a
FCT 3b
FCT 3c
FCT 4
FCT 5
FCT 6
FCT 7
FCT 8
FCT 9
FCT 10a
FCT 10b
FCT 11
FCT 12
FCT 13
FCT 14
FCT 15
FCT 16
FCT 17
FCT 18
FCT 19
FCT 20a
FCT 20b
FCT 20c
FCT 21a
FCT 21b
FCT 21c
FCT 22
FCT 23a
FCT 23b
FCT 24
FCT 25
FCT 26a
FCT 26b
FCT 27
FCT 28
FCT 29a
FCT 29b
FCT 30a
FCT 30b
FCT 30c

Appendix H Tuart Woodlands TEC assessment

Step	Key diagnostic characteristics	Outcome
1	Occurs in the Swan Coastal Plain Bioregion within the state of Western Australia.	The survey area is located on the Swan Coastal Plain in Western Australia.
	Primarily occurs on the Spearwood and Quindalup dune systems but can also occur on the Bassendean dunes and Pinjarra Plain. It can occur on the banks of rivers and wetlands.	The survey area is located on the Quindalup South Dune System.
	The primary defining feature is the presence of at least two living established *Eucalyptus gomphocephala* (Tuart) trees in the uppermost canopy layer, although they may co-occur with trees of other species. There is a gap of no more than 60 m between the outer edges of the canopies of adjacent Tuart trees. These trees may occur either as single stemmed trees or as a mallee growth form.	Scattered emergent Tuart (*Eucalyptus gomphocephala*) trees (>2 trees) occur within patches of vegetation community ArAcTOS and OaApRbLOS. Scattered occurrences are within threshold of 60 m.
	Most often occurs as a woodland but can occur in other structural forms, For example, forest, open forest, woodland, open woodland, and various mallee forms.	Patches of ArAcTOS and OaApRbLOS vegetation communities which contain Tuart trees occur as a low woodland.
	Other tree species may be present in the canopy or sub-canopy. They commonly include: *Agonis flexuosa* (Peppermint) and *Banksia grandis* (Bull Banksia) (both in the southern part of the range), *Banksia attenuata* (Candlestick Banksia), *Eucalyptus marginata* (Jarrah); and less commonly, *Corymbia calophylla* (Marri), *Banksia menziesii* (Firewood Banksia) and *Banksia prionotes* (Acorn Banksia).	No other dominant tree species listed are present in the canopy or sub-canopy.
	An understorey of native plants is typically present, which may include grasses, herbs and shrubs, although this is often modified by disturbance. Some understorey plant species that are most commonly present are listed in Section 2.3.3.	Commonly occurring native understory species occurring within vegetation community ArAcTOS and vegetation community OaApRbLOS include *Hardenbergia comptoniana, Daucus glochidiatus, Trachymene pilosa, Spyridium globulosum, Acacia cyclops, Acacia rostellifera, Melaleuca systena, Myoporum insulare, Olearia axillaris, Phyllanthus calycinus, Rhagodia baccata, Acanthocarpus preissii, Ficinia nodosa*.
2	**Defining a patch of the ecological community** A patch of the ecological community is a discrete and mostly continuous area of vegetation that meets the key diagnostic characteristics (above). The patch boundary is 30 m beyond the outer canopy of the established Tuart trees (≥15 cm diameter at breast height (DBH)), including dead Tuart trees (stags). Patches of Tuart woodlands and forests may contain areas that vary in structural or biological complexity. Variation in quality or condition of vegetation across a patch should not necessarily be considered to be evidence of multiple patches. A patch may include small areas without understorey vegetation, such as bare ground, as well as waterbodies or hardscape (e.g., roads, paths, car parks, or buildings) that do not significantly alter the overall function of the ecological community. These small areas do not break up a patch, or divide a patch into multiple patches, as long as there are some parts of the canopy within 60 m of	Individual Tuart trees were recorded, and canopies buffered 30 m beyond the outer canopy of established trees. Patches of Tuart within the survey area were not considered as varying in structural complexity. Areas of man-made structures (tracks, car parks) and areas without understory vegetation (parkland cleared areas) were considered as being likely to significantly alter the overall function of the ecological community and therefore were excluded from the calculation of patch size and condition. A patch was considered continuous if occurring within <30m of another buffered Tuart canopy.

Step	Key diagnostic characteristics	Outcome
	the outer edges of the canopies of adjacent Tuart trees. However, existing buildings and other human-made structures and gardens are not part of the nationally protected ecological community and should be excluded from the calculation of patch size and condition.	
3	**Further information to assist in defining a patch of the ecological community** • Patches of Tuart woodlands and forests may contain areas that vary in structural or biological complexity. One part of a patch may have a larger number of mature trees and more ecological diversity, whereas another part of the same patch may demonstrate fewer mature trees and less groundcover. Areas with soil exposed and/or plant litter can also be expected within this ecological community. • Variation in quality or condition of vegetation across a patch should not necessarily be considered to be evidence of multiple patches. Patches of the ecological community can be spatially variable and are often characterised by one or more areas within a patch that meet higher condition thresholds amongst areas of lower condition. • If an area meets the key diagnostic characteristics but the average condition across that area falls below the minimum condition thresholds, the largest area or areas of at least 0.5 ha that meet minimum condition thresholds on average, should be specified as the patch or patches of the nationally listed ecological community. This may result in multiple patches of the ecological community being identified within the overall area first identified as meeting the key diagnostics.	Average condition rating within defined patches ranges from Good to Excellent. Vegetation is continuous and variable vegetation condition was not considered to be evidence of multiple patches. Vegetation condition within the ecological community was considered as Moderate.
4	**Relationship with other ecological communities** The range of the ecological community overlaps and interacts with other ecological communities of the Swan Coastal Plain, including some listed under the EPBC Act. At some locations more than one ecological community may be present. The following considerations apply to the identification of the ecological community where it is likely to overlap with some other listed ecological communities: • Banksia woodlands of the Swan Coastal Plain. • Sedgelands in Holocene Dune Swales. • Aquatic root mat community of caves of the Swan Coastal Plain.	The vegetation community does not have a relationship with any of the listed ecological communities.
5	**Condition thresholds and categories** For confirmed patches of the ecological community, following the key diagnostic characteristics and patch definition above (Step 1), determine the following requirements for information on condition to indicate if they are part of the nationally protected ecological community:	On applying a 30 m patch boundary beyond the outer canopy of established Tuart trees, the following assessment was made: • Areas of <0.5ha were discounted from being part of the TEC.

Step	Key diagnostic characteristics	Outcome
	• If the patch is smaller than 0.5 ha it is not part of the nationally protected ecological community; • If the patch is at least 0.5 ha and up to 5 ha in size, conduct on ground surveys to see which condition category applies. Condition categories are outlined in the Tuart (*Eucalyptus gomphocephala*) woodlands and forests of the Swan Coastal Plain ecological community approved conservation advice (DotEE 2019). • All patches of 5 ha or greater that meet the key diagnostic characteristics are part of the nationally protected ecological community.	• Patches of 0.5 – 2ha vegetation were assessed against condition thresholds and categories and were determined as classed into moderate condition including: o having an important landscape role (<100m to native vegetation); and o have a habitat role (>2 trees per 0.5ha) A total of three patches were assessed as being likely to represent the Tuart TEC as follows: • Patch 1: 0.91ha • Patch 2: 0.98ha • Patch 3: 3.34ha.

[a]Non-native vegetation cover as % of perennial vegetation present in the ground layer or shrub layer

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Attachment 3: Site Photos – Pinnaroo Point

Due to active construction along the eastern extent of the revegetation site, and the density of vegetation, photos have only been collected from the western extent of the Pinnaroo Point revegetation offset at this stage.

Plate 1: Photo of the Pinnaroo Point revegetation site, facing south from the northern beach access path. Evidence of weed invasion. Taken from 31 48’14”S, 115 43’45”E.

Plate 2: Photo of the Pinnaroo Point revegetation site, facing southeast from along the beachfront. Evidence of weed invasion and unmanaged access. Taken from 31 48’14”S, 115 43’44”E.

Plate 3: Photo of the Pinnaroo Point revegetation site, facing south. Evidence of weed invasion and potential feral animal activity. Taken from 31 48’15”S, 115 43’44”E.

Plate 4: Photo of the Pinnaroo Point revegetation site, facing southeast from along the beachfront. Evidence of weed invasion and unmanaged access. Taken from 31 48’15”S, 115 43’44”E.

Plate 5: Photo of the Pinnaroo Point revegetation site, facing southeast from along the beachfront. Evidence of weed invasion and litter. Taken from 31 48’16”S, 115 43’44”E.

Plate 6: Photo of the Pinnaroo Point revegetation site, facing east from along the beachfront. Evidence of weed invasion and unmanaged access. Taken at 31 48’17”S, 115 43’44” E.

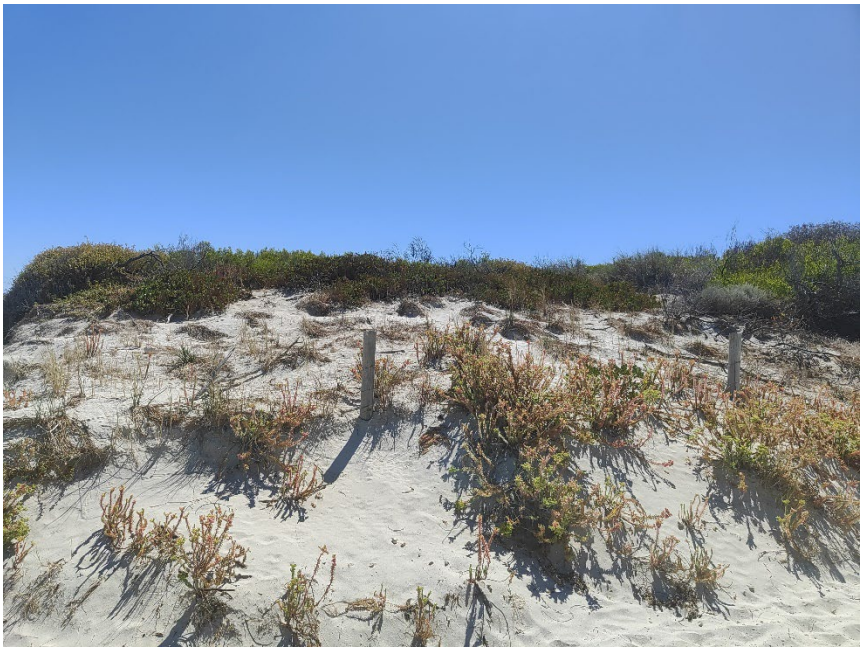

Plate 7: Photo of the Pinnaroo Point revegetation site facing northeast from along the southern beach access path, highlighting significant weed invasion, sand accretion, and damaged fencing. Taken from 31 48’18”S, 115 43’43”E.

Attachment 4: Pathogen Hygiene Procedure

City of Joondalup Staff and Contractors Pathogen Hygiene Procedure

All City staff and contractors are responsible for avoiding the spread of pathogens to protect the natural environment. This procedure is in accordance with the City of Joondalup *Pathogen Management Plan* and applies to City parks, urban landscaping areas and natural areas.

Clean-down procedures should be undertaken when conducting

- Works that disturb soil
- Tree pruning

Clean-down procedures consist of the following steps

1. Before entering the site, clean footwear, clothing, tools, equipment and vehicle to remove all soil and plant materials.
2. Conduct site activities.
3. Brush-down footwear, clothing, tools, equipment and vehicles within the site compound area or in the immediate vicinity of construction works to remove all soil and plant materials.
4. Exit the site.

Note: A vehicle washdown bay is available for use at the City of Joondalup Works Operation Centre. Contact your City representative for access.

General pathogen hygiene principles for on-site activities:

Parks and Urban Landscaping Areas

- In pathogen identified areas, avoid pruning trees during wet conditions where possible.
- Avoid damaging the trunk of trees when mowing or trimming.
- When walking on site, remain on paths and avoid bushland or vegetated areas where possible and/or practical.
- If accessing site with a vehicle, remain on formalised tracks or areas demarcated for vehicle access.
- Avoid water draining into bushland and vegetated areas.
- Use mulch that is certified pathogen free to the relevant Australian Standard (AS4454) and source plants from nurseries compliant with Nursery Industry Accreditation Scheme Australia (NIASA), where possible.

Natural Areas Bushland

- Works should commence in non-pathogen identified areas first and in known or suspected pathogen identified areas last.
- Avoid conducting works and accessing site in wet conditions, where possible.
- If accessing site with a vehicle, remain on formalised tracks or areas demarcated for vehicle access.
- When walking on site, remain on paths and avoid bushland or vegetated areas where possible and/or practical.
- In pathogen identified area, avoid pruning trees during wet conditions, where possible.
- Minimise water use in bushland and vegetated areas.
- Avoid water draining into bushland and vegetated areas.
- Use mulch that is certified pathogen free to the relevant Australian Standard (AS4454) and source plants from nurseries compliant with Nursery Industry Accreditation Scheme Australia (NIASA), where possible.

For any queries, please contact the Environmental Development Coordinator or email **enviro@joondalup.wa.gov.au**.

City of Joondalup | Boas Avenue Joondalup WA 6027 | PO Box 21 Joondalup WA 6919 | T: 9400 4000 F: 9300 1383 | **joondalup.wa.gov.au**

10995 - LAST UPDATED FEBRUARY 2021