


City Of Melville

Foreshore Restoration Strategy 2019

March 2020

Executive summary

Introduction

This report is a systematic review of the *City of Melville Foreshore Restoration Strategy* which was first published in 1997 by Alan Tingay & Associates, was reviewed in 2009 by NAMS and previously updated by GHD in 2014. This restoration strategy review considers the foreshore of the City of Melville (the City) which covers 18 km in length of foreshore along the Swan and Canning Rivers from East Fremantle Yacht Club, Bicton to Bateman Park, Bull Creek. Note that the following foreshore areas were excluded from this investigation:

- Between Page Street Attadale and West end of Tompkins Park, Alfred Cove
- The northern aspects of the South Perth Yacht Club

The foreshore area that was recently added and investigated in 2019 is located along Tompkins Park, Alfred Cove. Tompkins Park was not surveyed from the coastal or the ecological perspective in 2014, and an asset register has been added in 2019. Refer to Figure 8-1, Appendix B which outlines the foreshore zone of Tompkins Park with its associated vegetation types.

The purpose of this project was to review the existing 2014 Foreshore Restoration Strategy and build a field inventory with the aim of:

- Identifying further issues and required projects
- Assessing the recommendations and implementation of the previous Foreshore Restoration Strategy Review 2014
- Preparing a revised Foreshore Restoration Strategy Review in line with applicable legislation policies and guidelines

This Foreshore Restoration Strategy Review 2019 has been aligned with the Natural Areas Asset Management Plan (City of Melville, 2014) wherever possible in order to provide a systematic and consistent management approach for all natural areas within the City of Melville. This includes assessing works using a transparent and robust risk-based framework for prioritising management, based on the value of assets and the risk of threats.

Review of previous strategy

The recommendations of the previous strategy review (GHD 2014) were assessed to determine the success of the strategy.

Based on the 2014 strategy, all projects listed as priority 1 have been undertaken, including restoration works of the rock revetment on the west of the Point Walter boat ramp and the coastal verge supporting the trees east of the boat ramp. Based on the 2019 survey, this has been repaired with the exception of a few minor voids. Restoration works along the coastal path of Melville Beach Road has also been undertaken to address the exposure of tree roots and the coastal verge has also been repaired at Jeff Joseph Reserve opposite houses 29 to 17 that was previously noted as priority 1.

Other significant works undertaken between 2014 and 2019 include the upgraded erosion protection of the steep dune foreshore section at Point Heathcote and investigations undertaken into the potential cause and possible repair methodologies for the seawall around the Raffles Hotel at Canning Bridge, which is showing signs of subsidence in the path behind the wall.

Many of the 2014 recommendations included revegetation which has partly been implemented and work is ongoing in these areas. Some of the areas that were suggested to be rectified through hard approaches, such as rock revetment replacement, are now being considered with alternatives of softer approaches in the 2019 strategy. All project sites that require revegetation has been kept as priority 1 and will continue to be managed by the City Of Melville.

The 2014 recommendations that do not appear to have been successfully implemented are mainly those surrounding erosive processes. In particular, along the Canning River section, there is evidence of high-level erosive conditions over the last few years, and there has been a limited success from the remedial actions proposed in the previous review. Other areas of concern are Blackwall Reach Parade, with trampling causing a threat to existing trees and leading to the development of a steepened bank section due to increased erosion. This is particularly prevalent along the Blackwall Reach bushwalk. Although a gate has been provided for a formal access, there has been evidence of heavy trampling in close proximity to public path. A concept design has been developed for the coastal erosion in this area, as well as addressing the status of Bush Forever and potential TEC.

In general, the review noted that:

- Revegetation works are generally ongoing projects and that the recommendations relating to these issues should be continued.
- Erosive processes are ongoing and may increase in intensity due to increased boat use in the river and the potential impacts of climate change, including increased frequency and intensity of extreme events. Focused management actions were required at priority sites to reduce the risk to coastal infrastructure, recreational amenities and public safety.

Existing natural and cultural environment

The strategy review considered the existing natural and cultural environment of the foreshore and provided a description of:

- Land use
- Aboriginal heritage sites
- Non-indigenous heritage sites
- Climate
- Waves
- Landform and topography
- Geology and soils
- Shoreline types
- Reserves and conservation areas
- Environmentally sensitive areas
- Drainage, hydrology and water quality
- Vegetation and flora
- Fauna

Habitat Management Issues/threats

This strategy review involved consideration of the range of management issues or threats that occur along the foreshore, including consideration of:

- Vegetation clearing
- Trampling
- Vandalism and dumping of rubbish
- Weeds
- Introduced fauna
- Diseases and pathogens
- Fire
- Erosion
- Climate change
- Remediation works are to reflect natural aesthetics and in harmony with native flora and fauna communities

Note that a review of potential acid sulphate soils was not undertaken as part of the 2019 strategy review.

Prioritisation of Works

A prioritisation framework was developed to provide a method of prioritising works along the foreshore based on the value of the assets and the extent of the threat to the assets. Prioritisation of works is necessary due to the large area of the foreshore and the limited resources available. The prioritisation process determined high priority sites and issues requiring work. A workshop was held with staff of the City of Melville, DBCA and GHD coastal engineers and ecologists to further prioritise these sites to determine the Top 5 sites requiring works and for which concept designs will be prepared. These Top 5 sites/works are listed below:

- Point Heathcote stabilisation;
- Melville Beach Road stabilisation;
- Canning Beach No.3 and Esplanade Revetment No. 5 rock replacement;
- Esplanade Pathway remediation; and
- Blackwall Reach stabilisation.

The review also identified Tompkins Park as an additional area requiring further investigations (but not through concept design).

Recommendations

The principal recommendations determined in this strategy review are listed below. Items in italics denote recommendations to be continued from the previous review.

1. *Implement the revised restoration strategy detailed in this report with a view to softening the impact of the urban form on the landscape and re-establish a natural environment.*
2. *Revegetate the foreshore with native species using local seed stock, where practicable, particularly for species that may have developed a level of salt tolerance.*
3. Consider the presence of the Threatened Ecological Community 'Temperate and subtropical saltmarsh' along the foreshore and prioritise the revegetation of this community using appropriate species.
4. *Continue to work in partnership with the DBCA to maintain and improve foreshore areas*.

5. *Continue to delineate native vegetation from parkland by edge spraying to prevent grasses from invading native vegetation.* If possible, where new works are undertaken (works that include the provision of new footpaths) use the footpaths as a barrier between parkland and native vegetation to prevent grasses invading native vegetation.
6. Provide for greater community involvement in the City of Melville restoration programmes.
7. *Pursue funding sources to deal with Declared Plants and other highly invasive weeds on the Melville foreshore*.
8. Undertake an assessment of the inundated/damaged drainage outlets along the foreshore to ensure flow rates are acceptable and implement remedial action where applicable.
9. *Manage foreshore access to ensure traffic is directed away from sensitive areas and diverted to designated public access points.*
10. Remove failed foreshore treatments along the foreshore that have become potential safety hazards.
11. Continue to monitor weeds along the foreshore and update the weed list and mapping undertaken during the foreshore inventory in order to identify new weed species or new populations that may be able to be eradicated before they become fully established. Conduct future weed surveys in Spring to allow identification of greater numbers of weed species.
12. Review and audit these recommendations within five years of implementation of this report by the City of Melville..

This report is subject to, and must be read in conjunction with, the limitations set out in Section 1.6 and the assumptions and qualifications contained throughout the Report.

Acknowledgements

GHD would like to acknowledge the contribution of staff of the City of Melville and the DBCA at various stages of the study. GHD is particularly appreciative of DBCA sharing of supporting information and dataset (e.g. Asset Register). GHD also welcomes DBCA participation during the prioritisation workshop to facilitate the City's planning and approval process.

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1. Introduction

1.1 Background information

The City of Melville (the City) covers 18 km in length of foreshore along the Swan and Canning Rivers which requires management by the City as shown in Figure 1-1). Management strategies for foreshore areas require review as conditions and use of certain areas change over time. Currently, foreshore areas of the Swan River Estuary are under stress from both recreation and environmental pressures. The combined impacts of increasing boating numbers on the river and the natural effects (from sea level rise, salinity stress on flora and storm events) all contribute to negative impacts on the river's riparian strips and bank stability.

Figure 1-1 City of Melville Foreshore Area

This review (2019) of the current Foreshore Restoration Strategy Review 2014 (GHD) follows the recommendation for reviewing the City's Foreshore Restoration Strategy every 5 years. This report identified that three main issues are relevant along the foreshore: erosion, revegetation and softening of the rock revetment of the shoreline. Of these issues, foreshore erosion is the most challenging to manage and is an ongoing concern for the City due to the need to balance protection with environmental impact and the generally costly nature of erosion protection works.

1.2 Purpose of this report

The purpose of this project was to review the existing 2014 Foreshore Restoration Strategy and build a field inventory with the aim of:

- Identifying further issues and required projects
- Assessing the recommendations and implementation of the previous Foreshore Restoration Strategy Review

- Preparing a revised Foreshore Restoration Strategy Review in line with applicable legislation policies and guidelines

The revised Foreshore Restoration Strategy Review includes a risk-based framework for prioritising management, based on the value of assets and the risk of threats that are transparent and robust. This framework was developed in such a way that it can be used as an ongoing method of determining management priorities at a more localised scale or at the level of the whole foreshore.

1.3 Scope of works

The scope of work for this project as agreed between GHD Pty Ltd (GHD) and the City is as follows:

- Review of the existing 2014 Foreshore Restoration Strategy Review document and the informing documents specified in 2.4 of the Request for Quotation (RFQ192012).
- Conduct a detailed inventory of the study area including:
  - Vegetation communities
  - Significant weed locations
  - Significant fauna habitats
  - Landscape features
  - Erosion damage to both hard infrastructure and natural areas
  - Existing foreshore treatments
  - Existing infrastructure
  - Aboriginal sites/heritage sites
  - Recreational usage
- Develop a prioritised list of projects to be undertaken for five priority sites, including coastal erosion, revegetation strategies, rock revetment remediation through hard and soft methods, slope stabilisation, and indigenous connectivity. Project details will include:
  - Site description, photographs, location and area
  - Proposed foreshore treatments
  - Conceptual sketches and preliminary generic specifications
  - Order of magnitude cost estimates for construction
- Prepare a revised version of the Foreshore Restoration Strategy Review (this document) which incorporates findings from the:
  - Site inventory
  - Document reviews
  - Prioritised projects

1.4 Document structure

The Foreshore Restoration Strategy Review includes the following elements:

- Management commitments and purpose of the strategy (Chapter 2);
- Description of the existing natural and cultural environment, which outlines the major assets present along the foreshore (Chapter 3);
- Description of the management issues along the foreshore, i.e. the threats that currently, or have the potential to, impact on the assets along the foreshore (Chapter 4);

- Prioritisation of works required by combining ratings of both assets and threats. This provided a priority list of works required (Chapter 5);
- Discussion of potential management strategies - this is provided at a broad-scale and does not include detailed information on strategies that have existing guidelines (such as the guidelines of the DBCA) (Chapter 6); and
- Recommendations (Chapter 7).

1.5 Methodology

1.5.1 Desktop Study

This Foreshore Restoration Strategy Review includes a review of the City's current Foreshore Restoration Strategy Review (GHD, 2014), as well as a number of other relevant documents including:

- Bullcreek Reserves Strategic Management Plans 2014 – 2019 (Woodgis 2019)
- Natural Areas Asset Management Plan 2019 (Woodgis 2019)
- Estuarine Reserves Strategic Management Plan Supplement 2014 - 2019 (Woodgis 2018)
- Heathcote Strategic Management Plan 2014 - 2019 (Woodgis 2014)
- Community Planning Scheme No. 5 (City of Melville 1999)
- Metropolitan Region Scheme (Western Australian Planning Commission 2007)
- Swan and Canning Rivers Foreshore Assessment and Management Strategy (Swan River Trust 2008)
- Swan River Estuary Marine Park and Adjacent Nature Reserves Management Plan 1999-2009 (CALM 1999)
- Swan River Trust Best Management Practices for Foreshore Stabilisation (Swan River Trust 2009)

The following information sources were used to identify the existing environment of the City's foreshore (Table 1-1).

Table 1-1 Information sources

Aspect	Information Source
Heritage	• Department of Aboriginal Affairs Heritage Inquiry Search Tool • *Environment Protection and Biodiversity Conservation Act* 1999 Protected Matters Search Tool • State Heritage Office InHerit database
Climate	• Bureau of Meteorology climate data (BoM 2019)
Reserves	• Metropolitan Region Scheme maps (Western Australian Planning Commission 2007) • DBCA spatial dataset (GIS)
Environmentally Sensitive Areas	• Department of Environment Regulation Native Vegetation Viewer.
Surface water and Groundwater	• Hydrological features (SLIP) • Department of Water (DoW) Geographic Data Atlas. • DBCA Wetland base mapping tool
Vegetation	• Department of Environment Regulation Native Vegetation Viewer

Aspect	Information Source
	• Beard Vegetation Mapping (1979) • Heddle et al. (1980) and Webb et al. (2016) mapping • Field survey (Appendix C)
Threatened and Priority Ecological Communities	• DBCA Threatened Ecological Community (TEC) and Priority Ecological Community (PEC) spatial datasets (2014 data) • *Environment Protection and Biodiversity Conservation Act* 1999 Protected Matters Search Tool (DotEE 2019)
Conservation Significant Flora and Fauna	• Field Survey (Appendix C)

1.5.2 Consultation

Regular communication streams were maintained with the City of Melville to ensure the appropriate direction and progress was being maintained. A single workshop with the City of Melville and DBCA Riverbank Program personnel was also undertaken as detailed below.

City of Melville Prioritisation Workshop

A workshop was held with representatives from the City and the DBCA on the 4th November 2019 to discuss the sites which had been prioritised as critical locations requiring restoration. From the workshop, the top five sites were approved, for which concept designs were to be developed. Attendees included:

- City of Melville - Environmental Community Liaison Officer- Jacklyn Kelly
- City of Melville - Environmental Coordinator - Deanne Wynn
- City of Melville - Environmental Officer - Kellie Fowler
- City of Melville – Asset Management Coordinator - Paul Handcock
- GHD – Coastal Engineer - Andrew Sayce
- GHD – Structural and Coastal Engineer – Sarah Chapman
- GHD – Graduate Structural Engineer – Jessica Lee
- DBCA - Riverbank Project Officer - Michael Shaughnessy

1.5.3 Field inventory

A qualified Ecologist and a Coastal Engineer prepared a detailed inventory of the study area by traversing the foreshore from East Fremantle Yacht Club, Bicton to Bateman Park, Bull Creek. City of Melville's shoreline assets (for example paths and rock revetments) and natural features, such as Bush Forever sites and shoreline stability were captured using GIS field data collection methodologies through handheld mobile devices and customised input forms.

The following foreshore areas were excluded from this investigation:

- Between Page Street Attadale and West end Tompkins Park, Alfred Cove; and
- The North area of the South Perth Yacht Club,

A GHD coastal engineer traversed the City's foreshore during October 2019 and assessed:

- Erosion damage to hard infrastructure and natural areas including details on nature of the damage and a condition rating;
- Existing foreshore treatments;

- Infrastructure and landscape features; and
- Recreational usage based on available information, existing infrastructure and landscape features

The methodology followed by the coastal engineer is included in Appendix C.

Ecologist

A GHD ecologist traversed the City's foreshore during October 2019 and mapped:

- Vegetation types and condition;
- Significant weed locations; and
- Significant fauna habitats, including habitat trees.

The methodology followed by the ecologist is included in Appendix C.

1.6 Limitations

This report: has been prepared by GHD for the City of Melville and may only be used and relied on by the City of Melville for the purpose agreed between GHD and the City of Melville as set out in Section 1 of this report.

GHD otherwise disclaims responsibility to any person other than City of Melville arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

GHD has prepared this report on the basis of information provided by City of Melville and others who provided information to GHD (including Government authorities)], which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

The opinions, conclusions and any recommendations in this report are based on information obtained from, and testing undertaken at or in connection with, specific sample points. Site conditions at other parts of the site may be different from the site conditions found at the specific sample points.

Investigations undertaken in respect of this report are constrained by the particular site conditions, such as the location of buildings, services and vegetation. As a result, not all relevant site features and conditions may have been identified in this report.

Site conditions (including the presence of hazardous substances and/or site contamination) may change after the date of this Report. GHD does not accept responsibility arising from, or in connection with, any change to the site conditions. GHD is also not responsible for updating this report if the site conditions change.

2. Management Commitment and Purpose of the Strategy

2.1 Timing and priorities

This report presents a management strategy to be implemented over the next 5 years, at which point the strategy should be once again reviewed and updated. A general management strategy has been presented and concept designs for the top five priority sites have been provided in Appendix G.

2.2 Responsible management authorities

The City is responsible for implementing the strategy, with assistance from other government and community bodies, such as the DBCA and Bicton Environment Action Group, Friends of Attadale Foreshore and Swan Estuary Reserves Action Group as appropriate.

2.3 Assessment criteria

The implementation of the general and site-specific recommendations should be assessed through site monitoring and maintenance over the next five years and critically reviewed in the five year review of this document.

2.4 Integration of other documents/systems

The City has a number of environmental management plans and strategies that aim to implement the existing strategic goal to 'have ecologically sustainable management of the Western Australia's land, water, air and biodiversity resources for the benefit of existing and future generations' including:

- Corporate Environmental Strategic Plan 2016 – 2025
- Water Quality Improvement Plan – Bull Creek
- Urban Forest Strategic Plan 2017- 2036, Part A: City Controlled Land
- Environment Policy 2018 CP030.
- Natural Areas Asset Management Plan (Woodgis 2019)
- Public Spaces Strategy 2017
- Foreshore Restoration Strategy (this document)

3. Existing Natural and Cultural Environment

The legislation and background information that relate to the environmental factors discussed in this chapter are explained in detail in Appendix D**.**

3.1 Land use

The City of Melville covers 5,268 hectares (ha) and is approximately in the centre of the Perth Metropolitan Region. The City of Melville sits on the southern shores of the Swan River and a significant tributary, the Canning River, providing approximately 18 km of combined foreshores. The foreshore area of the City of Melville is reserved under the Metropolitan Region Scheme and the City of Melville Scheme 5 as “parks and recreation”.

As outlined in the previous foreshore strategy review, there are a number of common forms of recreation activity along the City of Melville Foreshore which have been included in Table 3-1. A description of the areas in which these activities are undertaken is also included.

Table 3-1 Recreational activities and facilities along the City of Melville Foreshore

Recreational activity	Recreational facilities	Specific areas with established recreational facilities
Walking and Running	Walking trails	Paths along the majority of the foreshore including Point Walter Reserve, Bicton Bath Reserve, excepting the southern end of Bull Creek
Cycling	Cycling trails	Paths along the majority of the foreshore including Tompkins Parks, excepting the southern end of Bull Creek
Scenic driving/viewing	Roads and parking areas	Scattered locations
Bird watching	Walking trails	Along the majority of the foreshore
Picnicking	Picnic benches, barbeques and grassed areas	Point Walter, Blackwall Reach, Jeff Joseph Reserve, Bicton Baths, Deepwater Point Reserve (not included in this strategy)
Fishing	Boat launches, jetties, groynes and parks	Applecross Jetty, Blackwall Reach, Bicton Bath Reserve, Apex Reserve, Point Walter, End of Point Heathcote towards Perth Yacht club ,
Windsurfing/kite surfing	Shower and parking areas	Melville Beach, Applecross Jetty, End of Point Heathcote towards Perth Yacht club
Water skiing	Boat launches	Point Walter, Deepwater Point Reserve (not included in this strategy)

Recreational activity	Recreational facilities	Specific areas with established recreational facilities
Jet skiing	Boat launches	Point Walter, Deepwater Point Reserve (not included in this strategy)
Sailing/boating	Boat launches	Point Walter, Deepwater Point Reserve and Swan River Rowing Club (not included in this strategy)
Swimming	Car parks and beach access areas	Point Dundas Boardwalk, Bicton Bath Reserve, Point Water East, Honour Avenue Point Water Golf Course
Sporting	Tennis fields	Jeff Joseph Reserve

In addition there are a number of events that take place across the year that result in large numbers of people utilising the foreshore, such as the Australia Day fireworks, triathlons and community events.

The previous strategy recommended that a recreational survey on activities and preferences within the City of Melville be undertaken to identify the main recreational activities carried out in foreshore areas. A minor recreation survey was carried out as part of this review but a comprehensive recreation survey has not yet been undertaken.

3.2 Aboriginal heritage sites

The Aboriginal Beeliar people are known to have occupied the area south of the Swan and Canning Rivers for 40,000 years or more. There are a number of sites of Aboriginal heritage significance that occur within the study area.

In Western Australia, the *Aboriginal Heritage Act 1972* protects places and objects customarily used by, or traditional to, the original inhabitants of Australia. A register of such places and objects is maintained under the Act, however, all sites are protected under the Act whether they have been entered on the register or not.

In Western Australia the Department of Aboriginal Affairs (DAA) manages the online Aboriginal Heritage Inquiry System, which identifies any registered indigenous heritage sites within the vicinity of the search area. A search of this database determined that three registered sites and four 'other heritage places' are located along the City of Melville Foreshore (Appendix B).These sites are detailed in Table 3-2.

Table 3-2 Aboriginal heritage sites identified within the City of Melville Foreshore

Site ID	Place Name	Type/Comments
Registered Sites		
3536	Swan River	Mythological
3538	Canning River	Mythological
18623	Goolugatup	Ceremonial, Mythological, Historical- located at Point Heathcote
Other Heritage Places		
3299	Bull Creek	Artefacts/Scatter
3650	Blackwall Reach, Bicton	Water Source
4104	Burke Drive	Artefacts/Scatter
20442	Raffles Hotel Site	Ceremonial, Mythological, Fish Trap, Quarry, Artefacts/Scatter, Historical

3.3 Non-indigenous heritage sites

At the Federal level, protection of significant non-indigenous heritage places is provided under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and the *Historic Shipwrecks Act 1976*.

The Australian Heritage Database contains information about Australian places that have natural, historic and indigenous value. This database contains information on heritage matters of national environmental significance, which are protected under the EPBC Act. This database includes places listed on the World Heritage List and the National Heritage List. A search of the database determined that no sites on the World Heritage or National Heritage List occur along the City of Melville Foreshore.

The Heritage Council of Western Australia is a state government agency responsible for the management of the historic resource. The *Heritage of Western Australia Act 1990* makes a provision for the preservation of places of historic significance. This significance is based on aesthetic, social and scientific principles. Under the Act, a Heritage Place refers only to a building, a definable piece of land and contents relevant to the building. A heritage agreement is formed between the Minister and the owner of a heritage place based on a voluntary agreement but this is then enforced by the Heritage Council on successive owners and mortgages, government departments, municipal councils and developers. Protection from inappropriate development of a heritage place is granted under the *Heritage of Western Australia Act 1990*, which requires all applications to modify a place to be referred to the Heritage Council. This protection is bestowed to buildings registered on the interim or permanent lists under Sections 50 and 51 of the Act.

The City of Melville also maintains a Local Government Inventory (Municipal Inventory) for heritage places which is not a statutory listing, but is a protection mechanism that assists planners to make important decisions about the future management of the places on the Inventory.

The State Heritage Office keeps a heritage register “InHerit” that contains comprehensive information about cultural heritage places listed in the State Register of Heritage Places, local government inventories and other lists, the Australian Government's heritage list, and other non-government lists and surveys. A search of the InHerit database and the City’s Municipal Inventory (City of Melville 2019) identified a number of heritage places that occur within or directly adjacent to the City’s foreshore. These heritage places are detailed in Table 3-3.

Table 3-3 Heritage places occurring within, or adjacent to the City of Melville foreshore

Place (City of Melville reference number)	Location	Type of listing	Description/Comments
Alfred Cove – Point Waylen Area (AC02)	Alfred Cove Reserve	Register of the National Estate - natural Municipal Inventory	This area is one of three areas – Pelican Point, Milyu Reserve and Alfred Cove of tidal flats which are important habitats for waders. This reserve also retains natural and extensive estuarine wetland saltmarsh. This area is within the Department of Parks and Wildlife managed land (outside of the study area)

Place (City of Melville reference number)	Location	Type of listing	Description/Comments
Swan Estuary Marine Park (AC06)	Swan River, Alfred Cove	Municipal Inventory	Similar area to Alfred Cove. It is significant for conservation, recreational value and commercial prospects.
Attadale Reserve and Troy Park (AT06)	Attadale Reserve and Troy Park	Municipal Inventory (new – 2013)	Natural open landscape for sporting and recreational use. This area links east to the Alfred Cove area to west of Point Walter.
Bicton Foreshore and Reserves, including Stam's Tearooms (BN03)	Durdham Crescent, Bicton	Municipal Inventory - Adopted	The place comprises of river beach and parkland, Stam's Tearoom and Commonwealth Animal Quarantine Station. However the Tearoom were removed in 1964.
Point Walter Reserve (BN06)	Honour Avenue and Carroll Drive and Blackwall Reach Parade, Bicton	Municipal Inventory (reinstate and new, 2013)	Natural significance, significance to the Aboriginal people, early settlement, popular community place
Applecross Jetty (listed in Municipal inventory as 'Point Dundas, Majestic Hotel Site, Boardwalk and Applecross Jetty' – AP02)	Point Dundas Applecross	Municipal Inventory - Adopted Town Planning Scheme	The jetty was built for the ferry service that provided the only direct link to Perth after the original Applecross subdivision
Raffles Hotel (AP09)	70 Canning Beach Rd, Applecross, adjacent (not within) the foreshore	Register of the National Estate – (listed not registered) State Register – Permanent Heritage Agreement Municipal Inventory - Adopted Town Planning Scheme	A well known landmark due to its prominent location and is known to have operated continuously to the present day as a licensed hotel since 1896 and possibly earlier.
German Jetty (Former) – site (AP11)	Near Cunningham St, Melville Beach, Applecross	Municipal Inventory - Adopted	A historic site with no remnant physical evidence surviving. Has a commemorative plaque on a concrete pedestal.
Coffee Point Boatyard/Slipway/Wharf (former) (AP14)	Corner Canning Beach Road and Flannagan St Applecross	Municipal Inventory - Adopted	Poor condition. The site now contains remnant metal sliprails in the Canning River and a metal plaque on a concrete pedestal.
Canning Bridge (AP20)		State Register - Permanent	The bridge is considered significant for a number of

Place (City of Melville reference number)	Location	Type of listing	Description/Comments
		Municipal Inventory - Adopted	reasons. The bridge comprises two timber and steel framed bridges crossing Canning River at Canning Highway connecting Melville and South Perth.
Point Heathcote Lower Land (AP22)	Point Heathcote, Duncraig Road, Applecross	Municipal Inventory (new – 2013)	Deteriorated. Aboriginal use of land, settler grazing, part of Heathcote Hospital
South of Perth Yacht Club (AP23)	Cnr. Flannigan Road and Canning Beach Road, Coffee Point, Applecross	Municipal Inventory (new – 2013)	Well maintained. It is a Clubhouse set in a grassed area on the foreshore at Coffee Point. There exist a number of jetties into the Swan River.
Rookwood Street Jetty (MP01)	Canning River foreshore, The Esplanade, opposite Rookwood Street	Municipal Inventory	Restored in 1999 through the efforts of local community volunteers. Timber pedestrian jetty projecting into the Canning River.
Swan River Rowing Clubhouse (MP02)	2 The Esplanade, Mount Pleasant	Municipal Inventory (new - 2013)	Significant as a rowing clubhouse and housing for single sculls, I the second oldest rowing club in WA.
Deep Water Point Reserve, including jetty and sculpture park (MP04)	Deep Water Point Reserve, The Esplanade, Mount Pleasant	Municipal Inventory	Important as recreational amenity for the community.
Bateman Reserve, incorporating Bateman Park (BR02)	Moonlight Cover, Brentwood	Municipal Inventory (new – 2013)	Well maintained, undergoing rejuvenation and removal of invasive weeks. Important for the natural environment, initial association with indigenous Aboriginal people, and later the pioneer settlers

Statutory listings are:

State register and Heritage Agreement, Heritage Council. Heritage of Western Australia Act 1990

Town Planning Scheme, Local government, Planning and Development Act 2005 and Local Planning Schemes

Non-statutory listings are:

Federal Register of the National Estate

Municipal Inventory, local governments, mandated under the Heritage of Western Australia Act 1990 but controlled by Local Governments

3.4 Climate

The City of Melville experiences a Mediterranean climate, with mild wet winters and hot dry summers. A summary of the climatic data (BoM 2019) for Perth (data from Perth Metro weather station number 9225) is below:

- Mean maximum temperature: 18.4 °C (July) to 31.6 °C (February)
- Mean minimum temperature: 7.9 °C (July) to 18.3 °C (February)
- Mean Annual Rainfall: 733 mm
- Mean number of days of rain ≥ 1 mm: 80.1

In 2018, the City of Melville, as part of the Perth Metropolitan area, experienced rainfall at a level close to the long term average. It was recorded to have the second-highest January daily rainfall record since January 2000.

Annual mean maximum and minimum temperature has been recorded close to average. The highest temperature recorded for 13 months was 41.2 °C in December 2019.

Figure 3-1 shows graphically, the annual temperatures and rainfall across Australia for 2018.

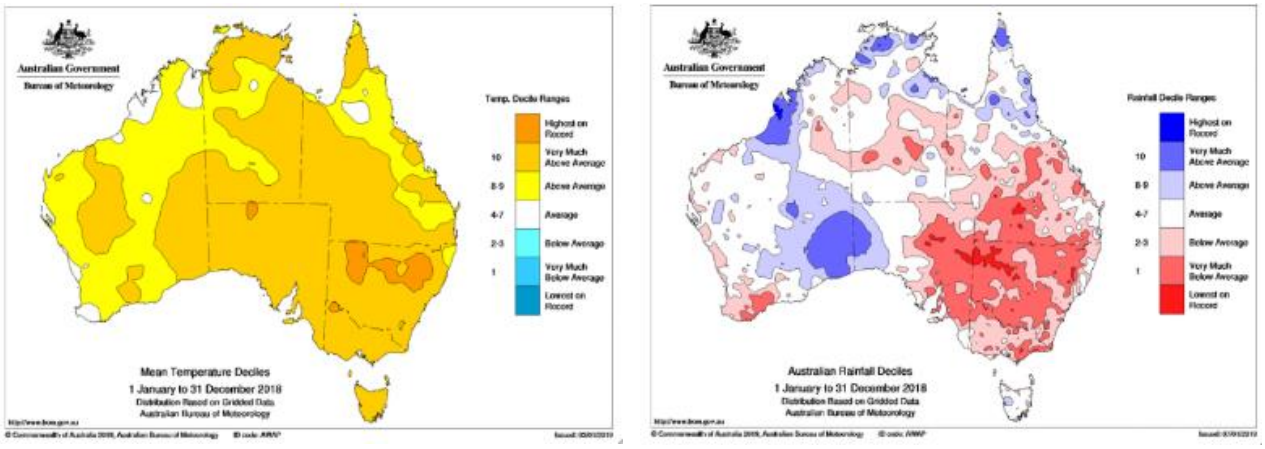


Figure 3-1 2018 Annual mean temperatures and rainfall (BOM, 2018)

The Perth annual wind profiles for the morning and afternoon are presented in Figure 3-2. The prevailing annual wind directions in Perth at 9am are easterly as a result of moderate summer morning easterlies and the prevailing annual 3pm wind direction is from the south west as a result of strong summer sea breezes. The data shown was recorded from 1944 – 2016.

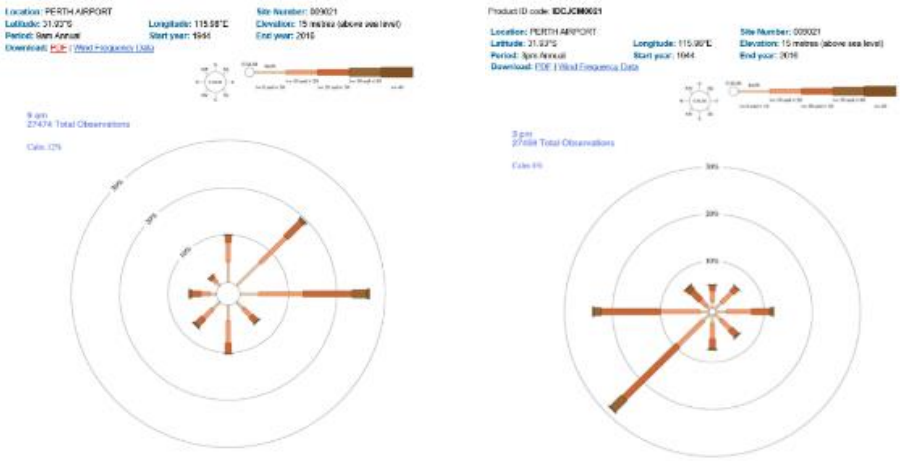


Figure 3-2 BOM Perth wind roses (BOM 2019)

3.5 Waves

The height and period of locally generated wind waves are dependent upon wind speed, duration of wind, water depth and fetch length (the length of water that the wind can act on). The orientation of the shoreline and fetch length varies throughout the City's foreshore areas, making some areas of the coastline more susceptible to erosion from wind generated waves than others.

Boating is common in these reaches of the lower Swan River Estuary and the wake from boats can result in erosive action on river banks. Boat wake wave heights for the area can be commonly expected in the order of 0.5 m and up to a maximum height of 0.8 m (AMC 2009 and CUT 2010). Potential change in traffic conditions including boat sizes and proximity of routes relative to shoreline may affect the intensity in erosion (e.g. larger boats have longer wake wave lengths with higher erosion potential). While wind generated waves from storm events can be of a similar magnitude, it is important to note that waves generated by passing vessels will impact the coastline on a much more regular basis.

3.6 Landform and topography

The City is located on the Swan Coastal Plain which consists of sedimentary deposits of the Perth Basin (Government of Western Australia 2000). Studies of the geomorphology and geology of the Plain have divided the Plain into a sequence of alluvial and/or colluvial deposits and Aeolian sands which identifies six major landform elements that lie more or less parallel to the coast. Two of these landforms occur within the City of Melville foreshore, and the foreshore also includes a transitional area between the two dune systems. The two dune systems are:

- Spearwood Dunes: occurs in the west of the study area, west of Canning Bridge

  These dunes are Pleistocene Aeolian sands overlying Tamala Limestones. The exposed ridges of Tamala Limestones are the most prominent landforms on the Swan Coastal Plain.

- Bassendean Dunes: occurs in the east of the study area, south-east of Canning Bridge

  Pleistocene Aeolian heavily leached sands. Relief ranges from 10-60 metres to almost sea level.

The 18 kilometres of foreshore bound by the City takes a wide variety of forms, from sandy beaches to rocky cliffs and built sea walls. The width of the river and angle of the coastline is also highly varied. The Melville foreshore is relatively flat with some elevated areas around Point Heathcote, Bicton and Point Walter Reserve. The cliffs at Blackwall Reach are up to 8m in height.

The wide variety of coastlines means that there are a number of different types of public usage for each segment and an array of erosion mechanisms occurring.

3.7 Geology and soils

The City foreshore sits on two dune systems; Bassendean and Spearwood, with three different soil types; Cottesloe, Karrakatta and Bassendean. The characteristics of these geomorphological systems have been summarised in Table 1, Section 1.5.2 of the Natural Areas Asset Management Plan (NAAMP) (Woodgis, 2019).

3.8 Shoreline Types

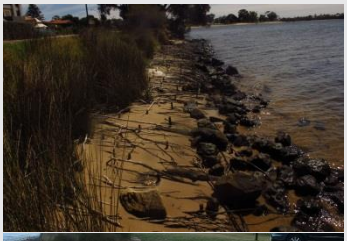
The City foreshore consists of both non-built shorelines and built shorelines. As defined by the Swan River Trust (2008) non-built foreshores are those without engineered erosion protection

systems and may include some artificially formed shores. Non-built shores can be further classified as rocky, vegetation or sedimentary shores as described in Table 3-4).

Built shorelines are hard-engineering approaches to shore stabilisation that reduce the response of the foreshore to environmental conditions (Table 3-4).

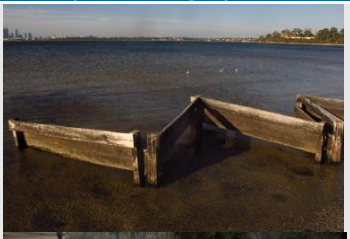
Table 3-4 Shoreline types along the City of Melville foreshore (After: Swan River Trust 2008)

Type	Sub-type	Example Photograph	Location
Non- built shoreline types			
Rock shore	Natural shore dominated by rock, with two sub-types: • Rocky (emergent) submerged reefs, planar shore platforms, emergent rock features and rocks shores in pool/riffle systems • Cliff-steeply graded (>60°) rock foreshore with elevation above 1. 5m		Point Dundas (2014)
			Blackwall Reach Point Heathcote (2014)
			South of Point Walter (2019)
			Jeff Joseph Reserve (2019)

Type	Sub-type	Example Photograph	Location
Sedimentary	An exposed shore largely comprised of mobile sediments including: • Beach –dominated by moderate to high wave action • Perched Beach – beach partly held in place by submerged rock platform or reef • Embankment – subject to low wave action		Occurrences along the whole foreshore (2014)
			Isolated occurrences – Point Dundas and west side of Point Walter (2019)
			
			Melville Beach Road (2019)
	Scarp – Steeply graded (>45°) exposed, relatively unconsolidated sediment, elevation above 1m.		Sections at Point Heathcote Small sections along Blackwall Reach Parade (2019)
			

Type	Sub-type	Example Photograph	Location
Vegetated	Sedge- shore with riparian vegetation dominated by sedges. This classification also covers wetland environments		Occurrences along the whole foreshore, particularly along Canning River and Bull Creek (2014 & 2019)
	Tree-lined – shore maintained by riparian trees		Sections along Canning River and Bull Creek (2014 & 2019)
	Grass/weeds- shore dominated by grass/weed coverage		Isolated occurrences along the foreshore. (2014 & 2019)
Built Structure			
Wall	Steep foreshore structure (>60°). Usually constructed from concrete, rock or timber.		Raffles Hotel (2014 & 2019))

Type	Sub-type	Example Photograph	Location
Revetment	Inclined foreshore structure (<60°). Usually constructed from rock. Material can be tipped, placed or cut to fit together.	 	Melville Beach Parade (2014) Point Walter East Boat Ramp and Jetty (2019)
Gabions	Baskets filled with rock units. These porous cages can be constructed as a wall, revetment or toe protection. Often placed in conjunction with revegetation.	 	Point Walter (2014) Along Melville Beach Road (2019)
Groynes	Shore connected and usually shore perpendicular structures placed to trap the longshore sediment transport to increase the quantity of sediment at particular locations. Groyne fields are often required to mitigate the erosion effects on the down drift side of individual groynes and this results in partitioning of the shoreline.	 	West of Applecross Jetty (2014) Point Heathcote (2019)

Type	Sub-type	Example Photograph	Location
Wave Attenuation Structures	The main structure used to provide wave attenuation in the Swan-Canning is wooden baffle boards.		East of Applecross Jetty (2014)
			East of Applecross Jetty (2019)

3.9 Reserves and conservation areas

The foreshore from Page Street in Attadale to Ness Road in Applecross is DBCA-managed land and is part of the Swan Estuary Marine Park and Adjacent Nature Reserves. The marine park covers the river to the high-tide mark and the adjacent land is part of the Alfred Cove Reserve. The marine park provides important feeding habitats for migratory wading birds that are protected under international agreements. The sand flats, mud flats and beaches provide significant feeding and resting areas in the Swan Estuary. This section of the foreshore is not considered as part of the City foreshore for the purposes of this report, as it is managed by DBCA

Bush Forever, which was released in December 2000 and proclaimed in 2010, is a government initiative to retain and protect regionally significant bushland on the Swan Coastal Plain within the Perth Metropolitan Region. Bush Forever aims to protect more than 51,000 hectares of regionally significant bushland within 287 sites across the metropolitan portion of the Swan Coastal Plain (Government of Western Australia 2000). The City foreshore includes three Bush Forever sites, mapped in**Error! Reference source not found.** Appendix B. The list of Bush Forever Sites are listed in Table 8 – Very High Value Reserves in the NAAMP (Woodgis, 2019) .

3.10 Environmentally Sensitive Areas

Environmentally Sensitive Areas (ESAs) are declared by a notice under Section 51B of the EP Act. The entire City foreshore is considered an ESA as there are a number of elements that have been declared ESAs within the foreshore areas (Appendix A) including:

- The foreshore is within 50 m of a defined wetland (the Swan River);
- Large sections of the foreshore are Bush Forever sites; and
- Areas of fringing native vegetation in the policy areas as defined in the *Swan and Canning Rivers Management Act 2006 (now endorsed by the DBCA).*

3.11 Drainage, hydrology and water quality

Wetlands include not only lakes with open water, but areas of seasonally, intermittently or permanently waterlogged soil. Approximately 25 percent of the Swan Coastal Plain between Moore River and Mandurah is classified as wetland (Hill, et al. 1996). Though extensive in area, not all wetlands retain significant ecological values due to the concentration of urban and agricultural development in the region. Most wetlands have been cleared, filled or developed

over, leaving only 20 percent of all the wetlands that were present on the Swan Coastal Plain prior to European settlement. Of these, an estimated 15 percent of the wetland area has retained high ecological values (Hill, et al. 1996).

Categorisation of wetlands has been conducted by Hill, et al. (1996), delineating Swan Coastal Plain into levels of protection and management categories. The entire area of Swan and Canning Rivers within the City foreshore area is classified as Conservation Category wetland (Figure 8-5, Appendix B). Conservation Category Wetlands are wetlands that support high levels of attributes and functions.

The Swan-Canning Estuary (code WA091) has been listed on the Directory of Important Wetlands in Australia as it was determined to be a good example of a shallow estuarine system that has substantial tidal exchange, is in reasonably good condition, has significant remaining areas of tidal flats and marshes, and is situated in a major urban centre (DotE 2014a).

The City foreshore consists of numerous storm water outlets to manage the outflows from the local road catchments. These outlets range in design and condition as shown in Figure 3-3. Potential water quality issues could result from poor condition of outlets and storm water treatment devices. An assessment of these issues was beyond the scope of this report.

Figure 3-3 Drainage Outlets (2019)

3.12 Bioregion

The City foreshore is located within the Swan Coastal Plain Interim Biogeographic Regionalisation of Australia (IBRA) Bioregion, Perth Sub-Region (SWA02). This sub-region is dominated by woodlands of *Banksia* and Tuart (*Eucalyptus gomphocephala*) on sandy soils, sheoak on outwash plains, and paperbark in swampy areas. The colluvial and aeolian sand areas represent three phases of Quaternary marine sand dune development (which provide relief), and include a complex series of seasonal fresh water wetlands, alluvial river flats, coastal limestones and several off-shore islands. Younger sandy areas and limestones are dominated by heath and/or Tuart woodlands, while *Banksia* and Jarrah–*Banksia* woodlands are found on the older dune systems (Mitchell et al. 2002).

3.13 Vegetation and flora

3.13.1 Desktop vegetation mapping

Vegetation associations

Broad scale vegetation mapping of the area (Beard 1979) identified the following two vegetation associations present along the City foreshore (Figure 8-4, Appendix B):

- Vegetation association 6 ‘Medium woodland: tuart (*Eucalyptus gomphocephala*) and jarrah (*E. marginata*)’: occurs across the majority of the foreshore

- Vegetation association 1001 'Medium very sparse woodland; jarrah (*E. marginata*) with low woodland, banksia and casuarina': occurs in the vicinity of Bull Creek at the eastern extent of the study area

Vegetation complexes

Regional vegetation has been mapped by Heddle et al. (1980) with updates from Webb et al. (2016) based on major geomorphic units on the SCP. The mapping indicates three vegetation complexes along the City foreshore (Government of Western Australia 2000) Figure 8-4, Appendix B,):

Spearwood Dunes

- **Cottesloe complex – central and south:** occurs along the foreshore west of Blackwall Reach

  Mosaic of woodland of *Eucalyptus gomphocephala* and open forest of *E. gomphocephala – E. marginata – E. calophylla* [now *Corymbia calophylla*]; closed heath on the Limestone outcrops.

- **Karrakatta complex – central and south:** occurs along the majority of the Swan Estuary foreshore from Blackwall Reach until Canning Bridge.

  Predominantly open forest of *E. gomphocephala – E. marginata – C. calophylla* and woodland of *E. marginata – Banksia* species.

Bassendean Dunes

- **Bassendean complex – central and south:** occurs along the Canning River foreshore, south-east of Canning Bridge.

  Vegetation ranges from woodland of *Eucalyptus marginata – Casuarina fraseriana - Banksia* spp. to low woodland of *Melaleuca* species and sedgelands on the moister sites.

Floristic community types

A detailed analysis of the patterning of plant communities on the Swan Coastal Plain was undertaken by Gibson et al. (1994) and updated for the System 6 and Part System 1 Update Program (DEP 1996). These assessments determined a total of 66 floristic community types on the Swan Coastal Plain (Government of Western Australia 2000). Floristic community types cannot be determined when the remaining vegetation is too disturbed to sample.

Floristic community types for the Bush Forever sites along the City of Melville foreshore are described in Table 3-5.

Table 3-5 Floristic community types previously recorded along the City of Melville foreshore (Government of Western Australia 2000)

Floristic Community Number and name	Occurrence in City of Melville Foreshore
16 Highly saline seasonal wetlands	Bush Forever site 331 Bush Forever site 338
S7 Northern woodlands to forests over tall sedgelands alongside permanent wetlands (most southern occurrence)	Bush Forever site 331 Bush Forever site 338
24 Northern Spearwood shrublands and woodlands	Bush Forever site 331

3.13.2 Field vegetation mapping

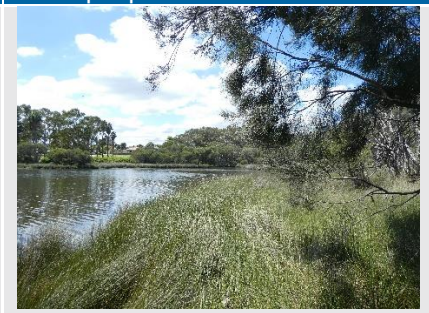
Prior to European settlement, the vegetation within the City of Melville foreshore would have consisted of riparian vegetation of saltmarshes and sedgelands with fringing *Melaleuca*

woodlands over sedgelands and with Tuart (*Eucalyptus gomphocephala*) and Flooded Gum (*Eucalyptus rudis*) woodlands in the upland areas. However, the foreshore has been heavily impacted following European settlement and much of the study area has been highly disturbed and has been cleared of native vegetation. Along much of the foreshore the riparian vegetation is restricted to a single line of trees or sedges along the shore. In some sections the foreshore has been revegetated with native or introduced plant species. In addition, the riparian vegetation along the foreshore has been altered due to changes in salinity throughout the Swan River Estuary since European settlement.

The vegetation types used in 2014 were also mapped for the 2019 survey. Nine of the vegetation types were considered native vegetation types and three were highly modified vegetation. The vegetation types have been mapped in Figure 8-6, Appendix B and are described in detail in Table 3-6.

Tompkins Park was not part of the 2014 survey but has been included in the 2019 survey. The remainder of the survey area has previously been mapped and has not significantly changed since the 2014 survey. Localised areas where the City has either landscaped or attempted weed eradication were the only main differences. Revegetation works along Point Heathcote has resulted in the establishment of endemic mid and understorey Tuart woodland community species. The foreshore and hillside that extends outside the survey area has a number of significant Tuarts (Diameter at Breast Height (DBH) >15 cm). Once the Tuarts planted by the City become of suitable size (DBH >15 cm), and at least six native species are established in the understorey, this area is likely to be considered representative of a Tuart Woodland. Tuart woodlands area now considered a conservation significant communities (refer Section 3.13.1 for more detail).

Table 3-6 Vegetation types mapped during the 2019 survey

Vegetation type	Description	Location	Example photo
VT1: *Juncus* dominated Sedgelands	*Juncus kraussii, J. pallidus, Ficinia nodosa and Bolboschoenus caldwellii* closed sedgeland over **Cynodon dactylon, *Stenotaphrum secundatum* and *Sporobolus virginicus* grassland with **Cakile maritima, **Atriplex prostrata* and *Suaeda australis* isolated herbs along the edges of beaches.	Occurs throughout the foreshore areas, often occurs as small fringing patches of vegetation	
VT2: *Melaleuca* and Flooded Gum woodlands	*Casuarina obesa* isolated trees with *Melaleuca rhaphiophylla* and *Eucalyptus rudis* woodland over of *Juncus kraussii, Hardenbergia comptoniana* and *Pteridium esculentum* sedgeland/ herbland.	Mainly occurs in the Bull Creek and Canning River area, on banks above the inundation area	
VT3: *Melaleuca* over sedgelands	*Melaleuca cuticularis* and *Casuarina obesa* isolated trees with *Melaleuca rhaphiophylla* woodland over *Juncus kraussii and/ or Typha orientalis* sedgelands with *Suaeda australis* open herbland.	Occurs as a line of fringing vegetation along the Canning River	

Vegetation type	Description	Location	Example photo
VT4: *Casuarina* stand	*Casuarina obesa* and *Melaleuca cuticularis* isolated clumps of trees over *Juncus kraussii* open sedgeland over **Cynodon dactylon* and **Stenotaphrum secundatum* open grassland	Small, isolated occurrences south of Canning Bridge and south of the South of Perth Yacht Club	
V5: Mixed *Acacia* shrublands (rehabilitation species)	*Acacia rostellifera, A. cyclops, A. saligna* and *Jacksonia furcellata* tall shrubland over **Pelargonium capitatum. Scaevola canescens* and *Conostylis candicans* low shrubland over **Cynodon dactylon* and**Bromus diandrus* grassland	Isolated occurrences east of Point Walter, at Jeff Joseph Reserve and along Blackwall Reach Parade	
VT6: Samphire shrubland and *Juncus* sedgeland	*Melaleuca cuticularis* and *Casuarina obesa cuticularis* isolated trees over *Juncus kraussii* closed sedgeland with *Sarcocornia blackii, S. quinqueflora* and *Suaeda australis* open shrubland over **Cynodon dactylon* open grassland	South of the South of Perth Yacht Club Plus very small isolated patches along the foreshore that are too small to map individually	

Vegetation type	Description	Location	Example photo
VT7: Cliffs with scattered salt-tolerant natives	Includes species adapted to living on limestone with salt spray including *Olearia axillaris, Rhagodia baccata, Acanthocarpus preissii, *Tetragonia decumbens* and *Alyxia buxifolia*	At Point Heathcote and Point Walter	
VT8: Mixed shrubland	*Banksia sessilis, Hakea prostrata* and *Acacia rostellifera* tall open shrubland *over Macrozamia riedlei Templetonia retusa, Melaleuca systena* and *Olearia axillaris* low open shrubland over **Ehrharta calycina* **Avena barbata* and **Lagurus ovatus* grassland	At Point Heathcote and Point Walter	
VT9: Tuart woodland	*Eucalyptus gomphocephala* and *Agonis flexuosa* woodland over *Spyridium globulosum, Acacia rostellifera* and *Olearia axillaris* tall open shrubland over *Rhagodia baccata, Acanthocarpus preissii* and *Lepidosperma gladiatum* low open shrubland/ sedgeland over **Oxalis pes-caprae, *Euphorbia terracina* and **Ehrharta* spp. herbland/grassland	Occurs in the area directly to the west of the Point Walter sandbar, and in the higher areas of the Point Heathcote area	

Vegetation type	Description	Location	Example photo
VT10: Parkland cleared	*Eucalyptus gomphocephala Eucalyptus rudis* **Eucalyptus* sp., *Agonis flexuosa*, **Araucaria heterophylla*, **Quercus suber*, **Erythrina x sykesii*), isolated trees over **Cynodon dactylon*, **Stenotaphrum secundatum* and **Cenchrus clandestinus*	Occurs along much of the foreshore. Often occurs in thin a strip between the footpath and fringing vegetation but also occurs all the way up to the foreshore. Larger areas occur within the park areas.	
VT11: Landscaped / rehabilitated	Planted native species including *Scaevola crassifolia, Olearia axillaris, Myoporum insulare, Leucophyta brownii, Eremophila glabra* and *Xanthorrhoea preissii*	Isolated occurrences along the foreshore, particularly at Point Walter, at the Raffles and along the Esplanade south of Canning Bridge	
VT12: Weedy shrubland	**Schinus terebinthifolius*, **Ficus carica*, **Arundo donax* over weedy grassland/ herbland	Adjacent to Spinaway Cresent	

3.13.1 Conservation significant communities

A description of conservation significant communities (Threatened Ecological Communities (TEC) and Priority Ecological Communities (PEC)) along with their conservation codes is provided in Appendix D

TECs and PECs are considered important vegetation communities and they should be protected, and their values enhanced, wherever possible. Federally listed TECs are protected under the EPBC Act. The BC Act provides for the Minister to list an ecological community as a TEC. Legislation also describes statutory processes for preparing recovery plans for TECs, the registration of their critical habitat, and penalties for unauthorised modification of TECs.

A search of the EPBC Act Protected Matters Search Tool (PMST) identified three TECs along the City of Melville foreshore area. A 2014 search of the DBCA TEC/PEC database identified two PECs along the City of Melville foreshore. A current DBCA database search was not made available at the time of writing this report, as a result conservation significant communities listed post 2014 are not included in the search results. Based on the results of the PMST search it is likely two additional PEC communities (listed post 2014) would occur in or around the survey area. The conservation significant communities identified in the database searches and considered likely to occur are detailed in Table 3-7. The 2014 DBCA database search is mapped in Figure 8-4, Appendix B. However it should be noted that additional conservation significant communities apart from the two mapped are considered likely to occur within the area.

Table 3-7 TECs and PECs identified in the desktop search potentially occurring along the City of Melville foreshore

Name	Status		Descritption
	EPBC Act	BC Act/ DBCA	
Subtropical and Temperate Coastal Saltmarsh	TEC- Vulnerable	PEC – Priority 3	Consists of the assemblage of plants, animals and micro-organisms associated with saltmarsh in coastal regions of sub-tropical and temperate Australia (south of 23oS latitude). The habitat is coastal areas under tidal influence. In southern latitudes saltmarsh are the dominant habitat in the intertidal zone and often occur in association with estuaries. It is typically restricted to the upper intertidal environment, generally between the elevation of the mean high tide, and the mean spring tide. The community consists mainly of salt-tolerant vegetation (halophytes) including: grasses, herbs, reeds, sedges and shrubs. Succulent herbs and grasses generally dominate and vegetation is generally <0.5m tall with the exception of some reeds and sedges (DBCA 2019)
Tuart (*Eucalyptus gomphocephala*) woodland and forests of the SCP (TEC)	TEC – Critically Endangered		The primary defining feature is the presence of *Eucalyptus gomphocephala* in the uppermost canopy, although this may co-occur with various other tree species. The ecological community varies in structure, with variable height and canopy closure across its range. Thus it can occur in a variety of forms, most commonly open forest, woodland and open woodland, but can also include other forms including various mallee structural formations. There is substantial floristic and structural variation in the understorey of the ecological community. This variation is influenced by the latitude and associated climatic variation, in particular, rainfall. It is also influenced by geomorphic and soil differences associated corresponding with position in the landscape (DotEE 2019b)
Tuart (*Eucalyptus gomphocephala*) woodlands of the SCP (PEC)	A component of the Tuart TEC	PEC – Priority 3	Mostly confined to Quindalup Dunes and Spearwood Dunes from Jurien Bay to the Sabina River, with outliers along some rivers. *Eucalyptus gomphocephala* is the key dominant canopy species however *Eucalyptus gomphocephala* communities comprise a variety of flora and fauna assemblages. Flora commonly occurring with Tuart include *Agonis flexuosa, Banksia attenuata, Banksia grandis, Allocasuarina fraseriana, Xylomelum occidentale, Macrozamia riedlei, Xanthorrhoea preissii, Spyridium globulosum, Templetonia retusa* and *Diplolaena dampieri* (DBCA 2019).
Banksia woodlands of the SCP (TEC)	Endangered		The ecological community is a woodland associated with the SCP. A key diagnostic feature is a prominent tree layer of Banksia, with scattered eucalypts and other tree species often present among or emerging above the Banksia canopy. The understorey is a species rich mix of sclerophyllous shrubs, graminoids and forbs. The ecological community is characterised by a high endemism and considerable localised variation in species composition across its range (TSSC 2016).

Name	Status		Descritption
	EPBC Act	BC Act/ DBCA	
Banksia dominated woodlands of the SCP IBRA Region (PEC)	A component of the Banksia TEC	PEC – Priority 3	Canopy is most commonly dominated or co-dominated by *Banksia attenuata* and/or *B. menziesii.* Other Banksia species that can dominate in the community are B. prionotes or B. ilicifolia. It typically occurs on well drained, low nutrient soils on sandplain landforms, particularly deep Bassendean and Spearwood sands and occasionally on Quindalup sands; it is also common on sandy colluvium and aeolian sands of the Ridge Hill Shelf, Whicher Scarp and Dandaragan Plateau and can occur in other less common scenarios (DBCA 2019)
Northern Spearwood shrublands and woodlands	Can form a component of the Banksia TEC and Tuart TEC	PEC – Priority 3	Heaths with scattered *Eucalyptus gomphocephala* occurring on deeper soils north from Woodman Point. Most sites occur on the Cottesloe unit of the Spearwood system. The heathlands in this group typically include *Banksia sessilis, Calothamnus quadrifidus* and *Schoenus grandiflorus* (DBCA 2019)

Based on the results of the desktop searches, dominant species, landform features and field observations, four conservation significant ecological communities are likely to occur along the City of Melville Foreshore area:

- Subtropical and Temperate Coastal Saltmarsh
- Tuart (*Eucalyptus gomphocephala*) woodland and forests of the SCP TEC
- Tuart (*Eucalyptus gomphocephala)* woodlands of the SCP PEC
- Northern Spearwood shrublands and woodlands PEC.

The TECs and PECs likely to occur within the survey area are described below

Subtropical and Temperate Coastal Saltmarsh TEC/PEC

This TEC was likely once present throughout much of the Swan River Estuary; however, it has likely declined in the area by over 50% (Keighery 2013). Species characteristic of the ecological community that are found along the City foreshore include:

- *Juncus kraussii*
- *Sporobolus virginicus*
- *Suaeda australis*

The key diagnostic characteristics of the Coastal Saltmarsh ecological community, as defined by DSEWPC (2013), is outlined below:

- occurs south of 23° 37' S latitude
- occurs on the coastal margin, along estuaries and coastal embayment's and on low wave energy coast
- occurs on places with at least some tidal connection, including rarely-inundated supratidal areas, intermittently opened or closed lagoons, and groundwater tidal influences, but not areas receiving only aerosol spray
- occurs on sandy or muddy substrate and may include coastal clay pans (and the like)
- consists of dense to patchy areas of characteristic coastal saltmarsh plant species (i.e. salt-tolerant herbs, succulent shrubs or grasses, that may also include bare sediment as part of the mosaic)
- proportional cover by tree canopy such as *Melaleucas* or *Casuarinas* is not greater than 50%,

Vegetation types VT6 and VT1 of Yagan wetland and are considered likely to be representative of the TEC/PEC Coastal Saltmarsh community

Tuart (Eucalyptus gomphocephala) woodland and forests of the SCP TEC and Tuart (Eucalyptus gomphocephala) woodlands of the SCP PEC

Tuart (*Eucalyptus gomphocephala*) woodland and forests of the SCP TEC was listed in July 2019 as a Critically Endangered TEC under the EPBC Act. DEE (2019b) defines the key diagnostic characteristics of this community to include, but not limited to:

- Occurs in the SCP Bioregion
- Primarily occurs on the Spearwood and Quindalup dune systems

- The primary defining feature is the presence of at least two living established (>15 cm Diameter at Breast Height) 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
- Biotic and patch size thresholds.

All of vegetation type VT9 was considered to be representative of the Tuart (*Eucalyptus gomphocephala*) woodland and forests of the Swan Coastal Plain TEC and the Tuart *(Eucalyptus gomphocephala)* woodlands of the SCP PEC. The key characteristics of VT9 that are synonymous with the Tuart TEC and PEC include:

- The community occurs on the SCP within the Spearwood dune system
- The community was described as a Tuart woodland with 10-30% Tuart canopy cover. The distance between the outer edges of significant tuart trees was <60 m and 32 potential black cockatoo habitat trees were recorded within the area
- Biotic thresholds were met with > 50% of the mid and ground cover stratum being native species
- The area mapped as VT9 was TBC ha and was predominately in Very Good – Good condition, which meets the thresholds to be considered the Tuart TEC.
- Additionally the vegetation of VT9 is part of a larger remnant of similar vegetation in similar condition, Point Walter Reserve which is approximately 13 ha. All Tuart patches that are >5 ha are considered part of the Tuart TEC regardless of the understorey condition.

The difference between the Tuart TEC and Tuart PEC is that the PEC has no minimum condition or patch size thresholds.

Northern Spearwood shrublands and woodlands (PEC)

The Northern Spearwood shrublands and woodlands (FCT24) is listed as a Priority 3 PEC by DBCA. This community occurs as heaths or heaths with scattered *Eucalyptus gomphocephala* occurring on deeper soils north from Woodman Point. Banksias found in this community include *Banksia attenuata* and *B. menziesii.* The heathlands in this group typically include *Dryandra sessilis* (now *Banksia sessilis*), *Calothamnus quadrifidus* and *Schoenus grandiflorus*, with other common species including *Hardenbergia comptoniana, Melaleuca acerosa* (now *Melaleuca systena*) *and Xanthorrhoea preissii*.

Vegetation type VT8 is likely representative of the Northern Spearwood shrublands and woodlands PEC due to the presence of key community species. The key characteristics of Northern Spearwood shrublands and woodlands PEC are:

- Occurs on the western SCP on the Cottesloe units of the Spearwood system
- The community occurs as heaths
- The heath community may consist of *Banksia sessilis, Calothamnus quadrifidus, Melaleuca systena, Xanthorrhoea preissii, Lepidosperma squamatum, Hardenbergia comptoniana, Phyllanthus calycinus, Conostylis aculeata, Dianella revoluta, Lomandra maritima, Schoenus grandiflorus, Desmocladus flexuosa* and *Austrostipa flavescens*.

3.13.2 Vegetation condition

The vegetation condition of the foreshore has not significant changed since the 2014 field survey. The vegetation condition for the 2019 field survey has been mapped in Figure 8-7,

Appendix B and the extents of each vegetation condition rating detailed in Table 3-8. The vegetation condition was assessed and mapped in accordance with the vegetation condition rating scale for the South West and Interzone Botanical Provinces of WA (devised by Keighery (1994) and adapted by EPA (2016)), refer Appendix D.

The majority of the foreshore has been highly modified and the vegetation structure has been altered from what would have previously occurred within the area. The areas of parkland are completed degraded with only scattered native species remaining and little ability to regenerate to a more natural condition.

Generally rehabilitated and or landscaped areas not given a condition rating. However the City has replanted endemic sedges in areas where there was previously bare sand and or weedy grassland. These areas have been rated as Good in condition because even though there are obvious signs of disturbances the basic vegetation structure for this area has been created. This will allow the area the ability to regenerate and merge with other remnants of sedgeland vegetation along the foreshore.

The western extent of Point Heathcote has been revegetated with endemic Tuart woodland species. This area has been rated as Very Good as, even though the area has obviously been altered, the disturbance has come from attempts to rehabilitate the area back to its natural state, refer Figure 3-4.

Figure 3-4 Point Heathcote revegetation

The remainder of the foreshore area supports remnants of native vegetation in a variety of conditions depending on width and size of the remnant. Much of the foreshore occurs in only a thin strip along the edge of the river, and this vegetation shows high levels of disturbance from edge effects, such as invasion of grasses. There are some larger areas of vegetation in better condition, and with the ability to potentially improve condition if management measures are implemented.

Table 3-8 Vegetation condition along the City of Melville Foreshore

Vegetation Condition	Extent (ha)
Excellent – Very Good	0.58
Very Good	0.21
Very Good - Good	3.59
Good	2.08
Degraded	4.28

Vegetation Condition	Extent (ha)
Total area	**10.74**

3.13.1 Flora diversity

164 flora taxa, representing 59 families and 131 genera were recorded from the survey area during the field survey. This total comprised 71 native taxa and 93 introduced flora taxa.

Dominant families recorded from the survey area included:

- Myrtaceae (17 taxa)
- Poaceae and Fabaceae (15 taxa)
- Asteraceae (12 taxa).

A flora taxa list by vegetation type is provided in Appendix E.

No EPBC Act or BC Act listed flora were recorded within the survey area. No DBCA Priority listed flora species were identified within the survey area during the field survey.

3.13.2 Introduced species

Over half of the flora species recorded during the field survey were introduced (57%). The flora species consisted of planted, garden escapes, common bushland weeds and Declared Pests and/ or Weeds of National Significance (WoNS). Four Declared Pests as listed under the Biosecurity and Management Act 2007 were recorded, three of these are also listed as WoNS:

- **Asparagus asparagoides* (Bridal Creeper) – Declared Pest and WoNS
- **Lantana camara* (Common Lantana)- Declared Pest and WoNS
- **Rubus laudatus* (Blackberry) – Declared Pest and WoNS
- **Zantedeschia aethiopica* (Arum lily) – Declared Pest

A list of the introduced species recorded along the foreshore is presented in Appendix E. Occurrences of Declared Pests and WoNS are mapped in Figure 8-6, Appendix B

3.14 Fauna

3.14.1 Fauna habitat

Fauna habitat types along the foreshore are closely associated with the vegetation types described in Section 3.13.2. The foreshore provides seven different types of habitat which are detailed in Table 3-9.

The fauna habitat along the foreshore is utilised by a number of fauna species, including conservation significant species. Conservation significant species are those species that are listed as Threatened under the federal EPBC Act or the state BC Act. The EPBC Act also protects migratory species that are listed under international agreements. In addition to these species that are protected under legislation there are conservation significant species that have been listed as priority species by DBCA and there are a number of species that are considered as significant on the Swan Coastal Plain portion of the Perth Metropolitan Region (Government of Western Australia 2000). Details of legislation relating to fauna species and conservation codes are detailed in Appendix D.

The Swan Estuary Marine Park is considered important habitat for migratory species and these species also occasionally occur along the foreshore areas using the shallows for feeding. A

number of migratory species were noted during the field inventory using the shallows adjacent to the beach east of Applecross Jetty and the rocky shoreline around Point Dundas.

One important habitat element that has been significantly impacted by clearing and disturbance along the foreshore is large, well-established habitat trees (particularly *Eucalyptus* species). Locations of trees with a Diameter at Breast Height (DBH) of greater than 300 mm were recorded during the field survey (Appendix B, Figure 8-6). These trees should be protected as they offer significant value as fauna habitat due to their potential to support nesting birds (particularly conservation significant species such as the three species of black cockatoo).

3.14.2 Habitat linkages

Habitat linkages are important to allow animals to move through the landscape between areas of resource availability. Habitat linkage is important for ground and aerial fauna, providing cover, resources and linking areas for foraging, rest and reproduction. The habitat along the foreshore provides some broad connectivity through the urban landscape, however the effectiveness of this linkage is limited by the large open areas and degraded habitat, and particularly the parkland cleared areas.

Fragmentation of habitat isolates resources for fauna. Where the distance between habitat fragments is short, species may still be able to move between the patches of habitat but may be more exposed to predation pressures in the cleared areas. The isolated patches of habitat along the City foreshore are highly separated from other areas of natural habitat. Fragmentation of habitat can also lead to edge effects, leading to degradation of the habitat. The foreshore habitat is highly impacted by edge effects such as erosion and weed infestation.

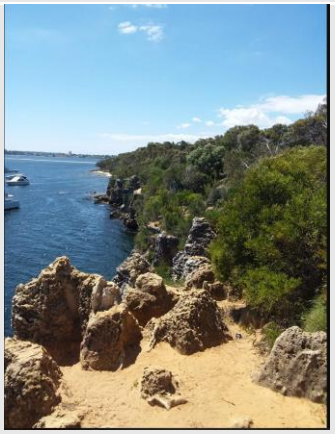
There are areas of foreshore habitat that retain high value resources for fauna such as the Bull Creek area, the woodlands around Point Walter Reserve and Blackwall Reach. These areas of vegetation along the foreshore are considered as important habitat linkages given the highly cleared landscape surrounding them (Alan Tingay & Associates 1998; Government of Western Australia 2000)

Birds are highly mobile and less affected by the isolation of habitat caused by fragmentation, though habitat degradation (caused by the edged effects of fragmentation) is a major threat to birds. Many species of birds are known to utilise the habitat at Bull creek, Point Walter and Blackwall Reach. Furthermore, the diversity of habitats valuable to (and utilised by) birds along the foreshore is much greater than other groups of taxa. Birds are known to use all the wetland, shore and terrestrial habits along the foreshore.

Table 3-9 Fauna habitat types recorded along the City of Melville foreshore

Habitat type	Description	Example photo
Sedgelands This habitat type is represented in the vegetation types; VT1: *Juncus* dominated Sedgelands VT6: Samphire shrubland and *Juncus* sedgeland	Scattered along the foreshore are sedgelands dominated by *Juncus kraussii* with a mosaic of samphire shrubs including *Salicornia blackiana* and *S. quinqueflora* and other sedges such *Ficinia nodosa* which is a species successfully utilised in revegetation along foreshore environments. These sedgelands are often associated with gently sloping shorelines and shallow adjacent aquatic habitat. The sedgelands provide supportive habitat for many bird species that forage in the shallow aquatic areas. Bird species would readily utilise these sedgelands for nesting and refuge. Small fauna species such as snakes and skinks are likely to utilise this habitat, particularly during hot and dry summer months. Other species such as Oblong turtles (*Chelodina colliei*) and Water Rats (*Hydromys chrysogaster*) would also potentially utilise this habitat for terrestrial refuge. Flora species that occupy these habitats are well adapted to the riparian zones of river banks and once established this habitat can be quite resilient against erosion and weed invasion. The sedgelands along the foreshore currently vary in condition. There are wave attenuation structures associated with some patches of this habitat and there is also evidence of previous restoration efforts of this habitat type. There is often sedgeland habitat adjacent to the sandy beach habitat types described below. Sedgelands in good to excellent condition are often associated with the *Melaleuca* and Flooded Gum woodlands (also described below).	 

Habitat type	Description	Example photo
Sandy Beaches	There are extensive areas of sandy beaches along the Melville foreshore. This habitat type is partly artificial (or artificially enhanced) to facilitate recreational activities and provide manageable open public spaces. The beach habitat is highly homogenous and provides limited resources for terrestrial fauna. The adjacent aquatic habitat is often devoid of foraging resources however bird species will utilise the habitat for foraging. Opportunistic species (such as Silver Gulls and Crows) are commonly associated with beaches and parkland areas along the Swan and Canning Rivers. There is evidence of active and ongoing erosion, mainly due to wave action, that is impacting these beaches along many parts of the Melville shoreline, particularly in the Canning Bridge area. This erosion is undermining the scattered trees and vegetation that remains within this habitat type. Restoration and stabilisation efforts are evident in several locations on the beaches, and the success of these efforts varies.	 
Riparian Woodlands This habitat type is represented in the vegetation types; VT2: *Melaleuca* and Flooded Gum woodlands VT3: *Melaleuca* over sedgelands VT4: *Casuarina* stand Stands of River Sheoak Paperbark and Flooded Gum association	Riparian Woodlands (dominated by Melaleuca Woodlands) occur along the foreshore; these woodlands vary considerably in condition. The Melaleuca woodlands in good to excellent condition include; • Flooded Gum (*Eucalyptus rudis*) in the upper structural layers • Scattered River Sheoak *Casuarina* with mid and upper structural layers • An understorey of intact sedgelands. Riparian Woodlands in good to excellent condition are largely restricted to the Bull Creek area and provide a broad suite of resources to fauna. When this habitat type is not overly degraded it provides nesting, roosting, foraging and refuge resources to many species, including fauna species of conservation significance such as roosting and foraging resources for Black Cockatoos and could provide all resource requirements for Water Rats (*Hydromys chrysogaster*). The Riparian Woodlands habitat in the Bull Creek area has high diversity in micro-habitats with fallen logs and branches, thick patches of leaf litter, variation in water inundation and depth, age class variation in many flora species, canopy connectivity and variation in the height and thickness of the vegetation. There are sections where this Riparian Woodland habitat is in degraded condition and therefore offer limited value to fauna species. Some patches of the habitat have very limited diversity in the flora species, age classes, ground cover and micro-habitat. These sections are often restricted to only mature Melaleuca or Sheoak trees with an understorey of introduced grasses such as Couch (**Cynodon dactylon*), Buffalo Grass (**Stenotaphrum secundatum*) and Kikuyu	 

Habitat type	Description	Example photo
	(**Pennisetum clandestinum*). Given the extent of degradation of these sections of Riparian Woodlands restoration of this habitat may be inhibited.	
Revegetation and weedy shrublands This habitat type is represented in the vegetation types; V5: Mixed Acacia shrublands (rehabilitation species) VT12: Weedy shrubland	There is habitat along the foreshore that has been previous revegetated or is highly disturbed that can be grouped as one habitat type. These areas included; • Degraded shrublands and open woodlands dominated in most structural layers by woody weeds and weedy grasses • Recently revegetated areas that are still open and have ground cover dominated by weedy grasses and herbs. • Areas that have been revegetated historically where revegetation has not resulted in self-sustaining, native vegetation. There are patches of this habitat type scattered all along the foreshore. This habitat is considered to be in poor condition due the dominance of weeds. However these areas do provide some value as fauna habitat. This habitat includes thickets of shrubs and vegetation that provide foraging and nesting habitat for birds. The thicker areas would also give shelter and habitat resources for a broader suite of fauna including many types of reptiles.	 
Cliffs This habitat type is represented in the vegetation types; VT7: Cliffs with scattered salt-tolerant natives Limestone cliff vegetation	The cliff habitat along Blackwall Reach and small patch near Point Heathcote is reasonably restricted in the broader region along the Swan and Canning rivers. The cliffs, particularly at Blackwall Reach, provide habitat for fauna species that are adapted to this habitat. The cliffs have some complexity with large and small cracks and crevices throughout the limestone which provides variation of resources to fauna. The habitat is mostly undisturbed due to the steepness and inaccessibility, and subsequently this habitat is largely intact. Long term recreational use of the areas is evident and there are several areas along the top of the cliffs where trails have been established, however these trails are more intrusive to the Tuart Woodland habitat along the top of the cliffs than the actual cliff habitat. Many birds such as the Nankeen Kestrel are likely to utilise small caves and crevices in the cliffs for breeding. Cormorants and other water birds use the site as perch and drying habitat. The vegetation is limited in this habitat type however the species that do grow there are also adapted to cope with the conditions.	

Habitat type	Description	Example photo
		
Tuart Woodland This habitat type is represented in; VT9: Tuart woodland VT8: Mixed shrubland *Banksia sessilis* heath vegetation	Woodland habitat dominated by Tuart (*Eucalyptus gomphocephala*) is largely restricted to the area adjacent to the cliffs along Blackwall Reach, Point Walter sandbar, and in the higher section near Point Heathcote. These woodlands have some structural and age class variation including patches of *Banksia sessilis.* The understorey of this habitat is often degraded and contains weedy grasses, particularly along the edges of footpaths. The habitat has some micro-habitat variation which increases its value as fauna habitat. The ground cover does include vegetation, logs, fallen branches and patches of leaf litter which will be used by a suite of fauna species.	 
Parklands and gardens This habitat type is represented in the vegetation types; VT10: Parkland cleared VT11: Landscaped gardens Parks of maintained lawns	Extensive areas of the City foreshore have been completely modified and now consist of lawns, parklands, gardens, walkways, roads and built structures. The vegetation within these areas is dominated by weeds but there are occasional mature native trees including Tuart (*Eucalyptus gomphocephala*), Flooded Gum (*Eucalyptus rudis*) and Peppermint (*Agonis flexuosa*). There is limited diversity of resources and habitat value in these areas. However, the trees and gardens will provide some habitat for fauna. The revetment foreshore stabilisation (usually piles of rock) does provide habitat for birds. Water Rats (*Hydromys chrysogaster*) are known to utilise these artificial rocky areas along the Swan and Canning Rivers. The walls, gabions, groynes and jetties along the foreshore also provide perching and resting habitat for many birds species such as Cormorants and Gulls. These areas are regularly used for recreational activities and are a focal point for the City providing extensive areas of public open space.	

Habitat type	Description	Example photo
/ Large non-native trees Landscaped gardens		

4. Management Issues/Threats

4.1 Acid Sulfate Soils

The Department of Environment and Regulation (DER) describes Acid Sulfate Soils (ASS) as "naturally occurring soils, sediments and peats containing iron sulphides (often present as pyrite materials)" and can be "found in low-lying land bordering the coast or estuarine and saline wetlands and freshwater groundwater-dependent wetlands" (DEC 2013). When buried, these materials do not pose a significant risk to human health or the environment. However, exposing ASS to oxygen (by disturbing the soil), has the potential to cause significant environmental and economic impacts including:

- Fish kills and loss of biodiversity in wetlands and waterways
- Effects on estuarine fisheries and aquaculture projects
- Contamination of groundwater resources by acid, arsenic, heavy metals and other contaminants
- Reduction in agricultural productivity through metal contamination of soils (predominantly by aluminium)
- Damage to infrastructure through the corrosion of concrete and steel pipes, bridges and other subsurface assets

Projects which disturb potential ASS must be assessed to determine associated risks and management measures put in place to avoid or mitigate environmental harm.

The DER Acid Sulfate Soil (ASS) risk mapping indicates that the majority of the City foreshore has 'High to moderate ASS disturbance risk' with some areas having 'Moderate to low ASS (<3m from surface) see Figure 8-5, Appendix B. This indicates that there is potential for ASS to occur within the first 3 m of the surface. However, ASS are unlikely to be a problem along the City foreshore unless excavation of soil is required. New projects, including any restoration works along the foreshore should be assessed to determine whether excavation of the soil is required, and if so a risk assessment should be undertaken to determine whether any disturbance to ASS may occur, and thus whether any management measures are required.

4.2 Vegetation clearing

Loss of vegetation reduces the species diversity, impacts on the fauna habitat availability, reduces habitat connectivity and may led to other issues such as reduction in nutrient stripping of water runoff.

Since European settlement large-scale clearing of the City foreshore has occurred. The large-scale clearing along the foreshore is no longer occurring; however, loss of vegetation is happening through secondary mechanisms such as erosion of the riverbank that leads to an undercutting of roots and lack of stability of vegetation. Where vegetation loss has occurred, hydraulic forces, such as waves from boat wake, are likely to have led to increased erosion of the riverbank.

Lack of regeneration of native vegetation can be considered as a loss of vegetation as in time areas that are no longer naturally regenerating will suffer loss of native vegetation. Lack of regeneration is a major issue in areas of maintained lawns where the mowing of grass beneath established native trees will prevent natural regeneration.

4.3 Trampling

Loss of vegetation can be caused by trampling of vegetation through uncontrolled access, such as the use of undefined tracks to access areas of the foreshores. Trampling can damage vegetation, change plant composition, reduce plant cover and may result in the spread of weeds. Trampling and loss of vegetation can also lead to soil erosion. Trampling impacts depend the type and density of vegetation.

4.4 Vandalism and dumping of rubbish

Vandalism can include destruction of property and facilities as well as damage to native vegetation, such as tree poisoning and illegal clearing. Foreshore vegetation may be removed by individuals in order to improve their views of the river.

Dumping of large amounts of rubbish along the foreshore is not as common as in other bushland areas within the City; however there is the potential for rubbish dumping including in some of the larger bushland areas adjacent to the foreshore such as Point Walter and Bull Creek. Dumping of rubbish can spread weed and diseases, can reduce the visual amenity of the foreshore and can constitute a fire hazard. Littering is a common problem along the foreshore and litter on the foreshore can enter the river system.

4.5 Weeds

Invasive species (including weeds) represent the biggest threat to biodiversity after habitat loss (DotE 2014c). Weeds are plants that grow in areas where they are not wanted and where they may have an environmental or economic impact. Weeds can impact on natural values by:

- Out-competing native species for nutrients, water, space and sunlight
- Reducing the natural diversity by smothering native plants or preventing them from growing back
- Reducing habitat for native animals
- Altering fire regimes (DPaW 2014)

Weeds have the potential to impact on areas of native vegetation by competing with native species for habitat. The City contains a large number of introduced (weedy) species due to its long history of disturbance and modification. In some instances introduced species dominate the foreshore and some of the weedy species play an important role in bank stabilisation as well as providing recreational amenity such as shade trees.

In some sections along the foreshore, such as the grassed recreation areas, introduced plants are part of the landscape and they are not considered a threat in place. However, they become a threat when they spread into areas of native vegetation adjacent to the maintained grass areas. This is a significant issue where there is a lack of delineation between grassed areas and native vegetation, which allows the grasses to enter and smother the vegetation. This is particularly prevalent in sedge beds along the foreshore.

The major vectors for the introduction and spread of weeds along the foreshore include:

- Dumping of rubbish
- Escape of garden plants: particularly in areas where gardens border the foreshore
- Human and animal transport

2019 weed management observations

During the 2019 survey it was noted that weed eradication and or management was attempted adjacent to Spinaway Crescent, Brentwood. Unfortunately the attempt to kill the Japanese peppers *(*Schinus terebinthifolius*) through herbicide and lodging nails into the stumps were unsuccessful; in many instances the tree has re-sprouted from the stump or roots (Figure 4-1). Also in the same area were numerous of Arum Lily (**Zantedeschia aethiopica*) saplings.

Figure 4-1 Japanese pepper re-sprouting after an attempt to eradicate

4.6 Introduced Fauna

There are a number of introduced fauna species that have the potential to occur along the City foreshore and these animals can have potential impacts on native species including:

- Predation on native fauna species and grazing of native plants
- Competition with native fauna for food and shelter
- Destroying habitat
- Spreading diseases
- Land degradation including soil erosion and destruction of vegetation by introduced fauna can lead to soil erosion (DotE 2014d)

Introduced fauna species that may be a threat to the City foreshore include:

- European rabbit (*Oryctolagus cuniculus*): grazes on native vegetation, may impact on revegetation efforts by killing juvenile plants
- European red fox (*Vulpes vulpes*): preys on native fauna species, competes with native fauna
- Feral cat (*Felis catus*): preys on native fauna species, competes with native fauna
- European bee (*Apis mellifera*): competition with native fauna species (such as cockatoos) for tree hollows
- A number of bird species: competition with native fauna species (e.g. the Rainbow Lorikeet [*Trichoglossus haematodus*],the Little Corella [*Cacatua sanguinea*] and the Eastern Long-billed Corella [*C. tenuirostris*].

The rabbit, fox and feral cat are all listed under the EPBC Act introduced species listed as a key threatening process.

4.7 Diseases and pathogens

Disease and pathogens of plants, such as *Phytophthora* spp. have the potential to cause death and decline of plants species along the City foreshore. Several *Phytophthora* spp. cause root rot in susceptible plants, thereby limiting or stopping the uptake of water and nutrients (Dieback Working Group 2014). *P. cinnamomi* is most commonly recognised as Phytophthora Dieback, and is the most well know of the *Phytophthora* spp. However there are several species of *Phytophthora* recognised in WA that are also responsible for the death of native plants and associated with tree declines (Centre for Phytophthora Science & Management 2019). Two species of *Phytophthora (P.humilis* and *P. littoralis*) have previously been identified within Attadale Foreshore Reserve. Other plant diseases that occur in Western Australia include:

- Rusts: The rust (*Uromycladium tepperianum*) has been recorded in the Bull Creek wetlands (Woodgis 2011)
- Root rot (*Armillaria luteobubalina*): This disease occurs does not occur in the Spearwood Dune System but may occur in the Bassendean Dune system (near Bull Creek)
- Cankers
- Mundulla Yellows

Diseases and pathogens are not considered to currently be a major threat along the City foreshore. Standard hygiene measures should be implemented when introducing soil or plants to the foreshore to minimise any risk of introduction or spread of diseases and environmental weeds. Future vegetation monitoring should include consideration of diseases and pathogens if these become a threat to the vegetation along the foreshore.

4.8 Fire

Fire can destroy property and be a safety hazard. Fire also impacts on native vegetation in a variety of ways, depending on the scale of the fire and the vegetation. The impacts of fire on vegetation can be very complex with some effects positive and some negative; however the negative impact of fire can be greater in small bushland remnants than large tracts of uncleared vegetation (Woodgis 2019).

Firefighting foams (per and poly-fluoroalkyl substances – PFAS) are a current concern for environmental stress. These chemicals have been identified worldwide as emerging contaminants. Some PFAS have been shown to be toxic to some animals, and because they do not break down in the environment, there is potential to bioaccumulate in plants and animals. (NTEPA, 2019).Firefighting foams also present risk of contamination to the environment and there is evidence that it should be handled as a toxic waste (The Guardian, 2017). This can highly affect the river and human health if the area is highly being used by the public for recreational activities such as swimming.

Bush Forever sites located along the foreshore are mostly likely of prone to develop bushfire. As firefighting foam poses risk outlined above. GHD recommends to use aerial firefighting to combat wildfires. As the Bush Forever Sites are in close proximity to the river, the firefighting aerial units are able to access water and dump on wildfire sites.

4.9 Erosion

4.9.1 Classification

During the site inventory, evidence of erosion to hard and natural infrastructure was recorded in the GIS tablet device and locations have been provided to the City as shape files. In line with

the past reviews, the erosion mechanisms were identified according to those specified in the DBCA Best Management Practices for Foreshore Stabilisation (2009) (Table 4-1).

Table 4-1 DBCA erosion mechanisms

Erosion Mechanisms
1. **Energetic Wave Conditions**: often associated with dramatic loss on beaches during single storm events.
2. **Increase in Mean Water Level:** causes an upwards migration of the active hydraulic zone.
3. **Decrease in Mean Water Level**: lowered water levels cause a downwards migration the active hydraulic zone.
4. **Vegetation Loss:** loss of vegetation tends to provide a bank that is less resistant to hydraulic action.
5. **Sediment Sink/Source:** locations where there is an imbalance of sediment transport experience net erosion or accretion.
6. **Sediment Deficit:** change that alters the prevailing sediment transport conditions, removing a quantity of sediment from active forcing before normal transport patterns return.
7. **Strong Currents:** located primarily where there are restrictions in cross-sectional area.
8. **Seasonality:** both the intensity of prevailing conditions and their persistence may affect the net sediment transport rate.
9. **Drainage Structures:** erosion associated with drainage outfalls may extend beyond the immediate vicinity of the flow path.
10. **Flow over Banks:** erosion, often in the form of gully erosion, associated with water flowing directly over the banks due to drainage of overtopped water or as a result of stormwater runoff.
11. **Sedimentation:** sedimentation of the channel decreases the channel cross-sectional area and thereby increases the potential for channel planform migration and inundation as a result of flooding.
12. **Trampling:** loss of vegetation and sediment can occur due to uncontrolled access, worm digging, boat launching and animal activity.

4.9.2 Condition rating

Assets were also given a condition rating based on the frame work shown in Table 4-2.

Table 4-2 Asset condition rating

Condition Rating	Description
1	**Excellent** Asset in ''As New'' condition, requiring only routine maintenance. No significant voids, no evidence of erosion and no evidence slumping.
2	**Good** Asset in good condition, with minor deterioration of the asset requiring a low level of maintenance.
3	**Fair** Asset is beginning to show moderate signs of deterioration with sections requiring repairs but asset is still functional.
4	**Poor** Significant amount of damage to asset has occurred, which would require a major upgrade or renewal to extend the life of the asset.
5	**Very Poor** No remaining life expectancy. Major work, total replacement or disposal required.

4.9.3 Nature and rating of erosion along the foreshore

The following erosion rating scale, as prescribed by NAMS (2009) ranks the extent of erosion damage occurring along the foreshore:

- High: Extensive erosion damage evident including extensive loss of soil, damage to existing erosion mitigation structures, severe undercutting of large trees and uprooting of fringing vegetation
- Medium: Some erosion damage evident, some soil lost from banks, slight undercutting of large trees and loss of some fringing vegetation, erosion mitigation structures still intact
- Low: Minimal erosion damage evident, banks still intact, some loss of fringing vegetation, no undercutting of large trees, erosion mitigation structures functioning
- Negligible: No evidence of erosion damage

To provide consistency between the reports, GHD used the same scale to rate the current extent of erosion. Table 4-3 summarises a comparison of the current erosion conditions witnessed along the City's foreshore and the foreshore ratings made by Alan Tingay & Associates (1997), NAMS (2009) and GHD (2014).

Table 4-3 Nature and rating of erosion along the foreshore

Area	Nature	Rating				Comments (2019)
		1997[a]	2009	2014	2019	
Bull Creek	4,12	Not Rated	Negligible	Low	Medium	Coastline is exposed to energetic wave conditions and experiencing erosion leading to areas of unstable verges and movement (evidenced by observations such as cracked pipes).

Area	Nature	Rating				Comments (2019)
		1997[a]	2009	2014	2019	
Canning River	1,2,3,4,5,8,9,10,12	4	High	High	Not rated	Not observed as part of the 2019 survey data.
South Perth Yacht Club to Canning Bridge	1, 4, 5	3	Negligible	Low	Not rated	This stretch of foreshore was part of the excluded zone.
Waylen Bay	1, 4, 9	2,3	Low	Med	Not rated	This stretch of foreshore has remained mostly stable, although there have been some instability issues at Pt Heathcote and verge erosion concerns along Jeff Joseph Reserve.
Melville Beach	4,9	1,2	Low	Low	High	This stretch of foreshore has been experiencing erosion from trampling and wave condition leading to undercutting of grass area leading to a drop of ground level.
Point Walter	1,2,3,4,5	Not Rated	Med	Low	High	There are erosion threats to trees.
Blackwall Reach	1,2,4,5,8,9,12	Not Rated	Low	High	Medium	The foreshore has been experiencing erosion from trampling, causing instability and trees under threat.

a: As rated by Tingay (1997); 1 (High): experiencing extensive seasonal soil loss and require significant remediation works; 2 (Medium): areas that require rehabilitation as a secondary consideration; 3 (Low): experiencing erosion but require only minor treatments; 4 (Interspersed patches): areas that have small sections (approximately 1 m wide) of erosion at inconsistent intervals.

4.9.4 Climate Change

According to the DBCA (2007) report, *Potential Impacts of Climate Change on the Swan and Canning Rivers*, the impacts of climate change will affect the Swan and Canning Rivers at an ecological, infrastructural, human health, social and economic level. The DBCA report states that many of the effects of climate change will unfortunately not have the opportunity for active management and for factors that can be controlled decisions will need to be made between developing foreshore protection measures or allowing processes to continue without interference. The predicted scenarios investigated by the DBCA indicate:

- accelerated atmosphere and ocean warming;
- decrease in total winter stream flows;
- accelerated sea and tidal estuary level rise;
- decreased winter rainfall;
- increased frequency of droughts;
- increase in extreme tidal estuary levels; and
- increase in frequency of warm spells and heat waves.

Because of the diverse nature of the Swan and Canning river foreshore and ecological system, the potential impacts from climate change are numerous and difficult to predict definitively. Climate change will inevitably effect: sediment composition and nutrient loads; dissolved oxygen levels; nutrient cycling; fringing vegetation; community structure (including trophic dynamics with a particular focus on birds and fish); mudflats; sea grass and macro-algae; biodiversity; acidification; and geomorphology. Table 4-4 presents examples of the potential impacts of climate change on the ecological aspects of the City's foreshore. Ongoing monitoring of ecological conditions will be required to predict and assess climate change related issues to ensure the best management practice is implemented.

Table 4-4 Summary of potential ecological impacts of climate change (Swan River Trust 2007)

Ecological Aspect	Example of Potential Impacts
Sediment composition and nutrient loads	Expected that over time the total amount of particulate and dissolved nutrients in the Swan Canning river system will increase.
Groundwater	Change in shallow groundwater composition.
Dissolved oxygen (DO) & nutrient cycling	Increased potential (intensity, frequency, duration) for low DO events and more fish kills in the middle and upper estuary due to increased sediment oxygen demand, increased stratification, increased water depth and higher temperatures.
Fringing vegetation	There is expected to be changes in vegetation distribution, vegetation density and species invasion.
Community structure	In the lower estuary, there will be limited change in productivity and a possible slight increase in species diversity.
Trophic dynamics	Potential for trophic dynamics to become even simpler (involving fewer species).
Mudflats	Landward migration of the intertidal zone and shallow subtidal zone in the lower estuary.
Seagrass and macro-algae	Expected to cause some changes favourable to seagrasses in the lower estuary, including a less extreme salinity range, maintenance of marine salinities for longer periods, and possibly improved water clarity.
Freshwater biodiversity	Expected to reduce the downstream extent of the freshwater reaches of the Swan River.
Acidification/buffering capacity	Biodiversity may be affected, as some species will be better suited to higher CO2 and lower pH.
Geomorphology – bank stability	Changes in 'foreshore' dynamics and potential readjustments to sedimentary processes.

Climate change may result in a change of appearance and usage of the City's foreshore, which may influence human health and social conditions. The effects of climate change on human health and social impacts will be the key drivers for managing the impacts of climate change. There is a large level of uncertainty involved in the effects of and reactions to climate change at a human health and social level. As a result, the DBCA (2007) recommends ongoing community engagement to ensure there is an understanding of their needs and aspirations, in order to develop the most appropriate actions.

The City's foreshore infrastructure (natural and built) will be impacted by an increase in water levels and storm events which is likely to result in an increase in the rate of erosion and inundation of coastal areas. Structural assessments and monitoring will need to be implemented for existing structures and the construction of new assets and protection measures will need to take into account the changing site conditions due to climate change.

4.9.5 Sea level rise

Sea level rise estimates are based on the 2007 publications from the Intergovernmental Panel on Climate Change (IPCC). Note that the IPCC Fifth Assessment Report (AR5) on the impacts of climate change was published in 2014. The next Assessment Report, AR6 will be published in 2022.

The IPCC (2007) provides an authoritative international statement of scientific understanding of climate change that is widely accepted and used in surge and inundation studies around the world. The report suggests that the predicted mean sea level rise in Western Australia may be assumed equal to the predicted global mean sea level rise.

The projected global average sea level rise during the 21st century is based on numerical models for six greenhouse emission scenarios for different combinations of political, social, cultural and educational conditions. These scenarios are referred to as the Special Report on Emissions Scenarios (SRES) marker scenarios. The projected sea level rise estimates presented in Figure 4-2 are bounded by the results from the B1 (sustainable world) and A1FI (world of very rapid economic growth) scenario predictions. The mean projection of the middle-range SRES scenario A1B is 0.48 m by 2099.

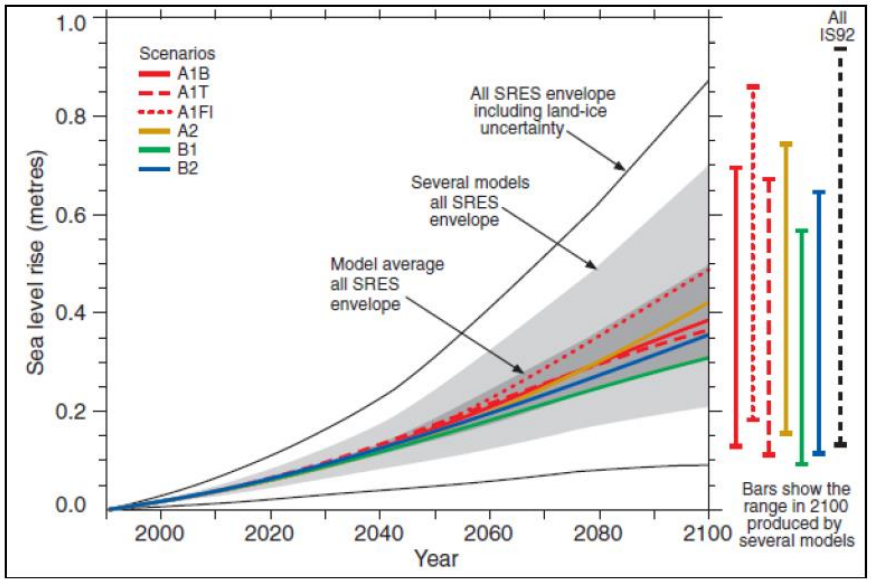


Figure 4-2 Sea level rise predictions (IPCC 2007)

For a thorough review of the IPCC (2007) report, refer to *Sea Level Change in Australia: Application to Coastal Planning*, published by the Department of Transport (DoT) in 2010. The report reviewed current information on mean sea level variation along the Western Australia (WA) coastline and provides recommendations on an approximate allowance for mean sea change for costal planning. The report is based on information presented in the Intergovernmental Panel on Climate Change Report (IPCC 2007) and other recent publications.

Based on the information reviewed, the DoT recommended a conservative vertical sea level rise of:

- 0.9 m for a 100 year planning timeframe
- 0.3 m for a 50 year planning timeframe

5. Prioritisation of Works

5.1 Objectives

A prioritisation framework was developed to provide a method of prioritising works along the foreshore based on the value of the assets and the extent of the threat to the assets. Prioritisation of works is necessary due to the large area of the foreshore and the limited resources available.

A framework was developed based on the City of Melville's Natural Areas Asset Management Plan (Woodgis 2019) and the DBCA's Foreshore Stabilisation Policy and Process. The framework is generic in nature and includes assessing the assets against known level of significances (such as statutory listings) so that it provides a robust and transparent mechanism for determining priorities for work. This framework is clearly defined and can be used for determining priorities during future foreshore strategy revisions. It can also be used at a local level for the development of management priorities for individual reserves or sites.

5.2 Broad-scale ranking of assets

The first stage of the prioritisation process was to identify a ranking of assets at a broad-scale level to provide an indication of the level of significance of assets.

Assets that are of high significance at an international, national or state level are identified based on legislation or policies. These assets do not tend to frequently change and there is generally sufficient information to determine these assets at a desktop level. These classifications and rankings were designed to align with the process set-out in the City's Natural Areas Asset Management Plan 2019 (Woodgis 2019).

Other assets are ranked according to infrastructure value, public safety, and recreational amenity. This generally comes from specialist skills and knowledge of the coastal engineers, ecologists or City staff. These classifications and rankings were designed to align with the DBCA guidelines (Best Management Practices for Foreshore Stabilisation, 2009).

This broad-scale ranking of assets shown in Table 5-1 provides a framework to enable a quick but robust assessment of site-specific assets. Detailed descriptions of the assets are included in Section 0 and Appendix D.

Table 5-1 Definitions of ranking for assets

Asset Ranking	Aspect	Level of significance	Description
Very High	Ecological	International (statutory)	Migratory species protected under international conventions and the Environment Protection Biodiversity Conservation Act 1999 (EPBC Act)
		National (statutory)	Communities and species protected under Federal legislation (EPBC Act)
		State (statutory)	Species and Communities protected under State legislation (Biodiversity Conservation Act 2016)
		State (non-statutory)	Communities and species listed by DBCA (Priority Ecological Communities and Priority listed species)
			Sites listed as Bush Forever by the Western Australian Planning Commission
			Vegetation complexes in Perth Metropolitan Region with <10% remaining
			Conservation category and Resource enhancement wetlands

Asset Ranking	Aspect	Level of significance	Description
	Heritage	National (statutory)	World heritage properties, national heritage places protected under Federal legislation (EPBC Act)
		National (non-statutory)	Heritage sites listed on the Register of National Estate
		State (statutory)	Registered Aboriginal Heritage sites under the Aboriginal Heritage Act 1972
			Registered sites under the Heritage of Western Australia Act 1990
	Assets	Infrastructure Value	Assets with value greater than $100,000
		Public Safety	Assets that involve a very high element of public safety, such as those that can cause major injury and unmanaged hazards
		Recreational Amenity	Foreshore area with large areas of established recreational facilities
High	Ecological	State (non-statutory)	Multiple-use Category Wetland
		Local	Listed by Bush Forever (Government of Western Australia 2000) or Alan Tingay & Associates (1998) as a regional linkage
			Listed as a significant species of the Perth Metropolitan Region in Government of Western Australia (2000) (those not listed under legislation or as priority by DBCA)
	Heritage	Local	City of Melville listed heritage sites
	Assets	Infrastructure Value	Assets with value between $10,000 and $100,000
		Public Safety	Assets that involve a high element of public safety, such as those that can cause major injury with hazard management or minor injury without hazard management
		Recreational Amenity	Foreshore area with some areas of established recreational facilities
Medium	Ecological	Local	The area is a natural area generally in good or better condition
			>4 ha of bushland
			Occurring in few reserves in the City of Melville
			Sites with active community involvement in management
	Assets	Infrastructure Value	Assets with value less than $10,000
		Public Safety	Assets that involve a medium element of public safety, such as those that can cause injury requires hazard management to be bypassed
		Recreational Amenity	Foreshore area with limited recreational facilities
Low	Ecological	Local	Individual trees
	Assets	Value	Assets with value less than $1,000
		Public Safety	No hazard management required
		Recreational Amenity	Foreshore area with no recreational facilities and no access

5.3 Ranking of threats

Where possible, threats were identified based on legislation or policies. These threats do not tend to frequently change and are generally high-level threats.

Other threats are ranked on reasons of risks to public safety, threats to infrastructure value and loss of recreational amenity. This generally came from specialist skills and knowledge of the coastal engineers, ecologists or City of Melville staff.

Threats that cannot be managed in a meaningful form at the local scale were excluded from the assessment. This included threats such as highly contagious pathogens that are managed through quarantine procedures by the Federal and State governments.

This broad-scale ranking of threats is shown in Table 5-2. This provides a framework to enable a quick but robust assessment of the ranking of threats at specific sites along the foreshore.

Table 5-2 Definitions of ranking for threats

Threat Ranking	Aspect	Level of significance	Threats
Very High	Ecological	National (statutory)	Any key Threatening Process listed under the EPBC Act • Includes: High level of impact from introduced pest species (i. e. grazing from rabbits) • High level of predation by Feral Cats or European Red Fox
		National (non-statutory) / State (statutory and non-statutory)	Infestation of Weeds of National Significance or a Declared Pest listed under the *Biosecurity and Agriculture Management Act 2007* likely to affect ecological asset >1 year Areas with significant weed invasions that are impacting the condition of the native vegetation
		Local	High amount of trampling of vegetation, potential to affect ecological asset >1 year
			Potential for dieback and other diseases to invade non-infested vegetation
	Assets (Condition assessment rating: Failing)	Infrastructure Value	Likely impact within one year
		Public Safety	Potential for accident within one year
		Recreational Amenity	Permanent interruption of foreshore area with high use by public for recreational activities
High	Ecological	Local	Medium amount of trampling of vegetation, potential to affect ecological asset 1-5 years
			Unofficial tracks/access to areas leading to erosion of banks and cliffs
			Areas with significant weed invasions which are not currently affecting the condition of the native vegetation but have the potential to spread and impact the condition of the vegetation.
	Assets (Condition assessment rating : Poor)	Value	Likely impact in 1 to 5 years
		Public Safety	Potential for safety hazard between 1 to 5 years
		Recreational Amenity	Reduced area or temporary interruption of high use foreshore area
Medium	Ecological and Social	Local	Rubbish dumping, but not likely to significantly impact ecological asset >1 year
	Ecological	Local	Low amount of trampling of vegetation, potential to affect ecological asset 1-5 years
			Areas with low levels, or isolated infestations of weeds

Threat Ranking	Aspect	Level of significance	Threats
	Assets (Condition assessment rating : Fair)	Infrastructure Value	Likely impact after 5 years
		Public Safety	Potential for safety hazard after 5 years
		Recreational Amenity	Foreshore activities can be relocated
Low	Ecological	Local	Areas with weeds that are not affecting native vegetation and that are currently well controlled (i. e. grassed areas that are regularly mowed and do not have the potential to invade native vegetation) Areas with weeds that have low potential to invade native vegetation
	Assets (Condition assessment rating : Good)	Infrastructure Value	Only during an extreme event
		Public Safety	Only during an extreme event
		Recreational Amenity	No disruption of foreshore activities

5.4 Prioritisation framework

Site-specific assets were identified and assessed through the following methods:

- Desktop review of existing strategies, management plans and literature
- Detailed inventory by engineering and ecological specialists
- Specialist knowledge of City of Melville and DBCA staff

These site-specific assets are present in (Appendix E).

These site-specific assets were aligned with the broad-scale asset ranking (Table 5-1), the threat ranking (Table 5-2) and information from the field inventory to assign a 'ranking of asset' and a 'ranking of threat'. The ranking of asset and ranking of threat were combined to provide a priority using the framework provided in Table 5-3. The priority rankings for the site-specific assets identified during this process are provided in Appendix E.

Table 5-3 Prioritisation Assessment Table

Ranking of Asset	Ranking of Threat			
	Very High	High	Medium	Low
Very High	Priority 1	Priority 1	Priority 2	Priority 2
High	Priority 1	Priority 1	Priority 2	Priority 2
Medium	Priority 2	Priority 2	Priority 2	Priority 3
Low	Priority 2	Priority 2	Priority 3	Priority 3

5.5 Top 5 prioritisation process

A workshop was held with representatives from the City and the DBCA on the 4th November 2019 to discuss the priorities determined from the process described above. These sites were to be further prioritised to determine the Top 5 sites requiring restoration works for which conceptual project specifications would be developed.

In attendance was:

- City of Melville - Environmental Community Liaison Officer- Jacklyn Kelly
- City of Melville - Environmental Coordinator - Deanne Wynn
- City of Melville - Environmental Officer - Kellie Fowler

- City of Melville – Asset Management Coordinator - Paul Handcock
- GHD – Coastal Engineer - Andrew Sayce
- GHD – Structural and Coastal Engineer – Sarah Chapman
- GHD – Graduate Structural Engineer – Jessica Lee
- DBCA - Riverbank Project Officer - Michael Shaughnessy

Both ecological and coastal infrastructure/assets were assessed and the sites which had been determined as either Priority 1 or Priority 2 using the Prioritisation Framework were presented to the workshop group for discussion. The details for the prioritisation process of the sites presented can be found in Appendix E.

During the Prioritisation Workshop, five of the Priority 1 sites were collaboratively determined to be of the highest priority. These five sites were chosen based on the nature of existing damage and clear threats to infrastructure, ecological values and public safety and presented in Table 5-4. Concept designs for each of the five sites with an estimated construction costs are presented in Appendix G.

Additional sites that require further investigations (but not through concept design) was also identified and are detailed in Table 5-5.

Table 5-4 Priority projects for concept design

Priority Workshop Top 5 (in no particular order of importance)
Point Heathcote Stabilisation
Melville Beach Road Stabilisation
Canning Beach Road and Esplanade Revetment Replacement
Esplanade pathway
Blackwall Reach Stabilisation

Table 5-5 Additional priority project

Proposed Projects Requiring Additional Investigations
Tompkins Park

6. Management Strategies

6.1 Introduction

Based on Section 5.4 and 5.5, and the outcome discussed during the prioritisation of the projects (refer to GHD Prioritisation Workshop meeting minutes), Table 6-1 shows a summary table of the priority sites selected and their associated management strategy approach.

Section 6.2 to Section 6.4 outlines a general overview of the strategy approach and methods. These strategies also ensures the protection of natural and City assets while promoting natural aesthetics and ecological linkage, whilst in harmony with DBCA guidelines of Best Management Practices for Foreshore Stabilisation (2009).

Table 6-1 Summary priority sites and management strategy

Priority sites	Management strategy	Reference
Point Heathcote	Revegetation and Slope Stabilisation	Section 6.3 Section 6.4
Melville Beach Road	Revegetation and Foreshore Integrity	Section 6.3 Section 6.4
Canning Revetment Replacement	Revetment Replacement reflecting Natural Aesthetics	Section 6.4
Esplanade Pathway	Path remediation	Section 6.3
Blackwall Reach	Revegetation and Foreshore Integrity	Section 6.3 Section 6.4

6.2 Erosion management

6.2.1 Introduction

Foreshore areas will inevitably experience erosive conditions because of the nature of a water to land connection and the effects of human activity. Some sites of erosion can be easily managed but generally the management of the erosion mechanisms at play can be quite difficult. It is noted that some foreshore protection projects along the City's foreshore have achieved limited success and limited life span, due to being short term strategies and designs not in harmony with aesthetic vistas and ecological connectivity.

6.2.2 Methods

The DBCA's Riverbank Program draws on Best Management Practices for Foreshore Stabilisation (2009) and more recent Habitat Protection and Foreshore Management - Foreshore Management (2015) outlines appropriate use of foreshore treatments along Perth's "Swan Canning Riverpark". The following direct shore stabilisation approaches are specified:

1. **Revegetation:** re-establishment of local native vegetation to stabilise bank sediments by generating a network of roots and partially absorbing wave and current forces
2. **Coir logs:** densely packed and biodegradable coconut fibre tubes anchored to the toe of riverbanks to provide short-term protection while vegetation is established

3. **Brush mattressing:** logs or branches (or both) placed in an overlapping structure around revegetated sedges and shrubs to stabilise the bank (and provide nutrients) while vegetation is established
4. **Log walling:** vertical structures constructed from round logs or timber planks attached to vertical piles to protect the toe of the bank and retain a higher elevation of foreshore
5. **Cut limestone block walling:** low gravity structures (often on reinforced concrete footings) that provide stabilisation while minimising the structure footprint and maintaining a high aesthetic level
6. **Gabions:** structures formed by a series of wire frame cages filled with rock that are wired together to provide shore or bed scour protection
7. **Rock revetments:** a system of graded, interlocked, quarried armour stone laid upon a bank to absorb erosive forces and stabilise the adjacent foreshore
8. **Geotextile revetments:** sand-filled containers placed as relatively flexible revetments to stabilise eroding foreshores

6.2.3 Strategy

The strategy for erosion management should aim to work with the existing treatments and strategies in place while offering new remedial actions to be undertaken based on condition assessments and prioritisation process. Treatments should be implemented with a focus on softening the impact of urban form and re-establishing a more natural environment where possible.

A combination of the Swan River Trust foreshore treatments has been used to develop the concept plans for the top 5 prioritised sites.

6.3 Revegetation

6.3.1 Introduction

Fringing plants, particularly sedges and rushes, help to stabilise riverbanks and protect them from erosion. Roots can trap sediment, slowing its movement and can reduce the velocity of water as it passes through the plants. Sedges and rushes remove nutrients and contaminants from runoff and water and soluble nutrients, such as nitrogen and phosphorus, can be absorbed by microorganisms associated with sedges (Swan River Trust 2008). In addition revegetation increases biodiversity, can create habitat areas, assists in stabilisation following weed management and increases visual amenity.

When used on its own for stabilisation, revegetation is effective only in areas that are protected from active erosive forces and have appropriate slopes. In other areas, other site stabilisation techniques are required in conjunction with revegetation (Swan River Trust 2009).

Revegetation should aim to reinstate native vegetation communities and ensure that these communities are self-sustaining.

Revegetation has been occurring along the foreshore for many years and a number of areas have had foreshore restoration strategy or rehabilitation plans implemented. This strategy supports and extends the works implemented by these plans.

6.3.2 Methods

Revegetation works require planning to ensure that they are appropriate for a specific site, have a good chance of success and will be supported by the local community. Following revegetation

regular monitoring and maintenance are required, which should include infill planting and weed control.

Revegetation should incorporate the following aspects (DBCA, Swan River Trust 2009):

- Resident support
- A landscape plan
- Work schedule
- Site preparation
- Protection of vegetation
- Species selection
- Hydrology and planting zones
- Revegetation techniques
- Plant size
- Planting densities
- Location of planting
- Timing of planting
- Watering
- Surface drainage
- Monitoring and maintenance

Revegetation should utilise best practice techniques including those set out in the following documents:

- Best Management Practices for Foreshore Stabilisation: Direct Shore Stabilisation Approaches (Swan River Trust 2009)
- River Restoration Manual – Stream Stabilisation (Water and Rivers Commission 2001)
- The Bradley method (Bradley 1988) to carry out assisted natural regeneration starting in the areas that are rated as 'Very Good' and moving progressively in neighbouring areas in worse condition and conduct reconstruction/revegetation in areas of worse condition.

Revegetation can include sedges, trees and shrubs and ground covers. Species to be used should be locally endemic (including local provenance genetic material), should seek to introduce diversity into the vegetation and should use appropriate species for their locations. In general the inundated zones along the waterline and the beaches will be most suitable for sedge and rush species as well as a number of saltmarsh and Chenopod species. Species suitable for use on the exposed banks include herb and shrub species and upland species can range from herbs and sedges to shrubs and trees.

Revegetation should include a variety of different plant types in order to provide a variety of habitat types for fauna.

Suitable species for use in revegetation along the City of Melville foreshore, with information on their planting requirements and position for plantings are detailed in Table 6-2.

Table 6-2 Suitable species for revegetation along the City of Melville foreshore

Species	Comment	Soil/Condition requirements	Landscape Position			
			Inundated areas	Banks	Scarp/cliffs	Upland areas
Juncus kraussii	Excellent for habitat and bank stabilisation. Clumping rush to 1.2m	Sand occasionally clay Fresh-saline water	X Damp zone to 30cm into emergent zone	X		
Juncus pallidus	Used to increase biodiversity and stabilise floodplain. Clumping rush to 1.5m	Sand, clay Fresh water	X Ephemeral to damp zone	X		
Bolboschoenus caldwellii	Good aquatic habitat. Rapid spreading rhizomatous grassy sedge to 0.8m.	Sand/clay Fresh to brackish	X Damp zone to 20cm into the emergent zone			
Cyperus gymnocaulos	Very useful for bank stabilisation in saline areas. Tufted plant to 1m which can tolerate quite dry conditions and is quite saline tolerant	Fresh to saline	X Damp zone to ephemeral zone	X		
Ficinia nodosa	Excellent stabiliser of loose sands, very hardy and salt tolerant	Sand. Fresh to saline	X Ephemeral to damp zone	X		
Lepidosperma gladiatum	Excellent stabiliser of loose sands.	Sand Fresh to brackish	X Ephemeral to damp zone	X		
Baumea juncea	Excellent for bank stabilisation of dry banks and weed control	Sand/clay Fresh/brackish	X Ephemeral zone to 30cm into emergent zone	X		

Species	Comment	Soil/Condition requirements	Landscape Position			
			Inundated areas	Banks	Scarp/cliffs	Upland areas
	Rhizome spreading sedge to 1m which forms dense meadows					
Gahnia trifida	Useful in habitat creation and weed control in saline areas. Large grassy tussock to 1.5m	Sand. Fresh to saline	X Damp zone	X		
Grasses						
Sporobolus virginicus (Marine Couch)	Perennial seagrass 0.1-0.4 m tall with numerous thick creeping scaly stems.	Sand Saline areas		X		
Samphires/Saltbushes						
Salicornia quinqueflora	Erect or spreading shrub up to 0.5 m high	Sand, Sandy loam, clay, Moderately saline soils	X Ephemeral to damp zone	X		
Salicornia blackiana	Erect spreading shrub up to 0.8 m high	Sand, silt Swampy or periodically waterlogged saline areas	X Ephemeral to damp zone	X		
Suaeda australis	Shrub up to 1m high	Sand Saline areas	X Damp zone	X		
Threlkeldia diffusa (Coast Bonefruit)	Prostrate to erect herb to 0.4 m high	Sand over limestone, clay Saline flats		X	X	
Herbs						
Cassytha racemosa	Herb and climber	Sand				X
Centella asiatica	Creeping perennial herb			X		
Hardenbergia comptoniana (Native Wisteria)	Twining shrub or climber	Sand			X	X
Shrubs						

Species	Comment	Soil/Condition requirements	Landscape Position			
			Inundated areas	Banks	Scarp/cliffs	Upland areas
Acacia Cyclops (Coastal Wattle)	Large, broad shrub generally to 3m (can be taller)	Sand		X	X	X
Acacia rostellifera (Summer Scented Wattle)	Shrub or tree up to 6m	Sand				X
Acanthocarpus preissii	Tufted perennial to 0.7m	Sand, sandstone, limestone			X	X
Alyxia buxifolia (Dysentery Bush)	Erect, rigid or spreading shrub to 3m	Various soils			X	X
Astartea scoparia	Shrub to 1.8m	Loam, sand				X
Atriplex cinerea (Grey Saltbush)	Erect to spreading shrub to 1.5m	Sand. Saline areas		X		
Atriplex hypoleuca	Shrub to 2m	Mud or sand Saline areas		X		
Banksia sessilis	Upright shrub or small tree to 5m Provide important cover and nesting-habitat for wildlife	Sand, limestone, laterite, granite			X	X
Dianella revoluta var. *divaricata*	Tufted perennial herb to 1.5m	Sand, sandy-clay, laterite, loam, clay			X	X
Hakea prostrata	Shrub or small tree	Most soils				X
Hakea varia	Shrub 1-4m	Sand, clay loam, laterite			X	X
Jacksonia furcellata	Upright shrub or small tree	Sand				X
Jacksonia sternbergiana (Stinkwood)	Shrub or small tree to 5m	Sand				X
Olearia axillaris	Shrub to 3m	Sand, loam			X	X
Patersonia occidentalis (Purple Flag)	Tufted perennial herb to 1.5m	Sand, sandy clay, clayey loam, limestone etc				X

Species	Comment	Soil/Condition requirements	Landscape Position			
			Inundated areas	Banks	Scarp/cliffs	Upland areas
Rhagodia baccata (Berry Saltbush)	Shrub to 2m	Sand			X	X
Scaevola crassifolia	Shrub to 1.5m	Sand.		X	X	X
Spyridium globulosum (Basket Bush)	Large shrub to 5m	Sand.			X	X
Templetonia retusa (Cockies Tongues)	Shrub to 4m	Sand, gravel, limestone			X	X
Tall Shrubs/Trees						
Casuarina obesa	Outstanding coloniser. Young plants grow rapidly in disturbed areas	Saline Sand, clay	X	X		
Eucalyptus gomphocephala	One of the most biologically valuable trees; value as habitat for bird species,	Sand over limestone		X (in Point Walter area)		X
Eucalyptus rudis	Ecologically valuable tree – used by insects and birds	Sandy or loam soils	X	X (in Bull Creek area)		
Melaleuca cuticularis	Canopy used by waterbirds	Saline- brackish Can tolerant waterlogging	X	X		
Melaleuca rhaphiophylla	Excellent bird habitat, often have hollows used for nesting	Fresh – saline Waterlogged sites	X			

6.3.3 Strategy

The previous revegetation strategy aimed at re-connecting isolated patches of fringing vegetation, stabilising the banks and sediment, reducing the area available for invasive species to colonise and increasing diversity and abundance of native species. This strategy also identifies these objectives and defines areas where revegetation will complement other foreshore restoration techniques.

This strategy provides broad-scale aims and methods for areas based around similar landforms and vegetation elements, as described in Table 6-3. It expands on existing revegetation works that are occurring along the foreshore.

Table 6-3 General revegetation strategy for foreshore areas

Landforms/vegetation element	Specific locations	Aim	Method
Limestone cliffs	Point Heathcote and Point Walter	Prevent erosion Increase structural complexity of limestone cliff vegetation Revegetate former access areas that have been fenced off Improve fauna habitat values	Erosion works (see Section 6.2) must be completed first in areas with existing severe erosion, followed by revegetation Direct planting Supplement natural regeneration with direct seeding
Embankments	Areas along Blackwall Reach Parade	Prevent erosion of embankments	Fencing where access is an issue Weed control and direct planting
Vegetated foreshore	Canning River Bull Creek Kent Street Vegetation south of the South of Perth Yacht Club	Increase diversity and abundance of native species Provide habitat for fauna, particularly wading and migratory birds	Weed control and direct planting, including infill planting
Sandy beaches	Blackwall Reach Parade Bicton Bath Reserve Canning Beach Road Coffee Point Reserve East of Point Walter (Carroll Drive area) Henry Bridge Jeff Joseph Reserve and The Strand Melville Beach Parade Point Heathcote	Reconnect isolated pockets of fringing sedge vegetation, reintroduce diversity and abundance of native vegetation and increase structural complexity of existing vegetation communities Improve habitat linkages	Weed control and direct planting Infill planting for existing revegetation areas
Drainage outlets and associated areas	Apex Reserve – John XXIII College Beach Rd – Dee Rd Blackwall Reach	Reduce water scouring at outlets through revegetation	Fencing, direct planting and possible jute matting

Landforms/vegetation element	Specific locations	Aim	Method
	Coffee Point Reserve Esplanade Henry Bridge Point Heathcote Reserve Point Walter		
Parkland cleared	Along much of the foreshore	Progressively replace non-local shade trees with local, provenance correct species, especially those suitable as fauna habitat	Direct planting as required (ie. after death or removal of existing trees)

6.4 Rock Revetment Replacement

6.4.1 Introduction

Interlocked armoured stone that is laid on an embankment design to absorb the energetic wave action contributing to erosive forces along the foreshore. Rock revetments are easy to construct through limestone or granite compared to rigid structures. Rock revetments are relatively easy to maintain. However along the foreshore, the rock revetments are experiencing heavy erosion which leads to separation of rocks, and in particular at along Canning Beach Road (Flanagan to Dunvegan Road in Applecross**Error! Reference source not found.** and Esplanade (Queens Road) in Mt Pleasant**Error! Reference source not found.**. These are the two locations where Priority 1 has also been assigned. The condition of these assets are currently in a poor condition which was rated the same in the 2014 field survey. These rock revetments are also in close proximity to the public path which may pose a public safety risk and potential failure of City assets. The method of a softer and ecological approach in conjunction with rock revetments is explored in the following sections.

Figure 6-1 Failure of rock revetment along Canning Beach Rd between Flanagan and Dunvegan Rd, Applecross (L145)

Figure 6-2 Slumping of rock revetment wall, Esplanade (Queens Rd), Mt Pleasant

6.4.2 Method

In the prioritisation workshop held on the 4th November 2019, followed by a meeting with the DBCA, an incorporation of a softer measure along the extent of the foreshore was recommended and was highly favourable amongst the attendees. The approach focuses on the emphasis on restoring the riverbank while promoting a natural feel. At these two locations Canning Beach Revetment no. 3 and Esplanade Revetment no. 5, refer to Appendix F – Rock Revetment , the method in regaining a natural aesthetic vista includes provision of slope protection, backfill such as sand on eroded sections, revegetation on the slope and/or vegetation nodes, repurposing of rocks, fringing vegetation and the option of gabion artificial reefs (refer Section 6.5).

The following elements should be taken into consideration in future detailed designs:

- Survey data of embankment levels;
- Design parameters (appropriate slope, crest elevation and toe depth);
- Type of matting (jute/flexmat/concrete flexmat);
- Timing to place matting in order for the optimal growth of vegetation; and
- Adjacent foreshore areas and use of adjacent waterways (in determining suitability for artificial reef options).

6.4.3 Strategy

A rock revetment strategy is a minimalist low cost installation solution, however this may provide the greatest level of maintenance. It was noted that in the previous (2014) strategy, rock revetment replacement was not on the priority list. Furthermore at the two locations shown in Figure 6-1 and Figure 6-2, the rock revetment was not remediated during the last five years, which has further decreased its asset value and use. During this 2019 foreshore survey and based on the priority process outlined in Section 5.5, wave action and other associated coastal processes are identified to compromise any coastal protection measures within 1 to 5 years. This is also noted in Appendix F.

6.5 Gabion Basket - Crustacean Reef Restoration

6.5.1 Introduction

Traditional application of gabion baskets are used on the foreshore or as part of a riparian strip that holds back sediment infill and also as a hard barrier against erosion forces, noting that this has successfully been implemented recently at Helm St, Mt Pleasant. This section presents another strategy for a known method in preventing foreshore erosion.

6.5.2 Method

An application of the traditional gabion baskets in a non-traditional way is considered here as a fringing artificial reef seeded with crustaceans that are suitable for the area. This reef provides a multitier benefit: prevents wave buffering by filtering wave energy, allow settlement sediments, establishing complex ecosystems, supporting aesthetics and protecting re-vegetation nodes from further erosion.

Crustacean reefs, either oyster or muscles, provide a natural water filter and dampening of wave energy. However due to large exploitation, pollution and other stresses, natural reefs have died back. Reef restoration programs of natural occurring crustaceans are becoming widely accepted and are found around the world including some estuaries/ports of Australia, including Oyster Harbour, Peel Harvey Estuary and soon within the Swan River, WA.

6.5.3 Strategy

With DBCA consultation, deployment of gabion baskets as an offshore fringing reef in front of each re-vegetated riparian zone is recommended for consideration. Further seeding of the baskets with crustaceans will accelerate the natural occurrence of crustaceans and may assist in consolidating the contents of the basket as the wire mesh corrodes over time.

Other applications for these artificial reefs may include the revitalisations of indigenous fish traps, providing both cultural connection, tourism and also foreshore protection e.g. Coffee Point.

6.6 Control of access

Access to sensitive areas that are being degraded by unrestricted public access and trampling by people and pets should include the following measures:

- Install fencing and signage explaining the process of coastal erosion and asking the public to keep to paths, may also include brushing of paths following fencing
- Replace fencing in poor condition
- Undertake an assessment of access requirements and provide formal access to areas that will likely continue to be accessed in an unrestricted manner (ie. areas of Point Walter in which the fence is continually cut to allow access)
- Undertake revegetation works in the areas that have been fenced
- Where possible involve the community and local groups to maximise the acceptance of the restricted access

Signage should be consistent with signage guidelines for the City of Melville and the City's *Brand Style Guide.*

6.7 Feral animal management

Feral animal management is a management measure that is required to be implemented at a local or regional scale, rather than at the scale of the foreshore. However, the City can undertake some measures that will assist in feral animal issues along the foreshore including:

- Include rabbit-proof fencing in revegetation programs
- Conduct public awareness raising of the issues associated with cats roaming the foreshore at night
- Consider active management if specific feral cat or fox issues are reported

6.8 Fire management

Fire management in bushland areas in the City is implemented through the City's *Bushfire Management Strategy.* Fire management is also incorporated into management plans for the larger bushland areas adjacent to the foreshore areas such as Blackwall Reach and Point Walter and Bull Creek wetlands. Specific management measures for fire along the foreshore areas are generally limited to ignition and fuel load reduction measures including:

- Reduce fuel load through weed control
- Encourage education of the public on the deleterious effects of fire

6.9 Community engagement

Community involvement in foreshore management is an important part of helping local groups and communities feel 'ownership' of the foreshore. Community consultation will also assist in acceptance of management measures throughout the community that may not be otherwise well received. Education will lead to a greater appreciation of the values of the foreshore.

Community groups can play an important role in management works that require extensive 'people power', such as hand weeding.

Community engagement in management measures conducted along the foreshore should include consideration of the following documents:

- *People Places Participation – A Community Plan for the City of Melville 2016-2026* (City of Melville 2007)
- *Environmental Friends Group Manual* (City of Melville 2015)

7. Recommendations

7.1 General recommendations

The following have been proposed as general recommendations for restoration works relevant to the full extent of the City's foreshore. Items in *italics* denotes recommendations to be continued over from the previous review.

Table 7-1 General recommendations 2019

General Recommendations
1. **Implement the revised restoration strategy detailed in this report with a view to softening the impact of the urban form on the landscape and re-establish a natural environment.**
2. **Revegetate the foreshore with native species using local seed stock, where practicable, particularly for species that may have developed a level of salt tolerance.** **Consider the presence of the Threatened Ecological Community 'Temperate and subtropical saltmarsh' along the foreshore and prioritise the revegetation of this community using appropriate species.**
3. **Continue to work in partnership with DBCA to maintain and improve foreshore areas.**
4. **Continue to delineate native vegetation from parkland by edge spraying to prevent grasses from invading native vegetation. If possible, where new works are undertaken (works that include the provision of new footpaths) use the footpaths as a barrier between parkland and native vegetation to prevent grasses invading native vegetation.**
5. **Provide for greater community involvement in the City of Melville restoration programmes.**
6. **Pursue funding sources to deal with Declared Plants and other highly invasive weeds on the Melville foreshore.**
7. **Undertake an assessment of the inundated/damaged drainage outlets along the foreshore to ensure flow rates are acceptable and implement remedial action where applicable. Consideration by the City should be made to ensure that all existing drainage outlets have suitable flow efficiency and are not contaminating the river. Depending on the results of such investigations, storm water treatment devices could be installed to remove contaminants from outflows before they reach the City's waterways.**
8. **Manage foreshore access to ensure traffic is directed away from sensitive areas and diverted to designated public access points.**
9. **Remove failed foreshore treatments along the foreshore that have become potential safety hazards.**
10. **Continue to monitor weeds along the foreshore and update the weed list and mapping undertaken during the foreshore inventory in order to identify new**

weed species or new populations that may be able to be eradicated before they become fully established. Conduct future weed surveys in Spring to allow identification of greater numbers of weed species.
11. **Review and audit these recommendations within five years of implementation of this report by the Melville City Council.**

7.2 Site recommendations

The following have been proposed as site specific recommendations for restoration works to be carried out along the City's foreshore. Items in *italics* indicate recommendations carried over from the previous review.

Table 7-2 Site specific recommendations 2019

Site Specific Recommendations
Bateman Park
12. Community loss due to bottom and mid story canopies smothered by weeds. Therefore weed eradication should be employed at fringing native vegetation adjacent to Spinaway Crescent.
Blackwall Reach
1. *Maintain ongoing weed management for invasive weeds* particularly behind the first row of trees 2. Remediate trampled path and erosion next to path causing instability and trees under threat particularly at Blackwall Reach South of Crewe Street 3. Remediate south of sand spit with two large vegetated nodes, backfill, protection of slope, fringing vegetation suitable at the toe 4. Re-establish TEC with isolated Tuart trees (trees within 60 m) *5. Restore areas experiencing erosion by obtaining funding and implementing the prioritised project; Bicton Foreshore Restoration.*
Canning River
1. *Restore areas experiencing erosion by obtaining funding and implementing the prioritised project; Medium Term Stabilisation of Foreshore from Canning Bridge to Mt Henry Bridge*
Coffee Point Reserve
1. Monitor/repair pathway and integrity of rock revetment located in the surroundings of Raffles Hotel 2. Replace revetment at Canning Beach Road (Flanagan to Dunvegan Road) with flexmat or other slope protection and repurposing of rocks and fringing vegetation 3. Restore areas experiencing erosion located near sailing club (P2, P3) which has been severe erosion of grassy verge
Esplanade Path
1. Monitor and repair erosion of grassy bank

Site Specific Recommendations
2. At the corner of Queen Street and the Esplanade, condition of rock revetment is the same as 2014. Site recommendation include replace like for like rock revetment/flexmat/other slope protection
Jeff Joseph Reserve
1. Restore areas experiencing erosion mainly under pathway
Melville Beach
1. Remediate trampled path and erosion close to public pathway 2. Stabilise significant erosion at foreshore between Ness Rd and Spey Rd, through backfill and revegetate nodes 3. Replace or relocate bench located at Melville Beach Rd opposite 13A as it has significant exposed reinforcement.
Point Heathcote
1. Monitor/maintain/replace the geotextile sand containers are ripped due to trampling as people come down from the path. 2. Remediate trampled paths through retaining earth with timber palisades, backfill and revegetate. 3. Northern and Eastern end of Point Heathcote Reserve is recommended to be reported. It is likely to be categorised as a TEC in the future once the planted Tuart trees have a DBH of > 150 mm and endemic mid and understory Tuart community species are self propagating.
Point Walter
1. Rocky shore at the south of Point Walter is a Bush Forever Site. Recommended to restore areas of erosion. 2. Repair boardwalk exhibiting corrosion and undermining of concrete footings of eastern structure 3. Remediate exposed tree roots 4. *Maintain revegetated areas east of the boat ramp through weed management and infill planting where required*
Tompkins Park
1. Maintain revegetated areas 2. Repair areas requiring revegetation which is path adjacent to vegetated foreshore

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Appendices

Appendix A – Review of Existing Foreshore Restoration Strategy

8.1.1 Review of Existing Foreshore Restoration Strategy

As outlined in the project brief, this Foreshore Restoration Strategy Review includes a review of the previous report presented in 2014 including an assessment of the success of the recommendations made. The 2009 Foreshore Restoration Strategy Review was undertaken by NAMS and was the first since the original Melville foreshore strategy that was undertaken in 1997 by Alan Tingay and Associates. Following the 2009 Foreshore Strategy Review, the report was then updated in 2014 by GHD and now 2019 in response to changes in foreshore coastal structures overtime.

The review presented fresh recommendations and a blueprint for management actions that emphasised the retention or re-establishment of foreshore habitat through erosion control, weed control and regeneration or revegetation of endemic species. **Error! Reference source not found.** and **Error! Reference source not found.** outlines the 2014 recommendations made by GHD with comments from 2019 observations recorded during field survey.

Table 8-1 Assessment of the general recommendations made by GHD (2014)

Item Number	General Recommendations (2014)	Comments (2019)
1	Implement the revised restoration strategy detailed in this report with a view to softening the impact of the urban form on the landscape and re-establish a natural environment. *	Attempts to re-establish a natural environment for the City's foreshore area have been made but a mix of hard and soft foreshore treatments is currently present.
2	Revegetate the foreshore with native species using local seed stock, where practicable, particularly for species that may have developed a level of salt tolerance. *	Revegetation has occurred in a number of locations along the foreshore, and is ongoing.
3	Consider the presence of the Threatened Ecological Community 'Temperate and subtropical saltmarsh' along the foreshore and prioritise the revegetation of this community using appropriate species.	The patch of vegetation, south of the South of Perth Yacht Club, is considered likely to be the 'Temperate and subtropical saltmarsh community'. This remnant vegetation has some evidence of trampling however dense stands of *Juncus* spp. is inhibiting weed invasion. The City may want to consider a fence or some other sort of barrier to prevent trampling.
4	Continue to work in partnership with DBCA, formerly the Swan River Trust, to maintain and improve foreshore areas. *	The partnership between the DBCA and the City of Melville is ongoing and consultation was undertaken as part of this review.
5	Continue to delineate native vegetation from parkland by edge spraying to prevent grasses from invading native vegetation.* If possible, where new works are undertaken (works that include the provision of new footpaths) use the footpaths as a barrier between parkland and native vegetation to prevent grasses invading native vegetation.	Edge spraying is apparent in a number of areas along the foreshore. Other areas had substantial grass growth around rock revetments

Item Number	General Recommendations (2014)	Comments (2019)
6	Provide for greater community involvement in the City of Melville restoration programmes.	The City has continued to support community action groups and maintained community involvement in restoration programs. A Friends of Bull Creek Catchment (FOBCC) group was formed and a Water Quality Improvement Plan (WQIP) for the Bull Creek Catchment.
7	Pursue funding sources to deal with Declared Plants and other highly invasive weeds on the Melville foreshore.. *	Some control of these species is apparent along the foreshore
8	Undertake an assessment of the inundated/damaged drainage outlets along the foreshore to ensure flow rates are acceptable and implement remedial action where applicable. Consideration by the city should be made to ensure that all existing drainage outlets have suitable flow efficiency and are not contaminating the river. Depending on the results of such investigations, storm water treatment devices could be installed to remove contaminants from outflows before they reach the City's waterways..	Observation recorded as part of the 2019 survey.
9	Manage foreshore access to ensure traffic is directed away from sensitive areas and diverted to designated public access points. *	Fences, stairs and paths are installed throughout the Melville foreshore to manage traffic but trampling in areas of unrestricted access is still a problem.
10	Remove failed foreshore treatments along the foreshore that have become potential safety hazards.	Observation recorded as part of the 2019 survey. Some areas noted have not been removed, such as failed sandbags located -The Strand opposite #54A . 
11	Continue to monitor weeds along the foreshore and update the weed list and mapping undertaken during the foreshore inventory in order to identify new weed species or new populations that may be able to be eradicated before they become fully established. Conduct future weed surveys in Spring to allow identification of greater numbers of weed species.	Weeds observation have been combined within vegetation survey.
12	Review and audit these recommendations within five years of	This review is being undertaken five years after the 2014 GHD's 'Foreshore Restoration Strategy Review' report.

Item Number	General Recommendations (2014)	Comments (2019)
	implementation of this report by the Melville City Council. *	

Asterisks (*) denotes recommendations to be continued over from 2009 previous review.

Table 8-2 Assessment of site recommendations made by GHD (2014)

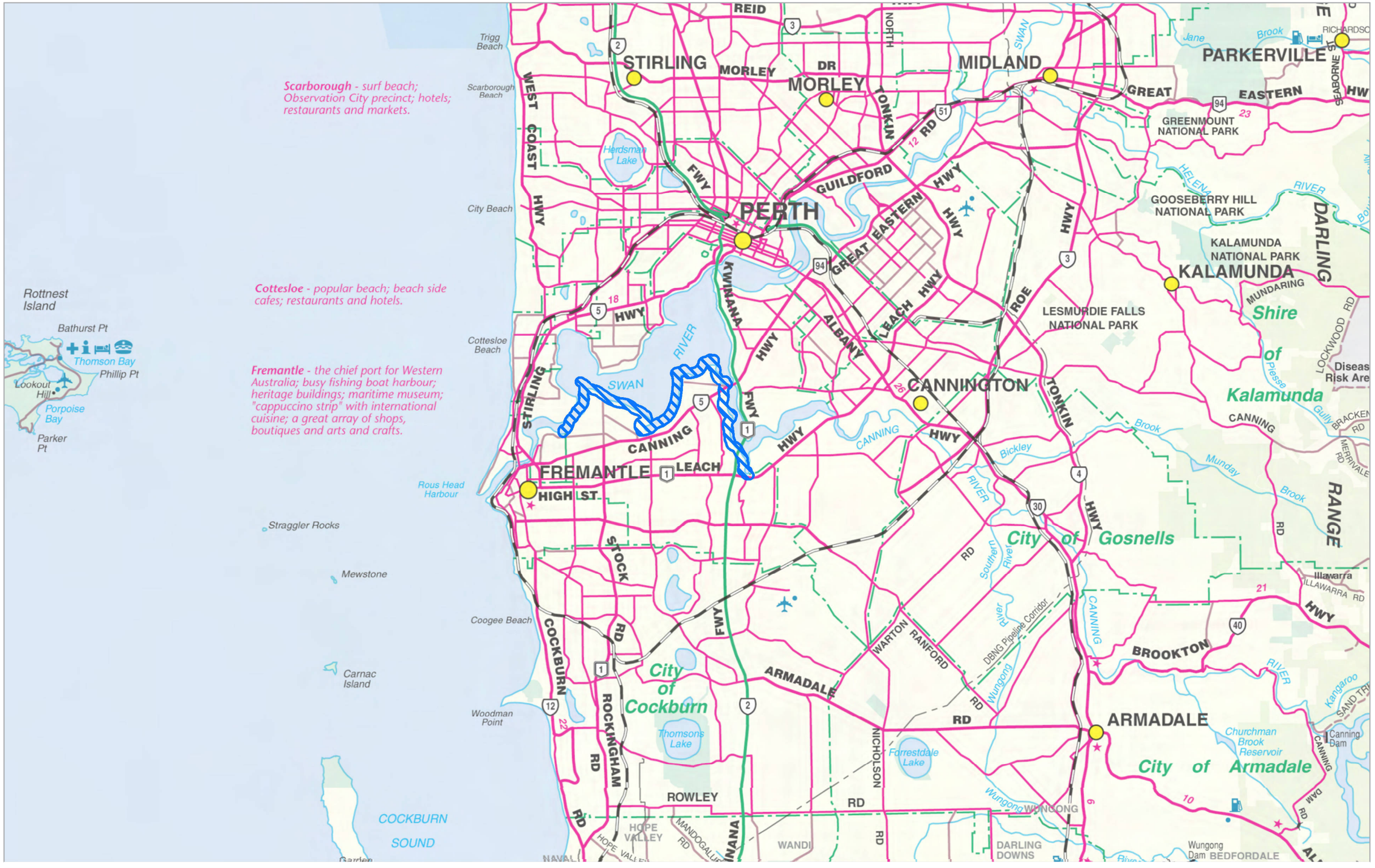
Item Number	Site Recommendations (2014)	Comments (2019)
BC	Bull Creek	
BC1	Maintain ongoing weed control for invasive weeds, including Giant Reed, Pampas Grass, Japanese Pepper tee, Arum Lily, Blackberry, Lantana, Grape Vine etc. Follow-up weed control with revegetation (direct planting) in areas with extensive weed invasion (particularly adjacent to Spinaway Crescent)	Infestation of Arum Lily, Blackberry and bridal creeper has increased since 2014. Arum lily and blackberry are beginning to dominate mid stratum in sections of the southern extent of Bateman Park in VT2.Couch and Kikyu are also dominating. Weed eradication and management should be employed .
BC2	Undertake repairs to the bitumen path through Bateman Park.	Tree roots have been repaired and no longer exposed. No undercutting of path that was noted in the 2019 survey.
BC3	Repair the damaged drainage outlet located at the path providing access to the river at Spinaway Crescent.	Does not appear to have occurred.
BC4	Assess usage and access to the boardwalk located within the wetlands at Bateman Park.	Two wooden planks are rotted and need replacement. Most of structure good condition
CR	Canning River	
CR1	Restore areas experiencing erosion by obtaining funding and implementing the prioritised project; Medium Term Stabilisation of Foreshore from Canning Bridge to Mt Henry Bridge	The Canning River is exposed to high level erosive conditions and there has been limited success from the remedial actions proposed in the previous review.
CR2	Connect vegetated areas with infill planting of sedge species	Some control of these species is apparent along the foreshore; however more work is required.
SoPYC	South of Perth Yacht Club	
SoPYC1	Investigate and restore areas experiencing erosion by obtaining funding and implementing the prioritised project; Maintenance and Management of Sinkholes and Pathway Subsidence from South Perth Yacht Club to Raffles Hotel	No comment as area will be managed by the Yacht Club.
SoPYC2	Weed control of sedgelands and sedge planting	Does not appear to have occurred.
PHWB	Point Heathcote and Waylen Bay	
PHWB1	Infill planting at Point Heathcote following restoration works	Weed invasion from **Ehrharta* spp. (Veldt Grass) and other species is minimal in the revegetated area at Point Heathcote. Restoration works appears to have been successful with native recruits recorded.

Item Number	Site Recommendations (2014)	Comments (2019)
PHWB2	Weed control of Giant Reed infestations east of Point Heathcote	Weed control has not been undertaken. **Arundo donax* (Giant Reed) still dominates the area 
PHWB3	Connect vegetation along The Strand and Jeff Joseph Reserve through revegetation	Does not appear to have taken place. Replacement of asset has been undertaken
PHWB4	Maintain weed control within the areas of vegetation in good condition in Jeff Joseph Reserve	Some control work is apparent; however ongoing work is required.
PHWB5	Investigate the replenishment of rocks for the Applecross Jetty and the two groynes to the west.	Does not appear to have occurred. Small rocks have been displaced from wave conditions
PHWB6	Restore areas experiencing erosion at Point Heathcote and Jeff Joseph Reserve by obtaining funding and implementing the prioritised projects; Point Heathcote Stabilisation and Jeff Joseph Foreshore Restoration.	The wetland area behind the tennis courts is now stable and in good health however the grass verge line to the east is experiencing erosion issues. Some areas are experiencing significant trampling and undercutting of pathway.
MB	Melville Beach	
MB1	Perform maintenance and repairs to the three sets of coastal stairs which are becoming inundated with sediment and plant waste.	Does not appear to have occurred. - TBC Sediment and plant matter building up. Vegetation buildup and undermining the stairs
MB2	Connect fringing vegetated areas with infill planting of sedge species	Does not appear to have occurred.
MB3	Assess/monitor/repair the footpath opposite number 97 Melville Beach Road which is being significantly raised by a tree's root network.	Have been repaired.
MB4	Weed control of Giant Reed infestations south of Point Dundas	Does not appear to have occurred.
PW	Point Walter	
PW1	Monitor and maintain the recent restoration work.	Native vegetation and re-vegetation area - already fenced and management works evident
PW2	Monitor the erosion occurring at the eastern boat ramp and implement stabilisation measures as necessary.	Point Walter Reserve has undergone a transformation to reduce environmental impacts such as erosion, vegetation loss and weed invasion as well as an upgrade to recreational facilities, however there are some erosion

Item Number	Site Recommendations (2014)	Comments (2019)
		causing instability at Bush Forever Site 331. - TBC
BR	Blackwall Reach	
BR1	Restore areas experiencing erosion by obtaining funding and implementing the prioritised project; Bicton Foreshore Restoration.	Some control work is apparent; however more work is required. This will be an ongoing management measure. The foreshore area is regularly used for recreation and is presenting manageable safety hazard - TBC
BR2	Investigate public access through the bushland by undertaking the prioritised project requiring additional investigations; Blackwall Reach Planning Advice.	Does not appear to have occurred in 2019. - TBC
BR3	Maintain ongoing weed management for invasive weeds	Sedgebeds look to have been revegetated and are in Very good condition.

Asterisks (*) denotes recommendations to be continued over from the previous review

Appendix B – Figures



Legend

Study Area

Paper Size ISO A3

0 1 2 3 4 Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

N

GHD

City of Melville

City Of Melville
Melville Foreshore Restoration Strategy 2019

Locality

Project No. **12514145**
Revision No. **0**
Date **24 Feb 2020**

FIGURE 1

G:\61\12514145\GIS\Maps\Working\6112514145_ProjectFolder\Rev0\12514145_001_Locality_Rev0.mxd
Print date: 24 Feb 2020 - 09:34

Data source: Landgate: Travellers Atlas - 2004; City of Melville: City of Melville boundary - 2014; GHD: Study Area - 20140304. . Created by: pjhernandez

Rock Revements
Rock Revements
Rock Revements
329
Rock Revements
Rock Revements
Rock Revements
Rock Revements
Rock Revements
Rock Revements
Rock Revements
Rock Revements
Rock Revements
221
334
Rock Revements
Rock Revements
Rock Revements
227
226
336
Rock Revements
228
337
338
339
SLIP
POWERED BY LANDGATE

Legend

- Coastal Assets
- Other Assets
- Rock revetments
- Bush Foever Sites

Paper Size ISO A3

0 0.2 0.4 0.6

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

GHD

City of Melville

City Of Melville
Melville Foreshore Restoration Strategy 2019

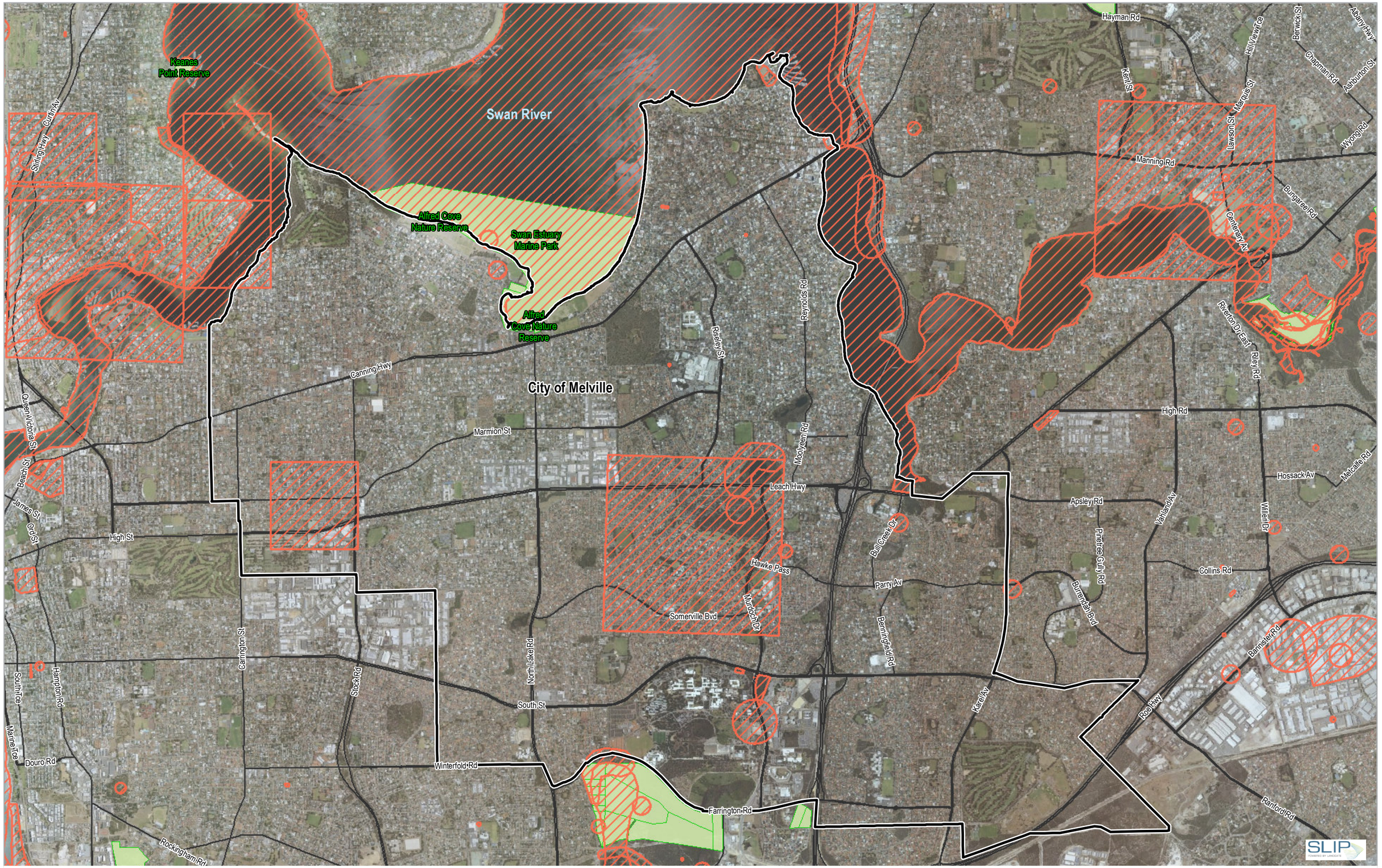
Overview of Study Area

Project No. **12514145**
Revision No. **0**
Date **25 Feb 2020**

FIGURE 2

G:\61\12514145\GIS\Maps\Working\6112514145_ProjectFolder\6112514145_ProjectFolder.aprx
Print date: 25 Feb 2020 - 15:51

Data source: GHD: Coastal asset collection - 20190424; DPLH: Bush Forever Site; WANow: Landgate / SLIP. Created by: slei



Legend

- Major road
- City of Melville
- Aboriginal heritage site
- DBCA Legislated Lands

Paper Size ISO A3

0 0.2 0.4 0.6 0.8 1

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

N

GHD

City of Melville

City Of Melville
Melville Foreshore Restoration Strategy 2019

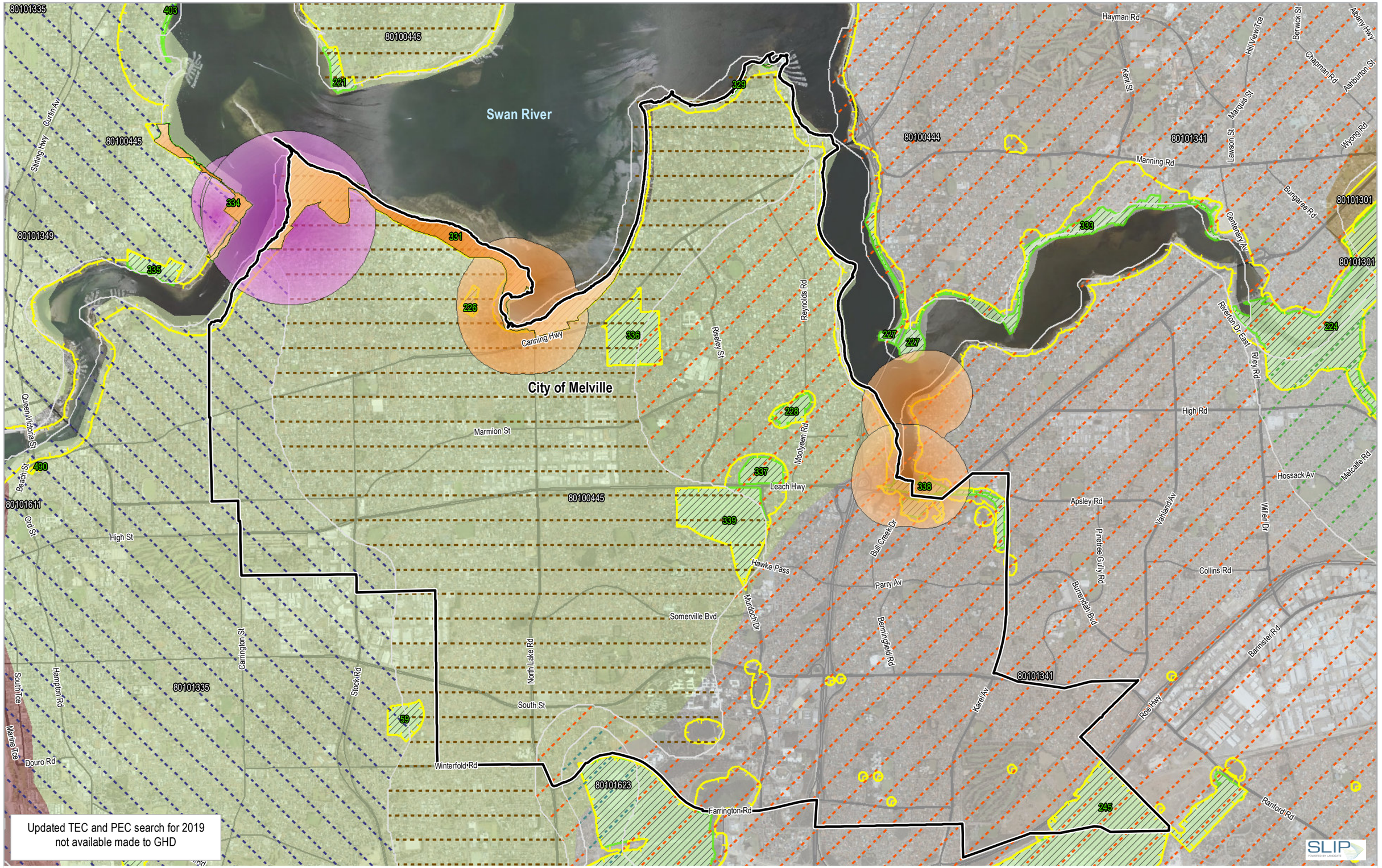
Social Context

Project No. **12514145**
Revision No. **0**
Date **25 Feb 2020**

FIGURE 3

G:\61\12514145\GIS\Maps\Working\Rev0\12514145_003_SocialContext_Rev0.mxd
Print date: 25 Feb 2020 - 15:48

Data source: DAA: Aboriginal Heritage Site - 20190314; DBCA - Legislated Lands - 2019030; Landgate: Roads - 20190128, City of Melville Boundary - 20180319, Imagery - 20190826 (accessed - 20191213). Created by: slei



Updated TEC and PEC search for 2019 not available made to GHD

Legend

- Major road
- City of Melville
- Environmentally sensitive area
- Bush forever site

Pre-European Vegetation

- Bassendean
- Pinjarra
- Rockingham
- Spearwood

Threatened Ecology and Priority Species

- Priority 1
- Priority 3

Heddle vegetation (Heddle et al., 1980)

- Bassendean Complex-Central and South
- Cottesloe Complex-Central and South
- Herdsman Complex
- Karrakatta Complex-Central and South
- Southern River Complex
- Swan Complex

Paper Size ISO A3

0 0.2 0.4 0.6 0.8 1

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

N

GHD | City of Melville

City Of Melville
Melville Foreshore Restoration Strategy 2019

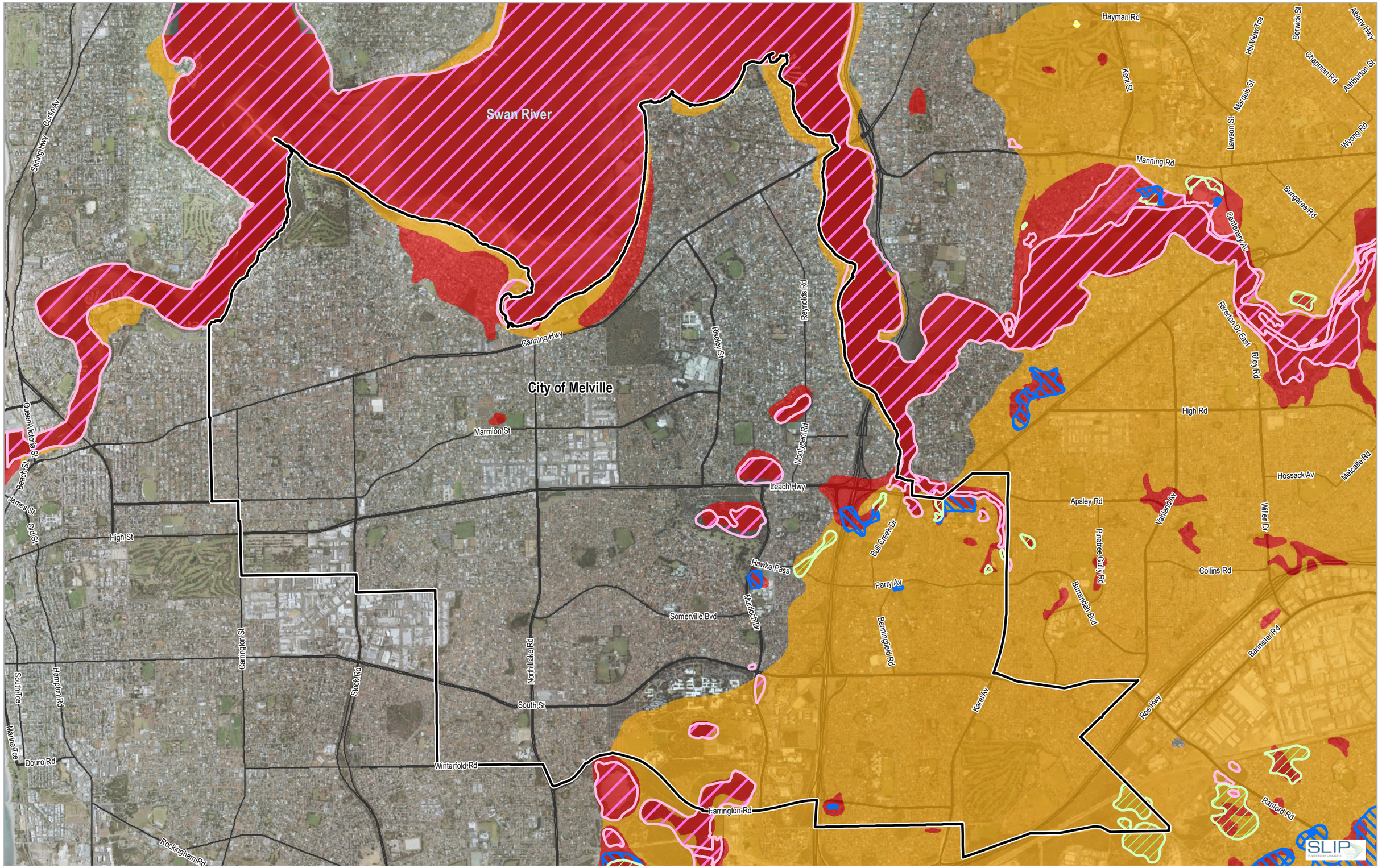
Environmental Context Vegetation

Project No. **12514145**
Revision No. **0**
Date **25 Feb 2020**

FIGURE 4

G:\61\12514145\GIS\Maps\Working\Rev0\12514145_004_Vegetation_Rev0.mxd
Print date: 25 Feb 2020 - 15:56

Data source: DBCA: Heddle Vegetation - 20191029; DWER: Environmentally Sensitive Areas - 20180223; DPIRD: Pre-European Vegetation - 20190131;DEC: Bush Forever Sites - 20140226; DPaW: TEC, PEC - 20140428; Landgate: Roads - 20190128, City of Melville Boundary - 20180319, Imagery - 20190826 (accessed - 20191213). Created by: slei



Legend

- Major road
- City of Melville

Geomorphic Wetlands

- Conservation
- Resource Enhancement
- Multiple Use
- Not Assessed

Acid Sulphate Soil Risk Mapping

- High to moderate ASS disturbance risk (<3m from surface)
- Moderate to low ASS disturbance risk (<3m from surface)

Paper Size ISO A3

0 0.2 0.4 0.6 0.8 1

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

N

GHD | City of Melville

City Of Melville
Melville Foreshore Restoration Strategy 2019

Environmental Context
Hydrology and Soils

Project No. **12514145**
Revision No. **0**
Date **25 Feb 2020**

FIGURE 5

G:\61\12514145\GIS\Maps\Working\Rev0\12514145_005_HydrologyAndSoils_Rev0.mxd
Print date: 25 Feb 2020 - 15:58

Data source: DBCA: Geomorphic Wetlands - 20191006; DWER: Acis Sulphate Soil Risk - 20191213; Landgate: Roads - 20190128, City of Melville Boundary - 20180319, Imagery - 20190826 (accessed - 20191213). Created by: slei

Legend

- *Eucalyptus gomphocephala*
- **Eucalyptus* planted*

Vegetation Type

- VT05 Mixed *Acacia* shrublands (rehabilitation species)
- VT10 Parkland cleared
- VT11 Landscaped gardens

Paper Size ISO A3

0 10 20 30 40 50

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

N

GHD

City of Melville

City Of Melville
Melville Foreshore Restoration Strategy 2019

Vegetation type, significant trees and conservation significant communities

Project No. **12514145**
Revision No. **0**
Date **03 Mar 2020**

Mapsheet 1 of 22

FIGURE 6

G:\61\12514145\GIS\Maps\Working\Rev0\12514145_006_VegetationType_Rev0.mxd
Print date: 03 Mar 2020 - 11:58

Data source: GHD: Vegetation Types, Tree Locations - 20191216; Landgate: Roads - 20190128, Imagery - 20190826 (accessed - 20191216). Created by: slei

Legend

Eucalyptus gomphocephala
Likely to be *Tuart (Eucalyptus gomphocephala)* woodlands and forests of the Swan Coastal Plain TEC

Vegetation Type

- VT05 Mixed *Acacia* shrublands (rehabilitation species)
- VT07 Cliffs with scattered salt-tolerant natives
- VT08 Mixed shrubland
- VT09 *Tuart* woodland
- VT10 Parkland cleared
- VT11 Landscaped gardens

Paper Size ISO A3
0 10 20 30 40 50
Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

N

GHD

City of Melville

City Of Melville
Melville Foreshore Restoration Strategy 2019

Vegetation type, significant trees and conservation significant communities

Project No. **12514145**
Revision No. **0**
Date **03 Mar 2020**

Mapsheet 2 of 22

FIGURE 6

G:\61\12514145\GIS\Maps\Working\Rev0\12514145_006_VegetationType_Rev0.mxd
Print date: 03 Mar 2020 - 11:58

Data source: GHD: Vegetation Types, Tree Locations - 20191216; Landgate: Roads - 20190128, Imagery - 20190826 (accessed - 20191216). Created by: slei

Legend

- *Eucalyptus gomphocephala*
- Likely to be *Tuart (Eucalyptus gomphocephala)* woodlands and forests of the Swan Coastal Plain TEC

Vegetation Type

- VT07 Cliffs with scattered salt-tolerant natives
- VT08 Mixed shrubland
- VT09 *Tuart* woodland

Paper Size ISO A3

0 10 20 30 40 50

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

N

GHD

City of Melville

City Of Melville
Melville Foreshore Restoration Strategy 2019

Vegetation type, significant trees and conservation significant communities

Project No. **12514145**
Revision No. **0**
Date **03 Mar 2020**

Mapsheet 3 of 22

FIGURE 6

G:\61\12514145\GIS\Maps\Working\Rev0\12514145_006_VegetationType_Rev0.mxd
Print date: 03 Mar 2020 - 11:58

Data source: GHD: Vegetation Types, Tree Locations - 20191216; Landgate: Roads - 20190128, Imagery - 20190826 (accessed - 20191216). Created by: slei

Legend

- *Eucalyptus gomphocephala*
- **Eucalyptus* planted*
- Stag
- Likely to be *Tuart (Eucalyptus gomphocephala)* woodlands and forests of the Swan Coastal Plain TEC

Vegetation Type

- VT05 Mixed *Acacia* shrublands (rehabilitation species)
- VT08 Mixed shrubland
- VT09 *Tuart* woodland
- VT10 Parkland cleared
- VT11 Landscaped gardens

Paper Size ISO A3

0 10 20 30 40 50

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

N

GHD

City of Melville

City Of Melville
Melville Foreshore Restoration Strategy 2019

Vegetation type, significant trees and conservation significant communities

Project No. **12514145**
Revision No. **0**
Date **03 Mar 2020**

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FIGURE 6

G:\61\12514145\GIS\Maps\Working\Rev0\12514145_006_VegetationType_Rev0.mxd
Print date: 03 Mar 2020 - 11:58

Data source: GHD: Vegetation Types, Tree Locations - 20191216; Landgate: Roads - 20190128, Imagery - 20190826 (accessed - 20191216). Created by: slei

Legend

- *Eucalyptus camaldulensis*
- *Eucalyptus rudis*
- **Eucalyptus* planted

Vegetation Type

- VT01 *Juncus* dominated Sedgelands
- VT05 Mixed *Acacia* shrublands (rehabilitation species)
- VT10 Parkland cleared
- VT11 Landscaped gardens

Paper Size ISO A3

0 10 20 30 40 50

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

N

GHD

City of Melville

City Of Melville
Melville Foreshore Restoration Strategy 2019

Vegetation type, significant trees and conservation significant communities

Project No. **12514145**
Revision No. **0**
Date **03 Mar 2020**

Mapsheet 5 of 22

FIGURE 6

G:\61\12514145\GIS\Maps\Working\Rev0\12514145_006_VegetationType_Rev0.mxd
Print date: 03 Mar 2020 - 11:58

Data source: GHD: Vegetation Types, Tree Locations - 20191216; Landgate: Roads - 20190128, Imagery - 20190826 (accessed - 20191216). Created by: slei

Legend

- *Corymbia calophylla*
- *Eucalyptus camaldulensis*
- *Eucalyptus rudis*

Vegetation Type

- VT01 *Juncus* dominated Sedgelands
- VT03 *Melaleuca* over sedgelands

Paper Size ISO A3

0 10 20 30 40 50

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

N

GHD

City of Melville

City Of Melville
Melville Foreshore Restoration Strategy 2019

Vegetation type, significant trees and conservation significant communities

Project No. **12514145**
Revision No. **0**
Date **03 Mar 2020**

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FIGURE 6

G:\61\12514145\GIS\Maps\Working\Rev0\12514145_006_VegetationType_Rev0.mxd
Print date: 03 Mar 2020 - 11:58

Data source: GHD: Vegetation Types, Tree Locations - 20191216; Landgate: Roads - 20190128, Imagery - 20190826 (accessed - 20191216). Created by: slei

Legend

- *Eucalyptus rudis*
- **Eucalyptus* planted

Vegetation Type

- VT01 *Juncus* dominated Sedgelands
- VT03 *Melaleuca* over sedgelands
- VT10 Parkland cleared

Paper Size ISO A3

0 10 20 30 40 50

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

N

GHD

City of Melville

City Of Melville
Melville Foreshore Restoration Strategy 2019

Vegetation type, significant trees and conservation significant communities

Project No. **12514145**
Revision No. **0**
Date **03 Mar 2020**

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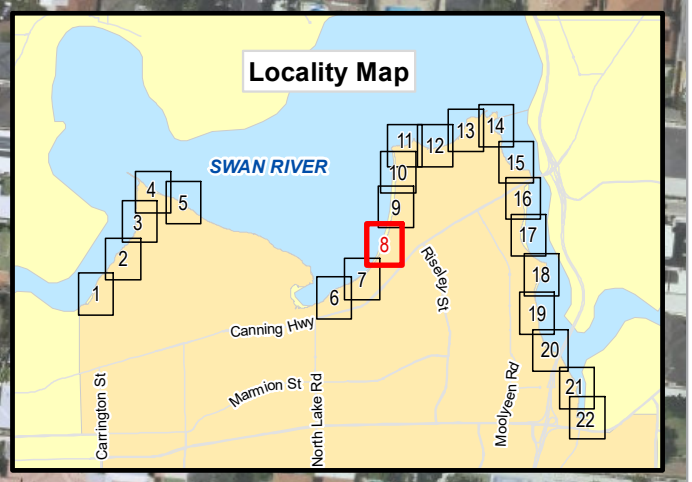
FIGURE 6

G:\61\12514145\GIS\Maps\Working\Rev0\12514145_006_VegetationType_Rev0.mxd
Print date: 03 Mar 2020 - 11:58

Data source: GHD: Vegetation Types, Tree Locations - 20191216; Landgate: Roads - 20190128, Imagery - 20190826 (accessed - 20191216). Created by: slei

VT10
VT11
Ness Rd
Melville Beach Rd
Conon Rd
Troy St
Matheson Rd
Collier St
Witham Cl
Dunkley Av
Cunningham St
VT10
VT01
VT10
VT01
VT03
SLIP

Locality Map



Legend

- *Eucalyptus rudis*
- **Eucalyptus* planted
- *Melaleuca lanceolata*

Vegetation Type

- VT01 *Juncus* dominated Sedgelands
- VT03 *Melaleuca* over sedgelands
- VT10 Parkland cleared
- VT11 Landscaped gardens

Paper Size ISO A3

0 10 20 30 40 50

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

N

GHD

City of Melville

City Of Melville
Melville Foreshore Restoration Strategy 2019

Vegetation type, significant trees and conservation significant communities

Project No. **12514145**
Revision No. **0**
Date **03 Mar 2020**

Mapsheet 8 of 22

FIGURE 6

G:\61\12514145\GIS\Maps\Working\Rev0\12514145_006_VegetationType_Rev0.mxd
Print date: 03 Mar 2020 - 11:59

Data source: GHD: Vegetation Types, Tree Locations - 20191216; Landgate: Roads - 20190128, Imagery - 20190826 (accessed - 20191216). Created by: slei

Legend

- *Agonis flexuosa*
- **Eucalyptus* planted
- *Melaleuca lanceolata*

Vegetation Type

- VT01 *Juncus* dominated Sedgelands
- VT10 Parkland cleared
- VT11 Landscaped gardens

Paper Size ISO A3

0 10 20 30 40 50

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

N

GHD

City of Melville

City Of Melville
Melville Foreshore Restoration Strategy 2019

Vegetation type, significant trees and conservation significant communities

Project No. **12514145**
Revision No. **0**
Date **03 Mar 2020**

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FIGURE 6

G:\61\12514145\GIS\Maps\Working\Rev0\12514145_006_VegetationType_Rev0.mxd
Print date: 03 Mar 2020 - 11:59

Data source: GHD: Vegetation Types, Tree Locations - 20191216; Landgate: Roads - 20190128, Imagery - 20190826 (accessed - 20191216). Created by: slei

Legend

- *Agonis flexuosa*
- *Eucalyptus gomphocephala*

Vegetation Type

- VT01 *Juncus* dominated Sedgelands
- VT10 Parkland cleared

Paper Size ISO A3

0 10 20 30 40 50

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

N

City Of Melville
Melville Foreshore Restoration Strategy 2019

Vegetation type, significant trees and conservation significant communities

Project No. **12514145**
Revision No. **0**
Date **03 Mar 2020**

Mapsheet 10 of 22

FIGURE 6

G:\61\12514145\GIS\Maps\Working\Rev0\12514145_006_VegetationType_Rev0.mxd
Print date: 03 Mar 2020 - 11:59

Data source: GHD: Vegetation Types, Tree Locations - 20191216; Landgate: Roads - 20190128, Imagery - 20190826 (accessed - 20191216). Created by: slei

Legend

Eucalyptus gomphocephala

Vegetation Type

- VT01 *Juncus* dominated Sedgelands
- VT05 Mixed *Acacia* shrublands (rehabilitation species)
- VT10 Parkland cleared

Paper Size ISO A3

0 10 20 30 40 50

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

N

GHD

City of Melville

City Of Melville
Melville Foreshore Restoration Strategy 2019

Vegetation type, significant trees and conservation significant communities

Project No. **12514145**
Revision No. **0**
Date **03 Mar 2020**

Mapsheet 11 of 22

FIGURE 6

G:\61\12514145\GIS\Maps\Working\Rev0\12514145_006_VegetationType_Rev0.mxd
Print date: 03 Mar 2020 - 11:59

Data source: GHD: Vegetation Types, Tree Locations - 20191216; Landgate: Roads - 20190128, Imagery - 20190826 (accessed - 20191216). Created by: slei

Legend

- *Eucalyptus camaldulensis*
- **Eucalyptus* planted

Vegetation Type

- VT01 *Juncus* dominated Sedgelands
- VT05 Mixed *Acacia* shrublands (rehabilitation species)
- VT10 Parkland cleared
- VT11 Landscaped gardens

Paper Size ISO A3

0 10 20 30 40 50

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

N

GHD

City of Melville

City Of Melville
Melville Foreshore Restoration Strategy 2019

Vegetation type, significant trees and conservation significant communities

Project No. **12514145**
Revision No. **0**
Date **03 Mar 2020**

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FIGURE 6

G:\61\12514145\GIS\Maps\Working\Rev0\12514145_006_VegetationType_Rev0.mxd
Print date: 03 Mar 2020 - 11:59

Data source: GHD: Vegetation Types, Tree Locations - 20191216; Landgate: Roads - 20190128, Imagery - 20190826 (accessed - 20191216). Created by: slei

Legend

- *Eucalyptus camaldulensis*
- *Eucalyptus gomphocephala*
- **Eucalyptus* planted

Vegetation Type

- VT01 *Juncus* dominated Sedgelands
- VT07 Cliffs with scattered salt-tolerant natives
- VT08 Mixed shrubland
- VT10 Parkland cleared
- VT11 Landscaped gardens
- VT12 Weedy shrubland

Paper Size ISO A3

0 10 20 30 40 50

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

N

GHD

City of Melville

City Of Melville
Melville Foreshore Restoration Strategy 2019

Vegetation type, significant trees and conservation significant communities

Project No. **12514145**
Revision No. **0**
Date **03 Mar 2020**

Mapsheet 13 of 22

FIGURE 6

G:\61\12514145\GIS\Maps\Working\Rev0\12514145_006_VegetationType_Rev0.mxd
Print date: 03 Mar 2020 - 11:59

Data source: GHD: Vegetation Types, Tree Locations - 20191216; Landgate: Roads - 20190128, Imagery - 20190826 (accessed - 20191216). Created by: slei

Legend

- **Eucalyptus* planted
- Likely to be the Subtropical and Temperate Coastal Saltmarsh TEC

Vegetation Type

- VT01 *Juncus* dominated Sedgelands
- VT04 *Casuarina* stand
- VT06 Samphire shrubland and *Juncus* sedgeland
- VT10 Parkland cleared

Paper Size ISO A3

0 10 20 30 40 50

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

N

GHD

City of Melville

City Of Melville
Melville Foreshore Restoration Strategy 2019

Vegetation type, significant trees and conservation significant communities

Project No. **12514145**
Revision No. **0**
Date **03 Mar 2020**

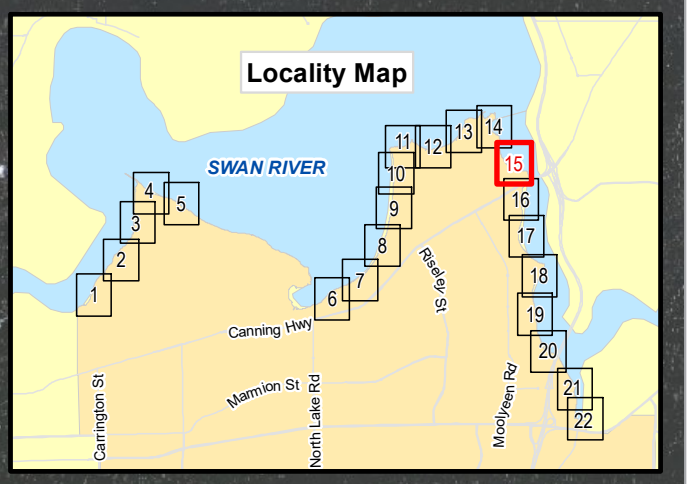
Mapsheet 14 of 22

FIGURE 6

G:\61\12514145\GIS\Maps\Working\Rev0\12514145_006_VegetationType_Rev0.mxd
Print date: 03 Mar 2020 - 12:00

Data source: GHD: Vegetation Types, Tree Locations - 20191216; Landgate: Roads - 20190128, Imagery - 20190826 (accessed - 20191216). Created by: slei

Dunvegan Rd
VT01
VT10
Killilan Rd
VT01
VT01
Riverway
Canning Beach Rd
VT10
VT01
VT01
VT10
VT11
Tweeddale Rd
Moreau Mews
Kintail Rd
VT11
First Av
Canning Hwy
VT10
VT04



Legend

Eucalyptus planted

Vegetation Type

VT01 *Juncus* dominated Sedgelands

VT04 *Casuarina* stand

VT10 Parkland cleared

VT11 Landscaped gardens

Paper Size ISO A3

0 10 20 30 40 50

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

N

GHD

City of Melville

City Of Melville
Melville Foreshore Restoration Strategy 2019

Vegetation type, significant trees and conservation significant communities

Project No. **12514145**
Revision No. **0**
Date **03 Mar 2020**

Mapsheet 15 of 22

FIGURE 6

G:\61\12514145\GIS\Maps\Working\Rev0\12514145_006_VegetationType_Rev0.mxd
Print date: 03 Mar 2020 - 12:00

Data source: GHD: Vegetation Types, Tree Locations - 20191216; Landgate: Roads - 20190128, Imagery - 20190826 (accessed - 20191216). Created by: slei

Legend

Vegetation Type

- VT03 *Melaleuca* over sedgelands
- VT04 *Casuarina* stand
- VT10 Parkland cleared
- VT11 Landscaped gardens

Paper Size ISO A3

0 10 20 30 40 50

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

N

GHD

City of Melville

City Of Melville
Melville Foreshore Restoration Strategy 2019

Vegetation type, significant trees and conservation significant communities

Project No. **12514145**
Revision No. **0**
Date **03 Mar 2020**

Mapsheet 16 of 22

FIGURE 6

G:\61\12514145\GIS\Maps\Working\Rev0\12514145_006_VegetationType_Rev0.mxd
Print date: 03 Mar 2020 - 12:00

Data source: GHD: Vegetation Types, Tree Locations - 20191216; Landgate: Roads - 20190128, Imagery - 20190826 (accessed - 20191216). Created by: slei

Legend

Vegetation Type

- VT01 *Juncus* dominated Sedgelands
- VT03 *Melaleuca* over sedgelands
- VT10 Parkland cleared

Paper Size ISO A3

0 10 20 30 40 50

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

N

GHD

City of Melville

City Of Melville
Melville Foreshore Restoration Strategy 2019

Vegetation type, significant trees and conservation significant communities

Project No. **12514145**
Revision No. **0**
Date **03 Mar 2020**

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FIGURE 6

G:\61\12514145\GIS\Maps\Working\Rev0\12514145_006_VegetationType_Rev0.mxd
Print date: 03 Mar 2020 - 12:00

Data source: GHD: Vegetation Types, Tree Locations - 20191216; Landgate: Roads - 20190128, Imagery - 20190826 (accessed - 20191216). Created by: slei

Legend

Vegetation Type

- VT01 *Juncus* dominated Sedgelands
- VT03 *Melaleuca* over sedgelands
- VT10 Parkland cleared
- VT11 Landscaped gardens

Paper Size ISO A3

0 10 20 30 40 50

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

N

GHD

City of Melville

City Of Melville
Melville Foreshore Restoration Strategy 2019

Vegetation type, significant trees and conservation significant communities

Project No. **12514145**
Revision No. **0**
Date **03 Mar 2020**

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FIGURE 6

G:\61\12514145\GIS\Maps\Working\Rev0\12514145_006_VegetationType_Rev0.mxd
Print date: 03 Mar 2020 - 12:00

Data source: GHD: Vegetation Types, Tree Locations - 20191216; Landgate: Roads - 20190128, Imagery - 20190826 (accessed - 20191216). Created by: slei

Legend

Vegetation Type

- VT01 *Juncus* dominated Sedgelands
- VT03 *Melaleuca* over sedgelands
- VT10 Parkland cleared
- VT11 Landscaped gardens

Paper Size ISO A3

0 10 20 30 40 50

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

N

GHD

City of Melville

City Of Melville
Melville Foreshore Restoration Strategy 2019

Vegetation type, significant trees and conservation significant communities

Project No. **12514145**
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Date **03 Mar 2020**

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FIGURE 6

G:\61\12514145\GIS\Maps\Working\Rev0\12514145_006_VegetationType_Rev0.mxd
Print date: 03 Mar 2020 - 12:00

Data source: GHD: Vegetation Types, Tree Locations - 20191216; Landgate: Roads - 20190128, Imagery - 20190826 (accessed - 20191216). Created by: slei

Legend

- *Eucalyptus rudis*

Vegetation Type

- VT03 *Melaleuca* over sedgelands
- VT10 Parkland cleared
- VT11 Landscaped gardens

Paper Size ISO A3

0 10 20 30 40 50

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

N

GHD

City of Melville

City Of Melville
Melville Foreshore Restoration Strategy 2019

Vegetation type, significant trees and conservation significant communities

Project No. **12514145**
Revision No. **0**
Date **03 Mar 2020**

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FIGURE 6

G:\61\12514145\GIS\Maps\Working\Rev0\12514145_006_VegetationType_Rev0.mxd
Print date: 03 Mar 2020 - 12:01

Data source: GHD: Vegetation Types, Tree Locations - 20191216; Landgate: Roads - 20190128, Imagery - 20190826 (accessed - 20191216). Created by: slei

Legend

- **Eucalyptus camaldulensis* planted
- *Eucalyptus rudis*
- **Eucalyptus* planted

Vegetation Type

- VT01 *Juncus* dominated Sedgelands
- VT02 *Melaleuca* and Flooded Gum woodlands
- VT03 *Melaleuca* over sedgelands
- VT10 Parkland cleared
- VT12 Weedy shrubland

Paper Size ISO A3

0 10 20 30 40 50

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

N

GHD

City of Melville

City Of Melville
Melville Foreshore Restoration Strategy 2019

Vegetation type, significant trees and conservation significant communities

Project No. **12514145**
Revision No. **0**
Date **03 Mar 2020**

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FIGURE 6

G:\61\12514145\GIS\Maps\Working\Rev0\12514145_006_VegetationType_Rev0.mxd
Print date: 03 Mar 2020 - 12:01

Data source: GHD: Vegetation Types, Tree Locations - 20191216; Landgate: Roads - 20190128, Imagery - 20190826 (accessed - 20191216). Created by: slei

Legend

- **Eucalyptus camaldulensis* planted
- *Eucalyptus rudis*
- **Eucalyptus* planted

Vegetation Type

- VT01 *Juncus* dominated Sedgelands
- VT02 *Melaleuca* and Flooded Gum woodlands
- VT03 *Melaleuca* over sedgelands
- VT10 Parkland cleared
- VT12 Weedy shrubland

Paper Size ISO A3

0 10 20 30 40 50

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

N

GHD

City of Melville

City Of Melville
Melville Foreshore Restoration Strategy 2019

Vegetation type, significant trees and conservation significant communities

Project No. **12514145**
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Date **03 Mar 2020**

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FIGURE 6

G:\61\12514145\GIS\Maps\Working\Rev0\12514145_006_VegetationType_Rev0.mxd
Print date: 03 Mar 2020 - 12:01

Data source: GHD: Vegetation Types, Tree Locations - 20191216; Landgate: Roads - 20190128, Imagery - 20190826 (accessed - 20191216). Created by: slei

Legend

Significant Weeds

Asparagus asparagoides

Vegetation Condition

- Pristine
- Pristine - Excellent
- Excellent
- Excellent - Very Good
- Very Good
- Very Good - Good
- Good
- Good - Degraded
- Degraded
- Degraded - Completely Degraded
- Completely Degraded

Paper Size ISO A3

0 10 20 30 40 50

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

N

GHD

City of Melville

City Of Melville
Melville Foreshore Restoration Strategy 2019

Vegetation condition and significant weeds

Project No. **12514145**
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Date **03 Mar 2020**

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FIGURE 7

G:\61\12514145\GIS\Maps\Working\Rev0\12514145_007_VegetationCondition_Rev0.mxd
Print date: 03 Mar 2020 - 12:05

Data source: GHD: Vegetation Condition, Signifiant Weeds - 20191216; Landgate: Roads - 20190128, Imagery - 20190826 (accessed - 20191216). Created by: slei

Legend

Vegetation Condition

- Pristine
- Pristine - Excellent
- Excellent
- Excellent - Very Good
- Very Good
- Very Good - Good
- Good
- Good - Degraded
- Degraded
- Degraded - Completely Degraded
- Completely Degraded

Paper Size ISO A3

0 10 20 30 40 50

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

N

GHD

City of Melville

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Melville Foreshore Restoration Strategy 2019

Vegetation condition and significant weeds

Project No. **12514145**
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FIGURE 7

G:\61\12514145\GIS\Maps\Working\Rev0\12514145_007_VegetationCondition_Rev0.mxd
Print date: 03 Mar 2020 - 12:05

Data source: GHD: Vegetation Condition, Signifiant Weeds - 20191216; Landgate: Roads - 20190128, Imagery - 20190826 (accessed - 20191216). Created by: slei

Legend

Significant

Asparagus asparagoides

Vegetation Condition

- Pristine
- Pristine - Excellent
- Excellent
- Excellent - Very Good
- Very Good
- Very Good - Good
- Good
- Good - Degraded
- Degraded
- Degraded - Completely Degraded
- Completely Degraded

Paper Size ISO A3

0 10 20 30 40 50

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

N

City Of Melville
Melville Foreshore Restoration Strategy 2019

Vegetation condition and significant weeds

Project No. 12514145
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Date 03 Mar 2020

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FIGURE 7

G:\61\12514145\GIS\Maps\Working\Rev0\12514145_007_VegetationCondition_Rev0.mxd
Print date: 03 Mar 2020 - 12:05

Data source: GHD: Vegetation Condition, Signifiant Weeds - 20191216; Landgate: Roads - 20190128, Imagery - 20190826 (accessed - 20191216). Created by: slei

Legend

Significant Weeds

Asparagus asparagoides

Vegetation Condition

- Pristine
- Pristine - Excellent
- Excellent
- Excellent - Very Good
- Very Good
- Very Good - Good
- Good
- Good - Degraded
- Degraded
- Degraded - Completely Degraded
- Completely Degraded

Paper Size ISO A3

0 10 20 30 40 50

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

N

GHD

City of Melville

City Of Melville
Melville Foreshore Restoration Strategy 2019

Vegetation condition and significant weeds

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Date **03 Mar 2020**

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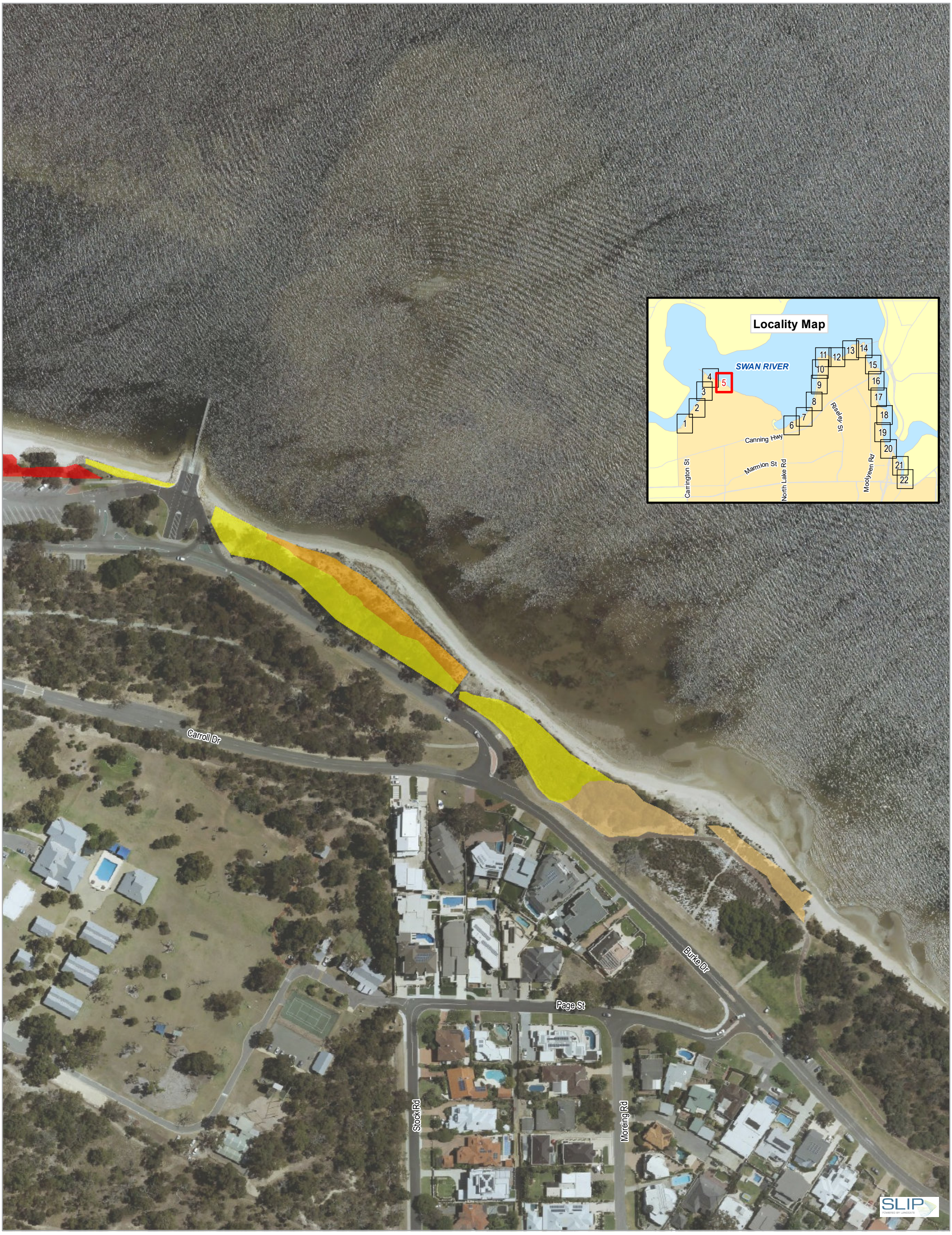
FIGURE 7

G:\61\12514145\GIS\Maps\Working\Rev0\12514145_007_VegetationCondition_Rev0.mxd
Print date: 03 Mar 2020 - 12:05

Data source: GHD: Vegetation Condition, Signifiant Weeds - 20191216; Landgate: Roads - 20190128, Imagery - 20190826 (accessed - 20191216). Created by: slei



Legend

Vegetation Condition

- Pristine
- Pristine - Excellent
- Excellent
- Excellent - Very Good
- Very Good
- Very Good - Good
- Good
- Good - Degraded
- Degraded
- Degraded - Completely Degraded
- Completely Degraded

Paper Size ISO A3

0 10 20 30 40 50

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

N

GHD

City of Melville

City Of Melville
Melville Foreshore Restoration Strategy 2019

Vegetation condition and significant weeds

Project No. **12514145**
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Date **03 Mar 2020**

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FIGURE 7

G:\61\12514145\GIS\Maps\Working\Rev0\12514145_007_VegetationCondition_Rev0.mxd
Print date: 03 Mar 2020 - 12:05

Data source: GHD: Vegetation Condition, Signifiant Weeds - 20191216; Landgate: Roads - 20190128, Imagery - 20190826 (accessed - 20191216). Created by: slei

Legend

Vegetation Condition

- Pristine
- Pristine - Excellent
- Excellent
- Excellent - Very Good
- Very Good
- Very Good - Good
- Good
- Good - Degraded
- Degraded
- Degraded - Completely Degraded
- Completely Degraded

Paper Size ISO A3

0 10 20 30 40 50

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

N

GHD

City of Melville

City Of Melville
Melville Foreshore Restoration Strategy 2019

Vegetation condition and significant weeds

Project No. **12514145**
Revision No. **0**
Date **03 Mar 2020**

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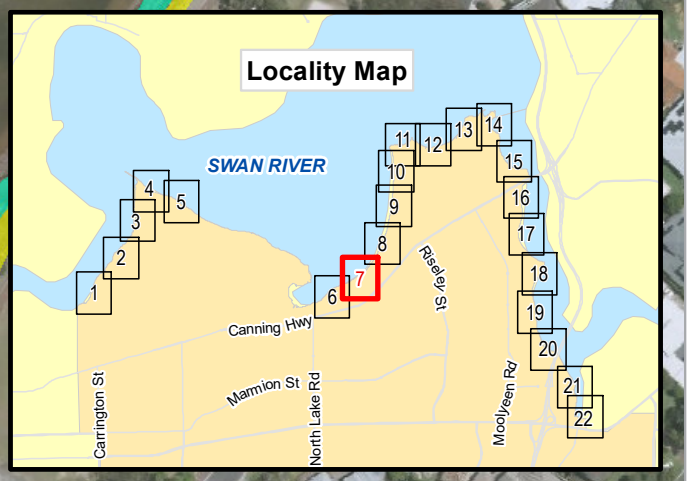
FIGURE 7

G:\61\12514145\GIS\Maps\Working\Rev0\12514145_007_VegetationCondition_Rev0.mxd
Print date: 03 Mar 2020 - 12:05

Data source: GHD: Vegetation Condition, Signifiant Weeds - 20191216; Landgate: Roads - 20190128, Imagery - 20190826 (accessed - 20191216). Created by: slei

Melville Beach Rd
Cunningham St
Cheyne Walk
Helen St
Dunkley Av
Canterary Av
Lilian Av
Canning Hwy
Francis Rd

Locality Map



Legend

Vegetation Condition

- Pristine
- Pristine - Excellent
- Excellent
- Excellent - Very Good
- Very Good
- Very Good - Good
- Good
- Good - Degraded
- Degraded
- Degraded - Completely Degraded
- Completely Degraded

Paper Size ISO A3

0 10 20 30 40 50

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

N

GHD

City of Melville

City Of Melville
Melville Foreshore Restoration Strategy 2019

Vegetation condition and significant weeds

Project No. **12514145**
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Date **03 Mar 2020**

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FIGURE 7

G:\61\12514145\GIS\Maps\Working\Rev0\12514145_007_VegetationCondition_Rev0.mxd
Print date: 03 Mar 2020 - 12:06

Data source: GHD: Vegetation Condition, Signifiant Weeds - 20191216; Landgate: Roads - 20190128, Imagery - 20190826 (accessed - 20191216). Created by: slei

Legend

Vegetation Condition

- Pristine
- Pristine - Excellent
- Excellent
- Excellent - Very Good
- Very Good
- Very Good - Good
- Good
- Good - Degraded
- Degraded
- Degraded - Completely Degraded
- Completely Degraded

Paper Size ISO A3

0 10 20 30 40 50

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

N

GHD

City of Melville

City Of Melville
Melville Foreshore Restoration Strategy 2019

Vegetation condition and significant weeds

Project No. **12514145**
Revision No. **0**
Date **03 Mar 2020**

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FIGURE 7

G:\61\12514145\GIS\Maps\Working\Rev0\12514145_007_VegetationCondition_Rev0.mxd
Print date: 03 Mar 2020 - 12:06

Data source: GHD: Vegetation Condition, Signifiant Weeds - 20191216; Landgate: Roads - 20190128, Imagery - 20190826 (accessed - 20191216). Created by: slei

Legend

Vegetation Condition

- Pristine
- Pristine - Excellent
- Excellent
- Excellent - Very Good
- Very Good
- Very Good - Good
- Good
- Good - Degraded
- Degraded
- Degraded - Completely Degraded
- Completely Degraded

Paper Size ISO A3

0 10 20 30 40 50

Metres

N

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

GHD

City of Melville

City Of Melville
Melville Foreshore Restoration Strategy 2019

Vegetation condition and significant weeds

Project No. **12514145**
Revision No. **0**
Date **03 Mar 2020**

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FIGURE 7

G:\61\12514145\GIS\Maps\Working\Rev0\12514145_007_VegetationCondition_Rev0.mxd
Print date: 03 Mar 2020 - 12:06

Data source: GHD: Vegetation Condition, Signifiant Weeds - 20191216; Landgate: Roads - 20190128, Imagery - 20190826 (accessed - 20191216). Created by: slei

Legend

Vegetation Condition

- Pristine
- Pristine - Excellent
- Excellent
- Excellent - Very Good
- Very Good
- Very Good - Good
- Good
- Good - Degraded
- Degraded
- Degraded - Completely Degraded
- Completely Degraded

Paper Size ISO A3

0 10 20 30 40 50

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

N

GHD

City of Melville

City Of Melville
Melville Foreshore Restoration Strategy 2019

Vegetation condition and significant weeds

Project No. **12514145**
Revision No. **0**
Date **03 Mar 2020**

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FIGURE 7

G:\61\12514145\GIS\Maps\Working\Rev0\12514145_007_VegetationCondition_Rev0.mxd
Print date: 03 Mar 2020 - 12:06

Data source: GHD: Vegetation Condition, Signifiant Weeds - 20191216; Landgate: Roads - 20190128, Imagery - 20190826 (accessed - 20191216). Created by: slei

Legend

Vegetation Condition

- Pristine
- Pristine - Excellent
- Excellent
- Excellent - Very Good
- Very Good
- Very Good - Good
- Good
- Good - Degraded
- Degraded
- Degraded - Completely Degraded
- Completely Degraded

Paper Size ISO A3

0 10 20 30 40 50

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

N

GHD

City of Melville

City Of Melville
Melville Foreshore Restoration Strategy 2019

Vegetation condition and significant weeds

Project No. **12514145**
Revision No. **0**
Date **03 Mar 2020**

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FIGURE 7

G:\61\12514145\GIS\Maps\Working\Rev0\12514145_007_VegetationCondition_Rev0.mxd
Print date: 03 Mar 2020 - 12:06

Data source: GHD: Vegetation Condition, Signifiant Weeds - 20191216; Landgate: Roads - 20190128, Imagery - 20190826 (accessed - 20191216). Created by: slei

Legend

Vegetation Condition

- Pristine
- Pristine - Excellent
- Excellent
- Excellent - Very Good
- Very Good
- Very Good - Good
- Good
- Good - Degraded
- Degraded
- Degraded - Completely Degraded
- Completely Degraded

Paper Size ISO A3

0 10 20 30 40 50

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

N

GHD

City of Melville

City Of Melville
Melville Foreshore Restoration Strategy 2019

Vegetation condition and significant weeds

Project No. **12514145**
Revision No. **0**
Date **03 Mar 2020**

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FIGURE 7

G:\61\12514145\GIS\Maps\Working\Rev0\12514145_007_VegetationCondition_Rev0.mxd
Print date: 03 Mar 2020 - 12:07

Data source: GHD: Vegetation Condition, Signifiant Weeds - 20191216; Landgate: Roads - 20190128, Imagery - 20190826 (accessed - 20191216). Created by: slei

Legend

Significant Weeds

Asparagus asparagoides

Vegetation Condition

- Pristine
- Pristine - Excellent
- Excellent
- Excellent - Very Good
- Very Good
- Very Good - Good
- Good
- Good - Degraded
- Degraded
- Degraded - Completely Degraded
- Completely Degraded

Paper Size ISO A3

0 10 20 30 40 50

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

N

GHD

City of Melville

City Of Melville
Melville Foreshore Restoration Strategy 2019

Vegetation condition and significant weeds

Project No. **12514145**
Revision No. **0**
Date **03 Mar 2020**

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FIGURE 7

G:\61\12514145\GIS\Maps\Working\Rev0\12514145_007_VegetationCondition_Rev0.mxd
Print date: 03 Mar 2020 - 12:07

Data source: GHD: Vegetation Condition, Signifiant Weeds - 20191216; Landgate: Roads - 20190128, Imagery - 20190826 (accessed - 20191216). Created by: slei

Legend

Vegetation Condition

- Pristine
- Pristine - Excellent
- Excellent
- Excellent - Very Good
- Very Good
- Very Good - Good
- Good
- Good - Degraded
- Degraded
- Degraded - Completely Degraded
- Completely Degraded

Paper Size ISO A3

0 10 20 30 40 50

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

N

GHD

City of Melville

City Of Melville
Melville Foreshore Restoration Strategy 2019

Vegetation condition and significant weeds

Project No. **12514145**
Revision No. **0**
Date **03 Mar 2020**

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FIGURE 7

G:\61\12514145\GIS\Maps\Working\Rev0\12514145_007_VegetationCondition_Rev0.mxd
Print date: 03 Mar 2020 - 12:07

Data source: GHD: Vegetation Condition, Signifiant Weeds - 20191216; Landgate: Roads - 20190128, Imagery - 20190826 (accessed - 20191216). Created by: slei

Legend

Vegetation Condition

- Pristine
- Pristine - Excellent
- Excellent
- Excellent - Very Good
- Very Good
- Very Good - Good
- Good
- Good - Degraded
- Degraded
- Degraded - Completely Degraded
- Completely Degraded

Paper Size ISO A3

0 10 20 30 40 50

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

N

GHD

City of Melville

City Of Melville
Melville Foreshore Restoration Strategy 2019

Vegetation condition and significant weeds

Project No. **12514145**
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Date **03 Mar 2020**

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FIGURE 7

G:\61\12514145\GIS\Maps\Working\Rev0\12514145_007_VegetationCondition_Rev0.mxd
Print date: 03 Mar 2020 - 12:07

Data source: GHD: Vegetation Condition, Signifiant Weeds - 20191216; Landgate: Roads - 20190128, Imagery - 20190826 (accessed - 20191216). Created by: slei

Kintail Rd
Canning Beach Rd
Moreau Mews
Canning Hwy
Kishorn Rd
The Esplanade
Ogilvie Rd
Helm St
Kavanagh St
View Rd

Locality Map
SWAN RIVER
Canning Hwy
Marmion St
Carrington St
North Lake Rd
Riseley St
Mooltyeen Rd
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22

SLIP

Legend

Vegetation Condition

- Pristine
- Pristine - Excellent
- Excellent
- Excellent - Very Good
- Very Good
- Very Good - Good
- Good
- Good - Degraded
- Degraded
- Degraded - Completely Degraded
- Completely Degraded

Paper Size ISO A3

0 10 20 30 40 50

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

N

GHD

City of Melville

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Melville Foreshore Restoration Strategy 2019

Vegetation condition and significant weeds

Project No. **12514145**
Revision No. **0**
Date **03 Mar 2020**

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FIGURE 7

G:\61\12514145\GIS\Maps\Working\Rev0\12514145_007_VegetationCondition_Rev0.mxd
Print date: 03 Mar 2020 - 12:07

Data source: GHD: Vegetation Condition, Signifiant Weeds - 20191216; Landgate: Roads - 20190128, Imagery - 20190826 (accessed - 20191216). Created by: slei

Legend

Vegetation Condition

- Pristine
- Pristine - Excellent
- Excellent
- Excellent - Very Good
- Very Good
- Very Good - Good
- Good
- Good - Degraded
- Degraded
- Degraded - Completely Degraded
- Completely Degraded

Paper Size ISO A3

0 10 20 30 40 50

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

N

GHD

City of Melville

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Melville Foreshore Restoration Strategy 2019

Vegetation condition and significant weeds

Project No. **12514145**
Revision No. **0**
Date **03 Mar 2020**

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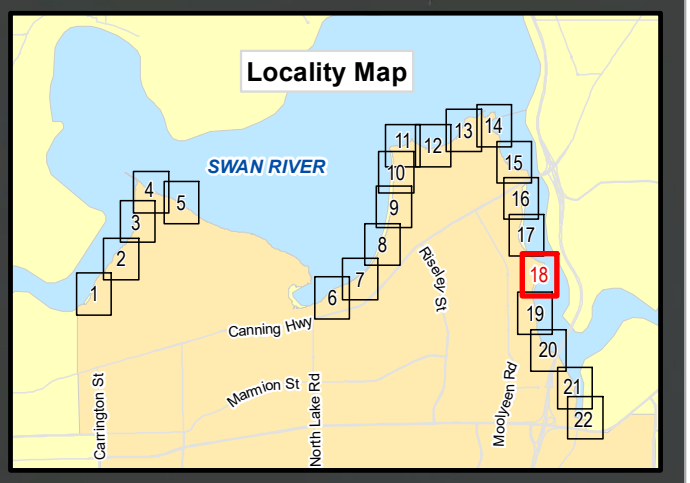
FIGURE 7

G:\61\12514145\GIS\Maps\Working\Rev0\12514145_007_VegetationCondition_Rev0.mxd
Print date: 03 Mar 2020 - 12:07

Data source: GHD: Vegetation Condition, Signifiant Weeds - 20191216; Landgate: Roads - 20190128, Imagery - 20190826 (accessed - 20191216). Created by: slei

Hawkins St
Park Rd
The Esplanade
Coogee Rd
Bateman Rd
Central Av

Locality Map



Legend

Vegetation Condition

- Pristine
- Pristine - Excellent
- Excellent
- Excellent - Very Good
- Very Good
- Very Good - Good
- Good
- Good - Degraded
- Degraded
- Degraded - Completely Degraded
- Completely Degraded

Paper Size ISO A3

0 10 20 30 40 50

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

N

GHD

City of Melville

City Of Melville
Melville Foreshore Restoration Strategy 2019

Vegetation condition and significant weeds

Project No. **12514145**
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Date **03 Mar 2020**

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FIGURE 7

G:\61\12514145\GIS\Maps\Working\Rev0\12514145_007_VegetationCondition_Rev0.mxd
Print date: 03 Mar 2020 - 12:07

Data source: GHD: Vegetation Condition, Signifiant Weeds - 20191216; Landgate: Roads - 20190128, Imagery - 20190826 (accessed - 20191216). Created by: slei

Legend

Vegetation Condition

- Pristine
- Pristine - Excellent
- Excellent
- Excellent - Very Good
- Very Good
- Very Good - Good
- Good
- Good - Degraded
- Degraded
- Degraded - Completely Degraded
- Completely Degraded

Paper Size ISO A3

0 10 20 30 40 50

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

N

GHD

City of Melville

City Of Melville
Melville Foreshore Restoration Strategy 2019

Vegetation condition and significant weeds

Project No. **12514145**
Revision No. **0**
Date **03 Mar 2020**

Mapsheet 19 of 22

FIGURE 7

G:\61\12514145\GIS\Maps\Working\Rev0\12514145_007_VegetationCondition_Rev0.mxd
Print date: 03 Mar 2020 - 12:08

Data source: GHD: Vegetation Condition, Signifiant Weeds - 20191216; Landgate: Roads - 20190128, Imagery - 20190826 (accessed - 20191216). Created by: slei

Legend

Vegetation Condition

- Pristine
- Pristine - Excellent
- Excellent
- Excellent - Very Good
- Very Good
- Very Good - Good
- Good
- Good - Degraded
- Degraded
- Degraded - Completely Degraded
- Completely Degraded

Paper Size ISO A3

0 10 20 30 40 50

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
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Print date: 03 Mar 2020 - 12:08

Data source: GHD: Vegetation Condition, Signifiant Weeds - 20191216; Landgate: Roads - 20190128, Imagery - 20190826 (accessed - 20191216). Created by: slei

Legend

Significant Weeds

- *Lantana camara*
- *Zantedeschia aethiopica*

Vegetation Condition

- Pristine
- Pristine - Excellent
- Excellent
- Excellent - Very Good
- Very Good
- Very Good - Good
- Good
- Good - Degraded
- Degraded
- Degraded - Completely Degraded
- Completely Degraded

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0 10 20 30 40 50

Metres

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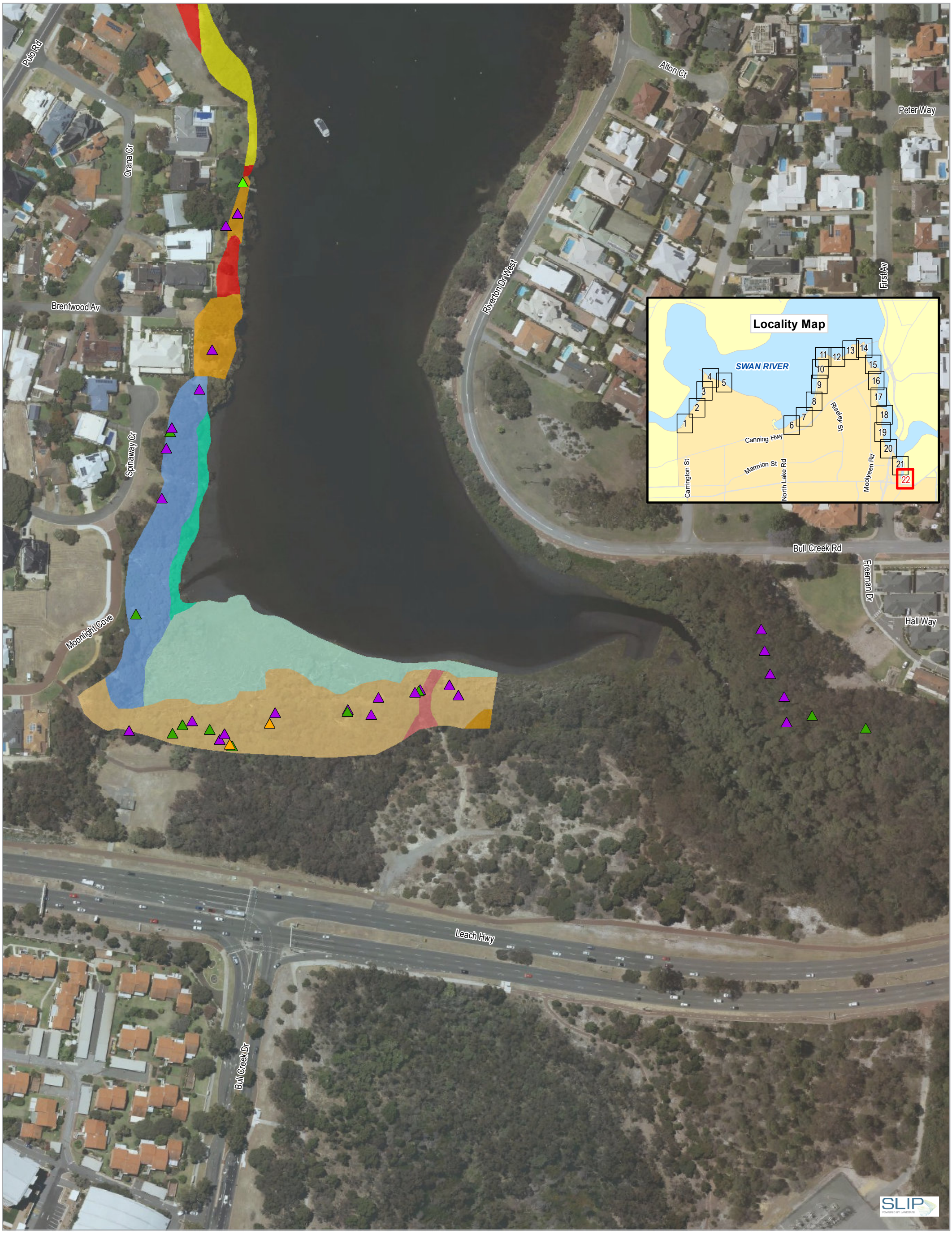
Data source: GHD: Vegetation Condition, Signifiant Weeds - 20191216; Landgate: Roads - 20190128, Imagery - 20190826 (accessed - 20191216). Created by: slei



Legend

Significant Weeds

- *Asparagus asparagoides*
- *Lantana camara*
- *Rubus laudatus*
- *Zantedeschia aethiopica*

Vegetation Condition

- Pristine
- Pristine - Excellent
- Excellent
- Excellent - Very Good
- Very Good
- Very Good - Good
- Good
- Good - Degraded
- Degraded
- Degraded - Completely Degraded
- Completely Degraded

Paper Size ISO A3

0 10 20 30 40 50

Metres

Map Projection: Transverse Mercator
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Appendix C – Site Inventory Methodology

1. Coastal Engineer

A GHD coastal engineer undertook an asset inventory and assessment of the City's foreshore areas during October 2019, with findings documented in a GIS tablet device. Site visits were carried out over four days with the coastal engineer traversing by foot and documenting the following observations as they arose:

- Erosion damage to hard infrastructure and natural areas including details on nature of the damage and a condition rating;
- Existing foreshore treatments
- Infrastructure and landscape features
- Recreational usage based on available information, existing infrastructure and landscape features

While on site, the location of a point of interest was recorded with the tablet's Global Positioning System (GPS) tool to accuracy approximately ± 5 m, a picture was taken and the relevant information was noted. Table A.1 presents the format used for documenting information while on site.

Table A.1 Data Collection Framework

Aspect	Details
Asset Name	Infrastructure/amenities, natural asset or existing foreshore treatment
Existing Foreshore Treatment	A drop down list of existing foreshore treatments was included for selection
Infrastructure or Amenities	A drop down list of infrastructure/amenities was included for selection
Natural Assets	A drop down list of natural assets was included for selection
Foreshore Segment	The Swan River Trust naming convention for foreshore locations was used
Site Details	A description of the site details was noted
Hazards	The details of potential hazards were noted
Condition	A verbal condition assessment was noted where necessary
Erosion Mechanisms	Erosive conditions were noted according to the Swan River Trust list (see below)
Condition Rating	A condition rating was as assigned to assets (see below)
Extra Comments	Any extra observations were documented
Recreational Usage	Recreational usage was noted based on available information, existing infrastructure and landscape features

The following asset classification scheme was developed to document the coastal observations while on site:

1. **Excellent:** Structure requires only routine maintenance

2. **Good:** Minor deterioration of the asset can be seen, requiring a low level of maintenance
3. **Fair:** Asset shows signs of significant deterioration but is still functional
4. **Poor:** Significant amount of damage to structure Major upgrade or renewal will be required to extend the life of the asset
5. **Unserviceable:** No remaining life expectancy. The asset has failed / asset needs to be replaced or rebuilt

And the following erosion mechanisms were documents according to Swan River Trust guidelines:

1. **Energetic Wave Conditions**: often associated with dramatic loss on beaches during single storm events.
2. **Increase in Mean Water Level:** causes an upwards migration of the active hydraulic zone.
3. **Decrease in Mean Water Level**: lowered water levels cause a downwards migration the active hydraulic zone.
4. **Vegetation Loss:** loss of vegetation tends to provide a bank that is less resistant to hydraulic action.
5. **Sediment Sink/Source:** locations where there is an imbalance of sediment transport experience net erosion or accretion.
6. **Sediment Deficit:** change that alters the prevailing sediment transport conditions, removing a quantity of sediment from active forcing before normal transport patterns return
7. **Strong Currents:** located primarily where there are restrictions in cross-sectional area.
8. **Seasonality:** both the intensity of prevailing conditions and their persistence may affect the net sediment transport rate.
9. **Drainage Structures:** erosion associated with drainage outfalls may extend beyond the immediate vicinity of the flow path.
10. **Flow over Banks:** erosion, often in the form of gully erosion, associated with water flowing directly over the banks due to drainage of overtopped water or as a result of stormwater runoff.
11. **Sedimentation:** sedimentation of the channel decreases the channel cross-sectional area and thereby increases the potential for channel planform migration and inundation as a result of flooding.
12. **Trampling:** loss of vegetation and sediment can occur due to uncontrolled access, worm digging, boat launching and animal activity.

2. Ecologist

Study area

The Study area for the field inventory included the foreshore area from the high water mark until the footpath, except where the footpath was at a considerable distance from the river, in which case a width of approximately 10 m was surveyed.

Flora and vegetation

A GHD ecologist undertook a reconnaissance vegetation and flora survey 14 – 16 October 2019. The survey was conducted to provide descriptions of the dominant vegetation unit's present, vegetation condition and flora species present at the time of the survey.

Data collection

Field survey methods involved a combination of relevés, photo points and traversing the study area on foot. Relevés (unmarked areas) were performed in identified vegetation units and photo

points were done to supplement the relevé data. The survey methodology was undertaken with reference to the EPA Technical Guidance – Flora and Vegetation Surveys for Environmental Impact Assessment (EPA 2016). Data collected from each relevé is included in Table A.2.

Table A.2 Data collected during the field survey

Aspect	Measurement
Collection attributes	Personnel/recorder; date, photograph.
Physical features	Landform
Location of important features	Coordinates recorded in GDA94 datum using a hand-held Global Positioning System (GPS) tool to accuracy approximately ± 5 m.
Vegetation condition	Vegetation condition was assessed using the condition rating scale EPA (2016).
Disturbance	Level and nature of disturbances (e. g. weed presence, fire — and time since last fire, impacts from grazing, exploration activities).
Flora	List of dominant flora from each structural layer.

Vegetation units

Vegetation units were identified and boundaries delineated using a combination of aerial photography, topographical features and field data/observations.

Vegetation units were described based on structure, dominant taxa and cover characteristics as defined by relevant data, field observations and previous reporting (GHD 2014). Vegetation unit descriptions follow NVIS and are consistent with NVIS Level V (Association). At Level V up to three taxa per stratum are used to describe the association (NVIS Technical Working Group 2017).

Species identification and nomenclature

Species well known to the survey ecologist were identified in the field; all other species were collected and assigned a unique collection number to facilitate tracking. All specimens collected during the field assessment were dried and processed in accordance with the requirements of the WA Herbarium. Species were identified by the use of taxonomic literature, electronic keys and online electronic databases.

The conservation status of all recorded flora was compared against the current lists available on FloraBase (WA Herbarium 1998–) and the EPBC Act Threatened species database provided by DotEE (2019). Nomenclature used in this report follows that used by the WA Herbarium as reported on FloraBase (WA Herbarium 1998–).

Vegetation condition

The vegetation condition was assessed and mapped in accordance with the vegetation condition rating scale for the South West and Interzone Botanical Provinces of Western Australia (IBRA) (devised by Keighery (1994) and adapted by EPA (2016)). The scale recognises the intactness of vegetation and consists of six rating levels. The vegetation condition rating scale is outlined below in Table A. 3.

Table A.3 Vegetation condition rating scale (EPA 2016)

Vegetation condition	Description
Pristine	No obvious signs of disturbance.
Excellent	Vegetation structure intact, disturbance affecting individual species, and weeds are non-aggressive species.
Very Good	Vegetation structure altered, obvious signs of disturbance.
Good	Vegetation structure significantly altered by very obvious signs of multiple disturbances retains basic vegetation structure or ability to regenerate it.

Vegetation condition	Description
Degraded	Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not in a state approaching good condition without intensive management.
Completely Degraded	The structure of the vegetation is no longer intact and the area is completely or almost without native species.

Introduced Species

Introduced taxa identified as a Weed of National Significance (WoNS) or Declared Pest as listed under the *Biosecurity and Management Act 2007* were recorded using a hand-held GPS tools (e.g. Samsung tablet and Garmin GPS). The Garmin GPS units used for this survey are accurate to within ±5 metres on average.

Habitat trees

Locations of Eucalypt trees with a Diameter at Breast Height (DBH) of more than 500 mm were recorded using a hand-held GPS tools (e.g. Samsung tablet and Garmin GPS). The Garmin GPS units used for this survey are accurate to within ±5 metres on average.

References:

Beard, JS 1979, *Vegetation Survey of Western Australia: Perth Map and Explanatory Memoir 1:250,000 series*, Perth, Vegmap Publications.

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Heddle EM Loneragan OW and JJ Havel 1980, *Vegetation Complexes of the Darling System, Western Australia*, In: Atlas of Natural Resources, Darling System Western Australia, Department of Conservation and Environment, WA.

NVIS Technical Working Group 2017, *Australian Vegetation Attribute Manual: National Vegetation Information System, Version 7.0*, Department of the Environment and Energy, Canberra. Prep by Bolton, M.P., deLacey, C. and Bossard, K.B. (Eds).

Webb, A., Kinloch, J., Keighery, G., Pitt, G. 2016, The extension of vegetation complex mapping to landform boundaries within the Swan Coastal Plain landform and forested region of south west Western Australia.

Western Australian (WA) Herbarium 1998–, *FloraBase—the Western Australian Flora*, retrieved October, 2013, from http://florabase.dpaw.wa.gov.au/.

Appendix D – Background and Conservation Codes

Heritage

Federal Aboriginal and Non-Aboriginal Heritage

At the Federal level, protection of significant places is provided under the EPBC Act; the *Aboriginal and Torres Strait Islander Heritage Protection Act 1984* and the *Historic Shipwrecks Act 1976*.

The Australian Heritage Database contains information about Australian places that have natural, historic and indigenous value. This database contains information on heritage matters of national environmental significance, which are protected under the EPBC Act. This database includes places listed on the following databases:

- World Heritage List – a list of places that are important to all the peoples of the world. World Heritage sites are recognised under the World Heritage Convention as being of international significance because of their outstanding natural and/or cultural values
- National Heritage List – comprises natural, historic and indigenous places that are of outstanding heritage value to the Australian nation.

State Aboriginal Heritage

In Western Australia, the *Aboriginal Heritage Act 1972* protects places and objects customarily used by, or traditional to, the original inhabitants of Australia. A register of such places and objects is maintained under the Act, however, all sites are protected under the Act whether they have been entered on the register or not.

In Western Australia, the Department of Aboriginal Affairs (DAA) manages the online Aboriginal Heritage Inquiry System, which identifies any registered indigenous heritage sites within the vicinity of the search area.

State Non-Aboriginal Heritage

The Heritage Council of Western Australia is a state government agency responsible for the management of the historic resource. The *Heritage of Western Australia Act 1990* makes a provision for the preservation of places of historic significance. This significance is based on aesthetic, social and scientific principles. Under the Act, a Heritage Place refers only to a building, a definable piece of land and contents relevant to the building.

A heritage agreement is formed between the Minister and the owner of a heritage place based on a voluntary agreement but this is then enforced by the Heritage Council on successive owners and mortgages, government departments, municipal councils and developers. Protection from inappropriate development of a heritage place is granted under the *Heritage of Western Australia Act 1990*, which requires all applications to modify a place to be referred to the Heritage Council. This protection is bestowed to buildings registered on the interim or permanent lists under Sections 50 and 51 of the Act.

The State Heritage Office keeps a heritage register “InHerit” that contains comprehensive information about cultural heritage places listed in the State Register of Heritage Places, local government inventories and other lists, the Australian Government's heritage list, and other non-government lists and surveys.

Acid Sulphate Soils

Acid Sulphate Soils (ASS) are naturally occurring soils containing iron sulphides. These soils are typically benign within an anaerobic environment, however they can become oxidised when exposed, resulting in acidic soil and groundwater. The resulting sulphuric acid can also break heavy metal bonds and result in groundwater contamination. Acid sulphate soils are typically considered to be a management issue.

Environmental Legislation

Federal Environment Protection and Biodiversity Conservation Act 1999

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) is the Federal Government's central piece of environmental legislation. It provides a legal framework to protect and manage nationally and internationally important flora, fauna, ecological communities and heritage places, which are defined in the EPBC Act as Matters of National Environmental Significance (MNES).

The EPBC Act is administered by the Department of the Environment and Energy (DEE).

State Environmental Protection Act 1986

The *Environmental Protection Act 1986* (EP Act) is the primary legislative Act dealing with the protection of the environment in Western Australia. The Act allows the Environmental Protection Authority (EPA), to prevent, control and abate pollution and environmental harm, for the conservation, preservation, protection, enhancement and management of the environment and for matters incidental to or connected with the foregoing.

State Biodiversity and Conservation Act 2016

The *Biodiversity Conservation Act 2016* (BC Act) provides for the conservation and protection of biodiversity and biodiversity components, as well as the promotion of the ecologically sustainable use of biodiversity components in Western Australia. The BC Act replaces both the repealed *Wildlife Conservation Act 1950* (WC Act) and the *Sandalwood Act 1929* (Sandalwood Act), as well as their associated regulations. To attain the objectives of the BC Act, principles of ecological sustainable development have been established:

- Decision-making processes should effectively integrate both long-term and short-term economic, environmental, social and equitable considerations
- If there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation
- The present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations
- The conservation of biodiversity and ecological integrity should be a fundamental consideration indecision-making
- Improved valuation, pricing and incentive mechanisms should be promoted.

The BC Act is administered by the Department of Biodiversity Conservation and Attractions (DBCA)

Reserves and Conservation Areas

Department of Biodiversity, Conservation and Attractions managed lands and waters

DBCA manages lands and waters throughout Western Australia to conserve ecosystems and species, and to provide for recreation and appreciation of the natural environment. DBCA managed lands and waters include national parks, conservation parks and reserves, marine parks and reserves, regional parks, nature reserves, State forest and timber reserves. DBCA managed conservation estate, is vested with the Conservation Commission of Western Australia. Access to, or through, some areas of DBCA managed lands may require a permit or could be restricted due to management activities. Proposed land use changes and development proposals that abut DBCA managed lands will generally be referred to DBCA throughout the assessment process.

Environmentally Sensitive Areas

Environmentally Sensitive Areas (ESAs) are declared by the Minister for Environment under Section 51B of the EP Act. Aspects of areas declared as ESA in the Environmental Protection (Environmentally Sensitive Areas) Notice 2005. Are listed below:

- A declared World Heritage property as defined in Section 13 of the EPBC Act.
- An area that is registered on the Register of the National Estate (RNE), because of its natural values, under the *Australian Heritage Commission Act 1975* of the Commonwealth (the RNE was closed in 2007 and is no longer a statutory list – all references to the RNE were removed from the EPBC Act on 19 February 2012)
- A defined wetland and the area within 50 m of the wetland. Defined wetlands include Ramsar wetlands, conservation category wetlands and nationally important wetlands.
- The area covered by vegetation within 50 m of rare flora, to the extent to which the vegetation is continuous with the vegetation in which the rare flora is located
- The area covered by a Threatened Ecological Community
- A Bush Forever Site listed in “Bush Forever” Volumes 1 and 2 (2000), published by the Western Australia Planning Commission, except to the extent to which the site is approved to be developed by the Western Australia Planning Commission.
- The areas covered by the following policies:
- The *Environmental Protection (Gnangara Mound Crown Land) Policy 1992*
- The *Environmental Protection (Western Swamp Tortoise Habitat) Policy 2002*
- Protected wetlands as defined in the *Environmental Protection (South West Agricultural Zone Wetlands) Policy 1998*

Surface Water and Groundwater

Geomorphic Wetlands

Categorisation of wetlands has been conducted by Hill et al. (1996), delineating Swan Coastal Plain wetlands into levels of protection and management categories. Conservation Category Wetlands are wetlands that support high levels of attributes and functions. Resource Enhancement Wetlands are those that have been partly modified but still support substantial functions and attributes. Multiple Use Wetlands are classified as those wetlands with few attributes that still provide important wetland functions. Multiple Use wetlands have few important ecological attributes and functions remaining.

The Geomorphic Wetlands Swan Coastal Plain dataset displays the location, boundary, geomorphic classification (wetland type) and management category of wetlands on the Swan Coastal Plain.

Ramsar Wetlands

The Convention of Wetlands of International Importance was signed in 1971 at the Iranian town of Ramsar. The Convention has since been referred to as the Ramsar Convention. Ramsar Listed wetlands are “sites containing representative, rare or unique wetlands, or wetlands that are important for conserving biological diversity … because of their ecological, botanical, zoological, limnological or hydrological importance” (DEE 2019b). Once a Ramsar Listed Wetland is designated, the country agrees to manage its conservation and ensure its wise use. Under the Convention, wise use is broadly defined as “maintaining the ecological character of a wetland” (DEE 2019b).

Nationally Important Wetlands

Wetlands of national significance are listed under the Directory of Important Wetlands in Australia. Nationally important wetlands are wetlands which meet at least one of the following criteria (DEE 2019a):

- It is a good example of a wetland type occurring within a biogeographic region in Australia
- It is a wetland which plays an important ecological or hydrological role in the natural functioning of a major wetland system/complex
- It is a wetland which is important as the habitat for animal taxa at a vulnerable stage in their life cycles, or provides a refuge when adverse conditions such as drought prevail
- The wetland supports one percent or more of the national populations of any native plant or animal taxa
- The wetland supports native plant or animal taxa or communities which are considered endangered or vulnerable at the national level
- The wetland is of outstanding historical or cultural significance

Vegetation

Vegetation extent & status

The National Objectives and Targets for Biodiversity Conservation 2001–2005 (Commonwealth of Australia 2001) recognise that the retention of 30 percent or more of the pre-clearing extent of each ecological community is necessary if Australia’s biological diversity is to be protected. This is the threshold level below which species loss appears to accelerate exponentially and loss below this level should not be permitted. This level of recognition is in keeping with the targets recommended in the review of the National Strategy for the Conservation of Australia’s Biological Diversity (ANZECC 2000).

The extent of remnant native vegetation in WA has been assessed by Shepherd et al. (2002) and the GoWA (2018), based on broadscale vegetation association mapping by Beard (various publications). The GoWA produces Statewide Vegetation Statistics Reports that are used for a number of purposes including conservation planning, land use planning and when assessing development applications. The reports are updated at least every two years.

Ecological communities

Conservation significant communities

Ecological communities are defined as naturally occurring biological assemblages that occur in a particular type of habitat (English and Blyth 1997). Federally listed Threatened Ecological Communities (TECs) are protected under the EPBC Act. The BC Act provides for the Minister to list an ecological community as a TEC (Section 27), or as a collapsed ecological community (Section 31) statutory listing of State TECs by the Minister. The legislation also describes statutory processes for preparing recovery plans for TECs, the registration of their critical habitat, and penalties for unauthorised modification of TECs.

Possible TECs that do not meet survey criteria are added to the DBCA Priority Ecological Community (PEC) List under Priorities 1, 2 and 3. These are ecological communities that are adequately known; are rare but not threatened, or meet criteria for Near Threatened. PECs that have been recently removed from the threatened list are placed in Priority 4. These ecological communities require regular monitoring. Conservation dependent ecological communities are placed in Priority 5. PECs are not listed under any formal Federal or State legislation, however, may be listed as TECs under the EPBC Act.

A4 - Conservation codes and definitions for TECs listed under the EPBC Act and/ or BC Act

Categories	Definition
Federal Government Conservation Categories (EPBC Act)	
Critically Endangered (CR)	An ecological community if, at that time, is facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with the prescribed criteria (as outlined in Environment Protection and Biodiversity Conservation Regulations 2000)
Endangered (EN)	An ecological community if, at that time: A) is not critically endangered; and B) is facing a very high risk of extinction in the wild in the near future, as determined in accordance with the prescribed criteria (as outlined in Environment Protection and Biodiversity Conservation Regulations 2000)
Vulnerable (VU)	An ecological community if, at that time: A) is not critically endangered or endangered; and B) is facing a high risk of extinction in the wild in the medium-term future, as determined in accordance with the prescribed criteria (as outlined in Environment Protection and Biodiversity Conservation Regulations 2000)
Western Australia Conservation Categories (BC Act)	
Threatened Ecological Communities	
Critically Endangered (CR)	An ecological community that has been adequately surveyed and found to have been subject to a major contraction in area and/or that was originally of limited distribution and is facing severe modification or destruction throughout its range in the immediate future, or is already severely degraded throughout its range but capable of being substantially restored or rehabilitated.
Endangered (EN)	An ecological community that has been adequately surveyed and found to have been subject to a major contraction in area and/or was originally of limited distribution and is in danger of significant modification throughout its range or severe modification or destruction over most of its range in the near future.
Vulnerable (VU)	An ecological community that has been adequately surveyed and is found to be declining and/or has declined in distribution and/or condition and whose ultimate security has not yet been assured and/or a community that is still widespread but is believed likely to move into a category of higher threat in the near future if threatening processes continue or begin operating throughout its range.
Collapsed ecological communities	

Categories	Definition
An ecological community is eligible for listing as a collapsed ecological community at a particular time if, at that time – (a) there is no reasonable doubt that the last occurrence of the ecological community has collapsed); or (b) the ecological community has been so extensively modified throughout its range that no occurrence of it is likely to recover – (i) its species composition or structure; or (ii) its species composition and structure. Section 33 of the BC Act provides for a collapsed ecological community to be regarded as a threatened ecological community if it is discovered in a state that no longer makes it eligible for listing as a collapsed ecological community.	

Conservation categories and definitions for PECS as listed by the DBCA

Category	Description
Priority 1	Poorly known ecological communities. Ecological communities that are known from very few occurrences with a very restricted distribution (generally ≤5 occurrences or a total area of ≤100 ha). Occurrences are believed to be under threat either due to limited extent, or being on lands under immediate threat (e.g. within agricultural or pastoral lands, urban areas, active mineral leases) or for which current threats exist. May include communities with occurrences on protected lands. Communities may be included if they are comparatively well-known from one or more localities but do not meet adequacy of survey requirements, and/or are not well defined, and appear to be under immediate threat from known threatening processes across their range.
Priority 2	Poorly known ecological communities. Communities that are known from few occurrences with a restricted distribution (generally ≤10 occurrences or a total area of ≤200 ha). At least some occurrences are not believed to be under immediate threat of destruction or degradation. Communities may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements, and/or are not well defined, and appear to be under threat from known threatening processes.
Priority 3	Poorly known ecological communities. (i) Communities that are known from several to many occurrences, a significant number or area of which are not under threat of habitat destruction or degradation or: (ii) communities known from a few widespread occurrences, which are either large or with significant remaining areas of habitat in which other occurrences may occur, much of it not under imminent threat, or; (iii) communities made up of large, and/or widespread occurrences, that may or may not be represented in the reserve system, but are under threat of modification across much of their range from processes such as grazing by domestic and/or feral stock, and inappropriate fire regimes. Communities may be included if they are comparatively well known from several localities but do not meet adequacy of survey requirements and/or are not well defined, and known threatening processes exist that could affect them.

Category	Description
Priority 4	Ecological communities that are adequately known, rare but not threatened or meet criteria for Near Threatened, or that have been recently removed from the threatened list. These communities require regular monitoring. (i) Rare. Ecological communities known from few occurrences that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection, but could be if present circumstances change. These communities are usually represented on conservation lands. (ii) Near Threatened. Ecological communities that are considered to have been adequately surveyed and that do not qualify for Conservation Dependent, but that are close to qualifying for Vulnerable. (iii) Ecological communities that have been removed from the list of threatened communities during the past five years.
Priority 5	Conservation Dependent ecological communities. Ecological communities that are not threatened but are subject to a specific conservation program, the cessation of which would result in the community becoming threatened within five years.

Other significant vegetation

Vegetation may be significant for a range of reasons other than a statutory listing. The EPA (2016b) states that significant vegetation may include vegetation that includes the following:

- Restricted distribution
- Degree of historical impact from threatening processes
- Local endemism in restricted habitats
- Novel combinations of taxa
- A role as a refuge
- A role as a key habitat for Threatened species or large population representing a significant proportion of the local to regional total population of a species
- Being representative of a vegetation unit in ‘pristine’ condition in a highly cleared landscape, recently discovered range extensions, or isolated outliers of the main range)
- Being poorly reserved.

This may apply at a number of levels, so the unit may be significant when considered at the fine-scale (intra-locality), intermediate-scale (locality or inter-locality) or broad-scale (local to region).

- ## Flora and fauna
- ## Conservation significant flora and fauna

Species of significant flora are protected under both Federal and State legislation. Any activities that are deemed to have a significant impact on species that are recognised by the EPBC Act, and/or the BC Act can warrant referral to the DEE and/or the EPA.

The Federal conservation level of flora and fauna species and their significance status is assessed under the EPBC Act. The significance levels for flora and fauna used in the EPBC Act align with the International Union for Conservation of Nature (IUCN) Red List criteria, which are internationally recognised as providing best practice for assigning the conservation status of species. The EPBC Act also protects land and migratory species that are listed under International Agreements. The list of migratory species established under Section 209 of the EPBC Act comprises:

Migratory species which are native to Australia and are included in the appendices to the Bonn Convention (Convention on the Conservation of Migratory Species of Wild Animals Appendices I and II)

Migratory species included in annexes established under the Japan-Australia Migratory Bird Agreement (JAMBA) and the China–Australia Migratory Bird Agreement (CAMBA)

Native, migratory species identified in a list established under, or an instrument made under, an international agreement approved by the Minister, such as the republic of Korea–Australia Migratory Bird Agreement (ROKAMBA)

The State conservation level of flora and fauna species and their significance status also follows the IUCN Red List criteria. Under the BC Act flora and fauna can be listed as Threatened, Extinct and as Specially Protected species.

Threatened species are those are species which have been adequately searched for and are deemed to be, in the wild, either rare, under identifiable threat of extinction, or otherwise in need of special protection, and have been gazetted as such. The assessment of the conservation status of Threatened species is based on their national extent and ranked according to their level of threat using IUCN Red List categories and criteria. Specially protected species meet 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 or Extinct species under the BC Act cannot also be listed as Specially Protected species.

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 flora or fauna.

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.

For the purposes of this assessment, all species listed under the EPBC Act, BC Act and DBCA Priority species are considered conservation significant.

Conservation categories and definitions for EPBC Act and BC Act listed flora and fauna species

Conservation category	Definition
Threatened species	
Critically Endangered (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.
Endangered (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”.

Conservation category	Definition
	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
Vulnerable (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.
Extinct species	
Extinct (EX)	Species where “there is no reasonable doubt that the last member of the species has died”, and listing is otherwise in accordance with the ministerial guidelines (Section 24 of the BC Act).
Extinct in the Wild (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).
Specially protected species	
Migratory (MI)	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
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.
Other specially protected fauna (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).

Conservation codes for DBCA listed Priority flora and fauna

Priority category	Definition
Priority 1	Poorly-known taxa Species that are known from one or a few locations (generally five or less) which are potentially at risk. All occurrences are either: very small; or on lands not managed for conservation, e.g. agricultural or pastoral lands, urban areas, road and rail reserves, gravel reserves and active mineral leases; or otherwise under threat of habitat destruction or degradation. Species may be included if they are comparatively well

	known from one or more locations but do not meet adequacy of survey requirements and appear to be under immediate threat from known threatening processes. Such species are in urgent need of further survey.
Priority 2	Poorly-known taxa Species that are known from one or a few locations (generally five or less), some of which are on lands managed primarily for nature conservation, e.g. national parks, conservation parks, nature reserves and other lands with secure tenure being managed for conservation. Species may be included if they are comparatively well known from one or more locations but do not meet adequacy of survey requirements and appear to be under threat from known threatening processes. Such species are in urgent need of further survey.
Priority 3	Poorly-known taxa Species that are known from several locations, and the species does not appear to be under imminent threat, or from few but widespread locations with either large population size or significant remaining areas of apparently suitable habitat, much of it not under imminent threat. Species may be included if they are comparatively well known from several locations but do not meet adequacy of survey requirements and known threatening processes exist that could affect them. Such species are in need of further survey.
Priority 4	Rare, Near Threatened and other taxa in need of monitoring A. Rare: Taxa 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 taxa are usually represented on conservation lands. B. Near Threatened. Taxa that are considered to have been adequately surveyed and that do not qualify for Conservation Dependent, but that are close to qualifying for Vulnerable. C. Taxa that have been removed from the list of threatened taxa during the past five years for reasons other than taxonomy.

Other significant flora

Flora species, subspecies, varieties, hybrids and ecotypes may be significant for a range of reasons, other than a statutory listing. The EPA (2016b) states that significant flora may include taxa that have:

- A keystone role in a particular habitat for threatened or Priority flora or fauna species, or large populations representing a considerable proportion of the local or regional total population of a species
- Relictual status, being representation of taxonomic or physiognomic groups that no longer occur widely in the broader landscape
- Anomalous features that indicate a potential new discovery
- Being representative of the range of a species (particularly, at the extremes of range, recently discovered range extensions, or isolated outliers of the main range)
- The presence of restricted subspecies, varieties, or naturally occurring hybrids
- Local endemism (a restricted distribution) or association with a restricted habitat type (e.g. surface water or groundwater dependent ecosystems)
- Being poorly reserved

Other significant fauna

Fauna species may be significant for a range of reasons other than those protected by international agreement or treaty, Specially Protected or Priority Fauna. Significant fauna may include short-range endemic species, species that have declining populations or declining distributions, species at the extremes of their range, or isolated outlying populations, or species which may be undescribed (EPA 2010).

Weeds and Pathogens

Declared Pests

Information on species considered to be Declared Pests is provided under State Biosecurity and Agriculture Management Act 2007.

Weeds of National Significance

The spread of weeds across a range of land uses or ecosystems is important in the context of socio-economic and environmental values. The assessment of Weeds of National Significance (WoNS) is based on four major criteria:

- Invasiveness
- Impacts
- Potential for spread
- Socio-economic and environmental values

Australian state and territory governments have identified thirty-two Weeds of National Significance (WoNS); a list of 20 WoNS was endorsed in 1999 and a further 12 were added in 2012.

State Biosecurity and Agriculture Management Act 2007

The Biosecurity and Agriculture Management Act 2007 (BAM Act) and associated regulations are administered by the Department of Primary Industries and Regional Development (DPIRD)

and replace the repealed Agriculture and Related Resources Protection Act 1976. The main purposes of the BAM Act and its regulations are to:

- Prevent new animal and plant pests (vermin and weeds) and diseases from entering WA
- Manage the impact and spread of those pests already present in the state
- Safely manage the use of agricultural and veterinary chemicals
- Increased control over the sale of agricultural products that contain violative chemical residues.

The Western Australian Organism List (WAOL) provides the status of organisms which have been categorised under the BAM Act. A Declared Pest is a prohibited organism or an organism for which a declaration under Section 22(2) of the Act is in force. Declared Pests may be assigned a control category including: C1 (exclusion), C2 (eradication) and C3 (management). The category may apply to the whole of the State, LGAs, districts, individual properties or even paddocks, and all landholders are obliged to comply with the specific category of control. Categories of control are defined below.

DPIRD Categories for Declared Pests under the BAM Act

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

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Appendix E - Flora List

2019 flora species list

Family	Genus	Species	Status	Vegetation Types											
				VT1	VT2	VT3	VT4	V5	VT6	VT7	VT8	VT9	VT10	VT11	VT12
Aizoaceae	*Carpobrotus*	*edulis*	*			x		x			x				
Aizoaceae	*Tetragonia*	*decumbens*	*		x			x		x					
Amaranthaceae	*Ptilotus*	*polystachyus*									x				
Anacardiaceae	*Schinus*	*terebinthifolius*	*	x	x	x									x
Apiaceae	*Centella*	*asiatica*		x	x	x									
Apocynaceae	*Alyxia*	*buxifolia*								x	x	x			
Araceae	*Zantedeschia*	*aethiopica*	* DP		x										
Araliaceae	*Schefflera*	*actinophylla*	*												x
Araucariaceae	*Araucaria*	*heterophylla*	*										x		
Arecaceae	*Archontophoenix*	*alexandrae*	*		x										x
Arecaceae	*Phoenix*	*canariensis*	*										x		
Arecaceae	*Syagrus*	*romanzoffianum*	*												x
Arecaceae	*Washingtonia*	*filifera*	*					x							x
Asparagaceae	*Acanthocarpus*	*preissii*						x			x	x			
Asparagaceae	*Asparagus*	*asparagoides*	* DP/WoNS		x										
Asparagaceae	*Lomandra*	*hystix*	*											x	
Asparagaceae	*Lomandra*	*maritima*									x				
Asphodelaceae	*Asphodelus*	*fistulosus*	*	x											
Asphodelaceae	*Trachyandra*	*divaricata*	*					x							
Asteraceae	*Conyza*	*bonariensis*	*					x			x				
Asteraceae	*Conyza*	*sumatrensis*	*	x		x		x			x	x	x		x
Asteraceae	*Dimorphotheca*	*ecklonis*	*										x		
Asteraceae	*Gazania*	*linearis*	*					x					x		
Asteraceae	*Hypochaeris*	*glabra*	*		x			x					x		x

Family	Genus	Species	Status	Vegetation Types											
				VT1	VT2	VT3	VT4	V5	VT6	VT7	VT8	VT9	VT10	VT11	VT12
Asteraceae	*Hypochaeris*	*radicata*	*										x		
Asteraceae	*Lactuca*	*serriola*	*	x	x	x		x			x		x		x
Asteraceae	*Leucophyta*	*brownii*												x	
Asteraceae	*Olearia*	*axillaris*						x			x	x			
Asteraceae	*Pseudognaphalium*	*luteoalbum*		x				x							
Asteraceae	*Sonchus*	*oleraceus*	*	x									x		
Asteraceae	*Taraxacum*	*officinale*	*										x		
Boraginaceae	*Heliotropium*	*curassavicum*	*										x		
Brassicaceae	*Brassica*	*tournefortii*	*	x									x		
Brassicaceae	*Cakile*	*maritima*	*	x				x			x				
Brassicaceae	*Raphanus*	*raphanistrum*	*					x			x				
Brassicaceae	*Rumex*	*crispus*	*	x											
Casuarinaceae	*Allocasuarina*	*humilis*			x										
Casuarinaceae	*Casuarina*	*glauca*	*										x		
Casuarinaceae	*Casuarina*	*obesa*		x	x	x	x	x	x		x	x	x		
Chenopodiaceae	*Atriplex*	*prostrata*	*	x	x	x	x	x	x	x		x			
Chenopodiaceae	*Chenopodium*	*album*	*	x											
Chenopodiaceae	*Dysphania*	*ambrosioides*	*			x									
Chenopodiaceae	*Enchylaena*	*tomentosa*										x			
Chenopodiaceae	*Rhagodia*	*baccata*		x		x		x			x				
Chenopodiaceae	*Salicornia*	*blackiana*				x			x						
Chenopodiaceae	*Salicornia*	*quinqueflora*							x						
Chenopodiaceae	*Suaeda*	*australis*		x	x	x		x	x	x			x		
Chenopodiaceae	*Threlkeldia*	*diffusa*								x					
Commelinaceae	*Commelina*	*benghalensis*	*										x		
Convolvulaceae	*Ipomoea*	*indica*	*		x										

Family	Genus	Species	Status	Vegetation Types											
				VT1	VT2	VT3	VT4	V5	VT6	VT7	VT8	VT9	VT10	VT11	VT12
Cupressaceae	*Callitris*	*pyramidalis*						x							
Cyperaceae	*Baumea*	*juncea*		x		x		x			x				
Cyperaceae	*Baumea*	*preissii*				x									
Cyperaceae	*Bolboschoenus*	*caldwellii*				x		x							
Cyperaceae	*Carex*	*appressa*													
Cyperaceae	*Cyperus*	*gymnocaulos*		x		x		x							
Cyperaceae	*Cyperus*	*involucratus*	*												x
Cyperaceae	*Cyperus*	*tenuiflorus*	*	x	x						x				
Cyperaceae	*Ficinia*	*nodosa*		x	x	x		x					x	x	
Cyperaceae	*Gahnia*	*trifida*		x	x						x	x			
Cyperaceae	*Lepidosperma*	*gladiatum*				x		x			x	x			
Cyperaceae	*Lepidosperma*	*longitudinale*		x											
Dennstaedtiaceae	*Pteridium*	*esculentum*			x										x
Ericaceae	*Leucopogon*	*parviflorus*									x				
Euphorbiaceae	*Euphorbia*	*terracina*	*	x							x				
Euphorbiaceae	*Ricinus*	*communis*	*												
Fabaceae	*Acacia*	*cochlearis*									x				
Fabaceae	*Acacia*	*cyclops*						x			x	x			
Fabaceae	*Acacia*	*longifolia*	*									x			x
Fabaceae	*Acacia*	*pulchella*						x						x	
Fabaceae	*Acacia*	*rostellifera*						x			x				
Fabaceae	*Acacia*	*saligna*						x				x			x
Fabaceae	*Bauhinia*	sp.	*										x		
Fabaceae	*Erythrina*	*x sykesii*	*										x		
Fabaceae	*Hardenbergia*	*comptoniana*			x			x			x				
Fabaceae	*Jacksonia*	*furcellata*						x			x				

Family	Genus	Species	Status	Vegetation Types											
				VT1	VT2	VT3	VT4	V5	VT6	VT7	VT8	VT9	VT10	VT11	VT12
Fabaceae	*Jacksonia*	*sternbergiana*									x				
Fabaceae	*Lupinus*	*cosentinii*	*										x		
Fabaceae	*Medicago*	*polymorpha*	*										x		
Fabaceae	*Templetonia*	*retusa*									x				
Fabaceae	*Trifolium*	*angustifolium*	*					x					x		
Fagaceae	*Quercus*	*suber*	*										x		
Geraniaceae	*Pelargonium*	*capitatum*	*					x		x					x
Goodeniaceae	*Lechenaultia*	*linarioides*									x				
Goodeniaceae	*Scaevola*	*canescens*						x			x				
Goodeniaceae	*Scaevola*	*crassifolia*				x		x				x	x		
Goodeniaceae	*Scaevola*	*nitida*									x				
Haemodoraceae	*Conostylis*	*candicans* subsp. *calcicola*						x							
Hemerocallidaceae	*Dianella*	*revoluta var. divaricata*						x			x				
Iridaceae	*Ferraria*	*crispa*	*												
Iridaceae	*Patersonia*	*occidentalis*						x							
Iridaceae	*Watsonia*	*meriana* var. *bulbillifera*	*					x							
Juncaceae	*Juncus*	*kraussii*		x	x	x	x	x	x		x		x		
Juncaceae	*Juncus*	*microcephalus*	*		x										
Juncaceae	*Juncus*	*pallidus*										x			
Lamiaceae	*Hemiandra*	*pungens*			x										
Lauraceae	*Cassytha*	*racemosa*				x		x							
Magnoliaceae	*Magnolia*	sp.	*												x
Malvaceae	*Brachychiton*	*populneus*	*												x
Malvaceae	*Malva*	*parviflora*	*												
Meliaceae	*Melia*	*azedarach*	*												x

Family	Genus	Species	Status	Vegetation Types											
				VT1	VT2	VT3	VT4	V5	VT6	VT7	VT8	VT9	VT10	VT11	VT12
Moraceae	*Ficus*	*benjaminiana*	*										x		
Moraceae	*Ficus*	*carica*	*			x									x
Moraceae	*Ficus*	*macrophylla*	*										x		
Myrtaceae	*Agonis*	*flexuosa*						x			x	x	x		
Myrtaceae	*Callistemon*	sp.	*		x	x		x							
Myrtaceae	*Chamelaucium*	*uncinatum*	*					x							
Myrtaceae	*Corymbia*	*citriodora*	*										x		
Myrtaceae	*Corymbia*	*maculata*	*										x		
Myrtaceae	*Eucalyptus*	*camaldulensis*	*										x		
Myrtaceae	*Eucalyptus*	*gomphocephala*									x	x	x		
Myrtaceae	*Eucalyptus*	*rudis*			x	x		x					x		
Myrtaceae	*Kunzea*	*glabrescens*			x										
Myrtaceae	*Lophostemon*	*confertus*	*										x		
Myrtaceae	*Melaleuca*	*cuticularis*		x	x	x	x	x	x						
Myrtaceae	*Melaleuca*	*huegelii*						x							
Myrtaceae	*Melaleuca*	*lanceolata*									x		x		
Myrtaceae	*Melaleuca*	*quinquinervia*	*		x										
Myrtaceae	*Melaleuca*	*rhaphiophylla*		x	x	x									x
Myrtaceae	*Melaleuca*	*systena*									x				
Myrtaceae	*Syzygium*	*smithii*	*												x
Nyctaginaceae	*Bougainvillea*	sp.	*												x
Oleaceae	*Olea*	*europaea*	*								x	x			
Onagraceae	*Oenothera*	*drummondii*	*					x							
Orobanchaceae	*Orobanche*	*minor*	*								x				
Papaveraceae	*Fumaria*	*capreolata*	*									x			x
Poaceae	*Arundo*	*donax*	*		x								x		x

Family	Genus	Species	Status	Vegetation Types											
				VT1	VT2	VT3	VT4	V5	VT6	VT7	VT8	VT9	VT10	VT11	VT12
Poaceae	*Austrostipa*	*elegantissima*									x				
Poaceae	*Avena*	*barbata*	*					x			x				
Poaceae	*Bromus*	*diandrus*	*					x							
Poaceae	*Cenchrus*	*clandestinum*	*	x		x		x					x		
Poaceae	*Cortaderia*	*selloana*	*		x										
Poaceae	*Cynodon*	*dactylon*	*	x	x	x	x	x	x		x		x		x
Poaceae	*Ehrharta*	*calycina*	*					x			x				
Poaceae	*Eragrostis*	*curvula*	*					x							
Poaceae	*Lagurus*	*ovatus*	*		x			x			x				
Poaceae	*Lolium*	sp.	*					x				x	x		x
Poaceae	*Paspalum*	*dilatatum*	*	x				x							
Poaceae	*Polypogon*	*monspeliensis*	*		x										
Poaceae	*Sporobolus*	*virginicus*		x				x					x		
Poaceae	*Stenotaphrum*	*secundatum*	*	x		x		x							x
Primulaceae	*Samolus*	*repens*		x											
Proteaceae	*Banksia*	*dallanneyi*									x				
Proteaceae	*Banksia*	*sessilis*						x			x	x		x	
Proteaceae	*Grevillea*	*crithimifolia*									x				
Proteaceae	*Grevillea*	*preissii*									x				
Proteaceae	*Hakea*	*prostrata*						x			x				
Proteaceae	*Hakea*	*varia*						x							
Ranunculaceae	*Clematis*	*pubescens*			x										
Rhamnaceae	*Spyridium*	*globulosum*									x	x			
Rosaceae	*Rubus*	*laudatus*	* DP/WoNS		x										
Salicaceae	*Poplus*	*nigra*	*										x		
Salicaceae	*Salix*	*babylonica*	*			x									

Family	Genus	Species	Status	Vegetation Types											
				VT1	VT2	VT3	VT4	V5	VT6	VT7	VT8	VT9	VT10	VT11	VT12
Scrophulariaceae	*Eremophila*	*glabra*												x	
Scrophulariaceae	*Myoporum*	*insulare*				x								x	
Solanaceae	*Solanum*	*nigrum*	*				x				x				
Strelitsiaceae	*Strelitzia*	sp.	*												x
Tropaeolaceae	*Tropaeolum*	*majus*	*												x
Typhaceae	*Typha*	*orientalis*	*	x	x	x		x							
Verbenaceae	*Lantana*	*camara*	* DP/WoNS												x
Verbenaceae	*Lantana*	*montevidensis*	*												x
Vitaceae	*Vitis*	*coignetiae*	*												x
Xanthorrhoeaceae	*Xanthorrhoea*	*preissii*									x	x			
Zamiaceae	*Macrozamia*	*fraseri*									x	x			

Appendix F - Priority Sites and Top 5 Site Summary

CoM ID#	GIS ID #	Foreshore Segment	Location	Asset	Asset Description	Threat to Asset	Hard Asset Condition Rating	Descriptors for Ranking of Asset	Ranking	Descriptors for Ranking of Threat	Ranking	Prioritisation	CoM Flagged	CoM Timeframe	Management Solutions	Cost/ Timeframes
CoM ID# not identified	P383	SLBic05 Blackwall Reach - Ledbrooke St	Blackwall Reach Parade South of Crewe St	Path	Vegetated coastal verge next to path and road	Erosion causing instability and trees under threat	4	Embankment is supporting path and road, the foreshore area is regularly used for recreation and is presenting a managable safety hazard	High	Likely impact on path and roard in 1 to 5 years and potential for significant safety hazard between 1 to 5 years	High	Priority 1	High	?	New Works Required	Between $50,000 and $100,000
CoM ID# not identified	L102	SLBic03 Point Walter Reserve- Honour Ave	Rocky shore to south of Point Walter	Vegetated Coastline	Section rocky shore, 1 to 1.5m high exposed bank.	Erosion threat to trees (some dead)	4	Bush Forever Site 331, Part of Perth Biodiversity Project regional ecological linkage	Very High	Potential to affect ecological asset within 1 year (trees already dying)	Very High	Priority 1				
CoM ID# not identified	L104	SLBic03 Point Walter Reserve- Honour Ave			Rocky shore	Erosion threat to trees (some dead)	4	Bush Forever Site 331, Part of Perth Biodiversity Project regional ecological linkage	Very High	Potential to affect ecological asset within 1 year (trees already dying)	Very High	Priority 1				
CoM ID# not identified	P431 P432 P433	SLBic01 Point Walter East Boat Ramp and Jetty	Point Walter	Boardwalk	2 boardwalk structures to east of Point Walter jetty	Corrosion of steel substructure. Undermining of concrete footings on eastern structure	3 to 4	Asset value between $10,000 and $100,000. Not currently a public safety threat	High	Likely to impact in 1 to 5 years	High	Priority 1				
CoM ID# not identified	P472	Tompkins Park	Tompkins Park opposite #31	Park	Park	Erosion resulting in water level rise.	4	Park area exposing water reducing area and temporary interruption of recreational area	HIgh	Significant damage likely to impact on ecological asset within 1 to 5 years	HIgh	Priority 1	High		Repair Existing Asset	
CoM ID# not identified	P478 and P480	SLApl09 Melville Beach Rd	Cnr of Dunkley Ave and Cunningham St	Vegetated Coastline	Vegetative Coastline	erosion from trampling and wave condition leading to undercutting of grass area leading to a drop of ground level	4	High value assets, with high amount of public use which require a high level of public safety due to proximity to water	High	Potential to affect ecological asset within 1 year (weeds look old and dry	High	Priority 1				
CoM ID# not identified	L121	SLApl09 Melville Beach Rd	Melville Beach Rd opposite #105B and #103	Sandy Beach	Sandy Beach	sandy beach with steep hill and uncontrolled open path access to foreshore .	4	Erosion due to energetic wave condition, minimal vegetation and trampling through uncontrolled access to foreshore	Very High	Likely impact on path and road within 1 year as close proximity to public carpark and potential for significant safety hazard 1 to 5 years	Very High	Priority 1				
CoM ID# not identified	P481	SLApl09 Melville Beach Rd	Melville Beach Rd Opposite #101	Vegetated Coastline	Vegetative Coastline	erosion from trampling and wave condition leading to undercutting of grass area leading to a drop of ground level	4	Erosion due to energetic wave condition, minimal vegetation and trampling through uncontrolled access to foreshore	High	Potential to affect ecological asset within 1 year. There is also unofficial access track to areas leading to erosion of area	High	Priority 1				
CoM ID# not identified	P484	SLApl09 Melville Beach Rd	Melville Beach Rd Opposite #93	Vegetated Coastline	Vegetative Coastline	erosion from trampling and wave condition causing an open area to vegetative coastline	3	Erosion due to energetic wave condition, minimal vegetation and trampling through uncontrolled access to foreshore	High	Potential to affect ecological asset within 1 year. There is also unofficial access track to areas leading to erosion of area	High	Priority 1				
CoM ID# not identified	P485	SLApl09 Melville Beach Rd	Melville Beach Rd Opposite #91			erosion from trampling and wave condition leading to undercutting of grass area leading to a drop of ground level	4		High		High	Priority 1				
CoM ID# not identified	P504	SLApl08 Beach Road-Dee Road	Melville Beach Rd opposite #47	Path	Tree roots exposed and tree is bent	Erosion causing instability and trees under threat	4	regularly used by public, presenting a potential for threat concern for public safety	High	High amount of trampling. It is situated adjacent to public pathway which has potential safety hazard within 1-5 years if not managed.	High	Priority 1				

CoM ID#	GIS ID #	Foreshore Segment	Location	Asset	Asset Description	Threat to Asset	Hard Asset Condition Rating	Descriptors for Ranking of Asset	Ranking	Descriptors for Ranking of Threat	Ranking	Prioritisation	CoM Flagged	CoM Timeframe	Management Solutions	Cost/ Timeframes
CoM ID# not identified	P514	SLApl07 Point Dundas Boardwalk - Jeff Joseph Reserve	Jeff Joseph Reserve	Path	Pathway	Severe erosion underneath pathway and some cracked path areas	3	High value assets, with high amount of public use which require a high level of public safety due to proximity to water	High	condition of asset likely to begin having significant affects on coastal protection after 1 to 5 years, generating more significant safety hazard	High	Priority 1				Between $15,000 and $50,000
CoM ID# not identified	P538	SLApl05 Point Heathcote Reserve	The Strand opposite #54A	Path	Geofabric containers	Multiple sandbags have been ripped causing loss of sand and asset cannot function as intended.	4	High value asset	High	High level of public activity along path	High	Priority 1			New Works Required	Between $15,000 and $50,000
ST9014303	145	SLApl02 Beach Rd - Coffe Point Reserve	Canning Beach Rd between Flanagan Rd and Dunvegan Rd	Rock Revetment	Rock Revtment supporting coastal verge including path and road	some areas have become disjointed, erosion behind occuring (incl holes)	3	Revetment is supporting path and road, the foreshore area is regularly used for recreation and is presenting a managable safety hazard	High	Likely for signicant impact on assets to be greater then 5 years but presenting immediate saftety hazard	High	Priority 1	Medium	?	Repair Existing Asset	Less than $15000
ST9014302	L2	SLApl02 Beach Rd - Coffe Point Reserve	Canning Beach Rd opposite #31 and #37	Rock Revetment	Rock Revetment	Rock revetment is exposed to energetic wave conditions causing small displaced rocks and experiencing erosion behind	3	High value assets, supporting grass verge and public path.	High	Fair condition of asset and current protection measures is likely to begin having significant affects on coastal protection within 1 to 5 years, generating more significant safety hazard and affecting public usage of the area	High	Priority 1				
ST9014302	P28	SLApl02 Beach Rd - Coffe Point Reserve	Cnr of Killian Rd and Canning beach Rd		Drainage Outlet	Coastal erosion	4	Medium value asset	Medium	Unknown colour substance may pose significant affect to coastal protection within 1 to 5 years and safety hazard within 1 to 5 years	High	Priority 2				
CoM ID# not identified	P39 and P558	SLApl01 Beach Rd-Coffe Pt Reserve	Raffles Hotel	Path	Paths and paving at top of rock wall	Some areas have been damaged from wave conditions and trampling and are in need of repair	4	High value assets, with high amount of public use which require a high level of public safety due to proximity to water	High	Have been repaired but repairs are poor quality, immediate safety hazard	Very High	Priority 1	High	?	Repair Existing Asset	Less than $15000
CoM ID# not identified	P574	CLPle06 Apex Reserve - John XXIII Rowing Club	The Esplanade opposite #27	Path	Coastal Path	erosion of embankment from wave conditions leading to path becoming severely cracked and there is a steep drop off on river side	4	High value asset, with high amount of public use which requires a high level of public safety due to proximity to water	High	presenting future safety risk and risk to path (between 1- 5 years)	High	Priority 1	Low	?	New Works Required	Less than $15000
ST9014171	L23	CLPle04 Deep Water Point Reserve	Cnr Queen St and The Esplanade	Rock Revetment	Rock revetment supporting vegetation, grass verge and coastal path	Rock revetment is exposed to energetic wave conditions and experiencing erosion behind and some dislodgement and tree instability	4	High value assets, with high amount of public use of path Individual trees	High	Poor condition of asset and current protection measures is likely to begin having significant affects on coastal protection between 1- 5 years, generating more significant safety hazard and affecting public usage of the area	High	Priority 1	Low	?	Repair Existing Asset	Between $15,000 and $50,000
CoM ID# not identified	P600, P603	CLPle02 the Esplanade - Regents Wy	Just north of no. 251 The Esplanade End	Vegetated Coastline	Vegetated Coastline	Erosion of grassy bank close to path	3 to 4	Path is a high value asset.	High	Eroded bank currentl 1.5 to 2m from path in places. Likely impact after 5 years	High	Priority 1			New Works Required	

CoM ID#	GIS ID #	Foreshore Segment	Location	Asset	Asset Description	Threat to Asset	Hard Asset Condition Rating	Descriptors for Ranking of Asset	Ranking	Descriptors for Ranking of Threat	Ranking	Prioritisation	CoM Flagged	CoM Timeframe	Management Solutions	Cost/ Timeframes
CoM ID# not identified		CLBre01	Bateman Park, and adjacent Spinaway Crescent	Native vegetation	Fringing native vegetation	Weeds, Arum Lily, Blackberry, Lantana,		Bush Forever Site338 Conservation Category Wetland	Very High	Infestations of WoNS and Declared Pests, affecting ecological asset	Very High	Priority 1	Low/medium			
CoM ID# not identified		CLBre01	VT12 (north of Bateman Park and opposite Brentwood Ave)		Fringing native vegetation	Weeds		The northern extent of Bateman Park, the area is a patch of land that backs onto the river. It is dominanted by WoNs, DPs and aggressive weeds. The area is also used by the public as a walkway.	Medium	Low levels, isolated infestations of weeds	Very High	Priority 2				
CoM ID# not identified		South of SLBic02 Point Walter West - north of SLBic05 Blackwall Reach - Ledbrooke St	Point Walter Reserve	Native vegetation	Tuart Woodland	Weeds		Tuart TEC	Very High	Weed invasion	High	Priority 1				
CoM ID# not identified			Tompkins Park		Fringing native vegetation, patches of very good.	Trampling and weeds		Patchy wetland vegetation good or better condition	Medium	weeds and trampling	High	Priority 2				
CoM ID# not identified		Between SLApl04 and SPApl05	Point Heathcote Reserve	Native vegetation	Native vege in need of revegetation in parts	weeds		Potenital TEC. Is it still Bush Forever site 329?	Potentially very high	Weed infestaion due to lack of native species	High	Priority 1				

Discussion Notes:	Photo #1	Photo Link	Photo #2	Photo Link	Photo #3	Photo Link	Photo #4	Photo Link	Photo #5	Photo Link	Photo #6	Photo Link
Still high priority, path amd tree at risk	COASTAL_SITE_POINT_383_Photo1.jpg	COASTAL_SITE_POINT_383_Photo1.jpg	COASTAL_SITE_POINT_383_Photo2.jpg	COASTAL_SITE_POINT_383_Photo2.jpg	COASTAL_SITE_POINT_383_Photo3.jpg	COASTAL_SITE_POINT_383_Photo3.jpg	COASTAL_SITE_POINT_383_Photo4.jpg	COASTAL_SITE_POINT_383_Photo4.jpg	COASTAL_SITE_POINT_383_Photo5.jpg	COASTAL_SITE_POINT_383_Photo5.jpg	COASTAL_SITE_POINT_383_Photo6.jpg	COASTAL_SITE_POINT_383_Photo6.jpg
New item	COASTAL_SITE_LINE_102_Photo1.jpg	COASTAL_SITE_LINE_102_Photo1.jpg	COASTAL_SITE_LINE_102_Photo2.jpg	COASTAL_SITE_LINE_102_Photo2.jpg	COASTAL_SITE_LINE_102_Photo3.jpg	COASTAL_SITE_LINE_102_Photo3.jpg	COASTAL_SITE_LINE_102_Photo4.jpg	COASTAL_SITE_LINE_102_Photo4.jpg	COASTAL_SITE_LINE_102_Photo5.jpg	COASTAL_SITE_LINE_102_Photo5.jpg	COASTAL_SITE_LINE_102_Photo6.jpg	COASTAL_SITE_LINE_102_Photo6.jpg
New item	COASTAL_SITE_LINE_104_Photo1.jpg	COASTAL_SITE_LINE_104_Photo1.jpg	COASTAL_SITE_LINE_104_Photo2.jpg	COASTAL_SITE_LINE_104_Photo2.jpg								
New item	COASTAL_SITE_POINT_431_Photo1.jpg	COASTAL_SITE_POINT_431_Photo1.jpg	COASTAL_SITE_POINT_431_Photo2.jpg	COASTAL_SITE_POINT_431_Photo2.jpg	COASTAL_SITE_POINT_432_Photo1.jpg	COASTAL_SITE_POINT_432_Photo1.jpg	COASTAL_SITE_POINT_432_Photo2.jpg	COASTAL_SITE_POINT_432_Photo2.jpg	COASTAL_SITE_POINT_433_Photo2.jpg	COASTAL_SITE_POINT_433_Photo2.jpg	COASTAL_SITE_POINT_433_Photo3.jpg	COASTAL_SITE_POINT_433_Photo3.jpg
Barricated area has been noted. High public use where recreational activities can be affected and potential for safety hazard.	COASTAL_SITE_POINT_472_Photo2.jpg	COASTAL_SITE_POINT_472_Photo2.jpg										
Can see significant amount of trampling to gain access to foreshore area and undercutting of grass close to public parking lot.	COASTAL_SITE_POINT_478_Photo1.jpg	COASTAL_SITE_POINT_478_Photo1.jpg										
New item in 2019. Survey noted there is a board sign that erosion control works is taking place.	COASTAL_SITE_LINE_121_Photo1.jpg	COASTAL_SITE_LINE_121_Photo1.jpg	COASTAL_SITE_LINE_121_Photo2.jpg	COASTAL_SITE_LINE_121_Photo2.jpg	COASTAL_SITE_LINE_121_Photo3.jpg	COASTAL_SITE_LINE_121_Photo3.jpg						
Sandy beach with significant erosion within close proximity to public park	COASTAL_SITE_POINT_481_Photo1.jpg	COASTAL_SITE_POINT_481_Photo1.jpg										
Can see significant amount of trampling to gain access to foreshore area	COASTAL_SITE_POINT_484_Photo1.jpg	COASTAL_SITE_POINT_484_Photo1.jpg										
New item in 2019. Can see significant trampling and undercutting of grass area in close proximity to the pathway used by the public. This may pose potential incident to public safety within 1 to 5 years.	COASTAL_SITE_POINT_485_Photo1.jpg	COASTAL_SITE_POINT_485_Photo1.jpg	COASTAL_SITE_POINT_485_Photo2.jpg	COASTAL_SITE_POINT_485_Photo2.jpg	COASTAL_SITE_POINT_485_Photo3.jpg	COASTAL_SITE_POINT_485_Photo3.jpg						
New item in 2019. Tree roots exposed in a regularly used area by the public.	COASTAL_SITE_POINT_504_Photo1.jpg	COASTAL_SITE_POINT_504_Photo1.jpg										

Discussion Notes:	Photo #1	Photo Link	Photo #2	Photo Link	Photo #3	Photo Link	Photo #4	Photo Link	Photo #5	Photo Link	Photo #6	Photo Link
Undercutting of pathway which may pose safety risks	COASTAL_SITE_POINT_514_Photo1.jpg	COASTAL_SITE_POINT_514_Photo1.jpg	COASTAL_SITE_POINT_514_Photo2.jpg	COASTAL_SITE_POINT_514_Photo2.jpg								
May require replacement of sandbags, as ripped sandbags cannot be repaired	COASTAL_SITE_POINT_538_Photo1.jpg	COASTAL_SITE_POINT_538_Photo1.jpg	COASTAL_SITE_POINT_538_Photo2.jpg	COASTAL_SITE_POINT_538_Photo2.jpg	COASTAL_SITE_POINT_538_Photo3.jpg	COASTAL_SITE_POINT_538_Photo3.jpg	COASTAL_SITE_POINT_538_Photo4.jpg	COASTAL_SITE_POINT_538_Photo4.jpg				
Rock revtement is still conditin 3. Still prority 1	COASTAL_SITE_LINE_145_Photo0.jpg	COASTAL_SITE_LINE_145_Photo0.jpg	COASTAL_SITE_LINE_145_Photo3.jpg	COASTAL_SITE_LINE_145_Photo3.jpg	COASTAL_SITE_LINE_145_Photo5.jpg	COASTAL_SITE_LINE_145_Photo5.jpg	COASTAL_SITE_LINE_145_Photo7.jpg	COASTAL_SITE_LINE_145_Photo7.jpg	COASTAL_SITE_LINE_145_Photo8.jpg	COASTAL_SITE_LINE_145_Photo8.jpg	COASTAL_SITE_LINE_145_Photo9.jpg	COASTAL_SITE_LINE_145_Photo9.jpg
2014 survey noted that some areas have become disjointed and some trees have fallen into the river. This is the same condition in 2019. There are also exposed geotextile	COASTAL_SITE_LINE_2_Photo0.jpg	COASTAL_SITE_LINE_2_Photo0.jpg	COASTAL_SITE_LINE_2_Photo1.jpg	COASTAL_SITE_LINE_2_Photo1.jpg	COASTAL_SITE_LINE_2_Photo4.jpg	COASTAL_SITE_LINE_2_Photo4.jpg	COASTAL_SITE_LINE_2_Photo6.jpg	COASTAL_SITE_LINE_2_Photo6.jpg	COASTAL_SITE_LINE_2_Photo7.jpg	COASTAL_SITE_LINE_2_Photo7.jpg	COASTAL_SITE_LINE_2_Photo8.jpg	COASTAL_SITE_LINE_2_Photo8.jpg
Pooling liquid with odd blue green colour	COASTAL_SITE_POINT_28_Photo1.jpg	COASTAL_SITE_POINT_28_Photo1.jpg										
Holes in path have attempted repairs. Pavers in worse condition with some missing. Remains Priority 1	COASTAL_SITE_POINT_39_Photo1.jpg	COASTAL_SITE_POINT_39_Photo1.jpg	COASTAL_SITE_POINT_39_Photo2.jpg	COASTAL_SITE_POINT_39_Photo2.jpg	COASTAL_SITE_POINT_39_Photo3.jpg	COASTAL_SITE_POINT_39_Photo3.jpg	COASTAL_SITE_POINT_558_Photo1.jpg	COASTAL_SITE_POINT_558_Photo1.jpg	COASTAL_SITE_POINT_558_Photo2.jpg	COASTAL_SITE_POINT_558_Photo2.jpg	COASTAL_SITE_POINT_558_Photo4.jpg	COASTAL_SITE_POINT_558_Photo4.jpg
	COASTAL_SITE_POINT_574_Photo1.jpg	COASTAL_SITE_POINT_574_Photo1.jpg	COASTAL_SITE_POINT_574_Photo2.jpg	COASTAL_SITE_POINT_574_Photo2.jpg								
Condition was poor in 2014, and has not been remeidated. Likely to affect Path in 1-5 years (see Photo 4)	COASTAL_SITE_LINE_23_Photo1.jpg	COASTAL_SITE_LINE_23_Photo1.jpg										
New sites identified	COASTAL_SITE_POINT_600_Photo1.jpg	COASTAL_SITE_POINT_600_Photo1.jpg										

Discussion Notes:	Photo #1	Photo Link	Photo #2	Photo Link	Photo #3	Photo Link	Photo #4	Photo Link	Photo #5	Photo Link	Photo #6	Photo Link
Infestation of Arum Lily, Blackberry and bridal creeper has increased since 2014. Arum lily and blackberry are beginning to dominate mid stratum in sections of the southern extent of Bateman Park in VT2.Couch and Kikyu are also dominating. Weed eradication and management should be employed .	AlilyBateman	Photos\AlilyBateman.jpg	BlackberryBateman	Photos\BlackberryBateman.jpg	KikyuBateman							
Unsuccessful weed control attempts have been made in the area mapped as VT12. Japanese pepper has been cut at the stumps however its growing back. There are many Arum Lily sapling s and the area is dominated by weedy grasses	Jpepper	Photos\Jpepper.jpg	WeedDominance	Photos\WeedDominance.jpg								
The Tuart Woodland vege within the survey area is approximtaely 1.7 ha, however it is part of a larger remnant that is approx 12 ha. Regardless of the condition any Tuart woodland that is >0.5ha in size and meets the diagnostic characters is considered the Tuart TEC. The rement patch does meet key diagnostic characters. Some parts of the foreshore are being eroded, exposing tree roots	Photos\PtWalterTuart.jpg	Photos\PtWalterErosion.jpg										
Vegetation closest to the river resembled vegetation type VT1 in Very Good condition. The area immediately adjacent to the path looked to have been revegetated a long time ago in sections and/or weeds have been sprayed. This has resulted in cleared areas with dead weeds and/ or exposed soil. Some large Eucalptus rudis line the edges of the foreshore along the western extent of Tompkins Park	Photos\Degraded.jpg	Photos\ThompParkVT1.jpg	Photos\ClearedEdges.jpg	Photos\TramplingWeeds.jpg	Photos\TomParkWest.jpg							
The western extent of Point Heathcote has been revegetated with endemic species. It is recommended that the northern and eastern extents of the reserve also be restored. The foreshore area has 3 significant Tuart trees (DBH >500mm), with more significant Tuarts occuring upslope. In 2019 Tuart woodland vegetation was listed as a TEC. Point Heathcote has the potential to be categorised as a TEC in the future once the planted Tuarts (within the revegetated area) become established (DBH >150mm) and endemic species are returned to the northern and eastern extents. The Tuart woodland TEC criteria is based on condition, size and other key features. In Point Heathcote Tuart vegetation covers approximately 1 ha, to be classed as a TEC the native undertsorey would need to be restoted to at least 8 natives spp./0.01ha. This has already been achieved along the wetsren extent.	Photos\HeathcoteRevege.jpg	Photos\HeathcoteDegraded.jpg	Photos\Heathcote.jpg									

Site	Site Description	Site Condition	Threats
Point Heathcote **Location:** Opposite BWG Steakhouse and corner of South Perth Yacht Club carpark. (approx. site work 90 m)	• Sandy beach along connecting to the rock shore coast located near the Yacht club. • Several sites along Point Heathcote is of vegetated coastal line • Passive recreational activity includes fishing. •	• Loss of vegetation along steep vegetated coastal headland • Path being undermined near the Yacht Club	• Erosion caused by water runoff from hillside • Energetic wave condition at base of slope • Increase mean sea level • Loss of vegetation due to beach access
Melville Beach Road **Location:** Between Spey Road and Ness Road. (approx. site work 740 m)	• Recreational activities include windsurfing and kitesurfing. • It exhibits wetland coastline and sandy beach used to launch boats. • Some areas are populated with dense vegetation with some erosion.	• Steep sandy beach, • Uncontrolled open path access and evident trampling. • Tree root exposed at the corner of Beach Rd and Dee Rd.	• Area of erosion is caused by trampling by public access to shore area and or animal activity
Revetment Replacement **Location:** Flanagan Road to Dunvegan Road of 90 m; Queens Road (approx. site work 90 m)	• Vegetated coastline in close proximity to path and road; • Occasional sandy beach and rock shore area; • Multiple inundated drainage outlets which is unserviceable and completely filled with sediment.	• Trees supporting soil is being eroded. • Rock revetment show signs of deterioration requiring repairs and geotextile exposed.	• Occasional energetic wave condition and increase mean sea level leading to erosion and trampling. • Damage rock revetment is currently presenting safety hazard
The Esplanade **Location:** • The Esplanade between no. 27 to no. 29. (approx. 400 m) • Nearest lot 249. (approx. 200 m) • Opposite 253B (approx. 100 m)	• Vegetated coastline is quite flat generally, and areas of sandy beach along the way • There are geo-sandbags used to protect however are damaged and geotextile is exposed.	• Some trees at risk of collapsing, and some tree roots have been exposed • Heavy trampling along the coast where most is located on the beach area used for launching rowing club boats • Embankment is also eroding currently from 1.5 m to 2 m drop.	• Occasional energetic wave condition and increase mean sea level leading to erosion and trampling. • Public pathway is also at risk due to erosion resulting in undercutting of pathway.
Blackwall Reach **Location:** North and South Node along Honour avenue **Site work length:** ~ 90 m for North node; ~ 70 m for South node.	• Mixture of sandy beach and vegetated coastline in close proximity to path and road. • Gabion baskets and limestone walls along areas of stretch. Gabion baskets are of metal wire, the rocks are exposed. • Few areas of limestone wall has eroded.	• There are areas of sedge vegetation at the base slope of the sandy beach. • There are several brush logs to help revegetation however they have degraded. • Exposed tree roots. Some trees are dead. • Trampled area due to launching and animal activities.	• Occasional energetic wave condition and increase mean sea level leading to erosion. • Sedimentation is a threat that increases sand migration and inundation as a result of flooding. • Furthermore there is erosion of slope exposing tree roots and risk to path

Appendix G – Concept Designs

CITY OF MELVILLE
MELVILLE FORESHORE RESTORATION STRATEGY
12514145

LOCALITY PLAN
NOT TO SCALE

DRAWING LIST

DRG No.	DRAWING TITLE
61-12514145-G001	COVER SHEET AND DRAWING LIST
61-12514145-K001	CONCEPT No. 1 - BEACH ACCESS AND SLOPE PROTECTION - TYPICAL PLAN AND SECTIONS
61-12514145-K002	CONCEPT NO. 2 - REVEGETATED NODES - TYPICAL PLAN AND SECTIONS
61-12514145-K003	CONCEPT NO. 3 - GABION BASKET - TYPICAL PLAN AND SECTIONS
61-12514145-K004	CONCEPT NO. 4 - OFFSHORE FISH TRAPS - TYPICAL PLAN AND SECTIONS
61-12514145-K005	CONCEPT NO. 5 - SLOPE PROTECTION WITH TIMBER PALISTRADES AND STAIR ACCESS - TYPICAL PLAN AND SECTIONS
61-12514145-K006	CONCEPT NO. 6 - REVEGETATED NODES - TYPICAL PLAN AND SECTIONS

CONCEPT ONLY

No	Revision	Note: * indicates signatures on original issue of drawing or last revision of drawing	Drawn	Job Manager	Project Director	Date
A	ISSUED FOR CLIENT REVIEW		CP	EA	HOK	28.02.20

0 0.5 1.0 1.5 2.0 2.5m
SCALE 1:50 AT ORIGINAL SIZE

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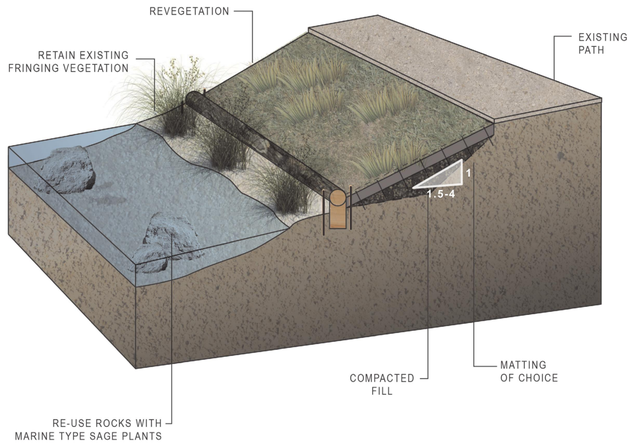
Drawn C PISAWIS		Designer J LEE	
Drafting Check		Design Check A SAYCE	
Approved (Project Director)			
Date			
Scale AS SHOWN	This Drawing must not be used for Construction unless signed as Approved		

Client CITY OF MELVILLE
Project MELVILLE FORESHORE RESTORATION STRATEGY
Title COVER SHEET AND DRAWING LIST

Original Size **A1** Drawing No: **61-12514145-G001** Rev: **A**

Plot Date: 18 March 2020 - 1:18 PM Plotted by: Sheriellade Anne Velecina Cad File No: N:\PH\Manila\Projects\61\12514145\CADD\Drawings\61-12514145-G001.dwg

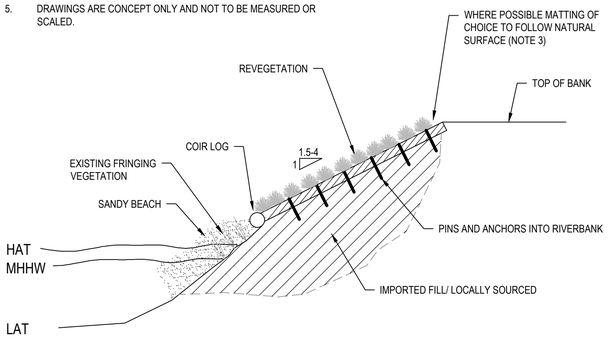


CONCEPT 1: BEACH ACCESS AND SLOPE PROTECTION
(BETWEEN NODES)

NOT TO SCALE
(DIAGRAM ONLY)

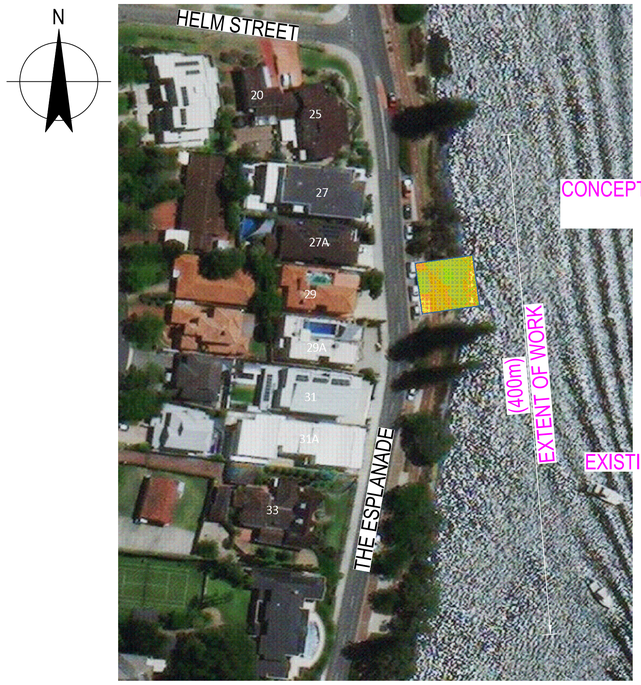
NOTES:

1. SLOPE 1:1.5-4 (ASSUMED SIMILAR TO OTHER SITES) RIVERBANK SLOPE TO BE SELECTED BASED ON EXISTING SLOPES AND TO BALANCE CUT/FILL VOLUMES.
2. CONCRETE MATTING MELVILLE BEACH ROAD BETWEEN NODES ALLOWING BEACH ACCESS AND JUTE MATTING AT ESPLANADE PATH.
3. USE FLEXIMAT AT MELVILLE BEACH ROAD T O ALLOW WALKING ON AND BEACH ACCESS.
4. ALL DIMENSIONS IN METRES UNO.
5. DRAWINGS ARE CONCEPT ONLY AND NOT TO BE MEASURED OR SCALED.



CONCEPT 1 - BEACH ACCESS AND SLOPE PROTECTION

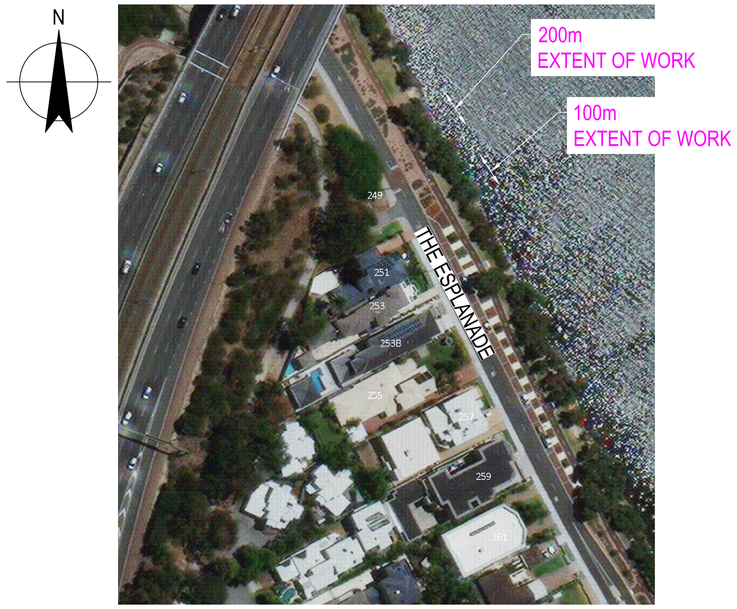
1:50



CONCEPT 1 - MAP PLAN

NTS

LOCATION: NORTH ESPLANADE PATH



LEGEND:

EXAMPLE OF AREA BEING UPGRADED

CONCEPT 1 - MAP PLAN

NTS

LOCATION: SOUTH ESPLANADE PATH

CONCEPT ONLY

No	Revision	Note: * indicates signatures on original issue of drawing or last revision of drawing	Drawn	Job Manager	Project Director	Date
A	ISSUED FOR CLIENT REVIEW		CP	EA	HOK	28.02.20

0 0.5 1.0 1.5 2.0 2.5m
SCALE 1:50 AT ORIGINAL SIZE

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Drafting Check		Design Check	A SAYCE
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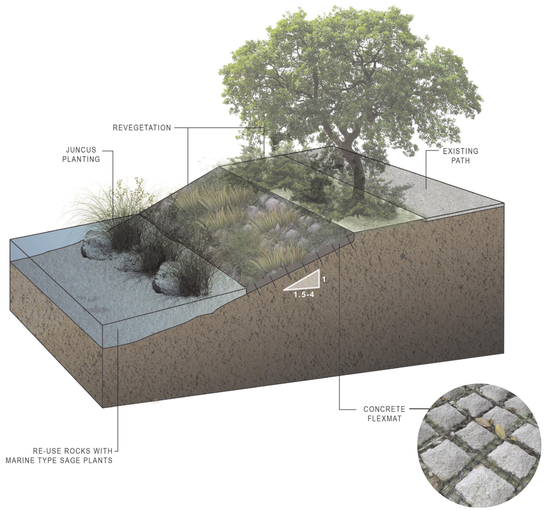
Client	CITY OF MELVILLE
Project	MELVILLE FORESHORE RESTORATION STRATEGY
Title	CONCEPT No. 1 - BEACH ACCESS AND SLOPE PROTECTION TYPICAL PLAN AND SECTION
Original Size	A1
Drawing No:	61-12514145-K001
Rev:	A

Plot Date: 18 March 2020 - 1:1□PM Plotted by: Sheriellade Anne Velecina Cad File No: N:\PH\Manila\Projects\61\12514145\CADD\Drawings\61-12514145-K001.dwg

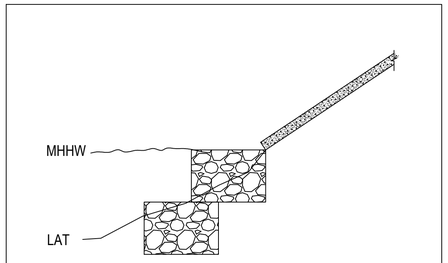


CONCEPT 2: ROCK & REVEGETATION (NODE)

NOT TO SCALE (DIAGRAM ONLY)

NOTES:

1. PLANTS ARE TO BE DEEP ROOTED DURING THE PLANTING PROCESS:
   - ROCKS AND PLANTS TO BE BUNDLED TOGETHER SO THAT THE ROCKS HELP PROTECT THE PLANTS AND ACT LIKE ISLAND NEXT TO THE "TOE AREA".
   - BREAKS UP THE COASTLINE.
2. CONCRETE BLOCK ABLE TO BE TAKEN OUT FOR DEEP ROOT PLANTING.
3. SLOPE 1:1.5-4 (ASSUMED SIMILAR TO OTHER SITES). RIVERBANK SLOPE TO BE SELECTED BASED ON EXISTING SLOPES AND TO BALANCE CUT/FILL VOLUMES.
4. IF FOOTPATH CLOSE TO EXISTING REVETMENT, REMOVE FOOTPATH.
5. ROCKS RE-USED FROM OLD REVETMENT.
6. ALL DIMENSIONS IN METRES UNO.
7. DRAWING ARE CONCEPT ONLY AND NOT TO BE MEASURED OR SCALED.



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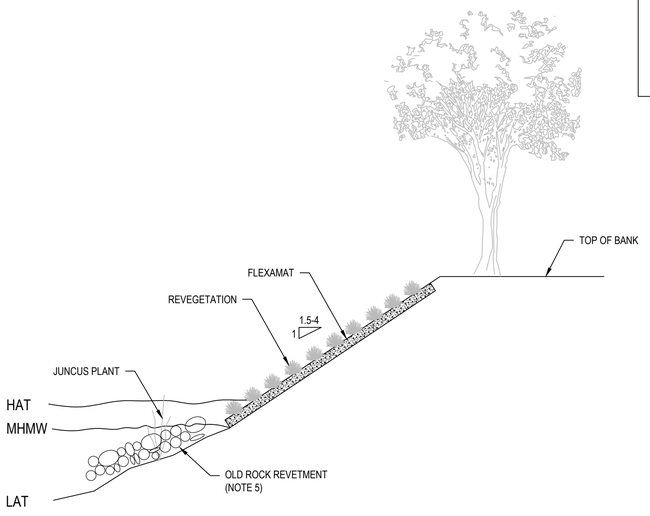
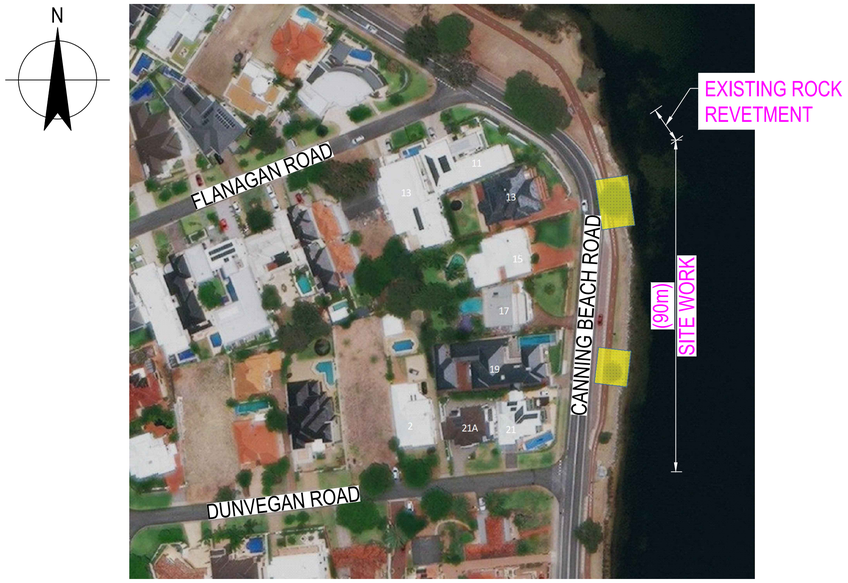


CONCEPT 2 - REVEGETATED NODES TYPICAL PLAN AND SECTION

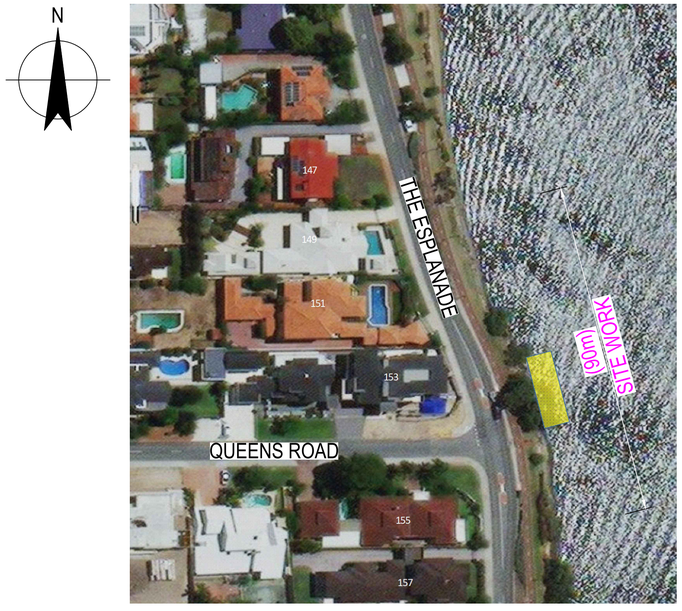
1:25



CONCEPT 2 - MAP PLAN

NTS

LOCATION: CANNING BEACH ROAD



CONCEPT 2 - MAP PLAN

NTS

LOCATION: QUEENS ROAD ALONG THE ESPLANADE

LEGEND:

EXAMPLE OF AREA BEING UPGRADED

CONCEPT ONLY

No	Revision	Drawn	Job Manager	Project Director	Date
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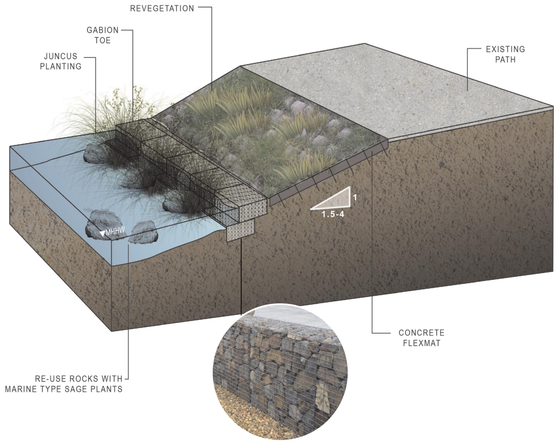
Title CONCEPT No. 2 - REVEGETATION NODES TYPICAL PLAN AND SECTION

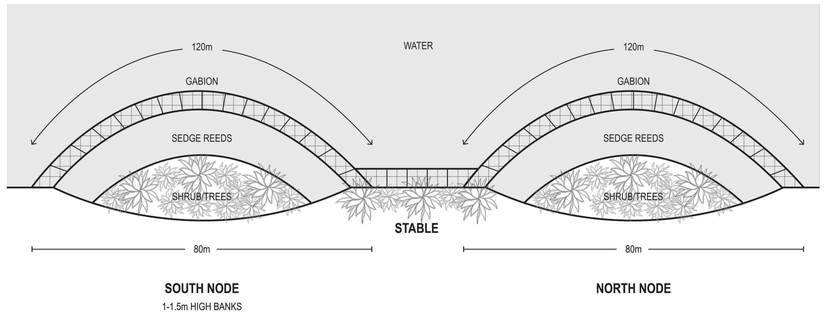
Original Size A1 Drawing No: 61-12514145-K002 Rev: A

Plot Date: 16 March 2020 - 3:41 PM Plotted by: Sheriellade Anne Velecina Cad File No: G:\61\12514145\CADD\Drawings\61-12514145-K002.dwg



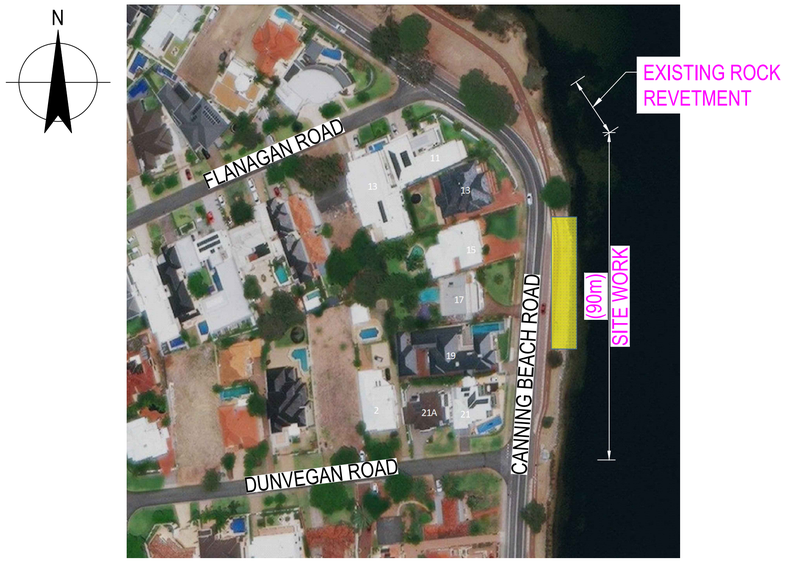
CONCEPT 3: GABION BASKET

NOT TO SCALE
(DIAGRAM ONLY)



CONCEPT 3: GABION BASKET - PLAN VIEW

NOT TO SCALE (DIMENSION ARE INDICATIVE)



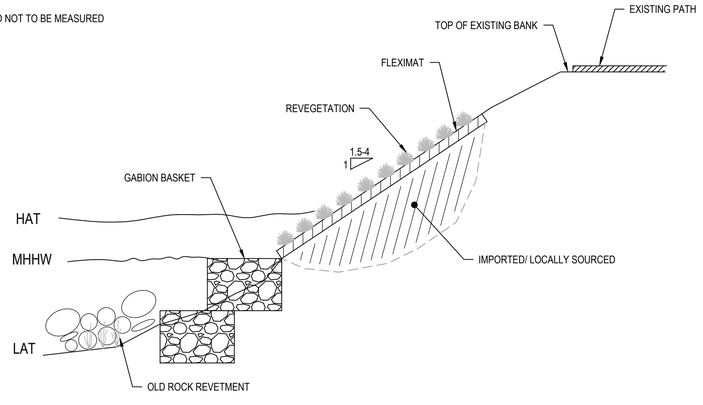
CONCEPT 3 - MAP PLAN

NTS

LOCATION: CANNING BEACH ROAD

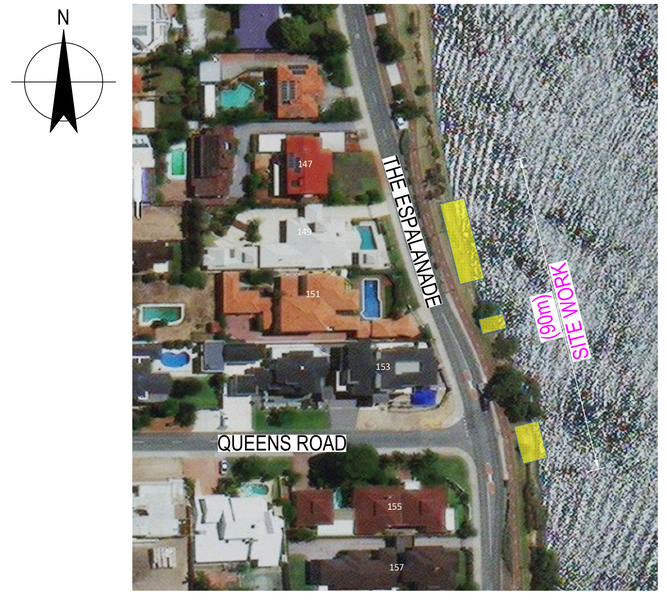
NOTES:

1. SLOPE 1:1.5-4 (ASSUMED SIMILAR TO OTHER SITES). RIVERBANK SLOPE TO BE SELECTED BASED ON EXISTING SLOPES AND TO BALANCE CUT/FILL VOLUMES.
2. CONCRETE MATTING AT CANNING BEACH No. 3 AND ESPLANADE REVETMENT No. 5 AND JUTE MATTING AT ESPLANADE PATH.
3. ALL DIMENSIONS IN METRES UNO.
4. DRAWINGS ARE CONCEPT ONLY AND NOT TO BE MEASURED OR SCALED.



CONCEPT 3 - GABION BASKETS TYPICAL PLAN AND SECTION

1:50



CONCEPT 3 - MAP PLAN

NTS

LOCATION: QUEENS ROAD ALONG THE ESPLANADE

LEGEND:

EXAMPLE OF AREA BEING UPGRADED

CONCEPT ONLY

No	Revision	Drawn	Job Manager	Project Director	Date
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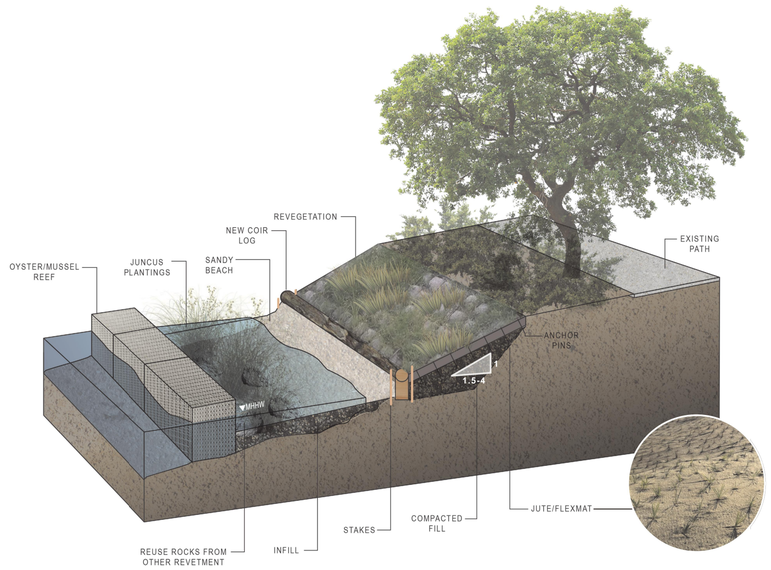
Project **MELVILLE FORESHORE RESTORATION STRATEGY**
Title **CONCEPT No. 3 - GABION BASKET TYPICAL PLAN AND SECTION**

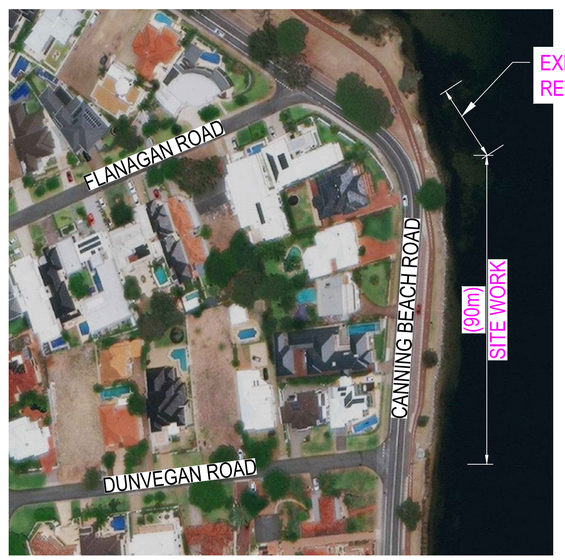
Original Size **A1**
Drawing No: **61-12514145-K003**
Rev: **A**

Plot Date: 16 March 2020 - 3:28 PM
Plotted by: Sheriellade Anne Velecina
Cad File No: G:\61\12514145\CADD\Drawings\61-12514145-K003.dwg



CONCEPT 4: OFFSHORE FISH TRAPS - WAVE BAFFLE

NOT TO SCALE
(DIAGRAM ONLY)

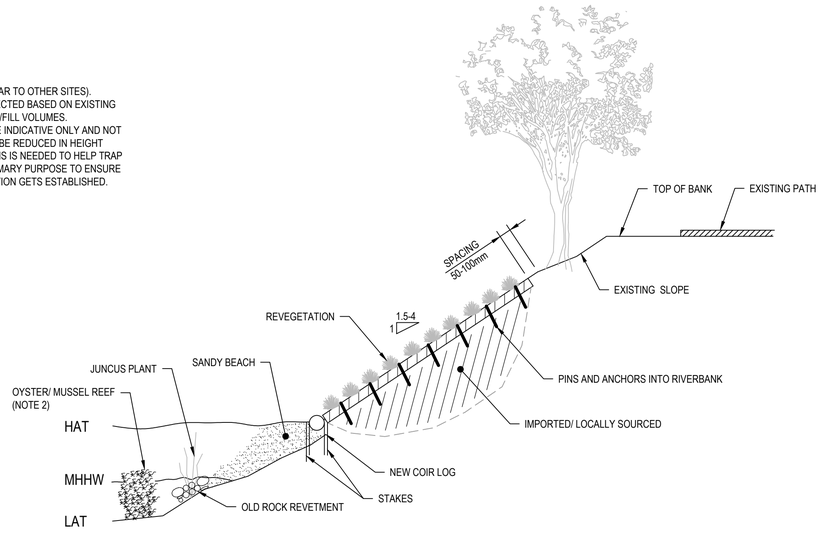


CONCEPT 4 - MAP PLAN
NTS

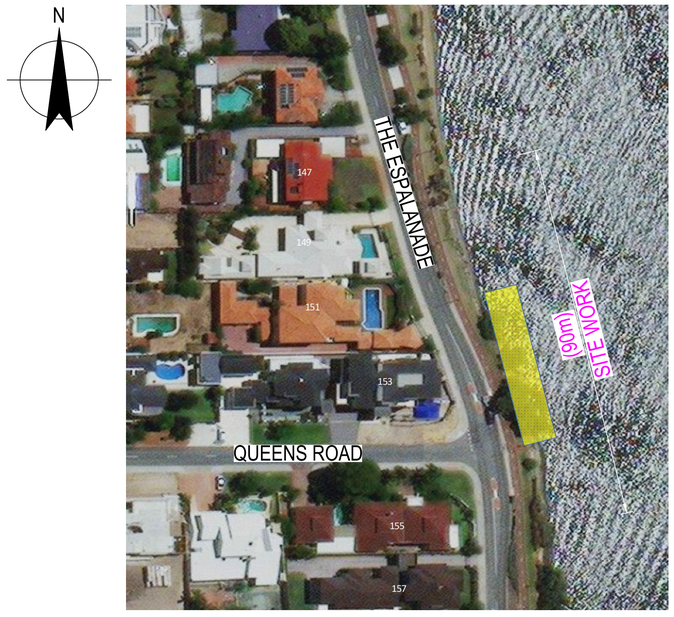
LOCATION: CANNING BEACH ROAD

NOTES:

1. SLOPE 1:1.5-4 (ASSUMED SIMILAR TO OTHER SITES). RIVERBANK SLOPE TO BE SELECTED BASED ON EXISTING SLOPES AND TO BALANCE CUT/FILL VOLUMES.
2. OYSTER OR MUSSEL REEF ARE INDICATIVE ONLY AND NOT TO SCALE. IT IS EXPECTED TO BE REDUCED IN HEIGHT AND DISTANCE OFFSHORE. THIS IS NEEDED TO HELP TRAP SEDIMENT ON BEACH AND PRIMARY PURPOSE TO ENSURE THAT THE WATER RE-VEGETATION GETS ESTABLISHED.



CONCEPT 4 - OFFSHORE FISH TRAPS TYPICAL PLAN AND SECTION
1:50



CONCEPT 4 - MAP PLAN
NTS

LOCATION: QUEENS ROAD ALONG THE ESPLANADE

LEGEND:

EXAMPLE OF AREA BEING UPGRADED

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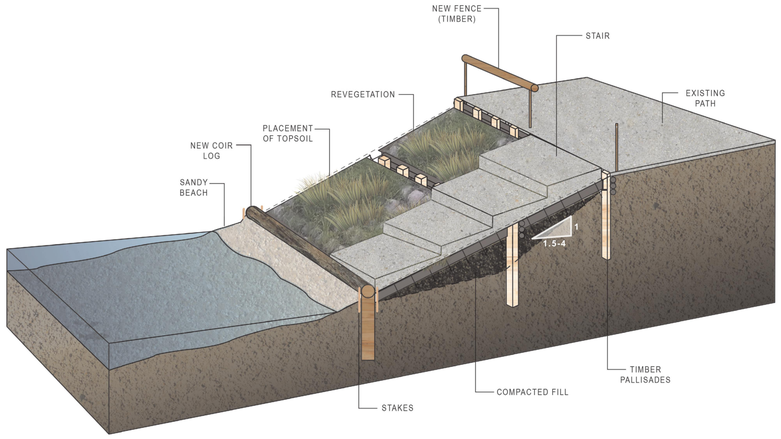
Title CONCEPT No. 4 - OFFSHORE FISH TRAPS TYPICAL PLAN AND SECTION

Original Size A1
Drawing No: 61-12514145-K004
Rev: A

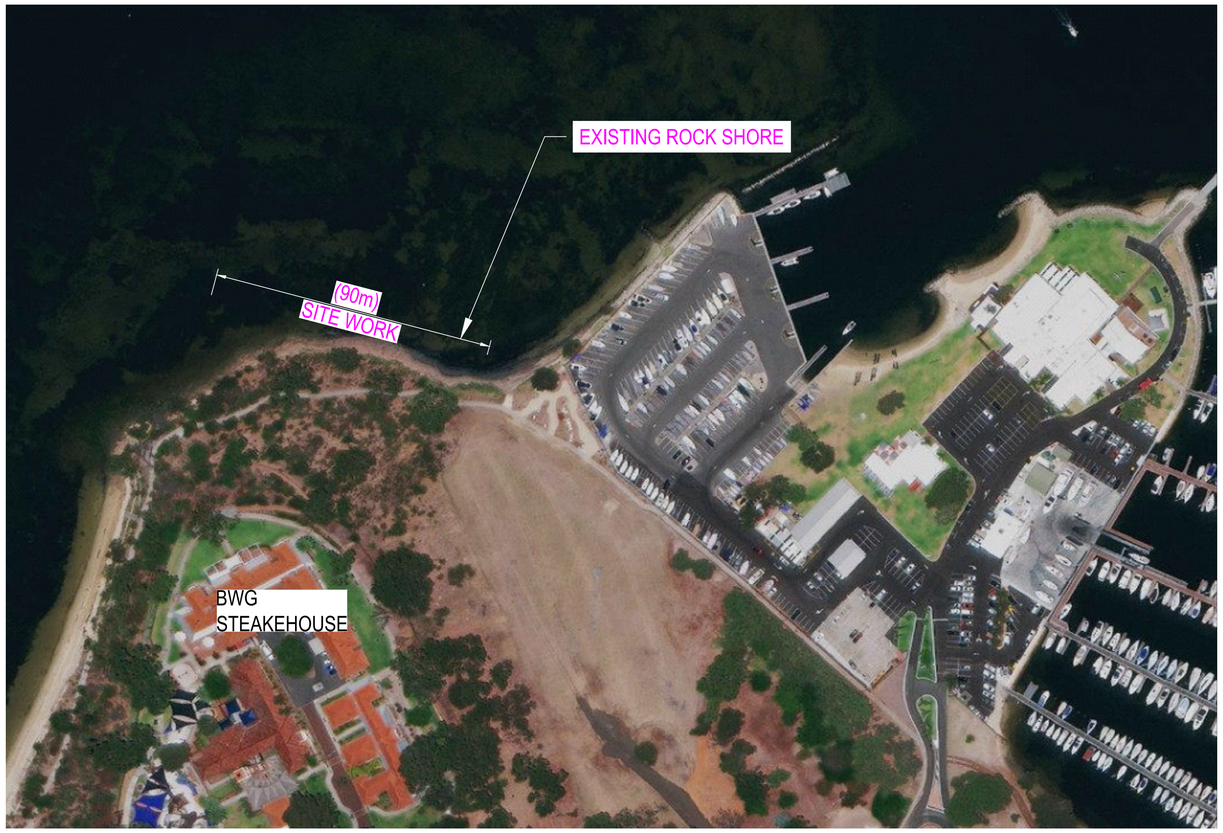
Plot Date: 16 March 2020 - 3:34 PM Plotted by: Sheriellade Anne Velecina Cad File No: G:\61\12514145\CADD\Drawings\61-12514145-K004.dwg



CONCEPT 5: STEEP SLOPE PRETECTION WITH TIMBER BALISTRADES AND STAIR ACCESS

NOT TO SCALE (DIAGRAM ONLY)

N



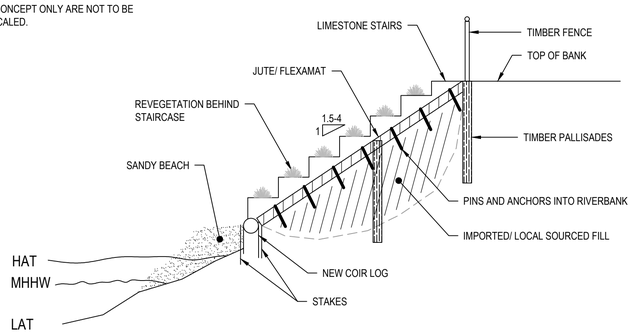
CONCEPT 5 - MAP PLAN

NTS

LOCATION: POINT HEATHCOTE

NOTES:

1. SLOPE 1:1.5-4 (ASSUMED SIMILAR TO OTHER SITES). RIVERBANK SLOPE TO BE SELECTED BASED ON EXISTING SLOPES AND TO BALANCE CUT/FILL VOLUMES.
2. ALL DIMENSIONS IN METRES UNO.
3. DRAWINGS ARE CONCEPT ONLY ARE NOT TO BE MEASURED OR SCALED.



CONCEPT 5 - SLOPE PROTECTION WITH TIMBER PALISTRADES AND STAIR ACCESS TYPICAL PLAN AND SECTION

1:50

CONCEPT ONLY

No	Revision	Note: * indicates signatures on original issue of drawing or last revision of drawing	Drawn	Job Manager	Project Director	Date
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Drafting Check		Design Check	A SAYCE
Approved (Project Director)			
Date			
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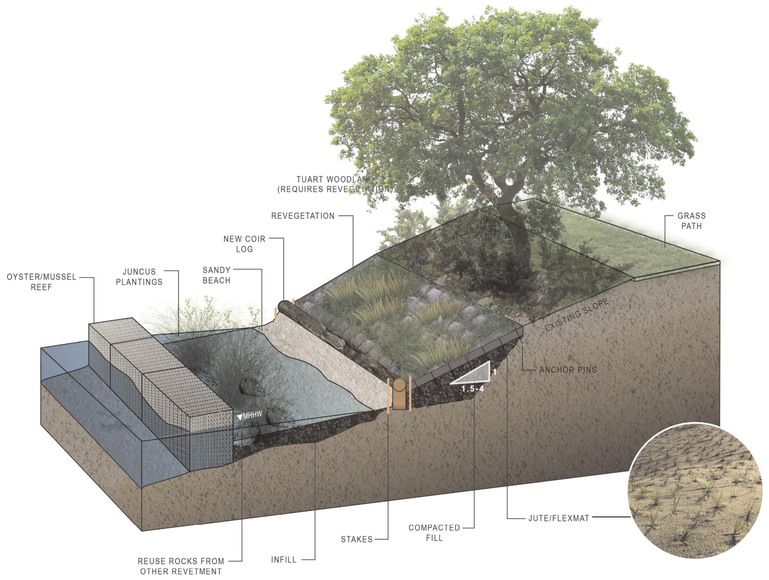
Client: CITY OF MELVILLE
Project: MELVILLE FORESHORE RESTORATION STRATEGY
Title: CONCEPT No. 5 - SLOPE PROTECTION WITH TIMBER PALISTRADES AND STAIR ACCESS TYPICAL PLAN AND SECTION

Original Size A1 | Drawing No: 61-12514145-K005 | Rev: A

Plot Date: 16 March 2020 - 3:36 PM | Plotted by: Sheriellade Anne Velecina | Cad File No: G:\61\12514145\CADD\Drawings\61-12514145-K005.dwg

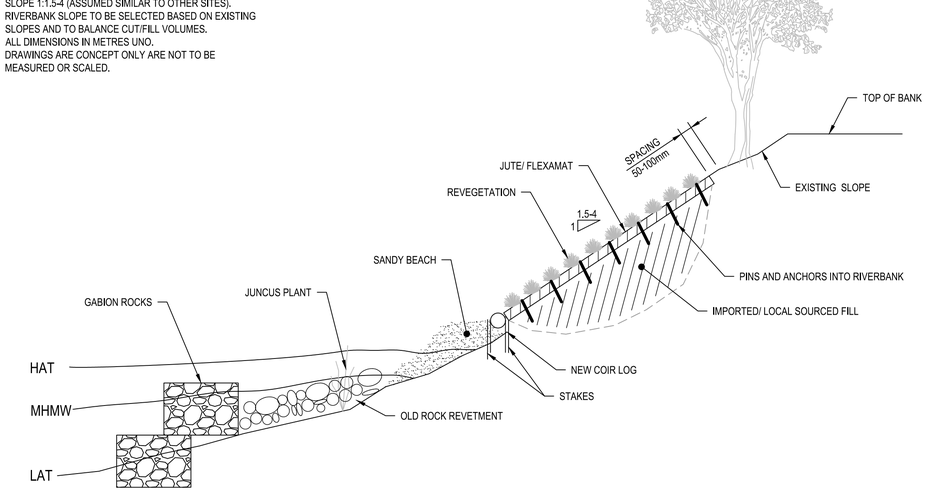


CONCEPT 6: REVEGETATED NODES
REEF TO PATH - BUSH AND REVEGETATION NODE

NOT TO SCALE
(DIAGRAM ONLY)

NOTE:

1. SLOPE 1:1.5-4 (ASSUMED SIMILAR TO OTHER SITES). RIVERBANK SLOPE TO BE SELECTED BASED ON EXISTING SLOPES AND TO BALANCE CUT/FILL VOLUMES.
2. ALL DIMENSIONS IN METRES UNO.
3. DRAWINGS ARE CONCEPT ONLY ARE NOT TO BE MEASURED OR SCALED.



CONCEPT 6 - REVEGETATED NODES TYPICAL PLAN AND SECTION
1:50

CONCEPT 6 - MAP PLAN
NTS

LOCATION: BLACKWALL REACH

CONCEPT ONLY

No	Revision	Note: * indicates signatures on original issue of drawing or last revision of drawing	Drawn	Job Manager	Project Director	Date
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Client CITY OF MELVILLE
Project MELVILLE FORESHORE RESTORATION STRATEGY
Title CONCEPT No. 6 - REVEGETATION NODES TYPICAL PLAN AND SECTION

Original Size A1
Drawing No: 61-12514145-K006
Rev: A

Plot Date: 16 March 2020 - 3:21 PM Plotted by: Sheriellade Anne Velecina Cad File No: G:\61\12514145\CADD\Drawings\61-12514145-K006.dwg

Appendix H – Concept Costs

Table A Point Heathcote Restoration Cost Estimate

Item no	Item Description	Quantity	Unit	Rate	Item Cost
1	Stockpiling of top soil, assume 200 mm depth	80	$/m^3	$ 15	$ 1,200
2	Supply and compact fill	220	$/m^3	$ 41	$ 9,020
3	Timber palisades (assume 2 rows)	140	$/m	$ 175	$ 24,500
4	Placement of topsoil	80	$/m^3	$ 41	$ 3,280
5	Revegetation	390	$/m^2	$ 43	$ 16,770
6	Supply and install new timber fence	70	$/m	$ 175	$ 12,250
7	Supply and install Coir log and stakes	70	$/m	$ 77	$ 5,390
8	Supply and install staircase, assume limestone block	1	Item	$ 5,000	$ 5,000
				Total Cost	**$ 77,410**
9	Mobilisation, demobilisation, contractors site management and as constructed survey.			30%	$ 23,220
10	Contingency			20%	$ 20,130
				Total Sum (+/- 30%)	**$ 120,760**

Notes:

1. Refer cross – section in Appendix G
2. Work around existing trees and significant shrub

Table B Melville Beach Road Restoration Cost Estimate

Item no	Item Description	Quantity	Unit	Rate	Item Cost
1	Revegetation - assume 3 m strip over 450 m length (assume 600 m actual length)	1,800	$/m^3	$ 43	$76,500
2	Supply and compact fill	1,350	$/m^3	$ 41	$55,690
3	Supply and placement of matting	1,800	$/m^2	$ 44	$79,200
4	Supply and placement of topsoil	1,800	$/m^3	$ 41	$74,250
5	Supply and install coir log and stakes (assume 50 m each node, 7 nodes)	350	$/m	$ 77	$26,950
6				**Total Cost**	**$ 312,590**
7	Mobilisation, demobilisation, contractors site management and as constructed survey.			30%	$ 93,780
8	Contingency			20%	$ 81,270
				Total Sum (+/- 30%)	**$ 487,640**

Notes:

1. Refer cross – section in Appendix G

Table C Rock Revetments Restoration Cost Estimate

Item no	Item Description	Quantity	Unit	Rate	Item Cost
	Canning Beach Revetment no. 3 (approx 90m Flanagan Rd to Dunvegan Rd)				
1	Removal of existing rocks, some repurposed on site	180	$/m^3	$ 150	$ 27,000
2	Supply and placement of flexmat	180	$/m^2	$ 70	$ 12,600
3	Supply and placement of topsoil	180	$/m^3	$ 41	$ 7,380
4	Revegetation of slope	180	$/m^2	$ 43	$ 7,740
5	Revegetation at toe (between rocks)	90	$/m^2	$ 43	$ 3,870
6	Oyster/mussel sprats for reef	350	$/m^2	$ 50	$ 17,500
7	Supply of Gabions baskets for reef (optional)	350	$/m^3	$ 220	$ 77,000
8	Supply of rock fill for Gabions baskets for reef (optional)	350	$/m^3	$ 176	$ 61,600
9	Placement and Filling of Gabions baskets for reef (optional)	350	$/m^3	$ 110	$ 38,500
	Esplanade Revetment no 5 (across 90m, near Queens Rd)				
1	Removal of existing rocks, some repurposed on site	180	$/m^3	$ 150	$ 27,000
2	Supply and placement of flexmat	180	$/m^3	$ 70	$ 12,600
3	Supply and placement of topsoil	180	$/m^3	$ 41	$ 7,380
4	Revegetation of slope	180	$/m^2	$ 43	$ 7,740
5	Revegetation at toe (between rocks)	90	$/m^2	$ 43	$ 3,870
6	Oyster/mussel sprats for reef	350	$/m^2	$ 50	$ 17,500
7	Supply of Gabions baskets for reef (optional)	350	$/m^3	$ 506	$ 177,100
8	Supply of rock fill for Gabions baskets for reef (optional)	350	$/m^3	$ 175	$ 61,250
9	Placement and Filling of Gabions baskets for reef (optional)	350	$/m^3	$ 175	$ 61,250
		Total (excluded toe option)			$ 152,180
		Total (included toe option)			$ 628,880
10	Mobilisation, demobilisation, contractors site management and as constructed survey.	Option excluded (30%)			$ 45,650
		Option included (30%)			$ 188,660
11	Contingency	Option excluded (20%)			$ 39,570
		Option included (20%)			$ 163,510
		Total Sum (+/- 30%) - option excluded			**$ 237,400**
		Total Sum (+/- 30%) - option included			**$ 981,050**

Notes:

1. Refer cross – section in Appendix G

Table D Esplanade Paths Restoration Cost Estimate (Concept 1)

Item no	Item Description	Quantity	Unit	Rate	Item Cost
1	Stockpiling of top soil, assume 200 mm depth	6	$/m^3	$ 15	$ 90
2	Compact fill	5	$/m^3	$ 41	$ 205
3	Supply and placement of geotextile matting	30	$/m^2	$ 44	$ 1,320
4	Placement of topsoil	6	$/m^3	$ 41	$ 246
5	Revegetation of slope	30	$/m^2	$ 43	$ 1,290
6	Supply and install Coir log and stakes	15	$/m	$ 77	$ 1,155
					$ 4,306
7	Mobilisation, demobilisation, contractors site management and as constructed survey.			30%	$ 1,292
8	Contingency			20%	$ 1,120
				Total Sum (+/- 30%)	**$ 6,718**

Notes:

1. Refer cross – section in Appendix G

Table E Blackwall Reach Restoration Cost Estimate

Item no	Item Description	Quantity	Unit	Rate	Item Cost
1	Supply and compact fill (south node only)	150	$/m^3	$ 41	$ 6,150
2	Supply and placement of geotextile matting	720	$/m^2	$ 44	$ 31,680
3	Supply and placement of topsoil	720	$/m^3	$ 41	$ 29,520
4	Revegetation of slope	720	$m/^{2}	$ 43	$ 30,960
5	Supply and install coir log and stakes	240	$/m	$ 77	$ 18,480
6	Oyster/mussel sprats for reef	240	$/m^2	$ 50	$ 12,000
7	Supply of Gabions baskets for reef	240	$/m^3	$ 220	$ 52,800
8	Supply of rock fill for Gabions baskets for reef	240	$/m^3	$ 176	$ 42,240
9	Placement and Filling of Gabions baskets for reef	240	$/m^3	$ 110	$ 26,400
					$ 250,230
10	Mobilisation, demobilisation, contractors site management and as constructed survey.			30%	75,070
11	Contingency			20%	65,060
		Total Sum (+/- 30%)			**$ 390,360**

Notes:

1. Refer cross – section in Appendix G

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12514145-38139/https://projectsportal.ghd.com/sites/pp18_04/cityofmelvilleforesh/ProjectDocs/12514145-REP_Foreshore Restoration Strategy Review Report.docx
Document Status

Revision	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
A	J Lee A.Benkovic	A. Sayce		H O'Keeffe	**H O'Keeffe*	20/12/2019
0	J Lee A Benkovic	H O'Keeffe	**H O'Keeffe*	H O'Keeffe S Hosseini	**H O'Keeffe*	20/3/2020

**indicates signed copy on file*

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