Port of Hastings Development Authority

Port of Hastings Container Expansion Project

Ecology Description - Final Report

October 2013

In May 2016 the Special Minister of State asked Infrastructure Victoria to provide advice on the future capacity of Victoria's commercial ports. Specifically, the Minister has asked for advice on when the need for a second container port is likely to arise and which variables may alter this timeline. The Minister has also asked for advice on where a second container port would ideally be located and under what conditions, including the suitability of, and barriers to investing in, sites at the Port of Hastings and the Bay West location.

In undertaking this task, Infrastructure Victoria reviewed work that was completed as part of the Port of Hastings development project before it was cancelled in 2014. This document forms part of the initial work undertaken for the proposed port development at Hastings. Infrastructure Victoria considers that much of the previous Hastings work, although preliminary in nature, is relevant and suitable for informing a strategic assessment. Therefore, Infrastructure Victoria has made the reports previously commissioned for the development project part of the evidence base on which Infrastructure Victoria will use in providing the Minister with advice.

The opinions, conclusions and any recommendations in this document are based on conditions encountered and information reviewed at the date of preparation of the document and for the purposes of the Port of Hastings Development Project.

Infrastructure Victoria and its consultants have used the information contained in these reports as an input but have not wholly relied on all the information presented in these reports.

Executive summary

The Port of Hastings is a commercial port serving international and domestic shipping including the import and export of oil, LPG, unleaded petrol, general cargo, project cargo, ship-to-ship transfer, pipe-laying operations and the lay up and repair of oil rigs and floating platforms. Currently the port facilities do not handle containerised freight.

The Victorian Government has identified the Port of Hastings as a key area for development and expansion for future container traffic as the Port of Melbourne reaches capacity. The Port Expansion Container Project is a major initiative of the Victorian government: it includes all activities to investigate, evaluate, plan, assess, permit, procure, construct and operate an expanded Port of Hastings to meet forecast demand for trade. The proposed development is in line with the legislated and business objectives of the Port of Hastings Authority.

Five work packages inform the assessment of conceptual port design options: Port Development Strategy; Commercial and Economic; Enterprise Risk; Hydrodynamics; and Ecology.

This document forms part of the Ecology works package. Its purpose is to provide a high level review of existing ecological values in Western Port and the Special Use Zone set aside for the Port development (SUZ1).

Through a review of literature, available databases and expert elicitation this report has reviewed current land use in SUZ1 and Western Port. Section 1 provides a general overview of the biophysical features of the Western Port environment, including past and present land uses, the unique environmental features of Western Port such as sediment and tidal movements, the diversity of biological habitats and the biodiversity values present within Western Port.

Section 2 then discusses the unique ecological values of international, national, state, regional and local importance that exist in western port in more depth. Key significant environmental values include

- The majority of marine and intertidal waters of Western Port which are listed as a Ramsar site;
- Threatened ecological communities;
- Threatened species;
- Important bird habitats;
- Marine protected areas;
- Special management areas;
- Reference areas;
- Sites of geomorphic and geological significance;
- BioSites;
- The Western Port biosphere reserve; and
- Commercial and recreational fishing values.

This is followed by an overview of sediment and water quality studies of Western Port in Section 3. Water and sediment movement are important physical processes that shape Western Port's marine environment. Wetland bathymetry, geomorphology and sedimentation have been identified as critical ecosystem elements and processes as part of Western Ports Ramsar listing. The results of historical water and sediment quality monitoring are reviewed and data gaps identified.

A description of the ecological values is then given in Sections 4, 5, and 6 to provide an overview of ecological values across the terrestrial, intertidal (coastal saltmarsh, mangrove and mudflats) and the marine (intertidal to deeper subtidal) ecosystems. Ecological values have been split into these three broad zones to inform additional parts of the ecological works package, including the development of conceptual models, hazard tables and species response curves. These three environs do not have hard edges and may merge into one another, which means some species may exist across multiple habitats. This is addressed in each section.

Sections, 4, 5 and 6 also provide specific detail on threatened species and communities listed under the *Environmental Protection and Biodiversity Act 1999,* the *Flora and Fauna Guarantee Act (1988)*, and the Victorian Department of Environment and Primary Industries Advisory lists for flora and fauna (DSE, 2005; 2009; DEPI, 2013). Western Port provides habitat for far more species and communities than those listed as threatened, near threatened, rare or poorly known. However, the report focuses on listed species, critical components of Western Port's Ramsar listing, to draw attention to habitats that may need to be considered as part of future impact assessments.

The report also identifies significant habitats and populations of non-threatened species that rely on the Western Port marine environment.

A wide range of legislation is pertinent to the protection of ecological values in Western Port and its catchment. Section 7 provides a list of legislation which serves to protect the ecological values identified in this report. It is not an exhaustive list of all legislation that may apply to the Project.

Finally, Section 8 lists threatening processes identified by the literature review. These have been included to inform the risk assessment in the Ecological Works Package. Information gaps have been identified: many of these are likely to be addressed in future baseline studies which would inform risk and impact assessments as part of port approvals.

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Glossary

Term	Expansion
BCS	Bioregional Conservation Status
CAMBA	China-Australia Migratory Bird Agreement
CSD	Cutter Suction Dredge
EIA	Environmental Impact Assessment
EPA	Environment Protection Authority (Victoria)
EPBC Act	Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*
EVC	Ecological Vegetation Class
FAFR	Flinders Aquaculture Fisheries Reserve
IBA	Important Bird Area (sites of global bird conservation importance)
IUCN	International Union for Conservation of Nature
JAMBA	Japan-Australia Migratory Bird Agreement
MNP	Marine National Park
PIANC	World Association for Waterborne Transport Infrastructure
PMST	Protected Matters Search Tool
Ramsar Convention	The Convention on Wetlands of International Importance named after the town in Iran where the convention was held in 1971.
ROKAMBA	Republic of Korea-Australia Migratory Bird Agreement
SEWPaC	Commonwealth Department of Sustainability, Environment, Water, Population and Communities
SMA	Special Management Area
SUZ1	Special Use Zone 1
Swing Basin	Dredged area adjacent to the wharf where ships can be turned
TAP	Technical Advisory Panel. The Authority
The Authority	Port of Hastings Development Authority
The Project	Port Expansion Container Project
TEU	Twenty Foot Shipping Container Equivalent Units
TSHD	Trailer Suction Hopper Dredge
VBA	Victorian Biodiversity Atlas

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Spatial data acknowledgements and disclaimers

The following spatial data were relied upon for much of the project:

- All base spatial information including but not limited to Parcels, Roads, Watercourses, Contours, Bathymetry, Planning Zones, Planning Overlays, Administration Boundaries; supplied by Spatial Vision (reseller), on behalf of DEPI, Jan 2013.

  It is acknowledged that the State of Victoria does not warrant the accuracy or completeness of information in this publication and any person using or relying upon such information does so on the basis that the State of Victoria shall bear no responsibility or liability whatsoever for any errors, faults, defects or omissions in the information.

- Environment spatial data including BIOSITE100_P, BIOSITE25_B, NV2005_EVC, NV1750_EVC, RAMSAR100, THFAU100, THFLO100, VBIOREG100, WETLAND_1994, VICTORIAN FLORA SITE DATABASE; © The State of Victoria, DEPI, 2012.

  The contribution of the Royal botanical Gardens Melbourne to the database is acknowledged for VBA Flora and Fauna datasets

- Seagrass, DEPI, collected between 1999-2000.

  Supporting documentation: Blake, S. and Ball, D. (2001). Victorian Marine Habitat Database, Seagrass Mapping of Western Port. GeoSpatial Systems Section, Marine and Freshwater Resources Institute Report No. 29, MAFRI, Queenscliff.

- Intertidal EVC; Victorian Saltmarsh Study (2011), Date completed March 2010.

  Supporting documentation: Victorian Saltmarsh Study (2011). Mangrove and coastal saltmarsh of Victoria: distribution, condition, threats and management. Institute for Sustainability and Innovation, Victoria University, Melbourne. Paul I boon, Tim Allen, Jennifer Brook, Geoff Carr, Doug Frood, Chris Harty, Jasmine Hoye, Andrew McMahon, Steve Mathews, Neville Resengren, Steve Sinclair, Matt White and Jeff Yugovic.

1. Background: The Port of Hastings container expansion project

1.1 Project background

The Port of Hastings is a commercial port serving international and domestic shipping including the import and export of oil, LPG, unleaded petrol, general cargo, project cargo, ship-to-ship transfer, pipe-laying operations and the lay up and repair of oil rigs and floating platforms. Currently the port facilities do not handle containerised freight.

The port environs include over 3,000 hectares of land (the Special Use Zone) surrounding the port that has been zoned for port related uses. The port includes jetties and land in three precincts– Long Island Point, Crib Point and Stony Point. The facilities include:

- Stony Point jetty and depot;
- Crib Point liquid berths 1 and 2;
- Long Island Point liquid berth;
- BlueScope Steel jetty owned by Blue Scope Steel Limited.

The facilities at Stony Point are used by passenger ferries to Cowes and French Island, the Royal Australian Navy (training vessel), fishing industry, oil exploration vessels and small commercial vessels, and the Harbour Master and maintenance operations including depot, tugs and harbour service vessels.

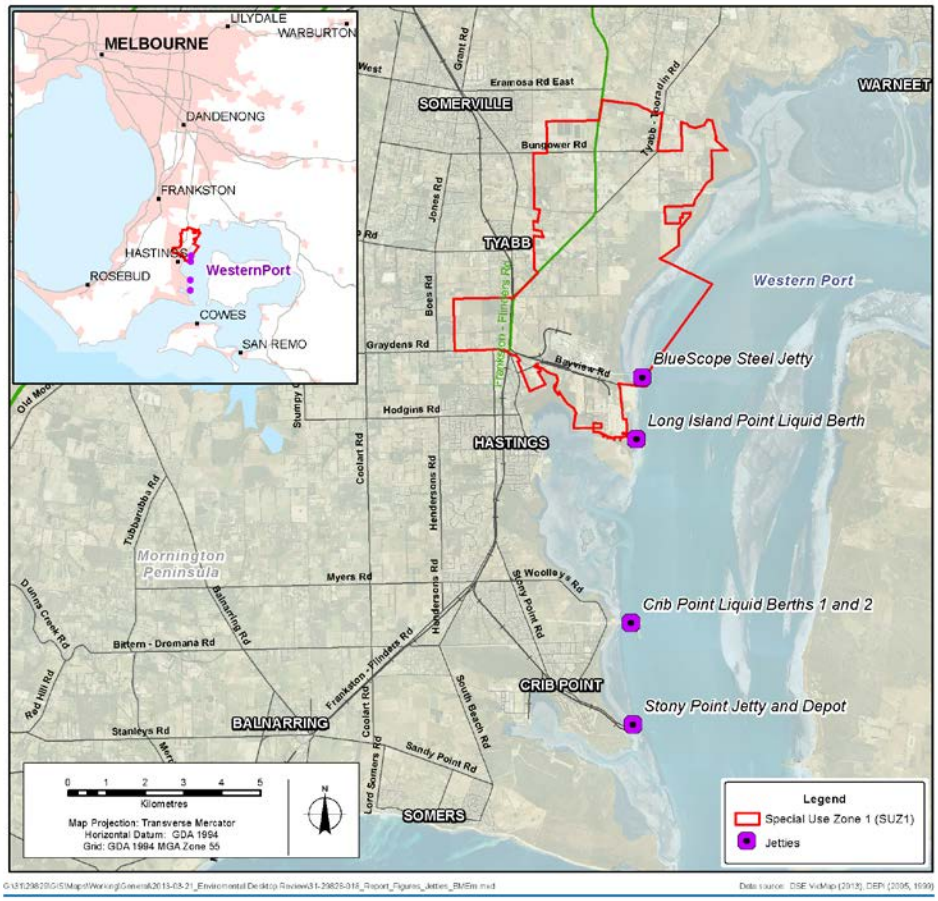

Figure 1 The Port of Hastings

1.2 Port of Hastings container expansion project

The Victorian government has identified the Port of Hastings as a key area for port development and expansion for future container traffic as the Port of Melbourne reaches capacity. The Port Expansion Container Project (The Project) is a major initiative of the Victorian government. The scope of the Project includes all activities to investigate, evaluate, plan, assess, permit, procure, construct and operate an expanded Port of Hastings to meet forecast demand for trade, in line with the legislated and business objectives of the Port of Hastings Development Authority (the Authority).

The Authority has adopted a vision for the expanded Port which is:

> *"To be a world-class, competitive port, with an ultimate capacity of 9 million TEU (twenty-foot equivalent units) by 2060."*

The Project will establish container-handling facilities with a minimum throughput of up to 9 million TEU per year, plus flexibility should another trade emerge.

To fulfil the Authority's vision and provide for future trade demand it is anticipated that the port expansion will include:

- Dredging of new or deepened shipping channels, berth pockets, swing basins and anchorages;
- Beneficial re-use of dredged materials, or disposal to an existing or new dredged material ground inside or outside Western Port;
- Construction of wharves and shipping berths, including the potential for land reclamation and provision of significant areas of hard stand;
- Port and logistics-related developments, including road and rail circulation within the port environs;
- New land use and development associated with the ongoing operation of the port;
- Upgrade of the arterial road network outside the port environs to increase capacity consistent with the increase in trade;
- Construction of a new rail line between the port and the existing rail network; and
- New terminal facilities, including container-stacking areas and equipment.

Preliminary investigations on the future development of the port have identified three high-level concepts for development:

- A fully land-backed quay and terminal;
- An island quay and terminal structure; and
- A piled quay structure with a detached container terminal on shore.

To inform the assessment of conceptual port design options, five work packages were undertaken:

- Port Development Strategy;
- Commercial and Economic;
- Enterprise Risk;
- Hydrodynamics; and
- Ecology.

This document forms part of the Ecology works package.

1.3 Ecology works package

The ecology works package provides input to port development options. It provides

- A literature review and descriptive assessment of the ecological values across the marine, coastal and terrestrial environments (this report);
- Conceptual models to define ecological values and threatening processes (GHD, 2013);
- A risk and impact assessment method and manual (GHD, 2013);
- A risk and impact assessment of the possible impacts to marine, coastal and terrestrial values of 11 port development options (GHD, 2013); and
- Identification of future baseline ecological investigations across the marine, coastal and terrestrial environments (GHD, 2013).

1.4 Purpose of this report

This report is based on a desktop study that identifies key ecological values in the Western Port marine, coastal and terrestrial environments. It includes descriptions of ecological values, their conservation status and threatening processes where known.

The assessment of marine, coastal and terrestrial values has identified the values that could be impacted by the development concepts. The review has been limited to searches of databases and review of existing information from specialists or published reports.

1.5 Area of investigation

Terrestrial ecological values of flora and fauna are limited to areas within the Special Use Zone (SUZ1) and areas north of Hastings as identified in Figure 2, as these are the primary area for the development of the Port.

The assessment of marine and coastal (including intertidal) ecological values encompasses all of Western Port as there may be direct and indirect impacts on marine and intertidal values.

The marine waters of Western Port are divided into six segments: Western Entrance, Confluence Zone, Lower North Arm, Upper North Arm, Corinella Segment and Rhyll Segment (Figure 2). These are referenced in various sections of the report.

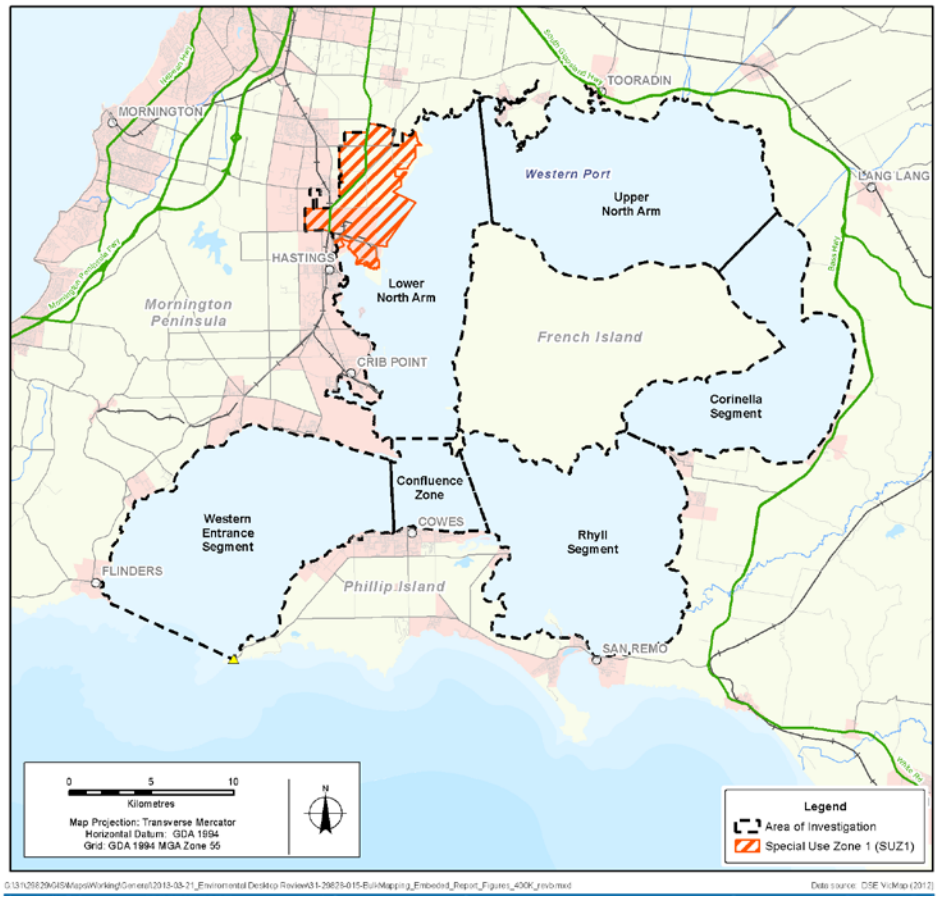

Figure 2 Area of investigation including SUZ1 the boundary of the terrestrial investigations. The area of assessment for marine waters included all segments defined above.

1.6 Methods applied for this assessment

The investigation identified three broad ecological zones: terrestrial, intertidal and marine (sub-tidal) to provide an informative spatially based assessment of ecological values.

It is acknowledged that many ecological values span multiple zones. This is addressed throughout the report where applicable.

Information in this report has been obtained primarily through a comprehensive review of available literature pertaining to the Western Port environment. The following databases were used to verify the relevance of the findings of the literature review, and provide additional project specific information:

- Ecological Vegetation Class Mapping (DEPI 2013h);
- *Environment Protection and Biodiversity Conservation Act 1999* (EPBC) Protected Matters Search Tool (PMST) (DSEWPaC 2013b);
- Threatened species records; The Victorian Biodiversity Atlas (DEPI, 2012);
- Ecological Vegetation Classes; The Victorian Biodiversity Atlas (DEPI, 2012);
- Biosites; The Victorian Biodiversity Atlas (DEPI, 2012);
- Habitat mapping; The Victorian Biodiversity Atlas (DEPI, 2012); and
- A review of items listed under the *Flora and Fauna Guarantee Act 1988* (FFG Act).

VBA searches were completed for the SUZ1 and Western Port. A buffer of five kilometres was applied for fauna species, and 10 km for flora species.

For the PMST search a buffer of 10 km was applied to the whole of Western Port to provide a comprehensive analysis of species and communities likely to inhabit the study area.

2. Western Port – character and environmental significance

2.1 Overview

Western Port is a coastal embayment in central Victoria, east of Port Phillip Bay and approximately 70 kilometres southeast of Melbourne. It is bounded by the Mornington Peninsula to the west, Koo Wee Rup to the north, Phillip Island to the south and features French Island at its centre (Figure 2). The bay is connected to Bass Strait by two channels: a wide western channel between Flinders and the western point of Phillip Island and a narrow eastern channel between San Remo and Phillip Island.

Western Port covers an area of 680 square kilometres at high tide, including 270 square kilometres of intertidal mudflats which are exposed for varying lengths of time at low tide (Chidgey *et al.* 2009; EPA Victoria, 2011). It is a shallow, well-flushed embayment with a large tidal range of 2.3 metres in the southern sections and up to 3.1 metres in the northern section; this approximates 30 per cent of the total volume of Western Port at high tide (Lee, 2011). As a result, relatively high-velocity currents occur in some parts of the bay (Lee, 2011). In the two channels connecting Bass Strait, the outgoing tide tends to be strongest on the eastern side of the bay with water generally circulating in a clock-wise direction (Shapiro, 1975; Chidgey *et al.,* 2009*)*.

Approximately 17 primary waterways and 20 smaller waterways make up the catchment for Western Port, flowing mostly through agricultural and urban landscapes. Primary waterways discharging into the bay include Cardinia Creek, Toomuc Creek, Bunyip River, Tarago River, Lang Lang River and Bass River (Shapiro, 1975; Kellogg Brown and Root, 2010).

Koo Wee Rup Swamp once occupied extensive areas of the Western Port hinterland; since the 1870s drainage of the swamp for agricultural development and improved transport access (Kellogg Brown and Root*,* 2010) has left this area highly modified, and the swamp/waterways persist as a series of channelised drains.

The terrestrial environment now supports a variety of ecological habitats, which have the potential to support a large diversity of flora and fauna species, including threatened flora and fauna species and communities.

Unique physico-chemical factors in Western Port have shaped a diverse array of physical features in the intertidal and sub-tidal environments, including intertidal mudflats, subtidal channel slopes, subtidal channels, sediment banks, deeper basins, isolated reefs and tide-flushed water columns (EPA Victoria, 2011; Chidgey *et al.,* 2009) as shown in Figure 3. A schematic presentation of the shallower sections of this is shown in Figure 3. They support a range of important ecological habitats including seagrasses, mangroves, saltmarshes, rocky reefs, intertidal mudflats and pelagic environments (Melbourne Water, 2011). These in turn support a large diversity of flora and fauna species, including threatened flora and fauna species and communities.

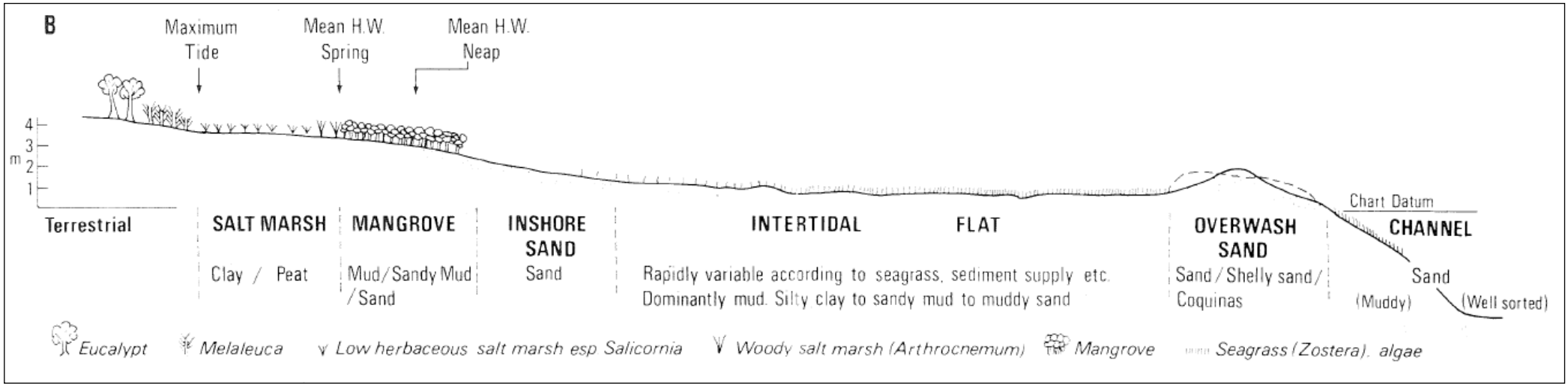

Figure 3 Schematic cross-section of generalised intertidal zonation

(Source: Marsden *et al*., 1979)

Western Port is home to a diverse array of marine fish species, primarily because of the wide range of habitats available. Fish species include pelagic, benthic, and higher-order predatory species.

Invertebrate communities in Western Port have been the focus of various studies since the early 1970s (Kimmerer and McKinnon 1985; Edgar *et al.* 1994). Invertebrates in Western Port are important in identifying the transfer of energy from primary producers such as seagrasses to higher-order organisms such as fish and birds (Chidgey *et al.,* 2009).

Western Port's coastal and marine ecosystems are widely recognised to be of international, national and regional significance; it has

- International and national zoological significance as a foraging area and high tide roosting site for migratory waders, as well as for its potential habitat for the critically endangered orange-bellied parrot, leading to the bay's listing as Western Port Ramsar site.
- National botanical significance for its extensive saltmarsh communities.
- National and international geomorphological significance.
- State significance for its marine community at San Remo.

Western Port is a significant breeding area and nursery for several fish species and supports commercial fisheries. Flinders Aquaculture Fisheries Reserve (FAFR) covers an area of 440 hectares immediately north of Flinders, and supports commercial leases particularly for the growth of abalone and mussels (ECC, 2000; Wilson *et al.,* 2011).

2.2 Ramsar listing

Ramsar wetlands are of international importance. They are listed under the Convention on Wetlands of International Importance, also known as the Ramsar Convention. The convention aims to halt the worldwide loss of wetlands and to conserve those that remain. Western Port was designated a Ramsar wetland in 1982.

The Western Port Ramsar site extends across approximately 60,000 hectares of the bay with its southernmost extent crossing between Point Leo in the east and Observation Hill on Phillip Island and across to a point just west of San Remo (Figure 4) (as shown in Kellogg Brown and Root, 2010). The shoreline of French Island is part of the Ramsar site (Kellogg Brown and Root, 2010). Four of the marine and coastal wetland types recognised under the Ramsar classification system are located in the Western Port Ramsar site: marine sub-tidal aquatic beds; intertidal mud and sand flats; intertidal marshes including saltmarsh; and intertidal forested wetlands including mangroves.

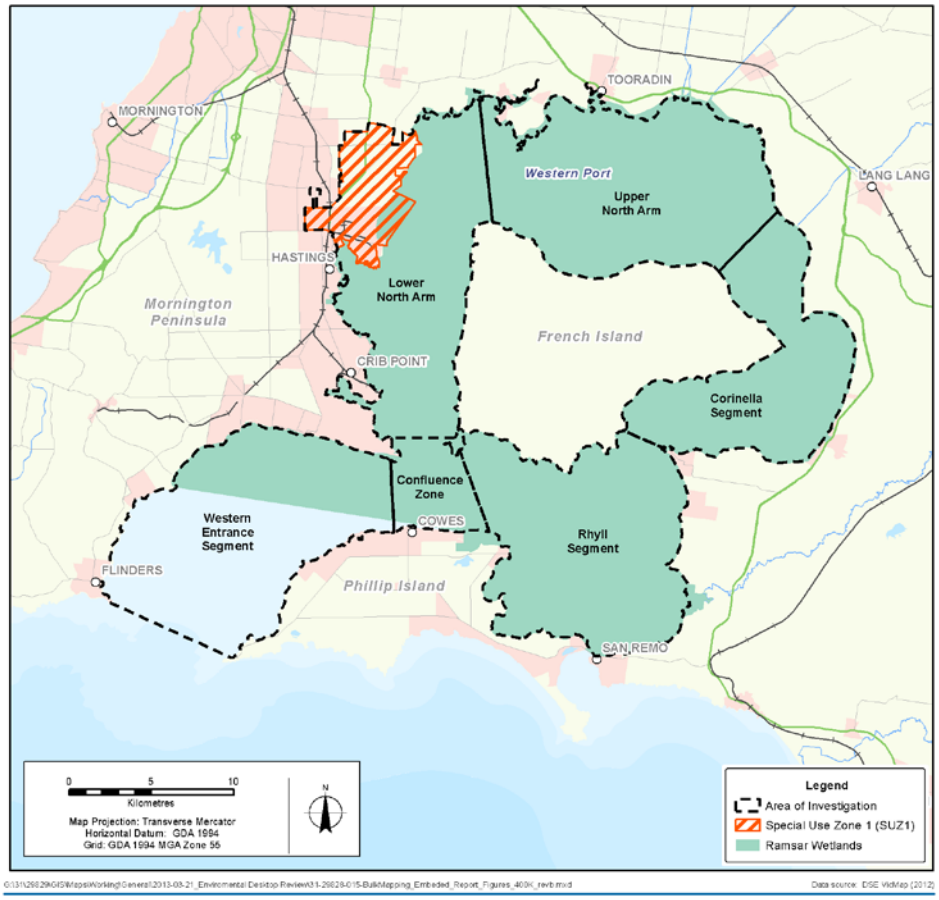

Figure 4 Western Port Ramsar site

The Western Port Ramsar site meets seven of the nine Ramsar criteria:

- Criterion 1: Western Port is a particularly good example of a natural wetland marine embayment with extensive intertidal flats, mangroves, saltmarsh, and seagrass beds within the South East Coastal Plain. It is also a very good example of a saltmarsh-mangrove-seagrass wetland system.
- Criterion 2: The site supports the Fairy Tern (*Sternula nereis*) which is a species of global conservation significance, and the Dense Leek-orchid (*Prasophyllum spicatum*) which is listed as *vulnerable* under the EPBC Act. Saltmarsh vegetation within the site provides important habitat for the Orange-bellied Parrot (*Neophema chrysogaster*), listed as *critically endangered* under the EPBC Act.
- Criterion 3: Western Port is one of the most important areas for migratory waders in south-east Australia with wader surveys indicating that the Ramsar site supports up to 39 species, and includes 10,000 to 15,000 summer migrants (approximately 12 to 16 per cent of the Victorian population). It supports seagrass and mangrove communities characteristic of the marine embayments of Southern Victoria.
- Criterion 4: The site is one of the three most important areas in southeast Australia for migratory waders in total numbers and density. It also provides overwintering habitat for the Orange-bellied Parrot and a number of important high tide roosts and breeding habitat.
- Criterion 5: The site regularly supports about 10,000 to 15,000 migratory waders, and periodically supports 1,000 to 3,000 ducks and 5,000 to 10,000 Black Swans (*Cygnus atratus*).

- Criterion 6: The site regularly supports more than one per cent of the estimated flyway population of five wader species and supports internationally significant numbers of several non-wader species.
- Criterion 8: Seagrass beds within the site are known to provide nursery habitat for a number of fish species, including commercially significant species.

When the Western Port Ramsar site was listed in 1982 there were 7,200 hectares of seagrass and macroalgae, 31,000 hectares of saltmarsh and 13,700 hectares of mangroves (Kellogg Brown and Root, 2010). Coverage of mangroves and saltmarsh was nearly continuous along the western and northern shoreline of Western Port and along the northern shoreline of French Island. Since then seagrass and saltmarsh distribution has changed, primarily as a result of management changes (Kellogg Brown and Root, 2010).

The Western Port Ramsar site supports a number of flora species of conservation significance. Grey Mangrove (*Avicennia marina* subsp. *australasica*), listed as rare in Victoria, is characteristic of the mangrove fringe in the site. Creeping Rush (*Juncus revolutus),* Marsh Saltbush (*Atriplex paludosa) and* Salt Lawrencia (*Lawrencia spictata)* are characteristic species of saltmarsh (Kellogg Brown and Root 2010). The site supports the *Subtropical and Temperate Coastal Saltmarsh* community, listed as Vulnerable under the EPBC Act.

Approximately 115 waterbird and shorebird species contribute to the site's ecological character (Kellogg Brown and Root, 2010). Between 1973 and 2010 total numbers of waders (shorebirds) and other non-pelagic waterbirds have exceeded 20,000 in all years studied (Kellogg Brown and Root, 2010). Nine of the waders breed locally in or near to Western Port. The site supports seabirds including small numbers of Little Penguins (*Eudyptula minor)* which nest on Barraliar Island within the Ramsar site (the main colonies of penguins are located on the southern coast of Phillip Island outside the Ramsar site), and Short-tailed Shearwaters (*Puffinus tenuriostris)* which nest at Tortoise Head (Kellogg Brown and Root, 2010). A number of non-pelagic waterbirds protected under bilateral agreements as described in Section 2.5.1 are also supported by the site.

Western Port supports a diverse array of marine fauna including 14 different phyla of marine invertebrates, with over 19,853 individuals per square metre recorded during surveys in 1974 (Kellogg Brown and Root, 2010).

Eighteen fauna species of national significance were recorded in the site prior to it being established as a Ramsar site in 1982. Saltmarshes provide habitat during winter for Orange-bellied Parrot (Kellogg Brown and Root, 2010), but none have been seen in Western Port or its catchment since the 1980s. The Australasian Bittern (*Botaurus poiciloptilus*), Grey-headed Albatross (*Thalassarche chrysostoma*), Wandering Albatross (*Diomedea exulans*), Southern Giant Petrel (*Macronectes giganteus*), and the Swift Parrot (*Lathamus discolor*) are listed as endangered under the *EPBC Act;* all are likely to visit Western Port Ramsar site occasionally (Appendix B and Appendix D).

2.3 Threatened ecological communities

The terrestrial, intertidal and marine environments of Western Port include ecological habitats which have the potential to support threatened ecological communities. These are summarised here, but described in more detail for each habitat in Sections 3 (terrestrial zone), 5 (intertidal zone) and 6 (marine zone).

2.3.1 Commonwealth listed threatened ecological communities

The Protected Matters Search Tool (PMST) identified three communities listed under the EPBC Act as potentially occurring:

One is known to be present, one is unlikely to be present, and one is not present within SUZ1:

- *Subtropical and Temperate Coastal Saltmarsh*, which was recently listed as Vulnerable under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC). The saltmarsh communities fringing Western Port form part of the community (refer to section 5.2.1);
- *Seasonal Herbaceous Wetlands (Freshwater) of the Temperate Lowland Plains* (Critically Endangered). This community most likely occurs within depressions of Grassy Woodland (EVC 175), however, given the fragmented and degraded nature of many of the remnant patches of Grassy Woodland (EVC 175) within SUZ1 (Section 4.1.1), it is unlikely that any intact remnants of this community are present, although field surveys are required to confirm its presence or absence; and
- *White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland* does not occur in the Western Port region and therefore cannot occur within SUZ1.

2.3.2 State listed threatened ecological communities

The San Remo Marine Community is listed under the *Flora and Fauna Guarantee Act 1988* (FFG). It occurs in an area of about 600 metres by 300 metres off the coast of San Remo (see Section 6.2.2).

2.4 Listed species

Listed species supported in Western Port include threatened, near threatened, rare and poorly known species as defined under the EPBC Act, FFG Act and the DEPI Advisory lists for Rare and Threatened species (DSE, 2005; 2009 and DEPI 2013g). These are summarised here, but described in more detail for each habitat in Sections 4, 5 and 6.

2.4.1 Listed flora species

At least 24 threatened, rare or poorly known flora species are considered moderately or highly likely to occur in the study area (Table 1). This includes

- Twelve terrestrial species;
- Ten species which typically occupy the intertidal zone;
- Four marine species (two of which also occupy the intertidal zone).

Six of these species were recorded by Venosta *et al.* (2009 and 2010).

Table 1 Numbers of threatened flora species (terrestrial, intertidal and marine) identified by the Victorian Biodiversity Atlas (VBA) and PMST searches for Western Port and the SUZ1

Group	EPBC	FFG	DEPI Advisory Listed (2005)	Total
Terrestrial	5	5	12	12
Intertidal	0	0	10	10
Marine	0	0	4	4
Total	**5**	**5**	**24**[1]	**24**

2.4.2 Listed fauna species

110 threatened fauna species are known or expected to occur in Western Port or its surrounding terrestrial environment (Table 2). Main groups include:

- Terrestrial fauna (ground-dwelling mammals, birds, reptiles, amphibians, freshwater fish);
- Intertidal fauna (particularly shorebirds, egrets, herons, waterfowl, but also fish and invertebrates);
- Marine fauna (invertebrates, fish, birds, marine reptiles, marine mammals).

Table 2 Numbers of threatened fauna species (terrestrial, intertidal and marine) identified by the Victorian Biodiversity Atlas(VBA) and PMST searches for Western Port and the SUZ1

Group	EPBC	FFG	DEPI Advisory Listed (2009, 2013)	Total
Mammals	11	7	10	13
Birds	24	37*	68	78*
Reptiles	3	2	3	5
Amphibians	1	1	2	2
Fishes	5	6	6	6
Invertebrates	1	6	6	6
Total	**45**	**59***	**95**	**110**

* includes two species nominated for listing, but not yet accepted.

[1] - There is overlap of where species may occur: two species (seagrasses), may occur on mudflats in the intertidal zone.

2.5 Western Port as habitat for birds

Western Port is included in at least four international bi-lateral agreements, and is recognised internationally as an Important Bird Area (IBA). Its significance is based primarily on its capacity to support large numbers of waterfowl and migratory shorebirds.

2.5.1 Migratory bird bilateral agreements and conventions

Australia is a signatory to a number of international bilateral government agreements, initiatives and conventions for the conservation of migratory birds which are relevant to the Western Port Ramsar site. Migratory birds listed under these agreements are considered Matters of National Environmental Significance (MNES) and are part of the assessment process of impacts to Ramsar sites under the EPBC Act.

Relevant agreements are:

- Japan-Australia Migratory Bird Agreement (JAMBA)—the Agreement between the Government of Australia and the Government of Japan for the Protection of Migratory Birds in Danger of Extinction and their Environment, 1974.
- China-Australia Migratory Bird Agreement (CAMBA)—the Agreement between the Government of Australia and the Government of the People's Republic of China for the Protection of Migratory Birds and their Environment, 1986.
- Republic of Korea-Australia Migratory Bird Agreement (ROKAMBA)—the Agreement between the Government of Australia and the Republic of Korea for the Protection of Migratory Birds and their Environment, 2006.
- Convention on Migratory Species of Wild Animals (also known as CMS or Bonn Convention)—the Bonn Convention countries with jurisdiction over any part of the range of a particular species cooperate to prevent migratory species becoming endangered. In Australia, many of the species are migratory birds.

2.5.2 Important bird areas

Western Port IBA (BirdLife International, 2008) has been known to support small numbers of the critically endangered Orange-bellied Parrot, declining numbers of the vulnerable Fairy Tern, and more than one percent of the world population of Eastern Curlew (*Numenius madagascariensis*), Red-necked Stint (*Calidris ruficollis*) and Pied Oystercatcher (*Haematopus longirostris*). The boundaries of the Western Port IBA align with its Ramsar boundaries, as shown in Figure 4.

2.6 Marine protected areas

Marine Protected Areas (which include Marine National Parks (MNPs)) protect the state's significant marine environmental and cultural values. Sites have been chosen to represent the uniqueness in Victoria's marine environment and provide some protection against loss due to unforseen catastrophic events (Barton *et al.,* 2012). There are three MNPs in Western Port; all in the Ramsar site. Each MNP also has a Special Protection Area for National Values which includes saltmarsh and mangrove habitat used by wading birds (Barton *et al.,* 2012). The location of each area is shown in Figure 5.

2.6.1 Yaringa Marine National Park

Yaringa MNP covers an area of about 776 hectares in the north-west of Western Port (Barton *et al.,* 2012). It is at Watsons Inlet between Watsons Creek and Quail Island Nature Conservation Reserve. Around 80 per cent of the park is intertidal and substrates are dominated by soft subtidal and intertidal sediments. The park contains areas of saltmarsh, mangroves and seagrass beds. Threatened species such as the Southern Emu-wren, *Stipiturus malachurus* also occur within this site (Barton *et al*., 2012).

Large areas of bare intertidal mudflats provide habitat for macroinvertebrates, microphytobenthos and demersal fish and are foraging habitats for shorebirds (Barton *et al*., 2012). The subtidal soft sediments are largely unvegetated; but they support some seagrass communities (Barton *et al.,* 2012).

Yaringa MNP protects feeding and roosting habitat for at least 27 internationally important migratory species protected under Australia's migratory bird agreements (Barton *et al*., 2012).

2.6.2 French Island Marine National Park

French Island MNP, in the north of Western Port near the township of Tooradin, extends 15 kilometres along the northern shore of French Island. It is approximately 3000 hectares in size and can only be accessed by boat (Barton *et al*., 2012). Around 73 percent of the park is intertidal, dominated by soft sediments. Mangroves, saltmarsh and seagrass beds grow on the intertidal mudflats (Barton *et al*., 2012).

French Island MNP provides habitat for at least 40 conservation listed bird species including the Orange-bellied Parrot (Barton *et al*., 2012). The network of tidal channels provides habitat for invertebrates such as sea stars and urchins (Barton *et al*., 2012). Threatened invertebrate species (e.g., Syngnathids, and the Brittle star, *Amphiura triscacantha*, listed under the FFG Act) have been recorded in the MNP (Barton *et al.,* 2012).

2.6.3 Churchill Island Marine National Park

Churchill Island MNP is located on the eastern coast of Phillip Island, south of Rhyll, and extends 11 kilometres along the coast from the high-tide mark (Barton *et al*., 2012). The substrate is dominated by soft sediments with some gravel-cobble reef in intertidal areas (Barton *et al*., 2012). The mudflats, mangroves and saltmarsh in the MNP are locally significant and included on the National Trust Register (Barton *et al*., 2012).

Churchill Island MNP is a feeding area for at least 29 internationally important migratory species protected under Australia's migratory bird agreements (Barton *et al*., 2012), and provides habitat for other birds including the critically endangered Orange-bellied Parrot (Barton *et al.*, 2012; Parks Victoria, 2013).

Seventeen macro-invertebrate species have been identified on the intertidal mudflats, including crabs, phoronids, polycheate worms and bivalve molluscs (Barton *et al*. 2012). Subtidal zones support large communities of the rare lampshell ('living fossil') (*Magellania flavescens*) (Barton *et al*., 2012).

2.7 Special management areas

Special Management Areas (SMA) in Western Port are designated through state legislative mechanisms for protection of special natural values. The areas are usually consistent with International Union for Conservation of Nature (IUCN) categories for marine protected areas. Western Port contains five SMAs (as shown in Figure 5).

2.7.1 Bass River Delta Special Management Area

Bass River Delta SMA occupies 635 hectares at the mouth of the Bass River (Wilson *et al.,* 2011). It includes extensive areas of intertidal and shallow subtidal soft sediments and provides habitat for vegetation species such as algae and seagrass (ECC, 2000). Soft sediment vegetation communities in this area support waders and other waterbirds, as well as commercial and recreational fisheries. The Bass River Delta SMA has been identified as a nursery area for sharks and whiting.

2.7.2 Rhyll Special Management Area

Rhyll SMA occupies 375 hectares adjacent to Rhyll township. The SMA includes large areas of intertidal and shallow soft sediments (mudflat and a dynamic sand spit) as well as rocky reef, mangroves and saltmarsh, and is used by at least 32 species of migratory waders (ECC, 2000).

2.7.3 Honeysuckle Reef Special Management Area

Honeysuckle Reef SMA is located on the Lower North Arm The area covers approximately 25 hectares (DSE, 2003b) and is of particular significance due to its high biodiversity. Honeysuckle Reef has been identified as having the most species-rich intertidal community in Victoria (Handreck and O'Hara, 1994; ECC, 2000; Bathgate *et al.*, 2011). The reef itself is flat, shallow and situated in a relatively sheltered bay. The majority of the reef is exposed at low tide with small pools regularly used by young fish. The high-tide shore area is also used as a roost for migratory waders (ECC, 2000).

2.7.4 Crawfish Rock Special Management Area

Crawfish Rock SMA is a 45-hectare rocky outcrop which is exposed at low tide. It lies north-west of French Island in the main tidal channel of the North Arm. Strong tidal currents prevent fine sands and gravels from accumulating. The area is significant as it supports species more commonly associated with deep water ecosystems of Bass Strait (Bathgate, 2011, cited in DEPI, 2013f). Significant loss of seagrass and resulting increased turbidity in Western Port has significantly impacted the macroalgae communities of Crawfish Rock, resulting in reduced distribution (by depth) of macroalgae communities.

2.7.5 San Remo Special Management Area

San Remo SMA is a 70-hectare temperate rocky reef that supports a reef community (*San Remo Marine Community*) listed under the FFG *Act*. The reef habitat is a combination of soft sediments, seagrass, macroalgae and basalt boulders (Bathgate *et al.*, 2011). More than 630 species of marine invertebrates have been recorded in the reef and in seagrass flats off San Remo, including 125 species of sea slugs (Opisthobranchs). The *San Remo Marine Community* is listed due to its diverse and unique populations of opisthobranch and bryozoan species.

2.8 Reference areas

Reference areas are areas of public land of ecological interest and significance reserved as a reference under the *Reference Areas Act 1978* (DEPI, 2013j). Their primary management objective is to allow natural processes to continue undisturbed.

There are two Reference Areas on French Island (Figure 5): French Island North Reference Area and French Island South Reference Area.

There is not much publicly available information on these sites. Mapping indicates that they cover an area of terrestrial and intertidal vegetation in the French Island National Park, but do not extend into the marine zone of Western Port (Parks Victoria, 1988).

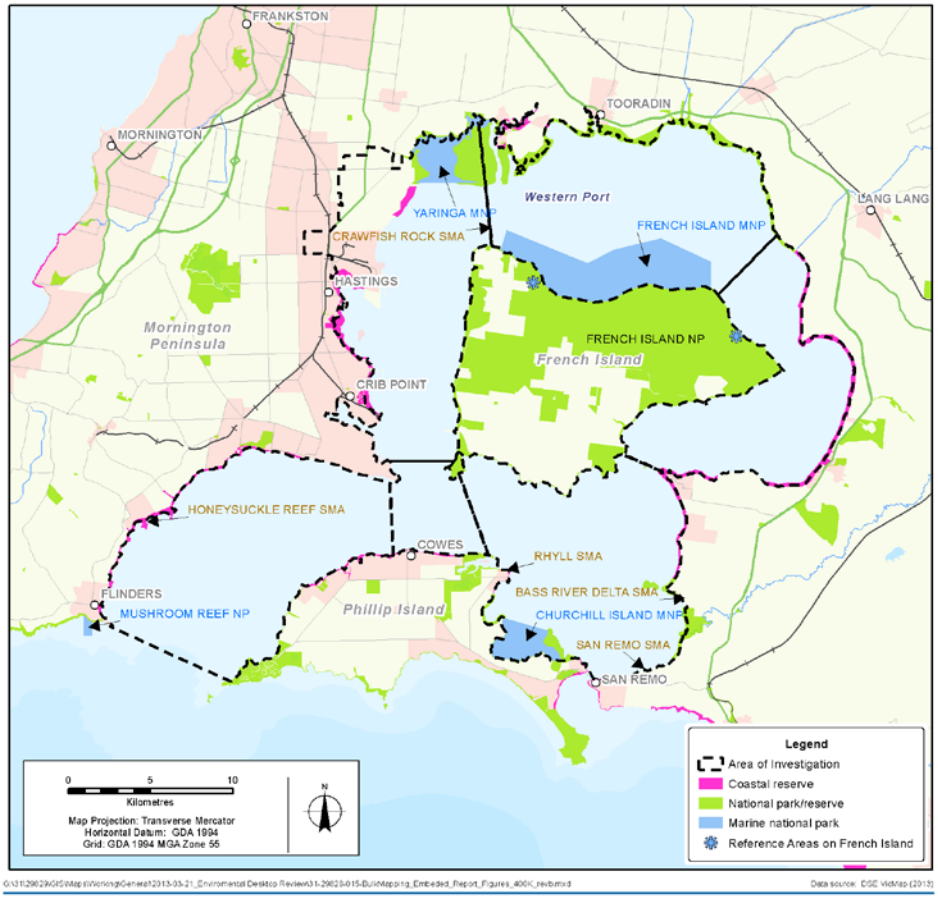

Figure 5 Special Management Areas (SMA) Marine National Parks (MNP), and Reference Areas in Western Port

2.9 Sites of geological and geomorphic significance

Sites of geological and geomorphological significance either represent a specific characteristic of the region or include an outstanding, rare, or unique geological or geomorphological feature. These sites are of interest to researchers, teachers, or those who wish to understand the composition, origin and dynamics of the physical landscape in an area (DEPI, 2013m). Sites have been classified as being of either international, national, state, or regional significance. Although not enforced under legislation, a number of management recommendations have been developed for the preservation of each site (DEPI, 2013m). Seventy-two sites of geological and geomorphic significance are located in and around Western Port (1984-88) (Figure 6), as cited on the Department of Environment and Primary Industries website (DEPI 2013b).

2.9.1 International significance

Two sites of international importance occur in Western Port: Western Port – Tidal Watershed (Site 110) and Pioneer Bay – Quaternary Sequence (Site 115).

Western Port – Tidal Watershed (Site 110) is between Palmer Point on French Island and the Lang Lang River. The site has two principal tidal drainage systems to the north-west and the south-east of French Island. At low tide a broad area of intertidal mudflats and sandflats is exposed. The surface has been incised by a network of tidal channels known as the tidal divide, or tidal watershed. The tidal divide system was listed due to its size and complexity. The seafloor sediments are of interest because they hold a history of the late Quaternary sea level changes at the northern end of Western Port (DEPI, 2013c).

Pioneer Bay- Quaternary sequence (Site 115) at Lang Lang contains a sequence of freshwater, marine and intertidal sediments of the late Quaternary. Freshwater peats, organic muds, salt marsh clays and some sand and shells are exposed as low cliffs or can be recovered by shallow coring. This is the best documented and dated site in the Western Port region to contribute to an understanding of late Quaternary sea level changes. It therefore constitutes a site of international significance as part of the growing network of such localities on the Australian coast (DEPI, 2013d).

2.9.2 National significance

There are three sites of national geomorphic significance in Western Port Bay: Lyall Inlet (Site 89) to Bunyip River, Yallock Creek (Site 91) swamp sediments and Bass River Delta and Floodplain (Site 142) (Figure 6).

Lyall Inlet (Site 89) is in Tooradin and extends inland to the South Gippsland Highway. The site is a coastal area of intertidal flats, sand beaches, chenier ridges, and mangrove and saltmarsh zones crossed by a network of active and abandoned tidal creeks. The area is of national significance because it displays the impact of the drainage of the Koo Wee Rup Swamp upon the coast. It also contains a low cliff which is an important feature in determining Holocene sea level changes in Western Port (DEPI, 2013a).

Yallock Creek – Swamp Sediments (Site 91), is in Tooradin. The lower course of the Yallock Creek was one of the few defined drainage channels existing prior to the drainage of the Koo Wee Rup Swamp. The site includes one of the few remnants of the swamp areas that existed to the north-east of Western Port (DEPI, 2013b).

Bass River – Delta and Floodplain (Site 142), is at Corinella. The site includes the floodplain, delta and intertidal sandy zone of the Bass River. The embaymemt between Kennedy Point and San Remo peninsula contains a complex of Quaternary sediments. These sediments represent a sequence of valley formation in infilling by the Bass River and marine incursions in the Late Pleistocene and Holocene. The site is of national significance because it includes one of the largest natural sediment influx into Western Port and is reconigised for importance in quaternary sedimentological and geomorphological sites (DEPI, 2013e).

2.9.3 State significance

Thirty-two sites of state significance are scattered across Western Port, including on Phillip Island and French Island. Two sites (Sandstone Island- Silurian outcrop (Site 48) and Jacks Beach- Silurian and Tertiary outcrops (Site 49)) are just south of Hastings and one site (Yaringa Mangrove Sedimentation (Site 47)) is just north of Tyabb (Figure 6). More information on the listing of these sites can be found at (DEPI, 2013m).

2.9.4 Regional significance

There are 35 sites of regional geological and geomorphic significance along the coast of Western Port. Two of these lie in the channel north-west of French Island (Crawfish Rock Site 222) and Barrallier Island (Site 221) (Figure 6). More information on the listing of these sites can be found at (DEPI, 2013m).

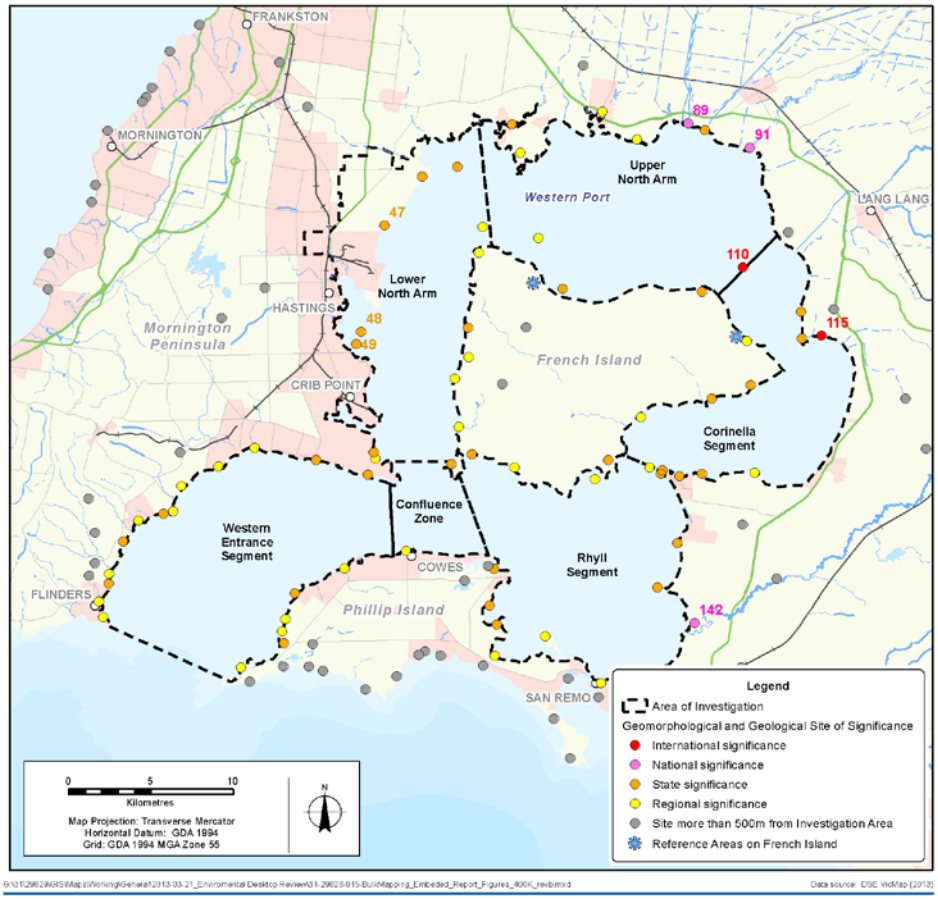

Figure 6 Sites of International, National, State and regional Geological and Geomorphological Importance in Western Port

2.10 BioSites and Biosphere Reserve

2.10.1 BioSites

BioSites are sites of conservation significance identified by DEPI (DSE, 2004). Whilst BioSites are not protected under legislation, they often contain attributes protected under international, federal, state or regional legislation. Significant attributes of a BioSite can include: rare and threatened flora and fauna, Ecological Vegetation Classes (EVCs), areas of high ecological integrity and viability, high species richness and diversity, and wildlife corridors. Information about sites of significance is obtained from a range of sources such as local government authorities and community groups. Sites are deemed of national, state or regional significance. BioSites have not been comprehensively mapped across the entire state, and the absence of a BioSite in an area does not necessarily correlate to an absence of ecological values.

BioSites have been designated at a large number of locations in Western Port and cover around 40 per cent of the coast (Figure 7). Most of the coast from the north-eastern section of the bay at Quail Island to Jerrup/Stockyard Point in the west, and most of the coast from Point Leo in south east of Western Port along the coast towards Port Phillip is designated as a BioSite (Figure 7). There are five BioSites surrounding French Island, and three to the north or east of the island. There are also Biosites scattered over terrestrial and mudflat areas throughout the Western Port.

2.10.2 Biosphere Reserve

Biosphere Reserves are part of an international network of reserves protected under a United Nations Educational, Scientific and Cultural Organisation (UNESCO) initiative. Biosphere reserves are areas considered to be significant on an international scale due to their unique landforms, flora, fauna and community importance. A biosphere reserve includes one or more protected areas and surrounding lands that are managed to combine both conservation and sustainable use of natural resources (MPWPBRF, 2013). The designation does not infer legislative protection of the area.

The Mornington Peninsula and Western Port Biosphere reserve covers approximately 2100 square kilometres including the Mornington Peninsula, Western Port and the southern part of the Western Port water catchment (MPWPBRF, 2013). The biosphere reserve was declared by UNESCO in 2002 following nomination by the community and state and local governments. Western Port was chosen as a biosphere reserve because it has outstanding natural values including a Ramsar wetland of international importance, diversity of habitat types (deep channels, seagrass meadows, mudflats, mangroves, saltmarsh communities etc), habitat for threatened species, located on the fringe of the expanding city of Melbourne (MPWPBRF, 2013).

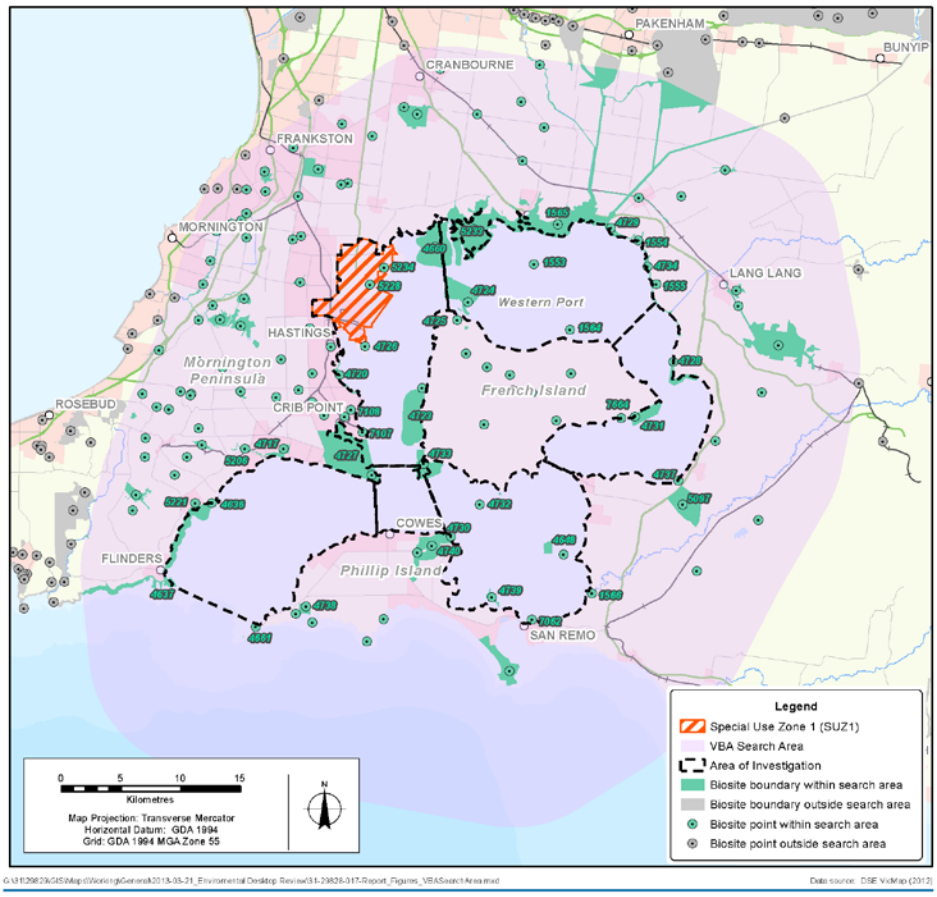

Figure 7 Biosites in the Western Port Region

2.11 Commercial and recreational activity

2.11.1 Commercial and recreational fishing

Western Port supported a commercial net fishing industry for over 100 years, until the practice was banned in 2007. Commercial catch declined between 1970 and 1984 from 260 tonnes to 150 tonnes, with a further decline to 100 tonnes per year in 1990 (Chidgey *et al*. 1995). These declines were reviewed in 1995 (Chidgey *et al.,* 1995) with conclusions made declines in commercial catch sizes to declines in seagrass habitat. Figure 8 shows the steady decline in commercial catch data (tonnes per annum.) for Western Port from 1978 to 2007 due depleting stocks of commercially available fish. After 2007, the decline is most likely attributed to the ban on commercial net fishing (hence a decline in catch data) rather than stocks crashing.

Recreational fishing continues to be an important industry with large economic value throughout the bay (Jenkins, 2011). Over the past 30 years recreational fishing pressure throughout Australia including Western Port has increased. Recreational fishing is common along the lower North Arm of the bay, with access facilities present at Hastings and Stony Point (Chidgey *et al.*, 2009).

Table 3 presents fish species of commercial and recreational significance in Western Port.

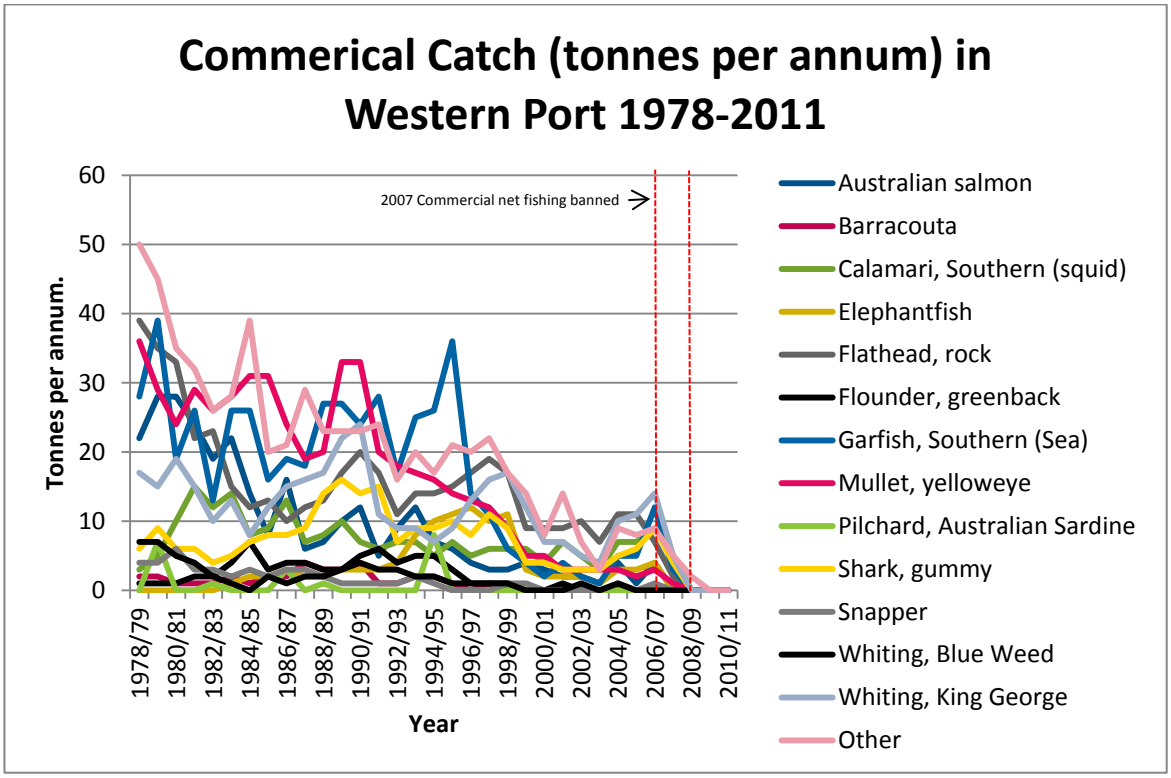

Figure 8 Department of Primary Industries commercial catch data for Western Port (Department of Primary Industries, 2012)

Table 3 Fish species of Recreational and Commercial Significance

Common Name	Scientific Name
King George Whiting	*Silliaginoides punctatus*
Snapper	*Chrysophrys auratus*
Australian Salmon	*Arripis sp.*
Rock Flathead	*Platycephalus laevigatus*
Gummy Shark	*Mustelus antarcticus*
Elephant Fish	*Callorhynchus milii*
Pilchard	*Sardinops neopilchardus*
Australian Anchovy	*Engraulis australis*
Southern Sea Garfish	*Hyporhamus melanochir*
Sand Flathead	*Platycephalus bassiensis*
Tailor	*Pomatomus saltator*
Silver Trevally	*Pseudocaranx dentex*
Jack Mackeral	*Trachurus declivis*
Yellow Eyed Mullet	*Aldrichetta forsteri*
Blue Rock Whiting	*Haletta semifasciata*
Barracouta	*Thyrsites atun*
Greenback Flounder	*Rhombosolea taparina*
Long Snouted Flounder	*Ammotretis rostratus*
Leatherjackets	*Meuschenia* sp

(Jenkins, 2011; Chidgey *et al.,* 2009).

2.11.2 Aquaculture

The Flinders Aquaculture Fisheries Reserve (FAFR) was declared a fisheries reserve under the *Fisheries Act* in 2003. The FAFR is 440 hectares in size and comprises a 350 hectare harvesting area and 90 hectare greenfield extension. The reserve is approximately 300 metres offshore from Flinders, extending from just north of Flinders to just south of Shoreham, and is the location of all offshore marine aquaculture in Western Port (DPI, 2005).

The predominant activity is long-line farming of blue mussels (*Mytilus edulis*), with some abalone activities. Most of the mussel harvesting is for human consumption, with a few licences for bait (DPI, 2005).

3. Water and sediment quality

3.1 Water quality

In Western Port water quality is influenced by factors including catchment and marine inputs, currents, rainfall, and Bass Strait and to a lesser extent Port Phillip Bay water quality, and sediment suspension and re-suspension. Water quality influences the growth and condition of flora and fauna that inhabit the bay (EPA Victoria, 2011).

Due to the relative size and depth of the western entrance there is a variable tidal exchange in Western Port. Water-residence times are 2-3 days in the southern section and up to three months in the northern section (Longmore, 1997).

The total area of the catchment is 3,433 square kilometres which is drained by 2,232 kilometres of waterways (Lee, 2011). Rivers and creeks include the Bass and Lang Lang rivers, and the Bunyip, Cardinia and Yallock creeks as well as a number of minor waterways, capture runoff from urban areas, rural land (including small properties, horticulture and broad acre farming) and areas of remnant vegetation (Lee, 2011) (Figure 9).

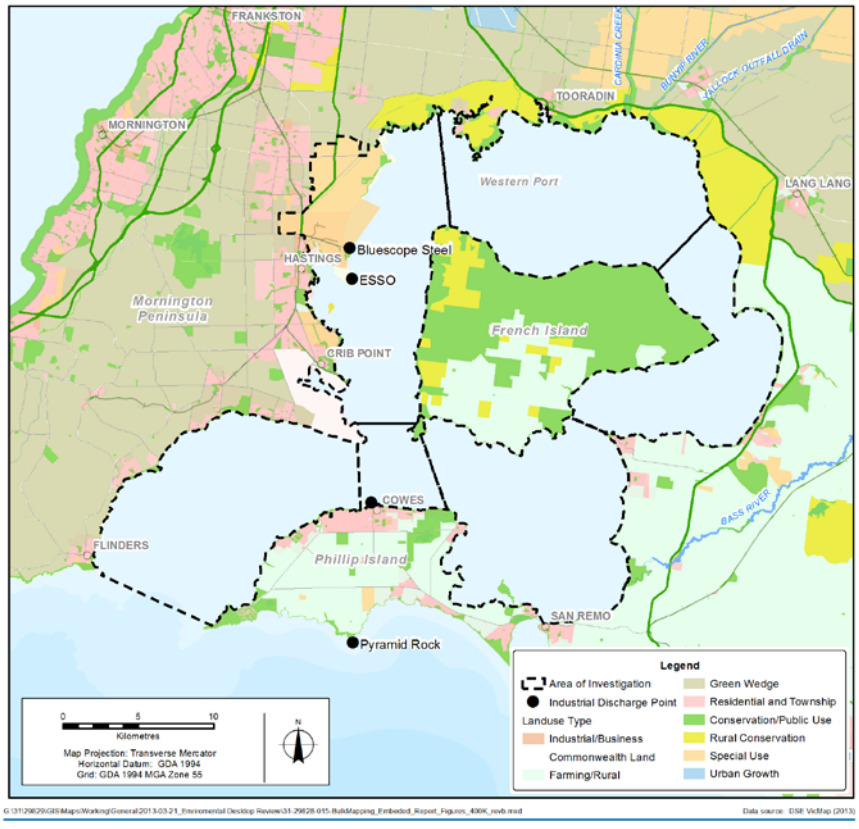

Figure 9 Land use in and around Western Port including industrial and domestic discharges

3.1.1 Previous studies of Western Port

A number of investigations into the water quality of Western Port have been undertaken by Shapiro (1975), Plummer (1974), and Lee (2011). The *Westernport Bay Environmental Study* is the most spatially extensive study ever undertaken in Western Port (Shapiro, 1975). It examined nutrients and contaminants contained in water, sediment and/or with biota of Western Port. The quality of marine waters was measured by parameters including nutrients, total suspended solids, pH (as a measure of acidity or alkalinity), temperature, contaminants such as metals or organic compounds, chlorophyll-a (as a measure of the level of phytoplankton biomass) and bacteriological indicators.

Since 1984, the Victorian Environment Protection Authority (EPA) has conducted an ongoing water quality monitoring program at Hastings, Barrallier Island and Corinella. The program measures water quality parameters including nutrients, heavy metals and physicochemical parameters such as salinity and pH (EPA Victoria, 2011). Reviews of data collected occur every five to ten years. The latest report, (EPA 2011) concluded that water quality was good throughout Western Port, but that it was characterised by intra-annual variability and shown to react quickly to wet weather and tidal variations such as catchment inflows causing sediment re-suspension and transport.

3.1.2 Metals, nutrients, clarity and suspended solids

Increasing loads of nutrients (phosphorus and nitrogen) and suspended solids from the surrounding catchments are identified as the major threats to the health of ecosystems supported in Western Port (EPA Victoria, 2011; Keough and Bathgate, 2011).

To summarise the findings of EPA (2011): Corinella had consistently elevated concentrations of Total Suspended Solids (TSS), nutrients, and heavy metals (particularly zinc), while Hastings has high levels of mercury, exceeding environmental quality targets. However, because the levels of dissolved metals were below national water quality guidelines (ANZECC 2000), and it is the dissolved fraction that is most bioavailable and therefore most likely to harm ecosystems, EPA concluded that there was unlikely to be a significant risk to the environment (EPA Victoria, 2011). The other sites generally met their targets, although dissolved oxygen exceeded the target during at least one sampling period.

It is most likely that differences between sites are due to the variable degrees of flushing in different parts of the bay. The Hastings and Barrallier Island sites are well flushed, whereas the Corinella site is more likely to experience sediment re-suspension, which could remobilise nutrients and toxicants attached to sediments.

Water clarity in the bay is assessed visually using light penetration and Secchi discs. The amount of light penetration in the water column can impact on primary productivity (EPA Victoria, 2011) and affect growth and survival rates of flora species, particularly seagrass. Data indicates that light penetration is high at the entrances to the bay and in the North Arm, although the upper North Arm does have higher suspended sediment levels than those found at the entrance (EPA Victoria, 2001). Light penetration is poor in the Eastern Arm (EPA Victoria, 2011). It is likely that much of the sediment re-suspended in the bay is derived from mudflats and marine beds, but studies have indicated that some sediment in the East Arm is likely to have been derived from catchment inputs after the Koo Wee Rup Swamp was drained (EPA Victoria, 2001).

3.1.3 Biomass (plant matter)

The pigment Chlorophyll is an indicator of the biomass of plant matter in the water column (EPA Victoria, 2001, 2011). EPA Victoria (2011) assessed the relative composition and abundance of the phytoplankton pigments in samples from the three Western Port sites. No differences were found in abundance of phytoplankton pigments, but phytoplankton communities at the Hastings and Barrallier Island sites differed from those the Corinella site (higher proportion of blue-green algae at Corinella).

EPA (2011) did not identify any long-term trends in chlorophyll levels, but observed a positive correlation between chlorophyll levels and suspended solid concentrations. Typically, these parameters have a negative correlation – high suspended solid loads tend to result in reduced light penetration and reduced plant growth. These results are thought to indicate that high suspended solid levels have resulted in high amounts of sediment-bound nutrients available for plankton growth (EPA Victoria, 2011).

3.1.4 Wastewater and Industrial discharge

There are two EPA licensed discharges into Western Port: Esso's Long Island Point which discharges treated waste water from the Bass Strait oil and gas production line; and BlueScope Steel's Western Port steel manufacturing facility, which discharges treated waste water from its steel manufacturing plant (BlueScope Steel, 2013; Exxon Mobil, 2013). A third discharge point, a sewage outfall pipe, is located just outside Western Point at Pyramid Rock, Phillip Island (EPA Victoria, 2012).

Ships visiting Western Port are required to meet the ballast water requirements of the *Victorian Environment Protection Ships' Ballast Water Regulations 2006* and the Environment Protection Authority's *Waste Management Policy (Ships' Ballast Water), July 2004.* The Port of Hastings has been an innovator in ballast water managment in Australia. The Port and the EPA undertook the Hastings National Demonstration Project in 2001/2002 to trial the intergrated management of international and domestic ballast water at the one port. The management system has been widely adopted as a result of the success of this project.

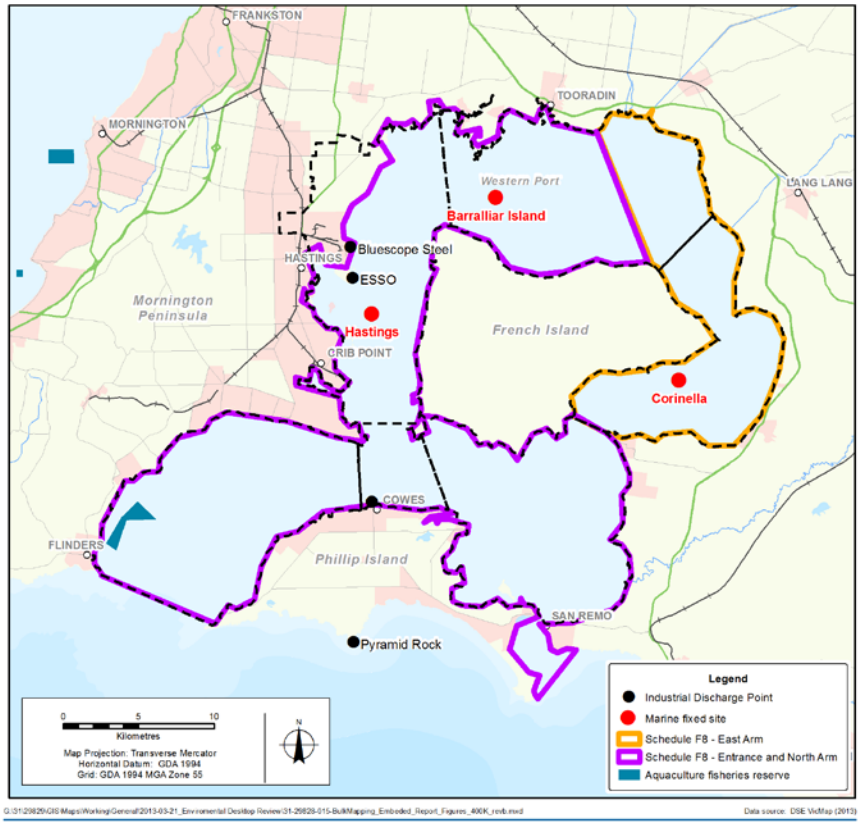

Figure 10 EPA sampling sites, wastewater discharges and segments for the *State Environment Protection Policy* (Waters of Victoria) Schedule F8 Western Port

3.2 Sediments

Soft sediments dominate Western Port, covering up to two-thirds of the bay (Wilson *et al.*, 2011). Sediments influence the growth and condition of flora and fauna inhabiting Western Port (EPA Victoria, 2011). They provide a substrate particularly for seagrass and mangroves (Bird, 1986) which create habitats for small fish and invertebrates and a substrate for algae (Chidgey *et al.*, 2009). Sediments are influenced by factors including catchment and marine inputs, currents, rainfall, Bass Strait and Port Phillip Bay (to a lesser extent) water quality, and sediment suspension and re-suspension.

Increasing loads of nutrients (phosphorus and nitrogen) and suspended solids from the surrounding catchments are identified as the major threats to the health of the ecosystems supported in Western Port (EPA Victoria, 2011; Keough and Bathgate 2011).

3.2.1 Sediment sources

The major sources of sediment input to Western Port are stream bank erosion, catchment erosion and coastal erosion (Sargeant, 1977; Hughes *et al*., 2003). Subsoil erosion of channels and gullies, accounts for approximately 80 per cent of all sediment eroded from the Western Port catchment (Hughes *et al.,* 2003).

Large-scale dredging projects during the 1960s and 1970s have also contributed to sediment loads (EPA 1996).

Terrestrial erosion in the catchment has increased since European settlement, as a result of land clearing, urban development (resulting in increased runoff), agricultural activity (soil disturbance), and alterations to the natural drainage system, particularly through draining of Koo Wee Rup Swamp (Wallbrink *et al.,* 2003, Lee 2011). Hughes *et al.* (2003) found that the Bunyip and Lang Lang rivers are the major sources of catchment inputs of fine sediments into Western Port, along with Cardinia Creek and the clay banks to the north-east of the Lang Lang River (Figure 11)). Modelling by Hughes *et al*., (2003) predicts that annual sediment supply to the coastal area of Western Port is approximately 96,000 tonnes per year. This accounts for 60 per cent of all sediment delivered to streams of Westernport (Hughes et al. 2003). These estimates are coarse and need to be re-evaluated for an accurate sediment budget for Western Port to be developed (Keough and Bathgate, 2011).

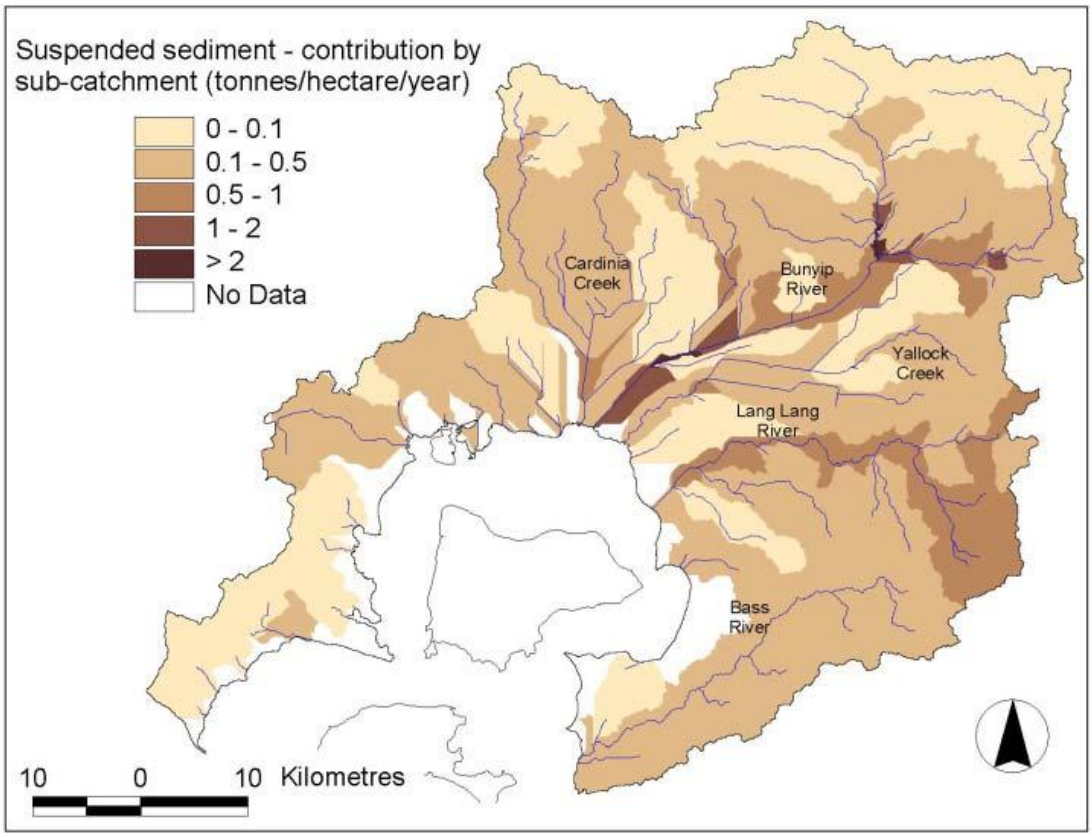

Figure 11 Suspended sediment contributions to Western Port as calculated by SedNet (Source: Hughes *et al.*, 2003)

3.2.2 Sediment movements – suspension and re-suspension

The distribution and types of sediments in Western Port have been extensively mapped (Hancock *et al.,* 2001). Studies in the 1970s found sands mostly dominate substrates west and north of French Island (Marsden and Mallet, 1974; Harris *et al.*, 1979; and Marsden *et al.*, 1979). Areas of mud were noted in intertidal zones in the north-east of the Upper North Arm and Corinella and Rhyll Segments.

Sediments are continually transported in the bay through re-suspension and deposition. These processes are largely influenced by bay bathymetry, tidal currents, zones of sediment input and the presence of vegetation (Wallbrink *et al.,* 2003). Generally finer grain materials tend to settle in areas of low energy. Figure 12 illustrates the sources and direction of sediment movement in Western Port.

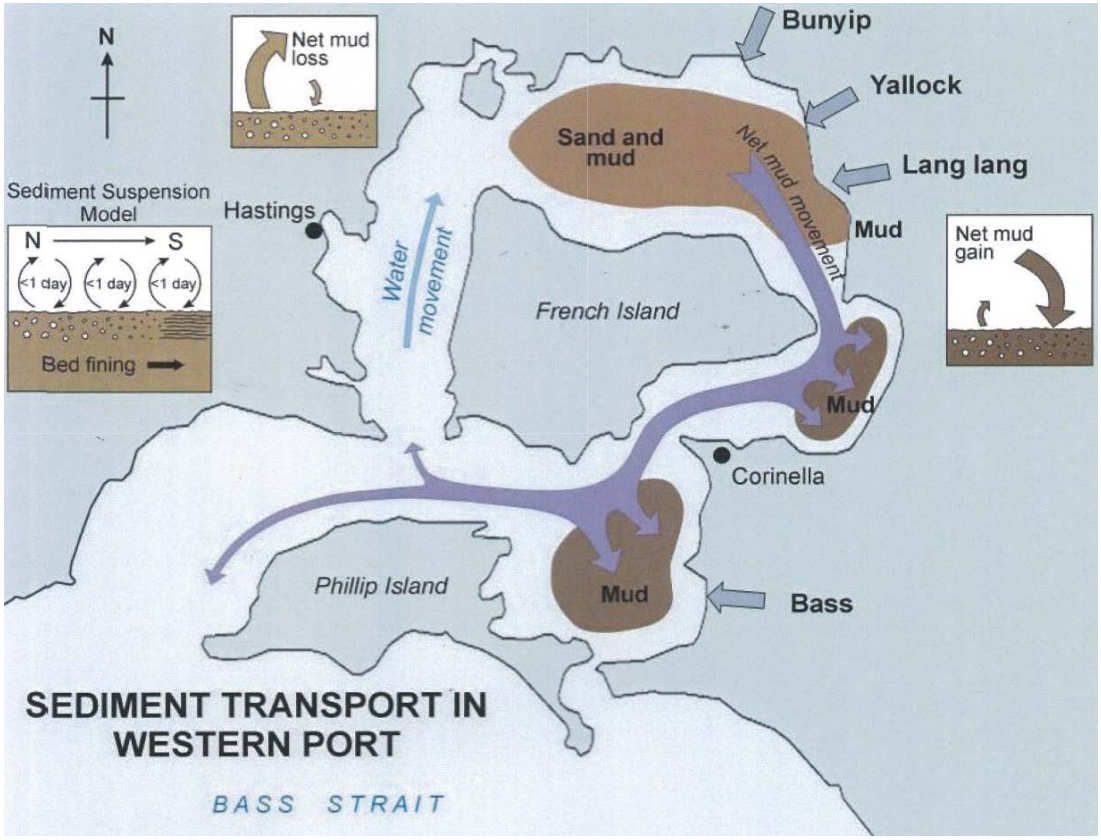

Figure 12 Sediment Transport in Western Port

(Source: Hancock *et al*., 2001)

3.2.3 Sediment quality

The most extensive sediment sampling program in Western Port was conducted as part of the *Westernport Bay Environmental Study* (Shapiro, 1975). In that study, preliminary work investigating concentrations of heavy metals, PCBs, hydrocarbons and pesticides in sediments found that concentrations of some heavy metals in sediments were higher than expected, in particular zinc, and suggested further research be conducted. Measured mercury levels in sediments were low (2-25 ng/g), but higher concentrations at the mouth of Cardinia Creek suggested that this was a source of mercury into the bay's sediments.

Organochlorine pesticides were all but absent, detected in only one of the 38 samples taken. Increased concentrations of Dieldrin were detected at the Hastings sampling site. Inputs of pesticides to Western Port were concluded to be negligible or effectively removed through metabolic processes after entering the bay.

A review of EPA sediment data collected from 1988 to 1994 at three sites in Western Port as part of the marine fixed site monitoring network identified limited sediment contamination. Sediment samples were analysed for metals in the <63 µm fraction. Only three values over the six year period (one each of cadmium, mercury and arsenic) were possibly above the interim sediment quality guidelines. However, interim sediment quality criteria under the National Assessment Guidelines For Dredging (2009) uses whole of sediment and those samples collected by EPA are the <63µm fraction and are unlikely to be above the lower guideline when sampled as whole of sediment due to level within the greater volume of sediment.

4. Ecological values – terrestrial zone

The review of terrestrial ecological values is limited to the area defined by the SUZ1 and other small pockets of land in the vicinity of Hastings (Figure 13). The search area used for the VBA and PMST databases is described in Section 1.6.

The land in the SUZ1 is predominantly cleared agricultural and industrial land with patches of remnant native vegetation and low density residential areas in the township of Hastings. Agricultural land use around the SUZ1 includes grazing, vegetable growing and poultry raising (Stewart, 2010).

As part of the Port of Hastings Development Stage 1, a terrestrial flora and fauna survey (Venosta *et al.* 2009) and a threatened flora and fauna survey (Venosta *et al*., 2011) were completed for a small part of the potential area of impact (Figure 13). Venosta *et al.* (2009) has been used as a main source document for information provided in this report, coupled with additional desktop information as available. For the remainder of the SUZ1, desktop searches only have been undertaken. The extent and condition of terrestrial vegetation and fauna habitat beyond the area covered by Venosta *et al.* (2009; 2011) represents a significant knowledge gap.

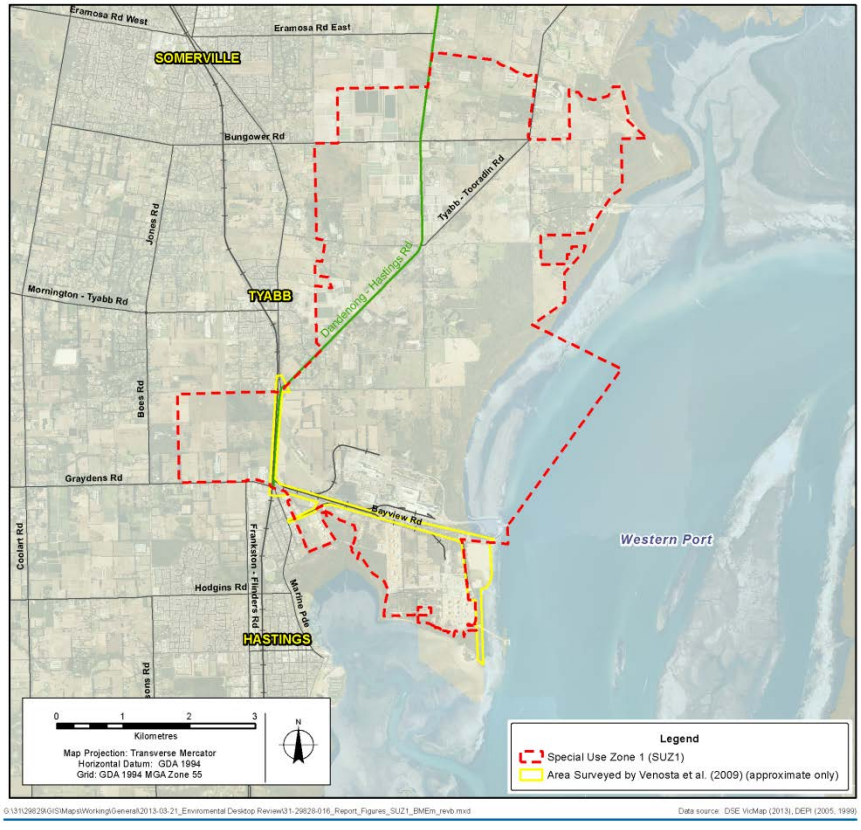

Figure 13 Special Use Zone 1

4.1 Terrestrial communities and species

4.1.1 Vegetation communities

Vegetation in Victoria is classified based on Ecological Vegetation Class (EVC) and Bioregion.

- Bioregions reflect natural boundaries between biodiversity assets and underlying environmental features such geology, soil profiles, average rainfall, and average temperature (DEPI, 2013i).
- An EVC describes the vegetation communities present within a bioregion such as grasslands, grassy woodlands, and heathlands. EVCs are grouped by characteristics such as floristic structure, species assemblages, disturbance regimes, topographic position (e.g. floodplain, escarpment, estuarine), and soil types.
- The Bioregional Conservation Status (BCS) is the conservation status of an EVC, which is assessed at a bioregional level. It takes into account the modelled pre-European settlement (pre-1750) distribution of the EVC within the bioregion, the current level of depletion and the level of degradation typical of remaining stands (DEPI, 2013i).

SUZ1 is located within the Gippsland Plain Bioregion. This bioregion is characterised by flat low lying coastal and alluvial plains with a gently undulating terrain dominated by barrier dunes and floodplains and swampy flats. The soils associated with the upper terrain are texture contrast soils (Dermosols and Chromosols), which support Lowland Forest EVC. The dunes are predominantly sandy soils (Podosols and Tenosols) supporting Heathy Woodland and Damp Sands Herb-rich Woodland EVC. The fertile floodplains and swamps are earths and pale yellow and grey texture contrast soils (Hydrosols) supporting Swamp Scrub, Plains Grassy Woodland, Plains Grassy Forest, Plains Grassland and Gippsland Plains Grassy Woodland/Gilgai Wetland Mosaic EVCs (DEPI, 2013i). Remnant native vegetation within SUZ1 has been mapped at a scale of 1:25,000 (VBA (DEPI, 2012)). Mapping of remnant EVCs indicates that seven EVCs occur in SUZ1[2] (Figure 14). The seaward side of SUZ1 comprises an almost continuous band of Mangrove Shrubland (EVC 140), backed by an almost continuous band of Coastal Saltmarsh (EVC 9). Behind this there are large patches (50-200 hectares) of Heathy Woodland (EVC 48). Embedded in one patch on the Bluescope Steel site are two small (*c.* 4 and 6 hectares) areas of Damp Heathland (EVC 710). There are several patches of Swamp Scrub (EVC 53) and Grassy Woodland (EVC 175) between 0.1 and 50 hectares across the whole SUZ1. Many small patches of Damp Sands Herb-rich Woodland (EVC 3) are mapped, particularly in the south. Larger patches of this EVC are also mapped, although they tend to be irregular and have a long boundary (Figure 14). An eighth EVC, Seagrass Meadow (EVC 845), and has a high likelihood of occurring in the study area. This EVC aligns with Seagrass / Algae distribution in the shallow intertidal zone of (Figure 14).

The extent of these EVCs and their conservation status in the Gippsland Plain Bioregion is provided in Table 4.

[2] There are limitations to the DSE mapping and it is therefore possible that EVCs other than those listed could occur close to the study site.

Table 4 EVCs which are mapped as occurring in the Special Use Zone

EVC Number	EVC Name	Bioregional Conservation Status	Area (ha)	
			Western Port (within a 10 km radius of Western Port)	Special Use Zone
3	Damp Sands Herb-rich Woodland	Vulnerable	1910	190
9	Coastal Saltmarsh	Least Concern	2685	60
48	Heathy Woodland	Least Concern	6855	360
53	Swamp Scrub	Endangered	5265	135
140	Mangrove Shrubland	Least Concern	2125	40
175	Grassy Woodland	Endangered	5300	110.
710	Damp Heathland	Rare	27	10
845	Seagrass Meadow	Depleted[3]	15253	213

The five terrestrial EVCs are covered in this section:

- Damp Heathland (EVC 710);
- Damp Sands Herb-rich Woodland (EVC 3);
- Heathy Woodland (EVC 48);
- Swamp Scrub (EVC 53); and
- Grassy Woodland (EVC 175).

The two intertidal Coastal Saltmarsh (EVC 9), and Mangrove Shrubland (EVC 140); and one marine Seagrass Meadow (EVC 845) are discussed in (Section 5) and (Section 6.2).

The EVC descriptions below are taken from Oates and Taranto (2001).

[3] Bioregional Conservation Significance has not been assigned by DEPI for Seagrass Meadow (EVC 845). . Seagrass distribution in Western Port declined by approximately 25% in the 1970s. The Bioregional conservation status of depleted 'greater than 50% pre-European extent remains and moderately degraded over a majority of this area' has been assigned in recognition of this decline.

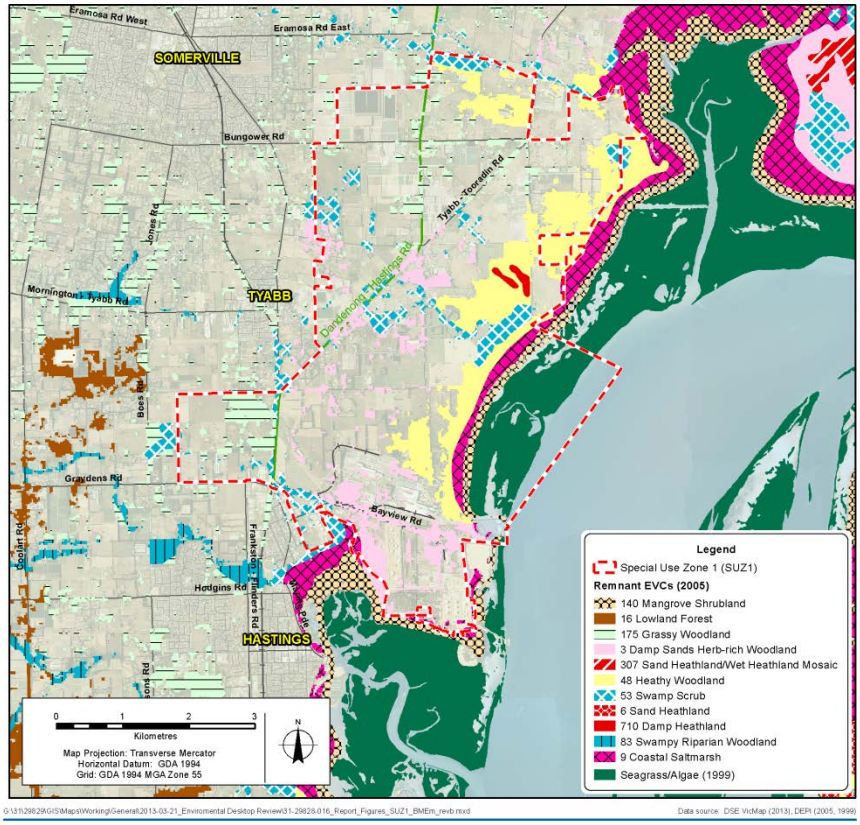

Figure 14 Remnant Ecological Vegetation Classes of SUZ1

EVC 3: Damp Sands Herb-rich Woodland (Vulnerable)

Damp Sands Herb-rich Woodland (EVC 3) occurs mainly on flat or undulating areas extending inland from the coast on moderately fetile, relatively well-drained, black to grey sand, or sandy loam. It typically consists of a woodland with a grassy or bracken-dominated understorey and a ground layer rich in herbs, grasses, and orchids. A component of heathy shrubs may also be present.

Key species typically include *Eucalyptus viminalis* subsp. *pryoriana* (Coast Manna Gum), *Eucalyptus radiata* (Narrow-leaf Peppermint) and occasionally *Eucalyptus obliqua* (Messmate) in the canopy. *Acacia mearnsii* (Black Wattle) and *Banksia integrifolia* var. *integrifolia* (Coast Banksia) with a shrub layer which might include *Banksia marginata* (Silver Banksia), and *Leptospermum laevigatum* (Coast Tea-tree), *Epacris impressa* (Common Heath), *Acrotriche serrulata* (Honey-pots). A number of forbs, graminoids and climbers are also associated with this EVC.

The EVC mapping (DSE, 2012) indicates there were several smaller patches of this vegetation type in the SUZ1 and some larger ones on the Esso site.

EVC 48: Heathy Woodland (Least Concern)

Heathy Woodland (EVC 48) occurs on low hills and rises, plains and slopes in areas of low to moderate rainfall, generally associated with deep, uniform-textured nutrient-poor sands. It is described as a eucalypt-dominated low woodland over narrow-leaved shrubs except where frequent fire has reduced the understorey structure to a dense cover of bracken (*Pteridium esculentum*). The overstorey typically consists of low scattered trees of *Eucalyptus obliqua* (Messmate), *Eucalyptus radiata* (Narrow-leaf peppermint), *Eucalyptus willisii* (Shining Peppermint) and *Eucalyptus viminalis* subsp. *pryoriana* (Coast Manna Gum). The heathy understorey is characterised by small, prickly leaved shrubs of the Myrtaceae, Epacridaceae, Dilleniaceae Fabaceae and Mimosaceae families. The EVC mapping (DSE, 2012) indicates this is one of the more abundant vegetation types in the SUZ1 with a band extending behind the Coastal Saltmarsh.

EVC 53: Swamp Scrub (Endangered)

Swamp Scrub (EVC 53) is a closed scrub at low elevations on alluvial deposits along streams or on poorly drained sites with higher nutrient availability. The vegetation characteristically lacks a eucalypt overstorey and is dominated by *Melaleuca ericifolia* (Swamp Paperbark) or sometimes Woolly Tea-tree (*Leptospermum lanigerum*) which often forms a dense thicket out-competing other species. Where light penetrates to ground level, a moss / lichen / liverwort or herbaceous ground cover is often present. Dry variants have a grassy / herbaceous ground layer. The EVC mapping (DSE, 2012) indicates that there were several patches between 0.1 and 50 hectares of this vegetation type in the SUZ1, these patches link with patches outside of SUZ1.

EVC 175: Grassy Woodland (Endangered)

Grassy Woodland (EVC 175) is described as a variable open eucalypt (or occasionally Sheoak) woodland over a diverse ground layer of grasses and herbs. The shrub component is usually sparse. It occurs on sites with moderate fertility on plains or undulating hills across a range of geologies. This EVC was previously widespread and locally extensive but now has largely been cleared for agriculture. Remnants are generally heavily grazed or altered by fire regimes.

The EVC mapping (DSE, 2012) indicates there are several patches of this vegetation type in SUZ1, concentrated in two areas towards the west of the study area. Patches in the SUZ1 may provide important habitat linkages to patches outside the northern and southern perimeters of SUZ1.

EVC 710: Damp Heathland (Rare)

A heathland or closed scrub that develops on sites with impeded drainage and typically wet in winter and dry in summer. Florisitically contains components of both Sand Heathland on well-drained substrates and Wet Heathland on poorly drained substrates, but equally nutrient poor.

The EVC mapping (DSE, 2012) indicates there is a small, isolated patch (10 hectares) in the study site. This patch will be especially vulnerable to edge effects.

4.1.2 Fauna habitats

Venosta *et al*., (2009) reported the following terrestrial fauna habitats in their area of investigation:

- Woodland – which corresponds with Grassy Woodland, Swampy Woodland and Damp Sands Herb-rich Woodland EVCs;
- Swamp scrub – which corresponds with Swamp Scrub EVC;
- Freshwater waterbodies (creeks and drains);

- Planted trees and shrubs – which corresponds with Predominantly Introduced Vegetation; and
- Pasture – which corresponds with Predominantly Introduced Vegetation.

The Venosta study also reported saltmarsh, mangrove and mudflat habitats – these are discussed separately in this report (Section 5).

4.1.3 Listed ecological communities

EPBC Act-listed Communities

The Protected Matters Search Tool (PMST) predicts the occurrence of *Seasonal Herbaceous Wetlands (Freshwater) of the Temperate Lowland Plains* (Critically Endangered). This community would most likely occur within depressions of Grassy Woodland (EVC 175).

Given the fragmented and degraded nature of many of the remnant patches of Grassy Woodland (EVC 175) in SUZ1, it is unlikely that any intact remnants of this community are present, although field surveys are required to confirm its presence or absence within SUZ1.

Subtropical and Temperate Coastal Saltmarsh is present in SUZ1; this community is listed as Vulnerable. More information can be found in Section 5.2.1.

FFG Act-listed Communities

No FFG Act listed communities are likely to occur within the terrestrial zone of SUZ1.

4.1.4 Listed species

Table 5 and Table 6 detail flora and fauna species listed under Commonwealth and State legislation thought to have a *high* or *moderate* likelihood of inhabiting terrestrial communities of SUZ1. Listed species include threatened, near threatened, rare and poorly known species. Appendices A and B provide more information.

Threatened Flora

Thirteen threatened, rare or poorly known terrestrial flora species are known (VBA; Venosta *et al.* (2009; 2011)*)* or predicted as likely to occur (PMST) in terrestrial habitats of SUZ1 (Table 5). Five species are listed under the EPBC Act, five under the FFG Act, and all 12 are listed under the DEPI *Advisory List of Rare or Threatened Plants in Victoria* (DSE, 2005) (Appendix A).

Two of the DEPI Advisory listed species were identified by Venosta *et al.* (2009; 2011) in SUZ1:

- *Dianella* sp. aff. *longifolia* (Benambra) (Arching Flax-lily) (vulnerable); and
- *Thelymitra pallidiflora* (Pallid Sun-orchid) (endangered).

Note: *Thelymitra pallidiflora* (Pallid Sun-orchid) was recently de-listed from the FFG Act list.

Threatened Fauna

Twenty-eight threatened or near-threatened fauna species have a moderate or high likelihood of occurring in saltmarsh habitats of Western Port (Table 6). Most are bird species most likely to be associated with coastal or marine environments. Five are more closely linked to, and may only occur in, terrestrial habitats: Southern Brown Bandicoot, Brown Quail, Swamp Skink, Glossy Grass Skink and Southern Toadlet.

Of the 28 species, two - the Southern Brown Bandicoot (*Isoodon obesulus obesulus*) and the Fairy Tern (*Sternula nereis*) – are listed under the EPBC Act. The Southern Brown Bandicoot typically occurs in heathland, shrubland, heathy forest and woodland habitat across southern Victoria. The Fairy Tern inhabits coastal environments including intertidal mudflats, sand flats and beaches, and nests above high-water mark on sandy shell-grit beaches. Targeted searches for the Southern Brown Bandicoot in January 2009 (Venosta *et al.* 2009) found no individuals.

Twelve of the 28 species are listed under the FFG Act. A Pacific Gull (*Larus pacificus*) has been nominated for listing, but is not included on the list (Table 6). The Pacific Gull is considered highly likely to occur in SUZ1. Targeted searches for Swamp Skink in November 2008 and January 2009 (Venosta *et al.* 2009) detected no individuals.

All 28 species are listed under the the *DEPI Advisory List of Threatened Vertebrate Fauna in Victoria* (DEPI 2013).

Migratory species listed under the EPBC Act

Nineteen of the threatened fauna species identified in the VBA and PMST searches for SUZ1 are also listed as Migratory under the EPBC Act (Appendix B). These include woodland birds, shorebirds, waterbirds and birds from a range of ecological guilds.

Of these, the migratory shorebirds and waterbirds are most likely to occur in or near the SUZ1. The migratory shorebirds, Caspian Tern and Little Tern are most likely to occur coastally. The Eastern Great Egret may occur coastally or in freshwater environments inland from the coast. Coastal, intertidal and marine migratory species are considered in later sections of this report (see Sections 5 and 6).

Marine Fauna Species listed under the EPBC Act

The Marine status of fauna under the EPBC Act is relevant only to Commonwealth Marine areas, so is not considered for the terrestrial zone for this project.

Table 5 Threatened flora species considered moderately or highly likely to occur in terrestrial environments of SUZ1

Scientific name	Common name	EPBC Act 1999	FFG Act 1988	DEPI Advisory list	Likelihood of occurrence
Acacia uncifolia	Coast Wirilda			r	M
Caladenia dilatata s.s.	Green-comb Spider-orchid			k	M
Dianella amoena	Matted Flax-lily	E	L	e	M
Dianella sp. aff. *longifolia* (Benambra)	Arching Flax-lily			v	H
Glycine latrobeana	Clover Glycine	V	L	v	M
Prasophyllum frenchii	Maroon Leek-orchid	E	L	e	M
Prasophyllum lindleyanum	Green Leek-orchid		I	v	M
Prasophyllum spicatum	Dense Leek-orchid	V		e	M
Thelymitra pallidiflora	Pallid Sun-orchid		I	e	H
Thelymitra X *irregularis*	Crested Sun-orchid			r	M
Thelymitra X *merraniae*	Merran's Sun-orchid		L	e	M
Xerochrysum palustre	Swamp Everlasting	V	L	v	M
EPBC Act					5
FFG Act					5
DEPI Advisory List					13

Key: k – poorly known, r – rare, v – vulnerable, e - endangered; M – moderate likelihood of occurrence; H – high likelihood of occurrence; x – considered for that habitat.

Table 6 Threatened fauna species considered moderately or highly likely to occur in the terrestrial ecological area (SUZ1)

Key: cr – critically endangered; EN/en – endangered; VU/vu – vulnerable; L – listed as threatened; I – nominated for listing; nt – near threatened; M – moderate likelihood of occurrence; H – high likelihood of occurrence.

Scientific name	Common name	EPBC Act 1999	FFG Act 1988	DEPI Advisory list	Likelihood of occurrence :
Mammals					
Isoodon obesulus obesulus	Southern Brown Bandicoot	EN	L	nt	M
Birds					
Actitis hypoleucos	Common Sandpiper			vu	H
Ardea modesta	Eastern Great Egret		L	vu	H
Calidris canutus	Red Knot			nt	H
Calidris tenuirostris	Great Knot		L	en	H
Coturnix ypsilophora	Brown Quail			nt	H
Egretta garzetta	Little Egret		L	en	H
Gallinago hardwickii	Latham's Snipe			nt	H
Haematopus fuliginosus	Sooty Oystercatcher			nt	H
Haliaeetus leucogaster	White-bellied Sea-Eagle		L	vu	H
Hydroprogne caspia	Caspian Tern		L	nt	H
Larus pacificus	Pacific Gull		I	nt	H
Numenius madagascariensis	Eastern Curlew			nt	H
Numenius phaeopus	Whimbrel			vu	H
Nycticorax caledonicus hillii	Nankeen Night Heron			nt	H
Phalacrocorax varius	Pied Cormorant			nt	H
Platalea regia	Royal Spoonbill			vu	H
Pluvialis fulva	Pacific Golden Plover			nt	H
Pluvialis squatarola	Grey Plover			nt	H
Sternula albifrons	Little Tern		L	vu	H
Sternula nereis	Fairy Tern	VU	L	en	H
Tringa brevipes	Grey-tailed Tattler		L	cr	H
Tringa glareola	Wood Sandpiper			vu	H
Xenus cinereus	Terek Sandpiper		L	en	H
Reptiles					
Lissolepis coventryi	Swamp Skink		L	vu	H
Pseudemoia rawlinsoni	Glossy Grass Skink			en	M
Frogs					
Pseudophryne semimarmorata	Southern Toadlet			vu	M

Scientific name	Common name	EPBC Act 1999	FFG Act 1988	DEPI Advisory list	Likelihood of occurrence :
Fishes					
Mugilogobius platynotus	Pale Mangrove Goby		L	vu	H
EPBC					2
FFG					12
DEPI Advisory list					28

5. Ecological values – coastal saltmarshes, mangroves and mudflats

Coastal saltmarsh, mangroves and mudflats are examples of intertidal wetland communities commonly occurring throughout Western Port. These habitats are often found close to each other. Mudflats occupy the intertidal zone, mangroves are found on the seaward coastal edge of the intertidal zone and saltmarsh occupies the landward edge (Pocklington *et al.,* 2012).

Mangroves, saltmarshes and mudflats contribute to a range of ecosystem functions including primary productivity, natural water filtering and stabilising coastal land and sediments (Pocklington *et al.,* 2012). Many species use all three habitats interchangeably (Pocklington *et al.,* 2012).

This section includes:

- A general description of each of the three habitats;
- Description of state and Commonwealth listed threatened ecological communities; and
- Description of state and Commonwealth listed threatened species that may occur in each of the habitats.

The discussion of bioregional conservation status of habitats, communities and species is presented in accordance with the following hierarchy

- The Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*, (EPBC);
- The *Victorian Flora and Fauna Guarantee Act 1988* (FFG); and
- Department of Environment and Primary Industries Advisory List of Rare or Threatened Plants, Invertebrate Fauna and Vertebrate Fauna (DSE, 2005; 2009; DEPI 2013g).

5.1 Overview of habitats

5.1.1 Coastal Saltmarsh

Coastal Saltmarsh Aggregate (EVC 9) forms part of the intertidal wetland communities which occur on areas of mudflat that are periodically inundated by very high tides in low energy environments (Boon *et al*., 2011). This vegetation type is characterised by low growing vascular plants usually less than 1.5 m in height (Boon *et al*., 2011). It is typically located between the mangrove fringe on the seaward side and terrestrial vegetation such as *Melaleuca ericifolia* (Swamp Paperbark) and *Eucalyptus viminalis* subsp. *pyriorana* (Coast Manna-gum) on the landward side (Boon, 2011). Due to its positioning in the landscape, coastal saltmarsh is linked to both landward and seaward vegetation through passage of water, nutrients, toxicants, flora propagules and fauna (Boon, 2011).

Western Port has around 85 per cent or 1000 hectares (Boon, 2011) of its pre-European settlement extent of Coastal Saltmarsh Aggregate (EVC 9) remaining. Much of the clearing has been around the Hastings area. Approximately 60 hectares is predicted to remain in SUZ1 (DSE, 2012).

Coastal Saltmarsh Aggregate (EVC 9) in Western Port corresponds to the nationally listed community, *Subtropical and Temperate Coastal Saltmarsh*. This community is listed as Vulnerable under the EPBC Act (DSEWPaC 2013b) as detailed in Section 5.2.3. It is also listed as one of the important marine vegetation types in the Western Port Ramsar site (listed as intertidal marsh) (DSE, 2003b), and provides important habitat and feeding areas for birds, detailed in Section 6.4.1.

5.1.2 Mangroves

Mangroves are salt-tolerant shrubs that grow in sheltered embayments and estuaries that are regularly inundated tidally. They are colonisers of mud, silt and sand and have an integral role in the ecological function of coastal ecosystems in Western Port. These functions include:

- Providing important habitat for a number of species including migrating birds, invertebrates and fish (depending on tide);
- Protecting the coastline from erosion (Pocklington *et al.,* 2012); and
- Filtering pollutants, stabilising sediments (thereby reducing turbidity), trapping and processing nutrients (Kellogg Brown and Root, 2010).

Mangroves use their extensive rhizome systems as an anchor and consequently stabilise the surrounding sediments (Blake and Ball, 2001). They play an important role in nutrient cycles and the bathymetry of Western Port. Mangrove distribution on the shoreline is highly influenced by tides and the habitat is regularly inundated with water.

The structural composition of mangrove forests provides habitat for a wide range of organisms. Birds, fish and invertebrates use mangroves for habitat, food, and in some cases a nursery for developing young. Mangroves provide ideal roosting habitat for shorebirds and waterbirds; many species roost in coastal vegetation including mangroves during high tide, then access intertidal mudflats exposed at low tide.

Mangroves support a wide variety of fish species, mainly at high tides. A study conducted by Hindell and Jenkins (2004) identified 37 different species of fish at Warneet, Hastings and Newhaven. The majority of fish were juveniles, with species richness the highest at the edge of the mangroves, indicating that many of the species were likely to be transient and inhabit mangrove systems during different life stages (Hindell and Jenkins, 2004). The distribution of fish in mangroves varies greatly depending on temporal and spatial zonation. The most abundant species were gobiids and juvenile atherinnids, with juvenile King George Whiting (*Sillaginodes punctatus*) and Smooth Toadfish (*Tetractenos glaber*) at the edge of the mangroves. Species diversity and richness appeared to be lowest during winter (Hindell and Jenkins, 2004).

Many of the species commonly found are tidal transients, visiting the outer edges of mangrove areas before leaving with the receding tide. Some species, however, including the Pale Mangrove Goby (*Mugilogobius platynotus*) live almost exclusively in mangrove forests (Hindell and Jenkins, 2004).

The pneumatophores of mangroves provide a substratum for epiphytic filamentous algae as well as epiphytic invertebrate species such as barnacles and mussels (Kellogg Brown and Root, 2010). The small barnacle *Elminus covertus* is the only barnacle found commonly in mangroves throughout Western Port and occurs in large numbers on pneumatophores (Kellogg Brown and Root, 2010). Studies on invertebrate communities in other mangrove forests have found that invertebrate communities play a significant role in food-web functioning and nutrient cycling. Many invertebrates common in mangrove systems provide food for fish, birds and larger invertebrates such as crabs (Dittman, 2011).

Western Port contains the most extensive mangrove community in Victoria (Ross, 2000). Mangroves cover 64.1 hectares or 64 per cent of the coastline of French Island (Plummer *et al.,* 2003). The 980 hectare Yaringa MNP, about nine kilometres south-west of Tooradin, includes 237 hectares covered by mangroves. This makes it the greatest area of mangroves in any of the marine parks in Western Port (Plummer *et al.,* 2003). There are also mangroves in Churchill MNP and along a large stretch of coastline around Hastings.

The Grey Mangrove (*Avicennia marina* subsp. *australasica*) (rare) is the dominant species of mangrove communities, covering an area of 2124 hectares (DSE, 2005; DSE, 2007). Western Port is close to the species' southernmost limit (Kellogg Brown and Root, 2010) and its presence is an important contributor to Western Port's Ramsar classification.

5.1.3 Mudflats

Western Port covers an area of approximately 680 square kilometres, with over 270 square kilometres of intertidal mudflats exposed at low tide (Chidgey *et al.,* 2009). These mudflats provide food and habitat for various burrowing invertebrate species. A comprehensive study of the infauna communities of mudflats in Western Port (Coleman *et al.,* 1978) identified 572 invertebrate species from 41 sites. Of those samples, 93 per cent were molluscs, crustaceans and polychaetes.

The array of benthic fauna living in the intertidal sediments provides food for numerous species of birds, predominantly at low tide. Western Port's intertidal mudflats provide foraging and roosting areas for internationally significant numbers of migratory and resident shorebirds and other waterbirds. Western Port is ranked third in Victoria and twentieth in Australia for shorebird sites in terms of total number of birds. The extent of waterbird and shorebird roosting and feeding sites in Western Port is shown in Figure 15. Substantial areas of the Lower North Arm and near Rhyll are considered high quality foraging areas. Western Port's capacity to support these birds is the main contributor to it being listed as a Ramsar wetland of international importance (see Section 2.2).

At high tides benthic infauna in sediments provide food for fish. Species considered characteristic of intertidal mudflat environments are the Blue-spot Goby (*Pseudogobius olorum*), Tamar River Goby (*Afurcagobius tamarensis*), Greenback Flounder (*Rhombosolea tapirina*) and Long-snouted Flounder (*Ammotretis rostratus*).

Mudflat areas in Western Port (intertidal and sub-tidal) have increased considerably in recent decades as seagrass areas have declined (Chidgey *et al*., 2009). Generally, vegetated areas of sediments (e.g. containing seagrass) support a higher diversity of biota than unvegetated mudflats (Kellogg Brown and Root, 2010).

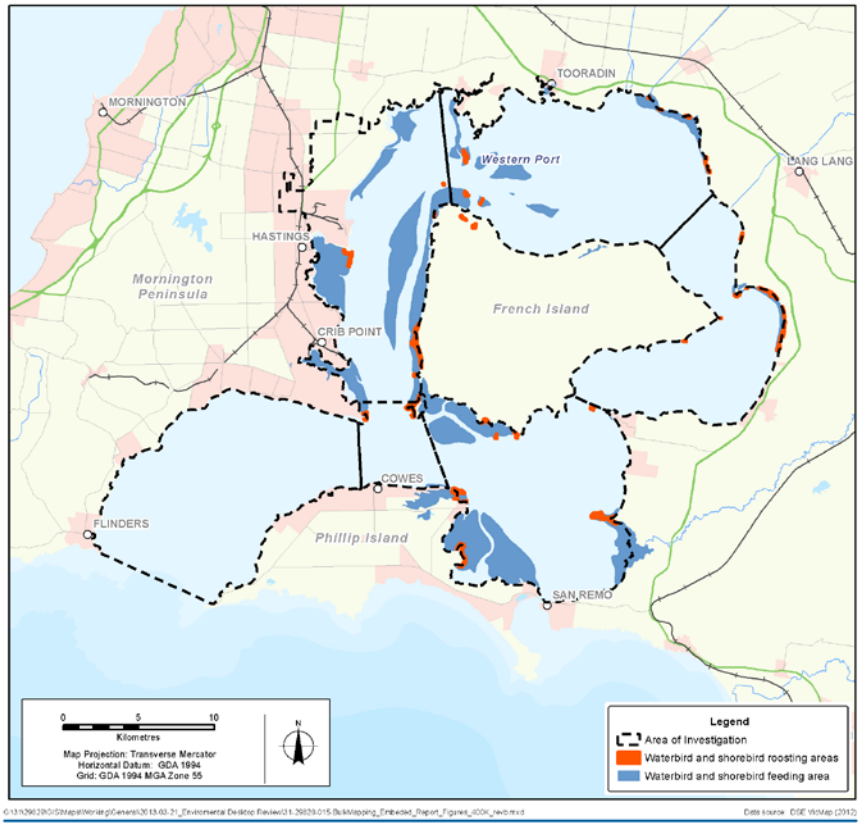

Figure 15 Waterbird and shorebird roosting and feeding sites around Western Port (Source: VBA (DEPI 2012))

5.2 Saltmarsh communities and species

5.2.1 Vegetation communities

Within Victoria coastal saltmarsh is described as the Ecological Vegetation Class Coastal Saltmarsh Aggregate (EVC 9) (Least Concern). This EVC is considered an aggregate because it is not floristically, structurally or ecologically homogeneous, and can be further refined into seven different EVCs (Boon, 2011; Boon *et al*. 2011).

Boon *et al.* (2011) describes each of these seven coastal saltmarsh communities as being present within Western Port, and mapped the following five coastal saltmarsh communities as being present within and around Special Use Zone 1:

- Wet Saltmarsh Shrubland;
- Wet Saltmarsh Herbland;
- Saltmarsh-grass Swamp;
- Coastal Tussock Saltmarsh; and
- Coastal Dry Saltmarsh.

The mapping by Boon *et al.* (2011) indicates that Wet Saltmarsh Shrubland and Wet Saltmarsh Herbland are the dominant EVCs in the vicinity of SUZ1.

5.2.2 Fauna habitats

Saltmarsh is known habitat for a wide variety of bird species, including migratory shorebirds, parrots, ibis, egrets, herons, ducks, geese and swans, small passerine birds such as chats, scrubwrens and thornbills, and raptorial birds of prey including the Swamp Harrier and White-bellied Sea Eagle (Boon *et al*., 2011a).

Shorebirds are perhaps the most significant group and they are integral to the Ramsar site's listing. Spencer *et al.* (2009) determined that little is known about whether saltmarsh provides food or roosting habitat or both to migratory shorebirds in Australia, but argue that in Europe, North America and South Africa, coastal saltmarsh fulfils a pivotal role. They believe migratory shorebird species visiting Australia may feed in the saltmarsh during the day and roost in them at night. Furthermore, the structure of saltmarsh may reduce exposure to predators and provide better landing and take-off areas than wooded vegetation types.

5.2.3 Listed ecological communities

EPBC Act-listed communities

Coastal Saltmarsh communities in Western Port correspond to the nationally listed community, *Subtropical and Temperate Coastal Saltmarsh*. This community is listed as Vulnerable under the EPBC Act (DSEWPaC, 2013a).

The saltmarsh community *Subtropical and Temperate Coastal Saltmarsh* spans six State jurisdictions from Queensland (Southern) to Tasmania and includes Western Port (DSEWPaC, 2013a). The community meets three listing criteria specified in Division 7.1 of the *Environment Protection and Biodiversity Conservation Regulations 2000* (DSEWPaC, 2013a):

- Criterion 2: as vulnerable. The ecological community has a very restricted distribution, being fragmented with small patches generally under 10 hectares, and it is subject to threats that could cause decline over the medium-term future.
- Criterion 4: as vulnerable. Its reduction in integrity is substantial, as indicated by degradation of the community or disruption of important community processes.
- Criterion 5: as vulnerable. Its rate of continuing detrimental change is substantial as indicated by a serious intensification in the disruption of a key driver of important community processes.

FFG Act-listed communities

Coastal Saltmarsh communities of Western Port are not listed under the FFG Act.

5.2.4 Listed species

Table 7 and Table 8 at the end of this section detail flora and fauna species listed under Commonwealth and State legislation thought to have a *high* or *moderate* likelihood of inhabiting Saltmarsh communities of Western Port. Listed species include threatened, near-threatened, rare and poorly known species. Appendices C and D provide more information.

Threatened flora

No flora species listed under the EPBC Act or FFG Act are known or predicted to occur within Coastal Saltmarsh Aggregate (EVC 9) of SUZ1.

Coastal Saltmarsh Aggregate (EVC 8) provides suitable habitat for seven species listed on the DEPI *Advisory List of Rare or Threatened Plants in Victoria* (DSE, 2005) (Table 7 and Appendix A). Each of these seven species is listed as rare (DSE, 2005).

Three rare species are known to occur in SUZ1 (Venosta *et al*., 2009):

- Creeping Rush *(Juncus revolutus)*
- Salt-blown grass *(Lachnagrostis robusta)*
- Yellow Sea-lavender *(Limonium austral)*

Threatened fauna

Thirty-seven threatened or near-threatened fauna species known (VBA) or predicted to occur (PMST) have a moderate or high likelihood of occurring in saltmarsh habitats of Western Port. All are birds: seven terns and gulls, 18 shorebirds, and 12 birds from a range of ecological guilds (bitterns, egrets, herons etc). The Australasian Bittern (*Botaurus poiciloptilus*) and Fairy Tern (*Sternula nereis*) are listed under the EPBC Act; 14 are listed under the FFG Act, and all 37 are listed under the *DEPI Advisory List of Threatened Vertebrate Species* (DEPI 2013).

The Australasian Bittern is mostly associated with freshwater habitats, particularly wetlands with tall, dense vegetation dominated by sedges, rushes and reeds. The Fairy Tern inhabits coastal environments including intertidal mudflats, sand flats and beaches, and nests above high-water mark on sandy shell-grit beaches. Both species may occasionally use adjacent coastal habitats such as saltmarsh.

Saltmarsh communities along the coast provide foraging habitat for the Orange-bellied Parrot. This species has been recorded using habitats including saltmarsh in and around Western Port, but not since 1987 (Higgins 1999, VBA). Venosta et al. (2009) provide an assessment of the relative likelihood of occurrence of this species in part of the SUZ1: As written by Venosta *et al.* (2009; p32): "*The saltmarsh within the study area has not been regularly surveyed for Orange-bellied Parrot as part of over-wintering monitoring surveys (Glenn Ehmke, pers. comm.)*". Consequently, Venosta *et al*. (2009) conclude that the likelihood of the Orange-bellied Parrot being present is low, but recommend targeted surveys in potentially suitable habitats in the study area.

Migratory species listed under the EPBC Act

Forty-nine bird species identified in the VBA and PMST searches are listed as Migratory under the EPBC Act (Appendix D). This includes shorebirds, gulls, terns, and other bird species from a range of ecological guilds.

Saltmarsh communities along the coast provide foraging habitat for the Orange-bellied Parrot.

Marine species listed under the EPBC Act

The Marine status of fauna under the EPBC Act is relevant only to Commonwealth Marine areas, so is not considered for the terrestrial zone for this project.

5.3 Mangrove communities and species

5.3.1 Vegetation communities

Mangroves in Western Port are classified as Mangrove Shrubland (EVC 140) (Least Concern). This EVC is confined to protected low energy coastal environments where there is sufficient shelter from strong wave action and currents to allow the accumulation of fine sediments, generally on mud flats in the tidal zone. It is dominated by Grey Mangrove (*Avicennia marina* var. *australasica*) and is usually associated with Coastal Saltmarsh Aggregate (EVC 9) (Oates and Taranto, 2001).

EVC mapping (DSE, 2012) indicates Mangrove Shrubland in Western Port extends in an almost continuous band along the coast, with the most extensive mangrove populations present along the northern and western shores of the bay and French Island (Dittman, 2011). The mangrove zone is around 100-300 metres wide and generally runs parallel to the shore (Kellogg Brown and Root, 2010).

5.3.2 Listed ecological communities

EPBC Act-listed communities

No EPBC Act-listed threatened ecological communities occur in the mangrove habitats of Western Port

FFG Act-listed communities

No FFG Act-listed threatened ecological communities occur in the mangrove habitats of Western Port

5.3.3 Listed species

Table 6 and Table 7 detail flora and fauna species listed under Commonwealth and State legislation thought to be of *high* or *moderate* likelihood in mangrove habitats of Western Port. Listed species include threatened, near threatened, rare and poorly known species. Appendices C and D provide further information.

Threatened flora

No flora species listed under the EPBC Act or FFG Act are known or predicted to occur in Mangrove Shrubland (EVC 140) of SUZ1. One species *Avicennia marina* subsp. *australasica* (Grey Mangrove) is listed as rare under on the DEPI *Advisory List of Rare or Threatened Plants in Victoria* (DSE, 2005). *Avicennia marina* subsp. *australasica* (Grey Mangrove) is the dominant species of Mangrove Shrubland (EVC 140).

Threatened fauna

Thirty-four threatened or near-threatened fauna species have a moderate or high likelihood of occurring in mangrove habitats of Western Port. The 34 are: one fish (Pale Mangrove Goby); six terns and gulls; 17 shorebirds, and 10 birds from a range of ecological guilds (e.g. bitterns, egrets, heron's etc) (Table 8).

Of these two bird species (Australasian Bittern (*Botaurus poiciloptilus*) Fairy Tern (*Sternula nereis*)) are listed under the EPBC Act.

Thirteen bird species and one fish species identified by the searches are listed under the FFG Act. The Pacific Gull (*Larus pacificus*) has been nominated for listing.

All 34 are listed under the *DEPI Advisory List of Threatened Vertebrate Fauna in Victoria* (DEPI 2013).

Habitat descriptions for the Australasian Bittern and the Fairy Tern are provided in Section 5.2.4. The Pale Mangrove Goby (*Mugilogobius platynotus*) is believed to be one of the few resident mangrove fish species. Records of the Pale Mangrove Goby in Western Port are believed to be the only records of this species in Victoria.

Migratory species listed under the EPBC Act

Forty-five bird species identified in the VBA and PMST searches for Western Port are listed as Migratory under the EPBC Act (Appendix D). This includes shorebirds, gulls, terns, and birds from a range of other guilds.

Marine fauna species listed under the EPBC Act

The Marine status of fauna under the EPBC Act is relevant only to Commonwealth Marine areas, so is not considered for the terrestrial zone for this project.

5.4 Mudflat communities and species

5.4.1 Mudflat vegetation communities

Unvegetated mudflats are not classified as an Ecological Vegetation Class due to the general absence of vegetation cover.

5.4.2 Listed mudflat communities

EPBC Act-listed Communities

Mudflats do not support any communities listed under the EPBC Act.

FFG Act-listed Communities

Mudflats do not support any communities listed under the FFG Act.

5.4.3 Listed species

Table 7 and Table 8 detail flora and fauna species listed under Commonwealth and State legislation thought to be of *high* or *moderate* likelihood in mudflat habitats of Western Port. Listed species include threatened, near threatened, rare and poorly known species. Appendices C and D provide more information.

Threatened flora

No flora species listed under the EPBC Act or FFG Act are known or predicted to occur in mudflat habitats of SUZ1. Whilst mudflats are generally unvegetated, three flora species listed under the DEPI *Advisory List of Rare or Threatened Plants in Victoria* (DSE, 2005) may extend into mudflat habitats. All three are known to occur in Western Port. Two are intertidal seagrass species and the third is *Avicennia marina* subsp. *australasica* (Grey Mangrove) (Table 7).

Threatened fauna

Thirty-two threatened or near-threatened fauna species have a *moderate* or *high* likelihood of occurring in mudflat habitats of Western Port: one fish (Pale Mangrove Goby) and 31 birds - six terns and gulls, 17 shorebirds, and eight birds from a range of ecological guilds (e.g. bitterns, egrets, herons).

The Fairy Tern (*Sternula nereis*) is listed as threatened under the EPBC Act, 12 species are listed under the FFG Act, and the Pacific Gull (*Larus pacificus*) has been nominated for listing. All 31 species are listed under the *DEPI Advisory List of Threatened Vertebrate Species* (DEPI 2013).

Migratory fauna species listed under the EPBC Act

Thirty-five bird species identified in the VBA and PMST searches for Western Port are listed as Migratory under the EPBC Act, and are considered to have moderate or high likelihood of using Western Port's mudflats (Appendix D). They are shorebirds, gulls, terns, and bird species from a range of other guilds.

Marine fauna species listed under the EPBC Act

The Marine status of fauna under the EPBC Act is relevant only to Commonwealth Marine areas, so is not considered for the terrestrial zone for this project.

Table 7 Threatened flora species considered moderately or highly likely to occur in intertidal habitats (saltmarshes, mangroves and mudflats)

Scientific name	Common name	EPBC Act 1999	FFG Act 1988	DEPI Advisory list	Saltmarsh	Mangroves	Mudflats	Likelihood of occurrence
Amphibolis antartica	Sea Nymph			r			x	H
Atriplex paludosa subsp. *paludosa*	Marsh Saltbush			r	x			M
Avicennia marina subsp. *australasica*	Grey Mangrove			r		x	x	H
Juncus revolutus	Creeping Rush			r	x			H
Halophila ovalis	Oval Sea-wrack						x	H
Lachnagrostis robusta	Salt Blown-grass			r	x			H
Lawrencia spicata	Salt Lawrencia			r	x			M
Lepidosperma canescens	Hoary Rapier-Sedge			r	x			M
Limonium australe	Yellow Sea-lavender			r	x			H
Triglochin minutissima	Triglochin minutissima			r	x			M
EPBC Act					0	0	0	
FFG Act					0	0	0	
DEPI Advisory List					7	1	3	

Key: r – rare; M – moderate likelihood of occurrence; H – high likelihood of occurrence; x – considered for that habitat.

Table 8 Threatened fauna species considered moderately or highly likely to occur in intertidal habitats (saltmarshes, mangroves and mudflats)

Key: cr – critically endangered; EN/en – endangered; VU/vu – vulnerable; L – listed as threatened; I – nominated for listing; nt – near threatened; M – moderate likelihood of occurrence; H – high likelihood of occurrence; x – considered for that habitat.

Scientific name	Common name	EPBC Act 1999	FFG Act 1988	DEPI Advisory list	Saltmarsh	Mangroves	Mudflats	Likelihood of occurrence
Birds								
Actitis hypoleucos	Common Sandpiper			vu	x	x	x	H
Anseranas semipalmata	Magpie Goose		L	nt	x			M
Ardea modesta	Eastern Great Egret		L	vu	x	x	x	H
Botaurus poiciloptilus	Australasian Bittern	EN	L	en	x	x		H
Calidris alba	Sanderling			nt	x	x	x	H
Calidris canutus	Red Knot			nt	x	x	x	H
Calidris melanotos	Pectoral Sandpiper			nt	x	x	x	H
Calidris subminuta	Long-toed Stint			nt	x	x	x	H
Cereopsis novaehollandiae	Cape Barren Goose			nt	x			H
Charadrius leschenaultii	Greater Sand Plover			vu	x	x	x	H
Charadrius mongolus	Lesser Sand Plover			vu	x	x	x	H
Chlidonias hybrida	Whiskered Tern			nt	x			H
Egretta garzetta	Little Egret		L	en	x	x	x	H
Gallinago hardwickii	Latham's Snipe			nt	x			H
Gelochelidon nilotica	Gull-billed Tern		L	en	x	x	x	M
Haematopus fuliginosus	Sooty Oystercatcher			nt	x	x	x	H
Haliaeetus leucogaster	White-bellied Sea-Eagle		L	vu	x	x	x	H
Hydroprogne caspia	Caspian Tern		L	nt	x	x	x	H
Larus pacificus	Pacific Gull		I	nt	x	x	x	H
Lewinia pectoralis	Lewin's Rail		L	vu	x	x		H
Limosa limosa	Black-tailed Godwit			vu	x	x	x	H
Numenius madagascariensis	Eastern Curlew			nt	x	x	x	H
Numenius phaeopus	Whimbrel			vu	x	x	x	H
Nycticorax caledonicus hillii	Nankeen Night Heron			nt	x	x	x	H
Phalacrocorax fuscescens	Black-faced Cormorant			nt	x	x	x	H
Phalacrocorax varius	Pied Cormorant			nt	x	x	x	H
Platalea regia	Royal Spoonbill			vu	x	x	x	H
Pluvialis fulva	Pacific Golden Plover			nt	x	x	x	H

Scientific name	Common name	EPBC Act 1999	FFG Act 1988	DEPI Advisory list	Saltmarsh	Mangroves	Mudflats	Likelihood of occurrence .
Pluvialis squatarola	Grey Plover			nt	x	x	x	H
Porzana pusilla	Baillon's Crake		L	vu	x	x	x	H
Sterna striata	White-fronted Tern			nt	x	x	x	H
Sternula albifrons	Little Tern		L	vu	x	x	x	H
Sternula nereis	Fairy Tern	VU	L	en	x	x	x	H
Thinornis rubricollis	Hooded Plover		L	vu	x	x	x	H
Tringa brevipes	Grey-tailed Tattler		L	cr	x	x	x	H
Tringa glareola	Wood Sandpiper			vu	x	x	x	H
Xenus cinereus	Terek Sandpiper		L	en	x	x	x	M
Fishes								
Mugilogobius platynotus	Pale Mangrove Goby		L	vu		x		H
EPBC Act					2	2	1	
FFG Act					14	14	12	
DEPI Advisory List					37	15	31	

6. Ecological values – marine zone

For the purposes of this report, Marine zone refers to all subtidal habitats in Western Port. This section is split into shallow water habitats (mainly including seagrass habitat and macroalgae) and deep water habitats (which includes channels, reefs, and pelagic areas). These categories overlap to some degree, and many organisms are likely to occur across both habitat types.

Some seagrass communities are intertidal rather than truly subtidal. For simplicity, intertidal and sub-tidal seagrass communities are grouped in this section.

This section also includes phytoplankton. This section differs from the others because phytoplankton communities do not have the same complement of known threatened flora, fauna or communities.

6.1 Overview of habitats

There have been widespread declines in the distribution and cover of marine flora since monitoring commenced in the 1960s, but the marine flora in Western Port remains highly diverse across seagrass meadows, macroalgae beds and phytoplankton. Rocky reefs, sediments and mangroves provide the substrate for colonisation by a range of species. This section provides an overview of the major marine floristic communities of Western Port.

6.1.1 Shallow water habitats (including seagrass and macroalgae)

Shallow water environments are widespread throughout Western Port. They support extensive seagrass beds and important macroalgae communities.

Seagrasses

Seagrass beds are important primary producers and habitat providers for a diversity of fish and invertebrate species. Seagrasses can form extensive meadows that are recognised as the key link in a wide range of marine ecosystem processes (Larkum *et al*., 2006). Seagrass beds play an important role in nutrient cycles and the bathymetry of the bay as sediments accumulate in the root structures, thereby reducing turbidity.

Seagrass is widely regarded as the key contributor to primary productivity in Western Port (Walker, 2011; Chidgey *et al.,* 2009). Although very few organisms physically feed on seagrass (some do, including swans, garfish and leatherjackets) (Chidgey *et al.,* 2009; Melbourne Water, 2011, Jenkins 2011), seagrasses act as habitat and nurseries for many different marine organisms including seahorses, juvenile whiting, school sharks and elephant fish (Jenkins, 2011). The leaves of seagrasses also provide habitat for many different algal and invertebrate epiphytes which in turn provide a major food source for higher level organisms (Edgar and Shaw, 1995b; Walker, 2011).

The area of seagrasses in Western Port dramatically declined from the mid to late 1970s. Most seagrass loss was from intertidal areas; subtidal beds tended to survive (Bulthuis *et al*. 1984). Approximately 70 per cent of the area of (intertidal) seagrass in Western Port was lost between the early 1970s and 1983 (Paul Boon, Victoria University, pers. comm.). This is thought to be due to sedimentation from catchments building up mudflats to a level where seagrass was exposed to heat desiccation during the strong El Nino event at the time. Seagrass loss was greatest from the upper North Arm and Corinella segments of Western Port: these areas still have very low seagrass cover (Ball *et al*., 2010). Figure 16 and Figure 17 show the dramatic nature of the change by 1976. Prior to the 1970s the area of seagrass appears to have been relatively stable except for an area adjacent to the Main Drain in the northeast of the bay which was covered by silt and sand prior to 1939 (Chidgey and Crockett, 2013). The previous area of sedimentation can be seen in the bottom right corner of Figure 16 (Marsden *et al*., 1979).

Some of the ecological consequences of seagrass loss include increased suspended sediment loads and increased turbidity (seagrass beds trap sediments in their root structures, thereby reducing turbidity), which result in a reduction in the ability of seagrass to recolonise bare areas.

Since the decline, there has been some recovery of seagrass beds (Figure 18 and Figure 19), and the most recent broad-scale mapping in Western Port (based on 1999 aerial images) showed an area of 107 square kilometres of seagrass in Western Port (Figure 19). Table 9 shows the decline in seagrass cover between the early 1970s and 80s and the gradual increase from the early 80s to late 90s. The location and extent of seagrass communities in 2009 is displayed in Figure 20.

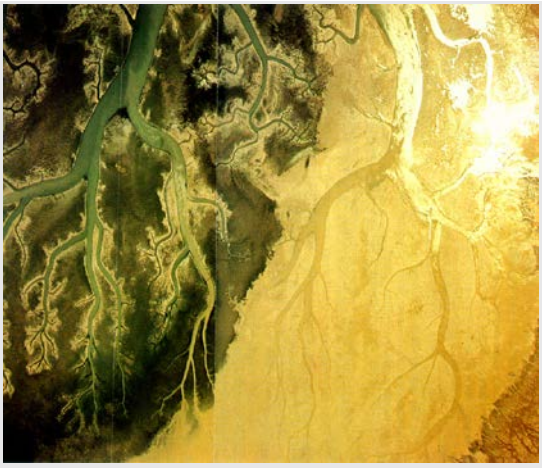

Figure 16 Distinct line of seagrass loss 1976

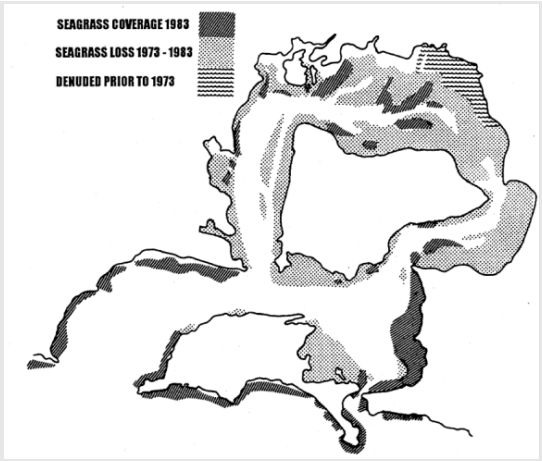

Figure 17 Seagrass distribution 1880s to 1984

Source: WRPCC, 1992.

Note: The figure shows extensive areas of seagrass along the south and west coast of Phillip Island, as well as the ocean coastline west of the Western Entrance and east of the Eastern Entrance. These areas are rocky reef with kelp, not seagrass (Chidgey *et al*. 2009).

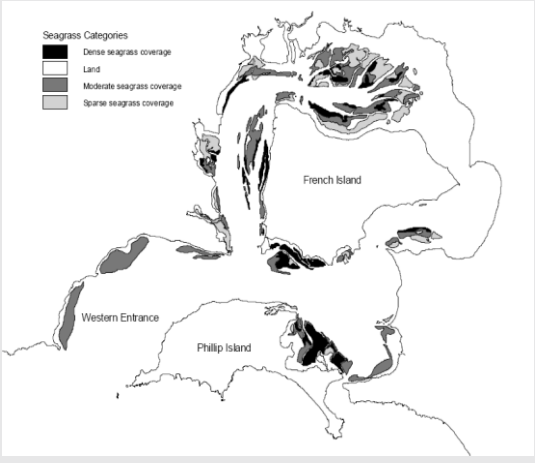

Figure 18 Seagrass distribution - 1994

Source: Stephens, 1995.

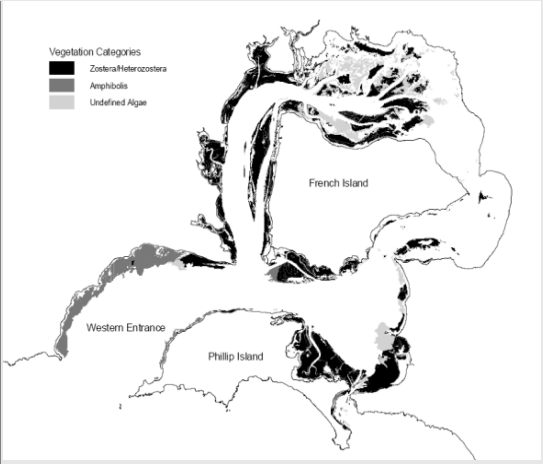

Figure 19 Seagrass distribution - 1999

Source: Blake and Ball, 2001.

Table 9 Aerial extent (km^2) of seagrasses in Western Port – 1970s - 1990s

Year mapped	Vegetated area (includes algae)	Seagrass area in the Western Entrance	Total seagrass area minus Western Entrance	Report
1973/74	250	20	142	NSR 1975
1983/84	72	13	53	Bulthuis et al. (1984)
1994	113	20	93	Stephens (1995)
1999	155	22	107	Blake and Ball (2001)

These figures include shallow subtidal seagrasses, however due to the difficulty in mapping subtidal seagrass where water clarity is low it is assumed most of the seagrass area is intertidal.

Seagrass communities in Western Port can be broadly divided into those occurring in intertidal areas (above mean low tide) and those occurring in subtidal areas (below mean low tide). The declines in seagrass extent mainly affected intertidal seagrasses, but there has been comparatively little study of subtidal seagrass beds. Seagrass mapping efforts in Western Port have generally only been reliable in intertidal areas (Blake and Ball, 2001; and Stephens, 1995). Mapping has relied on aerial photography, so the typically low water clarity in much of Western Port has limited researchers' ability to discern the extent of subtidal seagrass beds (Chidgey and Crockett, 2013).

Intertidal seagrasses are mostly found in the northern and eastern parts of the bay, away from the western and eastern entrances (Chidgey and Crockett, 2013).

Subtidal seagrasses are found along the south and east facing shores of the Western Entrance and extensively along the margins of tidal channels. They grow on the extensive areas of patchy reef and are generally mixed with stands of macroalgae (Chidgey and Crockett, 2013).

Subtidal seagrasses extend to two metres depth, and possibly up to four metres in areas of high water clarity. Suspended solids, and the influence they have on light penetrating, are likely to limit the maximum depth of seagrass beds (Chidgey and Crockett, 2013).

Fish species richness is high in seagrass habitats; typically, it is twice that of unvegetated mudflats (Edgar *et al.,* 1994; Edgar and Shaw, 1995a; Jenkins, 2011). There have been three major surveys of fish in Western Port seagrass since the mid 1970s (Shapiro, 1975; Edgar *et al.,* 1994; Edgar and Shaw, 1995a; and Hindell *et al.* (2004). More than 92 fish species were recorded, mostly of small species such as gobies, weed fish and pipefish, but also other common species including leather-jackets, garfish, anchovy, whiting and flathead.

Macroalgae

Abundant benthic micro and macroalgal species are found throughout Western Port, often sharing seagrass habitat. These species also play important roles in the ecosystem. The coenocytic green algae *Caulerpa cactoides* is found subtidally throughout Western Port, often as an understorey to seagrass, or forming monospecific beds in its own right (NSR 1974a; G Jenkins, University of Melbourne, pers comm). Microalgae may be found on the sediment surface (as microphytobenthos) or growing epiphytically on the leaves and stems of seagrasses (Sue, 2008). Drifting macroalgae such as *Gracilaria* have previously been found to be common (Shapiro, 1975).

A variety of macroalgae occur throughout Western Port. The majority of species are restricted to hard substrates such as reefs, jetty pylons and other structures or grow as epiphytes on seagrass and other algae (Chidgey *et al.,* 2009). The location and extent of macroalgal communities is displayed in Figure 20.

The extent of macroalgae in the lower North Arm declined significantly between 1973/74 and 1983, at the same time as large-scale seagrass loss occurred.

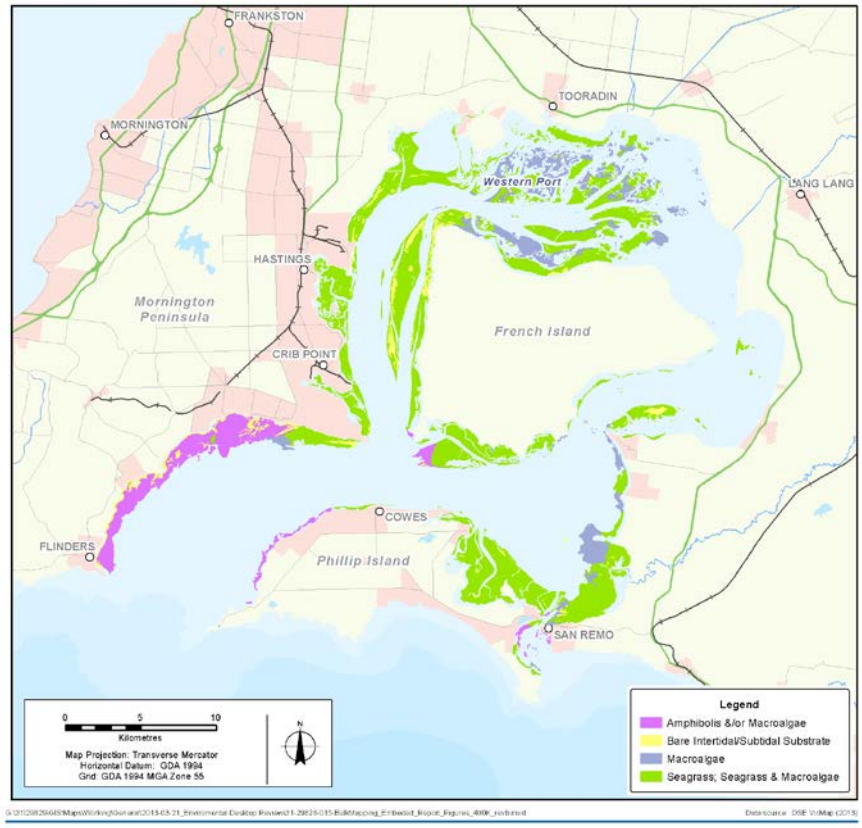

Figure 20 Seagrass and macroalgae communities in Western Port 2009

Several species of coralline red algae (algae have calcium carbonate in their cell walls) form unattached seabed communities called rhodoliths. Rhodolith beds occur in areas of muddy, sandy or pebbly substrates where there is sufficient water flow created by currents or wave action to prevent burial by sediments (Harvey and Bird, 2008). The rhodolith bed in Western Port is unusual in that it contains fertile spores, whereas plants in other populations such as those at Port McDonnell in South Australia appear to reproduce through fragmentation of the rhodoliths.

Rhodolith beds form spatially and morphologically complex habitats which provide a hard substrate for sessile invertebrates, while motile invertebrates can burrow into or hide in the beds (Harvey and Bird, 2008). In general, this habitat often contains a high biodiversity of invertebrates and is considered by Harvey and Bird (2008) to be of high conservation value, particularly as some species occur only on rhodolith beds. The main benthic faunal communities are crustaceans, polychaetes and molluscs. Polychaetes are the most abundant faunal group in Western Port's rhodolith bed (Harvey and Bird, 2008).

The most notable reef in Western Port is Crawfish Rock, located on the North West point of French Island in the Upper North Arm. Macroalgae assemblages on this reef system have been studied by researchers since the early 1970s and are considered important as they resemble a deep-water Bass Strait community. The formation of this assemblage was a result of the extensive vertical zonation of macroalgae due to the high water clarity and light penetration.

The algal assemblages of Crawfish Rock were surveyed in 1971-1976 and again in 2002-2006. In 1971 the algal flora had unusually high diversity, with 138 species recorded. In 2002–2006 only 47 of those 138 species remained, and some of those were rare. This represents an overall decline of 66 per cent in the number of algal species at Crawfish Rock (Shepard *et al.,* 2009). Shepard *et al*. (2009) also noted that the surface of Crawfish Rock and associated algal species was now characterised by silty deposits. The degredation of Crawfish Rock over the past 30 years was attributed to lower light penetration due to suspended solids and direct sedimentation (Shepard *et al*. 2009, Chidgey *et al*. 2009).

6.1.2 Deep water zone

Deep water sections of Western Port include subtidal channels, deeper basins, isolated reefs and tide-flushed water columns (EPA Victoria, 2011; Chidgey *et al.,* 2009). These physical features support a range of important ecological habitats including rocky reefs and pelagic environments (Melbourne Water, 2011), which in turn support a large diversity of resident and transient marine fauna species, including threatened fauna species. Fauna species range from invertebrates to large oceanic and pelagic fish, migratory and marine birds and mammals, and possibly (albeit rarely) marine reptiles.

Subtidal reef surfaces occupy only a small area of Western Port, with most reefs present as scattered outcrops in the North Arm. The best known of these outcrops is Crawfish Rock which has been studied since 1971. Crawfish Rock once displayed diverse algal and macroinvertebrate assemblages which were affected by sedimentation over the past 30 years resulting in substantial declines in biodiversity (more information on the algal assemblages is presented in 6.1.1).

Rocky intertidal and subtidal temperate reef systems make up considerably less area in Western Port than other habitat types such as seagrass and mudflats, but are an important habitat for fish.

Formal scientific sampling of pelagic fish populations has been limited. Recreational sampling of pelagic fish is likely to have been extensive, but the results are unknown. The majority of sampling has been confined to the oceanic entrances and southern expanses of the bay (Jenkins 2011). Pelagic fish populations in the south west were surveyed in the early 1990s (Hoedt and Dimmlich 1994; Hoedt *et al.,* 1995).East Australian Salmon (*Arripis trutta*), West Australian Salmon (*Arripis truttaceus*), Snook (*Sphyraena novaehollandiae*), Barracouta (*Thrysites atun*) and Jack Mackerel (*Trachurus declivis*) were identified. Gut contents of higher-order predatory pelagic fish contained smaller pelagic fish, including Australian Anchovy (*Engraulis australis*), Pilchard (*Sardinops neopilchardus*) and Sandy Sprat (*Hyperlophus vittatus*)(Hoedt *et al.,* 1995).

Two marine fauna locations of note (Seal Rocks and Summerland Peninsula) occur at the westernmost tip of Phillip Island. While both locations lie just outside the boundaries of Western Port for the purposes of this project, the fauna from both locations are likely to forage to some degree in Western Port waters.

Seal Rocks is a small rocky outcrop close to the Nobbies, at the western tip of Phillip Island. These rocks are exposed to prevailing southerly oceanic swells which create a high-energy environment. The rocks are home to a diverse range of marine flora and fauna; they provide nesting and roosting habitat for seabirds (e.g., Short-tailed Shearwater, *Puffinus tenuirostris*, or 'Muttonbird'), and are home to a large breeding colony of Australian Fur Seals (*Arctocephalus pusillus doriferus*) (Gilmour *et al.,* 2006). Seal Rocks support approximately 30,000 Australian Fur Seals, the largest known colony in the world of this species (Kirkwood *et al.,* 2010 as cited in Dann, 2011).

The Summerland Peninsula at the western end of Phillip Island supports a large colony of Little Penguins (*Eudyptula minor*). The colony size has been estimated at 26,000 (Gormley and Dann, 2009). Another (smaller) colony exists at Barrellier Island. The extent to which the Phillip Island penguins use Western Port is uncertain; it is believed they seldom enter the North West extent of the bay (Chidgey *et al.,* 2009).

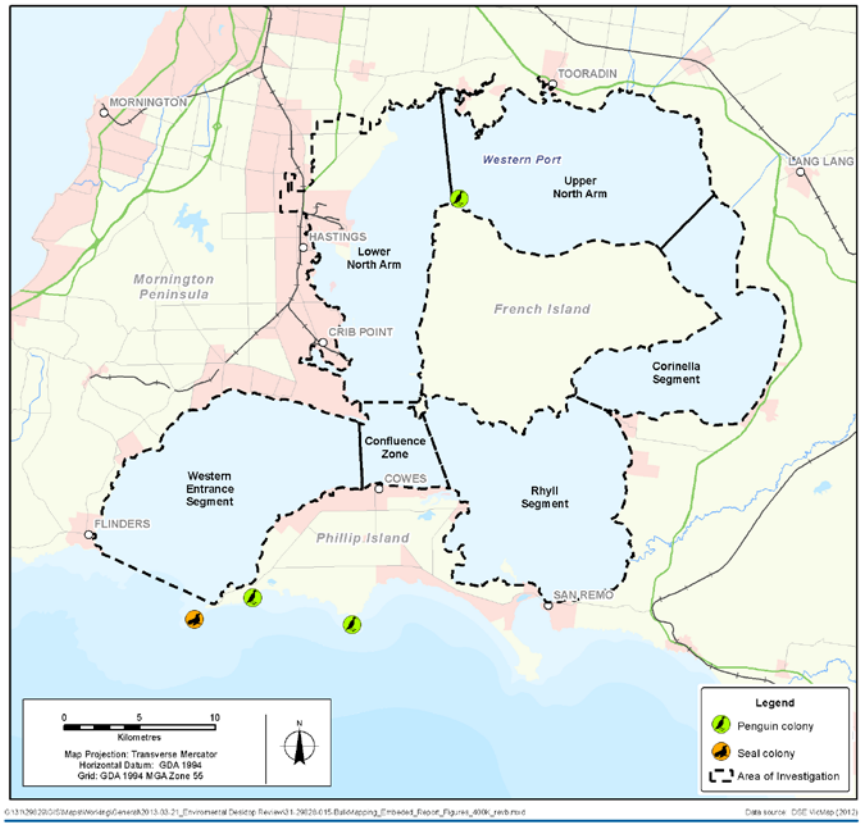

Figure 21 Seal and Penguin Colonies in and around Western Port

6.1.3 Phytoplankton

Phytoplankton are small single-celled organisms that play an important role in the functioning of ecosystems by providing food for larger organisms and the production of dissolved oxygen (Jenkins, 2011). Phytoplankton are generally the major primary producers in aquatic ecosystems such as Port Phillip Bay (Harris *et al.,* 1996). This is not the case in Western Port where seagrass is believed to contribute a greater proportion of primary productivity (Lee, 2011).

Early studies reported in Shapiro (1975) provide information on the composition of phytoplankton species in Western Port (Jenkins, 2011). Abundant species collected during the survey included diatoms (*Chaetoceros spp.* and *Ditylum brightwellii*). *Ditylum brightwellii* was sampled again between June 1973 and September 1974 (Shapiro, 1975) with the highest abundances recorded at Hastings.

Data collected in 1999-2009 as part of the Flinders Aquaculture Fisheries Reserve (FAFR) fortnightly monitoring program indicates the presence of potentially toxic or nuisance species of phytoplankton (Jenkins, 2011):

- *Pseudonitzchia sp.*, a potentially toxic species of diatom was collected across all ten years of sampling; however its abundances have remained small.
- The diatom *Rhizosolenia chuii* is considered a nuisance species, which has been recorded in all years, however is more frequent during colder months.

- The dinoflagellette *Dinophysis sp.* is potentially toxic and is collected intermittently across the 10 sampling years and always in low concentrations.
- There has been one occurrence of the potentially toxic dinoflagellette *Alexandrium sp*.; however its concentrations were low.

Phytoplankton surveys of other areas indicate nuisance species may be present but not in numbers that may impact shellfish or other biota. The concentrations of all species were low enough that regulatory responses were not required (Jenkins, 2011).

6.2 Shallow marine (Seagrasses and Macroalgae) communities and species

6.2.1 Vegetation communities

The Ecological Vegetation Class, Seagrass Meadow (EVC 845), is present in Western Port. The EVC has not been assigned a bioregional conservation significance by DEPI, but it has dramatically declined in Western Port and Corner Inlet in the past 50 years (Warry and Hindell, 2009). It is known that at least 25 per cent of its former distribution has been lost in Western Port (Chidgey *et al*. 2009). The Bioregional conservation status of depleted 'greater than 50% pre-European extent remains and moderately degraded over a majority of this area' has been assigned in recognition of this decline and degredation. This conservation status needs to be confirmed with DEPI.

Seagrass Meadow (EVC 845) is described as an aquatic meadow dominated by stands of *Zostera* spp. often in association with Mangrove Shrubland. The intertidal community is often found associated with sheltered marine shallows, intertidal flats and estuarine inlets (DEPI 2013k). The Victorian Saltmarsh Study (2011) describes the community as a sward forming aquatic herbland or sheltered marine shallows, intertidal flats and lower estuarine habitats. The community is dominated by Grass-wracks or Seagrasses (*Zostera* spp.), which are often monospecific and in close proximity to *Avicennia marina* (Grey Mangrove). The most extensive patches exist in Western Port and Corner Inlet (Boon *et al*., 2011).

Four species of seagrass occur in Western Port and have distinct distributions in intertidal and subtidal seagrass beds (Chidgey and Crockett, 2013). They are:

- *Zostera nigricaulis* occurs in shallow subtidal and lower intertidal habitats in the north and east of Western Port;
- *Zostera muelleri* occurs on intertidal mudflats;
- *Amphibolis antarctica* is found in the oceanic section of the western entrance; and
- *Halophila ovalis* occurs in sparsely populated beds in the deeper and lower light waters of parts of Western Port.

6.2.2 Threatened ecological communities

EPBC Act-listed communities

No marine communities occurring in Western Port are listed under under the EPBC Act.

FFG Act-listed communities

The *San Remo Marine Community* is listed under the *Flora and Fauna Guarantee Act 1988*. It occurs at the eastern entrance in an area about 600 metres by 300 metres off the coast of San Remo. At this site the community extends from the edge of a deep channel with a fast-flowing current between Phillip Island and the mainland. The community is known for its unusually species-rich assemblages, boasting a high diversity of opisthobranch molluscs and bryozoans, some of which are considered to be rare. Algae and fish that form part of the community are also protected (DSE, 2003a).

6.2.3 Listed species

Table 10 and Table 11 detail flora and fauna species listed under Commonwealth and State legislation thought to be of *high* or *moderate* likelihood in shallow subtidal habitats of Western Port. Listed species include threatened, near threatened, rare and poorly known species. Appendix C and Appendix D provide further information.

Threatened flora

No flora species listed under the EPBC Act or FFG Act are predicted to occur in seagrass and macroalgae habitats of Western Port.

Four species of seagrass known to be present in Western Port are listed as rare or poorly known under the *DEPI Advisory List of Rare or Threatened Plants* (DSE, 2005) (Table 10 and Appendix C).

Threatened fauna

Thirty-four fauna species are considered likely to use sub-tidal marine environments. These include marine mammals, birds, reptiles, marine fish and invertebrates. Other fauna species that fly over sub-tidal marine habitats, but that tend not to settle on or forage in the water (e.g., migratory shorebirds), are not included here. They are discussed in the relevant sections for intertidal habitats (Section 5).

Those species expected to occur in sub-tidal parts of Western Port are included in Appendix D with an evaluation of their likelihood of occurrence, which is based on historical records in the immediate area and current known distributions and movements of the species.

In summary, eighteen threatened or near-threatened fauna species have a *moderate* or *high* likelihood of occurring in seagrass and macroalgae habitats. This includes 14 species of birds, one marine reptile, one fish and three marine invertebrates (Appendix D). Of these, six bird species are listed under the EPBC Act, 10 species under the FFG Act and, two are nominated for listing. Fifteen fauna species are listed under the *DEPI Advisory Lists* of threatened vertebrate and invertebrate fauna (DEPI 2009; DEPI 2013) (Table 11).

Migratory Species listed under the EPBC Act

The VBA and PMST searches for Western Port identified ten bird species that use shallow-water marine habitats and are listed as migratory under the EPBC Act (Appendix D).

Marine fauna species listed under the EPBC Act

The Marine status of fauna under the EPBC Act is relevant only to Commonwealth Marine areas, so is not considered for the terrestrial zone for this project.

6.3 Deep subtidal communities and species

6.3.1 Vegetation communities

No vegetation communities occur predominantly or exclusively in the deep water sections of Western Port. Seagrasses and macroalgae (e.g., kelp) may occur there: they are described in Section 6.2.

6.3.2 Threatened ecological communities

EPBC Act-listed communities

No ecological communities listed under the EPBC Act occur in the deep water zone of Western Port.

FFG Act-listed communities

Part of The *San Remo Marine Community* is listed under the *Flora and Fauna Guarantee Act 1988* may extend into the Deep Water Zone. More information on this community can be found in Section 6.2.2.

6.3.3 Listed species

Table 10 and Table 11 detail flora and fauna species listed under Commonwealth and State legislation thought to be of *high* or *moderate* likelihood in deeper subtidal habitats of Western Port. Appendix C and Appendix D provide more information.

Threatened flora

Two flora species Sea Nymph (*Amphibolis Antarctica)* and Oval Sea-wrack (*Halophila ovalis*) may extend into the deeper subtidal sections of Wes tern Port. Seagrass communities and macroalgae are described in Section 6.2.

Threatened fauna

A total of 20 threatened or near-threatened fauna species are known (VBA) or are considered likely to use sub-tidal marine environments of Western Port, and have a moderate or high likelihood of occurrence. These include marine mammals, birds, and marine fish and invertebrates (Appendix D). Other fauna species that fly over sub-tidal marine habitats, but that tend not to settle on or forage in the water (e.g., migratory shorebirds), are not included here. They are discussed in Section 5.

Of the 20 threatened or near threatened fauna, six are EPBC-listed threatened fauna species (Table 11). Due to the fur seal colony at the Nobbies at the western tip of Phillip Island, areas around Phillip Island provide important habitat for the threatened EPBC-listed Great White Shark (*Carcharodon carcharias*) (Gilmour *et al.,* 2006).

Two other species of threatened EPBC-listed shark are reported for Western Port in Jenkins (2011), Chidgey *et al.* (2009), and Chidgey *et al.* (2010). These are:

- School Shark (*Galoerhinus galeus*) – listed as Conservation Dependent; and
- Grey Nurse Shark (*Carcharius taurus*) – listed as Critically Endangered.

However, the PMST report generated does not indicate that either species occurs in Western Port, so these species are not included.

Eleven species are listed under the FFG Act (Table 11). This includes six birds (gulls, terns, eagles and albatross), two species of fish, and three invertebrate species. Two additional bird species are nominated for listing.

Chidgey *et al*. (2009) includes four additional FFG-listed marine invertebrates for Western Port – two echinoderms and two molluscs (Table 12). These were not identified in the PMST or VBA searches, so are not included in Appendix D.

Eighteen DEPI-listed threatened or near-threatened fauna species (one marine mammal, 12 birds, two fishes and three invertebrates) have a moderate or high likelihood of occurrence (Table 11).

Migratory species listed under the EPBC Act

There are 12 Migratory fauna species (11 birds and one fish) that have a moderate or high likelihood of occurrence (Appendix D).

Numerous species of threatened and Migratory marine mammal (whales, dolphins, seals and allies) were identified in the VBA and PMST searches. While some of these species are likely to occur in waters outside Western Port, few are considered likely to use the waters in Western Port any more than rarely (i.e., they have been assigned low or negligible as the likelihood of occurrence). These species are all listed in Appendix D.

Marine fauna species listed under the EPBC Act

The Marine status of fauna under the EPBC Act is relevant only to Commonwealth Marine areas, so is not considered for the terrestrial zone for this project.

Table 10 Threatened flora species considered moderately or highly likely to occur in marine habitats (shallow water and deep water)

Key: k- poorly known; r – rare; M – moderate likelihood of occurrence; H – high likelihood of occurrence; x – considered for that habitat.

Scientific name	Common name	EPBC Act 1999	FFG Act 1988	DEPI Advisory list	Seagrass Habitats	Deep Water	Likelihood of occurrence :
Amphibolis antartica	Sea Nymph			r	x	x	H
Zostera capricornii	Eel Grass			k	x		H
Heterozostera nigricaulis	Australian Grass-wrack			k	x		H
Halophila australis	Oval Sea-wrack			k	x	x	H
EPBC Act					0	0	
FFG Act					0	0	
DEPI Advisory List					4	2	

Table 11 Threatened fauna species considered moderately or highly likely to occur in sub-tidal marine habitats (shallow and deep water)

Key: en – endangered; VU/vu – vulnerable; L – listed as threatened; I – nominated for listing; nt – near threatened; M – moderate likelihood of occurrence; H – high likelihood of occurrence; x – considered for that habitat.

Scientific name	Common name	EPBC Act 1999	FFG Act 1988	DEPI Advisory list	Seagrass habitats	Deep water	Likelihood of occurrence
Mammals							
Arctocephalus forsteri	New Zealand Fur Seal			vu		x	H
Birds							
Gelochelidon nilotica	Gull-billed Tern		L	en	x	x	M
Haliaeetus leucogaster	White-bellied Sea-Eagle		L	vu	x	x	H
Hydroprogne caspia	Caspian Tern		L	nt	x	x	H
Larus pacificus	Pacific Gull		I	nt	x	x	H
Pachyptila turtur	Fairy Prion			vu	x	x	H
Pelecanoides urinatrix	Common Diving-Petrel			nt	x	x	H
Phalacrocorax fuscescens	Black-faced Cormorant			nt	x	x	H
Pterodroma mollis	Soft-plumaged Petrel	VU			x	x	M
Sterna striata	White-fronted Tern			nt	x	x	H
Sternula albifrons	Little Tern		L	vu	x	x	H
Sternula nereis	Fairy Tern	VU	L	en	x	x	H
Thalassarche cauta	Shy Albatross	VU	L	vu	x	x	H
Thalassarche melanophris	Black-browed Albatross	VU	I	vu	x	x	H
Thalassarche salvini	Salvin's Albatross	VU			x	x	M
Fishes							
Carcharodon carcharias	Great White Shark	VU	L	vu		x	M
Mugilogobius platynotus	Pale Mangrove Goby		L	vu	x	x	H
Invertebrates							
Eucalliax tooradin	Ghost shrimp		L	vu	x	x	M
Michelea microphylla	Michelea Species 5256		L	vu	x	x	M
Platydoris galbana	Marine opisthobranch		L	vu	x	x	H
EPBC					6	6	
FFG					10	11	
DEPI Advisory List					15	18	

Table 12 Other marine Invertebrates listed under the *Flora and Fauna Guarantee Act 1988* that may occur in Western Port (Chidgey *et al.* 2009)

Scientific Name	Common Name	Habitat	Known locations
Echinoderms			
Amphiura triscacantha	Brittle star species	Bay and channel. *Posidonia* and *Zostera* seagrass beds (subtidal)	Nooramunga and possibly Western Port (Vic) and Spencer and St Vincent Gulfs (SA)
Apsolidium handrecki	Sea-cucumber species	Bay. Rocky shallows (on rock platforms)	Merricks (Vic), Arno Bay (SA) and Trigg Island (WA)
Molluscs			
Bassethullia glypta	Chiton	Bay and open coast. Under rocks in sand (intertidal to 10 m)	Southern Port Phillip Bay, Bass Strait (Port Phillip Heads), Flinders (Vic) and Stanley (Tas)
Rhodope genus	Opisthobranch	Bay. Reef Flat	San Remo (Vic)

7. Legislative drivers and approvals – Ecology

This section provides an overview of major legislation relevant to ecological values of the Project. Legislation relating to values other than flora or fauna, e.g. heritage and planning, is not considered in this report (e.g. *Aboriginal Heritage Regulations 2007*, *Environment Protection Act 1970*, *Land Act 1958*, and *Water Act 1989*). Further studies are required to determine the impacts of the Project on ecological values, and to determine whether permits or referrals are required for the Project.

At this stage it is unknown what the impacts of the Project will be, therefore further studies of the impact of the Project will be needed to determine if permits or approvals will be required.

7.1 Commonwealth

7.1.1 Environment Protection and Biodiversity Conservation (EPBC) Act 1999

There are eight Matters of National Environmental Significance (MNES) identified in the EPBC Act. Certain actions – in particular, actions that are likely to have a significant impact on any MNES – are subject to a rigorous assessment and approval process (DEWHA, 2009).

Significant Impact Guidelines (DEWHA, 2009) provide guidance on determining whether or not an action is likely to have a significant impact on a MNES protected under the EPBC Act.

7.2 Victorian

7.2.1 Major Transport Projects Facilitation Act 2009 (MTPF Act)

The project is being planned under the MTPF Act, which provides a streamlined assessment and approvals process for major transport projects. The Act gives the Minister for Planning the power to grant a number of planning approvals under different pieces of legislation. This means that one overarching decision can be made about a project by the Minister, rather than separate decisions being required from several ministers or agencies. The Act covers applicable approvals under the following Acts (note that the Heritage Act 1995 and the Road Management Act 2004 are not covered in this report).

- *Planning and Environment Act 1987*
- *Flora and Fauna Guarantee Act 1988*
- *Conservation, Forests and Lands Act 1987*
- *National Parks Act 1975;*
- *Wildlife Act 1975*
- *Coastal Management Act 1995*
- *Water Act 1989*
- *Environment Protection Act 1970*
- *Heritage Act 1995*
- *Road Management Act 2004*

Under the Act a Comprehensive Impact Statement (CIS) is likely to be required.

7.2.2 Environmental Effects (EE) Act 1978

The project now comes under the *Major Transport Projects Facilitation Act 2009* (the MTPF Act), therefore the approval under the Environmental Effects Act 1978 is not required for the Project.

7.2.3 Planning and Environment Act 1987

The Planning and Environment Act sets out procedures for preparing and amending the Victoria Planning Provisions and planning schemes, obtaining permits under schemes, settling disputes, enforcing compliance with planning schemes, and other administrative procedures.

The main functions of the Act are to:

- Set the broad objectives for planning in Victoria.
- Set the main rules and principles for how the Victorian planning system works.
- Set up the key planning procedures and statutory instruments in the Victorian planning system.
- Define the roles and responsibilities of the Minister, councils, government departments, the community and other stakeholders in the planning system.

Under the Act a planning permit is required to remove, destroy or lop native vegetation unless an exemption applies. Native vegetation is defined as plants that are indigenous to Victoria, including trees, shrubs, herbs and grasses (as defined in Clause 72 of planning scheme) (DTPLI, 2013).

7.2.4 Flora and Fauna Guarantee (FFG) Act 1988

The FFG Act is the key piece of Victorian legislation for the conservation of threatened species and communities and for the management of potentially threatening processes. The Act seeks to establish preventative management mechanisms to ensure no biota or ecological communities become extinct in Victoria, and to ensure that the processes that threaten biodiversity are identified and addressed. The Act is broader than 'endangered species' legislation and covers ecological communities, potentially threatening processes, community involvement in conservation and a strategic approach to biodiversity conservation and sustainable use.

Under the Act, a permit is required from DEPI for the removal or disturbance of listed threatened flora or fauna, listed protected flora, flora species that form part of listed communities, or any listed flora or fauna communities. The Act applies to public land and to projects undertaken by State Government authorities, even if on private land.

The FFG Act 1988 will apply to this project because some of the work is proposed to occur on public land. Therefore, as a minimum, the project should aim to meet the stated objectives of the FFG Act. This would involve demonstrating to DEPI that measures have been taken to avoid impacts upon FFG Act listed threatened species and communities, and that potentially threatening processes have been avoided or minimised. For listed items where Action Statements have been prepared, the project must be undertaken in accordance with those Action Statements.

7.2.5 Conservation, Forests and Lands Act 1987

This Act provides for the administrative restructure that originally created the Department of Conservation, Forests and Lands in 1983. It centralises the legislative mechanism necessary for the delegation of powers by the Department, Minister and the Secretary (S.31), and for public participation in formulation of codes of practice such as the Code of Forest Practices for Timber Production (DEPI, 2013j).

The Act applies to catchment management, coastal management, crown land management, fisheries management, flora and fauna, forests management, heritage rivers, land, national parks, reference areas and wildlife management. The Act is administered by the Minister for Environment and Climate Change except for the matters which relate to the *Fisheries Act 1995*, which are administered by the Minister for Agriculture (DEPI 2013j).

A plan of works must be submitted under this Act for works such as soil and vegetation disturbance above 1220 metres elevation, construction of dams or in vegetation deemed to be critical habitat under the FFG Act.

7.2.6 National Parks Act 1975

The *National Parks Act 1975* provides for protection and management of certain areas of land as national parks, state parks, marine national parks and marine sanctuaries.

The Act aims to reserve, preserve and permanently protect land characterised by the natural and predominantly unspoilt landscape, and its flora, fauna or other features, for the benefit of the public, including:

- Wilderness, remote and natural areas;
- Indigenous flora and fauna and features of scenic or archaeological, ecological, geological, historic or other scientific interest; and
- The study of ecology, geology, botany, zoology and other sciences relating to the conservation of the natural environment.

Victoria's Marine National Parks and Marine Sanctuaries are established under the National Parks Act (1975) (Power and Boxshall, 2007), and governed by the State Secretary of Victoria. Churchill Island MNP, French Island MNP, and Yaringa MNP are protected under this Act) (Power and Boxshall, 2007).

7.2.7 Wildlife Act 1975 and Wildlife Regulations 2002

In Victoria, the legislation for protecting and managing wildlife is the *Wildlife Act 1975*. Under this Act, it is illegal to handle, disturb or destroy wildlife without appropriate authorisation. Wildlife is defined as including indigenous vertebrate species (except declared pest species), terrestrial invertebrate species listed under the *Flora and Fauna Guarantee Act 1988* and some introduced game species. This Act does not apply to fish or listed aquatic invertebrates as defined under the *Fisheries Act 1995*.

Authorisation under the *Wildlife Act 1975* would be required for the Port of Hastings Development Project if capture, handling, relocation, or temporary housing of wildlife is conducted as a mitigation measure before, during or after construction.

Note that the Wildlife Act applies to marine vertebrate fauna also, with the exception of fishes.

7.2.8 Coastal Management Act 1995

The *Victorian Coastal Management Act 1995* provides for co-ordinated strategic planning of the Victorian Coast through the establishment of Victorian Coastal Council, Regional Coastal Boards, and the Victorian Coastal Strategy, as well as the preparation and implementations of management plans for coastal Crown land, and a co-ordinated approach to approvals for the use and development of coastal crown land.

The Act aims to plan for and manage the use of Victoria's coastal resources on a sustainable basis for conservation, tourism, recreation, commerce and similar uses. It strives to protect and maintain environmental significance in areas of the coast including geomorphological, ecological, geological, landscape and cultural features. The Act provides the framework to improve public awareness and understanding of the coast and to encourage the public to be involved in coastal planning and management.

The Victorian Coastal Strategy (VCS) developed in accordance with the Act to establish the overall framework for planning and management of the Victorian coast. Consistent with the VCS, Coastal Action Plans and Coastal Management Plans are developed and integrated with planning schemes at the regional and local level to provide detail and give attention to regional and local issues.

Under the Act development of coastal Crown land requires written consent from the Minister.

7.2.9 Water Act 1989

The Water Act provides a framework to manage and allocate surface water and ground water throughout Victoria. The Act, with its amendments, aims to define the law relating to water in Victoria, this is achieved through a framework for the management and conservation of the terrestrial phase of the water cycle, promotion of equitable and efficient use of water resources, including water entitlements. The Act also aims to maximise community involvement in the making and implementation of arrangements relating to the use, conservation or management or water resources. The Act provides a formal mechanism for the protection and enhancement of the environmental qualities of waterways and their in-stream uses throughout Victoria.

The Act also provides the basis for Rural Water Authorities, Catchment Management Authorities and Melbourne Water to undertake management of works on waterways, as well as floodplain management and regional drainage functions. Any construction or maintenance activity that affects beds and banks of waterways, riparian vegetation, quality or quantity of water, requires a licence in accordance with Section 67 (and related sections) of the Act, or a permit or approval from the relevant authority under By Laws established in accordance with Sections 160 and 219 of the Act.

7.2.10 Environment Protection Act 1970

Key aims of the Act include sustainable use and holistic management of the environment, ensuring consultative processes are adopted so that community input is a key driver of environment protection goals and programs and encouraging a co-operative approach to environment protection.

To help achieve these aims, the following Principles of Environment Protection were added to the Act in 2001:

- Integration of economic, social and environmental considerations
- The precautionary principle
- Intergenerational equity

- Conservation of biological diversity and ecological integrity
- Improved valuation, pricing and incentive mechanisms
- Shared responsibility
- Product stewardship
- Wastes hierarchy
- Integrated environmental management
- Enforcement
- Accountability

Changes made to the Act by the *Environment Protection (Resource Efficiency) Act 2002* were designed to help all sectors of the Victorian community to continue to find innovative ways of using resources more efficiently and to reduce the ecological impact.

The Act applies to noise emissions, air, water and land in Victoria, sea along the Victorian coast and discharge of waste to the Murray River from any premises in Victoria.

The Act establishes the powers, duties and functions of EPA. These include the administration of the Act and any regulations and orders made pursuant to it, recommending State environment protection policies (SEPPs) and industrial waste management policies (WMPs) to the Governor in Council, issuing works approvals, licences, permits, pollution abatement notices and implementing National Environment Protection Measures (NEPMs).

EPA's statutory functions under the *Environment Protection Act 1970* include:

- works approvals
- licences
- research development and demonstration approvals
- pollution abatement notices
- waste transport permits and certificates
- appeal rights that exist in certain statutory processes.

7.2.11 Biodiversity assessment guidelines 2013 – permitted clearing of native vegetation

The Permitted clearing of native vegetation – Biodiversity assessment guidelines (DEPI 2013a) is a new system for determining the approvals process and offset requirements for native vegetation removal in Victoria. The guidelines have been developed and are currently being incorporated into the Victoria Planning Provisions and all Victorian planning schemes. The Guidelines replace *Victoria's Native Vegetation Management – A Framework for Action* (Department of Natural Resources and Environment (DNRE) 2002).

7.2.12 Catchment and Land Protection Act (1987) (CALP Act)

The CALP Act is the main legislation covering noxious weed and pest animal management in Victoria.

One of the main objectives of the CaLP Act is to protect primary production, Crown land, the environment and community health from the effects of noxious weeds and pest animals. The CaLP Act defines roles and responsibilities and regulates the management of noxious weeds and pest animals. The Act prohibits the movement of noxious weeds of all categories anywhere in the State, and covers weed seeds occurring as contaminants in seed lots, plant products or on vehicles, machinery or animals.

Under the CaLP Act all land owners have legal obligations regarding the management of declared noxious weeds and pest animals on their land.

7.2.13 Victorian Reference Areas Act 1978

The Victorian Reference Areas Act 1978 regulates setting aside and management of Reference Areas, which are areas of special ecological interest and significance. The Act also provides for the establishment of the Reference Areas Advisory Committee to advise the Minister on the control and management of Reference Areas (DEPI 2013j).

7.2.14 Fisheries Act 1995

The *Fisheries Act 1995* provides the legislative framework for the regulation, management and conservation of fisheries including aquatic habitats in Victorian waters. Its purpose is to provide for the management, development and use of Victoria's fisheries, aquaculture industries and associated aquatic biological resources in an efficient, effective and ecologically sustainable manner. It aims to protect and conserve fisheries resources, habitats and ecosystems including the maintenance of aquatic ecological processes and genetic diversity. The Act authorises the approved government agencies to enforce regulations for commercial and recreational fisheries including aquaculture. Under the Act the approved government agencies authorise commercial and recreational licenses and quotas to manage the sustainability of the resource with the needs of the operations. The Act promotes sustainable commercial fishing and viable aquaculture industries and quality fishing opportunities for the benefit of present and future generations.

8. Threatening processes

A range of current and historic activities in and around Western Port have created threatening processes that jeopardise the condition of ecological values. This section provides an overview of threatening processes that have been identified. Many of these are also listed as threatening processes under the FFG Act and the EPBC Act (7.1.1, and 7.2.4). This section is split into potential impacts that threaten terrestrial habitats and marine habitats (intertidal and subtidal). As a large amount of literature was present in regard to threatening processes on seagrasses, another section is provided for seagrasses alone.

8.1 Threatening processes to terrestrial flora and fauna species and communities

The expansion of the Port of Hastings has the potential to threaten the ecological values of terrestrial vegetation and fauna habitat in the study area and broader Western Port region. These effects may be direct, such as habitat loss or displacement of species, or indirect, such as changes to hydrology, drainage or colonisation by pest species. These processes have the potential to alter the composition or structure of vegetation, which in turn may reduce the habitat availability for flora and fauna species, or a reduction in ecosystem services provided by the vegetation community. Alteration or loss of native vegetation has the potential to impact natural values beyond the study area through processes such as fragmentation and changes in hydrology.

Threatening processes to vegetation are identified in White (2012). The potential impacts on existing terrestrial flora and fauna values as a result of the development of the port are outlined below.

Land clearing. Clearing areas of grassland, woodland, scrub, and/or heathland, has the potential to reduce habitat and food availability for various species of mammals, birds, reptiles, amphibians, fish and invertebrates. The clearing of small patches of these vegetation types may cause the fragmentation of habitat for different species.

Habitat loss is a result of the direct clearing of land, which leads to flora and fauna being displaced from the site through lack of available habitat or creation of unsuitable conditions. Habitat loss can also result from the degradation of habitats as a result of nearby changes (e.g., fragmentation and edge effects) or colonisation by invasive species (e.g., weeds or feral predators).

Fragmentation occurs where larger patches of vegetation are cleared or severed, thereby creating smaller patches, and those remaining patches lose connectivity. This impacts the movement of fauna and flora propagules between patches. Fragmentation and loss of connectivity, coupled with edge effects, tends to result in loss of biodiversity.

Edge effect is the term used to describe the situation when fragments of remnant native vegetation and fauna habitat are reduced in size (e.g., through land clearing or fragmentation) to the point that they have a large edge-to-area ratio, and as such tend to be exposed to higher levels of weed propagules, dust, insect attack, predator incursions, nutrient enrichment, soil erosion and disease such as phytophthora. Edge effects can alter the microclimate of a site, including humidity and soil moisture (e.g., wetter habitats dry out) and temperature (small patches may be subjected to higher or lower temperatures than they normally experience).

Pest animals and plants can result in significant impacts to disturbed and undisturbed sites. Native flora and fauna species may be displaced as a result of colonisation by invasive species (e.g., weeds, feral predators or competitors). Construction activities have the potential to destroy, fragment, and impact root zones which can lead to increased weed invasion of a site or community. Weeds alter the composition and structure of vegetation and lead to the loss of habitat for dependent fauna. Even if native vegetation re-colonises an area which has been cleared, overly dense re-growth stands can impact on the biodiversity and availability of fauna habitat at a site. Disturbance of remnant habitats through construction (e.g., removal of habitat or creation of paths and roads) can open up new areas to feral fauna such as cats, foxes and rabbits, which generally results in detrimental impacts on the native fauna.

Soil erosion / degradation / bare ground, and **degradation of the biological soil crust** are cyclical processes where bare ground can lead to further soil erosion and degradation of the biological soil crust.

Altered hydrology can impact a range of soils by increasing the height of the water table leading to soil salinisation, increased wetting or drying of the soil profile and changes in soil pH. This can reduce diversity of native plants and animals, alter the composition and structure of vegetation communities and may lead to soil erosion, reduced water quality in waterways, and loss of habitat for fish and aquatic invertebrates resulting in impacts to other components of the food chain.

Stock access can result in significant physical disturbance of natural systems (e.g., woodlands, heathlands, saltmarshes) resulting in loss of native species and increased potential for the colonisation of invasive weed species.

Alteration to fire intervals (e.g., reducing the frequency of fire) can lead to changes in the structure and composition of vegetation and loss of fire-adapted species.

Recreational impacts from greater access to new areas can result in a range of physical impacts such as trampling of terrestrial and coastal vegetation, impeded drainage and water logging.

Acid sulphate soils can be exposed through disturbance of the soil profile leading to oxidation of iron sulphides present in the soil, resulting in acid generation which can lead to significant impacts to flora and fauna in terrestrial and aquatic environments.

Land claim is a physical disturbance of habitat leading to marine habitat loss and other indirect impacts such as fragmentation.

Inappropriate management intervention can directly impact vegetation communities through often misguided knowledge and appreciation of the habitat and restoration techniques.

Contaminants can have chronic and acute impacts resulting in widespread impacts on biota and accumulation through higher orders of the food chain.

Coastal modifications as a result of changed land use can lead to a range of impacts including reduced salinity, fragmentation, and increased human access, disturbance of breeding and roosting sites for shorebirds.

8.2 Threatening processes to marine species, communities and habitats (intertidal and subtidal)

A recent qualitative risk assessment for Melbourne Water (Keough and Bathgate, 2011) concluded that deteriorating water quality is a serious and consistent threat across all key ecosystems in Western Port. Habitat loss and fragmentation, sediment extraction and disturbance, sea level and temperature rise were generally identified as an intermediate to high threat to ecosystem processes, particularly for mangrove shrubland, coastal saltmarshes, seagrass habitats, shorebirds, marine mammals, unvegetated sediments and recreational fishing. Introduction of non-native flora or fauna species is considered to be a high threat for mangroves and saltmarshes, an intermediate threat for unvegetated sediments and recreational fishing, but a low threat to other habitats.

Possible threats may exist as either direct (e.g., dredging resulting in loss of fauna habitat or seagrass communities) or indirect (e.g., increased turbidity and eutrophication after cessation of dredging) impacts.

Intertidal habitat clearing/removal. Clearing or removing areas of mangrove shrubland, coastal saltmarsh or non-vegetated mudflats has the potential to reduce roosting areas, habitat and food availability for various species of birds, fish and marine invertebrates. The clearing of small patches of these vegetation types may cause the fragmentation of habitat for different species which rely on these areas for food, breeding and as nurseries for young. The rhizome systems of mangroves provide sediment stability and significantly reduce the impacts of erosion on the shoreline.

Fragmentation as described in Section 8.1 can occur in marine habitats. In marine habitats fragmentation reduces the movement of fauna and flora propagules between patches, and can change the distribution and movement of water and nutrients.

Acid sulphate soils as described in Section 8.1 occur in inter-tidal habitats.

Excessive freshwater inputs into estuarine or marine environments can alter the hydrological and salinity regime such that predominantly marine environments (e.g., Coastal Saltmarsh) are colonised by freshwater species.

Artificial barriers can alter the water regime leading to reduction in inundation of coastal areas. This can be caused by creation of artificial embankments, drainage and altered freshwater inputs.

Increased shipping movement may physically disturb remaining habitats due to increased localised sediment movement and wave scour in low energy systems.

Wave scour from passing ships has the potential to turn low-energy shorelines into higher energy shorelines.

Increased nutrients into marine systems can result in a range of impacts as a result of increased primary production through growth of phytoplankton or filamentous algae that can smother leaves of seagrass and macroalgae by reducing light availability. Long-term epiphyte growth can lead to loss of seagrass and macroalgae.

Increased suspended sediments from activities such as dredging and construction can increase turbidity and reduce the light availability for primary producers such as seagrasses. Sediment loads, once settled, can smother flora, benthic and sessile fauna and alter habitat.

Dredging of marine habitats (particularly capital dredging) can physically destroy foraging and breeding habitat used by organisms such as fish, birds and invertebrates and may result in re-distribution of sediments that impact on other habitats.

Introduction of marine pests may increase with increased shipping movement in and out of the area. Although exotic species are present in the Western Port, none are currently present in pest proportions. Pest species are currently absent around the Port of Hastings (Keough and Bathgate, 2011), this is thought to be due to the strong tidal currents in Western Port (Currie and Crookes, 1997). The most likely pathway for pest organisms entering Western Port in the future is through the ballast water of arriving ships (Keough and Bathgate, 2011).

Contaminants can have chronic and acute impacts resulting widespread impacts to biota and accumulation through higher orders of the food chain.

Oil spills may occur in areas of high shipping movement. The large tidal movements and shallow waters of Western Port make biota highly vulnerable to such spills (Keough and Bathgate 2011). Typically, spills are minor and are not evident in the receiving environment. Data for Port Phillip Bay shows that the highest frequency of spills occurs from recreational watercraft (<5L), with instances occurring daily.

Change to bathymetry. The alteration of existing bathymetry can result in changes to erosion and deposition patterns such that areas of the bay that were shallow can become deep and those that were deep can become shallow. There are also potential changes in the currents that may influence habitats for some fauna and flora, and result in larval deposition and recruitment. Stronger currents may preclude settlement. Altered currents may also influence food availability for filter feeders, flora and other species.

Vessel lighting. Presence of lights may influence behaviour of a range of marine fauna and migratory fauna (e.g., birds flying at night).

Noise and Vibration. Dredging can produce sounds from propellers, dredge head operation, pumps, hydraulic equipment and spud deployment. Noise and vibration are influenced by the sediments that are being dredged; coarser and more compacted sediments are likely to be nosier to dredge than soft silts. The behaviour of the dredge also influences noise, with a stationary dredge clearly producing continuous noise in one location compared to another which moves to dispose of material. Generally noise values from dredging are similar to those from shipping operations.

Blasting may be used to remove rocks etc. Concussion and noise are significant issues.

Collision with fauna. Dredges are generally slow moving and collisions with fauna (mainly marine mammals and reptiles) are relatively rare. Data suggests that the faster ships travel, the greater the likelihood of collision. Most Australian collisions appear to be with turtles and dugongs in warmer waters, collisions with cetaceans and other animals that occur in Western Port are rare.

Shading of areas may result in impacts on seagrass and other algae resulting in habitat loss or altered composition.

Piling May have impacts on fauna when close to piling operations. Sustained underwater noise from piling further away may also cause impacts.

8.3 Threatening processes to seagrass communities

A large amount of literature is available on anthropogenic activities that threaten seagrass ecosystems worldwide (Ralph *et al*., 2006). Threatening processes known to impact on seagrass communities tend not to act in isolation.

Research conducted over the past 40 years (Bulthuis and Axelrad, 1984; Chidgey *et al.*,1995; Chidgey and Crockett, 2013; Parry, 2009; Stephens, 1995; and WPCGG 1983a) has determined seagrass habitats in Western Port are affected by a range of factors including:

- Deposition of suspended solids;
- Desiccation;
- Seabed erosion;
- Sediment biochemistry;
- Light availability;
- Temperature;
- Nutrients;
- Sedimentation;
- Sediment physiology; and
- Climate change.

The loss of intertidal seagrasses in Western Port illustrates the complex interactions between anthropogenic impacts and the natural biological and physical environment.

Changes in seagrass ecosystems, such as increased phytoplankton or epiphyte populations or loss of seagrass cover or biomass, tend to have flow on effects on the rest of the biological community, the physics of the ecosystem and biogeochemical nutrient cycling (Chidgey and Crockett, 2013). In Western Port, sediment transport, deposition and re-suspension processes indicate that sediment transported to the North Arm of the bay could affect seagrass habitat in the Eastern and Southern regions (Hancock *et al*. 2001).

Seagrasses are ecosystem engineers that both influence sediment transport and sediment biogeochemistry, initial losses of intertidal seagrasses likely led to instability in the ecosystem (Chidgey and Crockett, 2013). With no or reduced cover of seagrass, intertidal banks had less protection from seabed erosion. Seabed erosion exacerbates the problem of excess suspended solids as well as eroding intact seagrass. In Western Port, seabed erosion is implicated in the loss of the raised banks of ‘overwash’ sands that helped intertidal *Zostera nigricaulis* beds retain water at low tide (Chidgey and Crockett, 2013).

Generally, the threatening processes most often cited as causing negative impacts on seagrass (and macroalgae) communities include:

Eutrophication. Nutrient inputs may impact indirectly upon seagrasses by stimulating excess phytoplankton and/or epiphyte growth thereby depriving seagrasses of light or directly through nutrient toxicity to the plants.

Sedimentation. Increased suspended solids in the water column or seabed may impact directly on seagrass through smothering or attenuating light in the water column. Terrestrial erosion, dredging of the seabed, and disturbance to the seabed from shipping traffic can lead to increased suspended solids in the water column (Bulthius *et al*., 1984; Chidgey *et al*., 2009).

Heavy metal contamination. No guidelines for safe-levels of heavy metals have been developed for seagrasses and heavy metal contamination has not been implicated in any major seagrass losses, however heavy metals are thought to be stressors of the seagrass environment (Chidgey and Crockett, 2012; Ralph *et al.,* 2006).

Petrochemical impacts on seagrasses have a range of effects. Field studies of the effects of oil spills indicate they may cause short-term mortality of intertidal seagrass, however studies following the immediate aftermath (0-12 months) of both the Exxon Valdez oil spill and the Gulf War of 1990-91 found no overall impact on the biomass, density, flowering, seed production or productivity of oiled seagrass meadows (Ralph *et al*., 2006). The use of dispersants may exacerbate oil spill impacts, including causing impacts over a greater area, through direct toxicity and breakdown of plant leaf cuticles allowing penetration of petrochemicals (Ralph *et al.* 1996). Impacts of oil spills on seagrasses are more pronounced in intertidal areas where oil comes into direct contact with the plants than in subtidal areas, where direct contact does not occur (Chidgey and Crockett, 2013; Ralph *et al.,* 2006).

Herbicide pollution is found throughout coastal areas as the result of agricultural and municipal use and to a lesser degree through the use of biocides on ships' hulls. Herbicides are persistent and tend to accumulate around point sources (rivermouths, drains) though some remain in the water column (Ralph *et al*., 2006).

Changes in weather and climate. Weather and climatic conditions may have also been major contributors to losses of intertidal seagrass. Daytime low tides, combined with summer heatwaves, may be a factor that exacerbates the effects of desiccation.

8.4 Information gaps

There is a number of information gaps related to the potential direct and indirect impacts of the project on ecological values. They include:

Terrestrial

The lack of on-ground mapping of the extent and quality of native vegetation and fauna habitat across the entire SUZ1 remains the most prominent information gap with regards to terrestrial ecology. The extent and condition of vegetation and habitat is currently only known for the small area (relative to the SUZ1 area) covered by Venosta *et al.* (2009; 2011).

Any native vegetation which will need to be cleared as part of the project will require detailed vegetation assessments and mapping to determine the vegetation distribution, extent and quality will be required to determine impacts. Where vegetation is to be removed, offsets will need to be investigated through detailed Habitat Hectares assessments.

Targeted species searches will be required for species listed under the EPBC Act, FFG Act, and the DEPI advisory list.

Marine

In the marine environment, knowledge gaps include:

- Extent of loss of inter-tidal and marine habitats – coastal land clearing, land reclamation, jetties, shading, dredging.
- Extent of sediment disturbance as a result of dredging and ship movements – sediment movement, turbidity, and smothering of other habitats.
- Extent of dredging – duration, frequency, geographical area.
- Input of pollution and contaminants.
- Introduction of pest marine flora and fauna (e.g., in ballast water), and resulting ecological consequences.
- Impact of altered ecological processes on critical habitats (e.g., changes in benthic infauna and shorebird foraging habitat).

A future works program has been developed by the Authority to gather information in regard to the above information gaps.

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Appendices

Appendix A Threatened flora species relevant to SUZ1

This table identifies flora known to occur within 10 km of the SUZ1 (VBA) or predicted to occur at the SUZ1 (PMST). Flora relevant to the remainder of Western Port (i.e., marine and intertidal areas) are shown in Appendix C

Key

EPBC	Listed under the *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act)
FFG	Listed under the *Flora and Fauna Guarantee Act 1988* (FFG Act)
VRoTS	Victorian Advisory List for Rare or Threatened Species (Department of Environment and Primary Industries) - list also includes poorly knowns.
BSC	Bioregional Conservation Significance
VU	Vulnerable under the EPBC Act
EN	Endangered under the EPBC Act
I	Delisted under the EPBC Act
L	Listed as threatened under the FFG Act
e	Endangered under the Victorian Advisory List for Rare or Threatened Species
k	Poorly known under the Victorian Advisory List for Rare or Threatened Species
r	Rare Victorian under the Victorian Advisory List for Rare or Threatened Species
vu	Vulnerable under the Victorian Advisory List for Rare or Threatened Species
EVC	Ecological Vegetation Class
H	High probability of occurrence
M	Moderate probability of occurrence
Lo	Low probability of occurrence
N	Negligible probability of occurrence
Study site	SUZ1
Local area	The broader area surrounding the study site (i.e. 5 km radius) in which database searches of threatened species have been undertaken.

Terrestrial Flora Species

Scientific name	Common name	EPBC Act 1999	FFG Act 1988	VRoTS 2005	Likelihood of occurrence	Habitat Description	Source
Acacia uncifolia	Coast Wirilda			r	M	Occurs from Geelong to Wilsons Promontory, on coastal dunes or near saltmarsh, chiefly on calcareous sand and sandy loam soils. (Walsh and Entwisle 1996). Nearest record in Somers (12 km away) in 1963, high density of records (and more recent) from Tootgarook (30 km, 2004).	VBA (DEPI, 2012)
Amphibromus fluitans	River Swamp Wallaby-grass	Vu	L		L	Apparently confined to permanent swamps principally along the Murray River between Wodonga and Echuca, uncommon to rare in the south probably due to alteration of habitat (Walsh and Entwisle 1994). Nearest occurrence Cranbourne (12.5 km, 2007)	PMST
Caladenia dilatata s.s.	Green-comb Spider-orchid			k	M	Apparently confined to higher rainfall and hinterland areas of Southern Victoria. Found in heathlands, heathy woodlands and open forests on sandy soils and clay loams (Backhouse and Jeanes 1995). Nearest known occurrence less than 5 km away in 2006.	VBA (DEPI, 2012)
Caladenia fragrantissima subsp. *orientalis*	Cream Spider Orchid	E	L	e	N	Grows in open forests and heathy woodlands and extends into adjacent tall heathland. Substrates are well drained sandy soils. Apparently confined to a few coastal and hinterland areas of the South West of Victoria (Backhouse and Jeanes 1995). Nearest known occurrence over 100 km away in Port Campbell National Park in 1998.	PMST
Dianella amoena	Matted Flax-lily	E	L	e	M	Possible- Grasslands and grassy woodlands (Walsh and Entwisle 1994). Nearest known occurrence in Clyde (13 km, 2005)	PMST

Scientific name	Common name	EPBC Act 1999	FFG Act 1988	VRoTS 2005	Likelihood of occurrence	Habitat Description	Source
Dianella sp. aff. *longifolia* (Benambra)	Arching Flax-lily			vu	H	Usually near rocky outcrops in open-forests (Walsh and Entwisle, 1994). Found within study area in 2009.	Venosta *et al*. 2009
Glycine latrobeana	Clover Glycine	Vu	L	vu	M	Widespread but of sporadic occurrence and rarely encountered. Grows mainly in grasslands and grassy woodlands. (Walsh and Entwisle 1996). Nearest known occurrence Shoreham (20 km, 1970).	PMST
Prasophyllum frenchii	Maroon Leek-orchid	E	L	e	M	Widespread but sporadic across southern Victoria, growing in grassland, heath and grassy woodland. An endangered orchid, mostly restricted to small populations along road and rail reserves (Jeanes and Backhouse 2006). Nearest record Clyde (12.5 km, 1998).	PMST
Prasophyllum lindleyanum	Green Leek-orchid		I	vu	M	Occurs in more fertile soils of woodland or scrubby heath, but now localized and uncommon (Walsh and Entwisle 1994). Scattered mainly across southern Victoria but with several isolated occurrences in the Eastern Highlands and the western Goldfields. Found mainly in open forests, woodlands, heathy woodlands and heathlands. Soils are generally sand and clay loams that may be moist for at least part of the year (Backhouse and Jeanes, 1996). Nearest known occurrence Crib Point (7.5 km, 2005).	VBA (DEPI, 2012)
Prasophyllum spicatum	Dense Leek-orchid	Vu		e	M	Widespread but sporadic across Victoria, growing in heath and heathy woodland (Jeanes and Backhouse 2006). Nearest known occurrence Crib Point (5 km, 2009).	VBA (DEPI, 2012)

Scientific name	Common name	EPBC Act 1999	FFG Act 1988	VRoTS 2005	Likelihood of occurrence	Habitat Description	Source
Pterostylis cucullata	Leafy Greenhood	Vu	L	vu	L	Widely distributed but disjunct, mostly occurring in small groups in coastal areas, rarely inland. (Walsh and Entwisle 1994).Widespread across southern Victoria, and extending into montane areas of the Eastern Highlands and East Gippsland. Grows in closed scrublands on the landward slopes, swales and tops of coastal sand dunes. Also grows in open forests on moist slopes, on seasonally inundated inland river flats, and in other riparian habitats. On the coast it grows in deep, well-drained sandy loams while inland it favours heavier sandy loams (Backhouse and Jeanes 1995). Nearest known occurrence Frankston (11km, 1930).	PMST
Thelymitra pallidiflora	Pallid Sun-orchid		I	e	H	Newly separated. Undescribed orchid species with similarities to Thelymitra pauciflora. Currently known from near Anglesea and Crib Point in south central Victoria, growing in heathy and grassy woodland (Jeanes and Backhouse 2006). Occurs near to Anglesea (FIS). Found within study area in 2009.	Venosta *et al*. 2009; VBA (DEPI, 2012)
Thelymitra X *irregularis*	Crested Sun-orchid			r	M	Believed to be a natural hybrid between T. ixiodes (swamps and heaths on sandy soils near the coast to low woodlands on skeletal soils inland) and either T. carnea (margins of swampy heaths to open forests of drier areas) or T. rubra (watercourses to scrubby woodlands, in sand gravel and clay soils), sporadically occurring where the parent-species grow intermingled (Walsh and Entwisle 1994).	VBA (DEPI, 2012)

Scientific name	Common name	EPBC Act 1999	FFG Act 1988	VRoTS 2005	Likelihood of occurrence	Habitat Description	Source
Thelymitra X *merraniae*	Merran's Sun-orchid		L	e	M	Known with certainty only from Aireys inlet and Anglesea areas and the Mornington Peninsula. Grows in heathlands, woodlands and open forests, sometimes in moist depressions and around swamp margins. Soils include well-drained sand and clay loams and heavier moist, peaty loams (Backhouse and Jeanes 1995). Nearest known occurrence Crib Point in (5 km, 1995).	VBA (DEPI, 2012)
Xerochrysum palustre	Swamp Everlasting	Vu	L	vu	M	Occurs in lowland swamps, usually on black cracking clay soils, scattered from near the South Australian border north-west of Portland to Bairnsdale district, but rare due to habitat depletion (Walsh and Entwisle 1999).Nearest known occurrence French Island (7 km, 2005) and Clyde North (12 km).	PMST

Appendix B Threatened fauna species relevant to SUZ1

This table identifies vertebrate and invertebrate fauna known to occur within 5 km of the SUZ1 (VBA) or predicted to occur at the SUZ1 (PMST). Fauna relevant to the remainder of Western Port (i.e., marine and intertidal areas) are shown in Appendix D.

Key

EPBC	Listed under the Environmental Protection and Biodiversity Conservation Act 1999 (EPBC Act)
FFG	Listed under the Flora and Fauna Guarantee Act 1988 (FFG Act)
DEPI	Victorian Advisory Lists for Threatened Vertebrate (DEPI 2013) or Invertebrate (DEPI 2009) Fauna Species (Department of Environment and Primary Industries)
CR/cr	Critically endangered under the EPBC Act / DEPI list
EN/en	Endangered under the EPBC Act / DEPI list
VU/vu	Vulnerable under the EPBC Act / DEPI list
Ma	Listed as Marine under the EPBC Act
Mi	Listed as Migratory under the EPBC Act
L	Listed as threatened under the FFG Act
I	Nominated for listing as threatened under the FFG Act, but not yet accepted
nt	Near threatened under DEPI list
H	High probability of occurrence
M	Moderate probability of occurrence
Lo	Low probability of occurrence
N	Negligible probability of occurrence

Scientific name	Common name	EPBC Act 1999	FFG Act 1988	DEPI Advisory list	Likelihood of occurrence :	Notes	Most recent database record	Other records
Mammals								
Isoodon obesulus obesulus	Southern Brown Bandicoot	EN	L	nt	M	Typically occurs in heathland, shrubland, heathy forest and woodland habitat across southern Victoria. Previous records within 5 km of SUZ1, and suitable habitat may occur within study area.	1980	PMST
Potorous tridactylus tridactylus	Long-nosed Potoroo	VU	L	en	N	Six populations of Long-nosed Potoroo occur in Victoria in a range of habitats from open forests to heathy woodlands, typically dominated by Eucalypts. No previous records within 5 km of SUZ1, and suitable habitat unlikely to occur in study area.	-	PMST
Pseudomys novaehollandiae	New Holland Mouse	VU	L	vu	Lo	Inhabits a variety of habitats along the coast of south-eastern Australia, including coastal heath, heathy woodland and coastal scrub habitats with a high density of leguminous ground plants (Braithwaite and Gullan 1978). Previous records within 5 km of SUZ1, but not for more than 40 years. Suitable habitat may occur in study area.	1972	PMST
Pteropus poliocephalus	Grey-headed Flying-fox	VU	L	vu	Lo	Uses a wide range of habitats in Victoria, from lowland rainforest and coastal Stringybark forests to agricultural land and suburban gardens. Established colonies known in Melbourne, Geelong and Mallacoota. No previous records within 5 km of SUZ1, but suitable habitat likely to occur in study area.	-	PMST
Birds								
Actitis hypoleucos	Common Sandpiper	Mi, Ma		vu	H	Migrates to Australia for austral summer. In Australia, inhabits a wide variety of coastal and inland wetlands with muddy margins. No previous records within 5 km of SUZ1, but suitable habitat occurs in study area.	-	PMST
Anthochaera phrygia	Regent Honeyeater	EN, Mi	L	cr	N	Inhabits dry woodlands and forests dominated by Box Ironbark eucalypts. Distribution currently restricted to the Chiltern - Mt Pilot National Park in north-eastern Victoria following severe range contraction and population decline. No previous records within 5 km of SUZ1, and suitable habitat unlikely to occur in study area.	-	PMST

Scientific name	Common name	EPBC Act 1999	FFG Act 1988	DEPI Advisory list	Likelihood of occurrence :	Notes	Most recent database record	Other records
Ardea modesta	Eastern Great Egret	Mi, Ma	L	vu	H	Uses terrestrial freshwater wetlands, wet grassland habitats, freshwater meadows, channels and larger dams, intertidal and estuarine mudflats, and mangroves. Recent records within 5 km of SUZ1, and suitable habitat occurs in study area.	2010	PMST
Aythya australis	Hardhead			vu	N	Aquatic species, generally preferring large, deep freshwater environments with abundant aquatic vegetation, including slow moving areas of rivers. Also occurs in brackish wetlands, deep dams and water storage ponds. Occasionally in estuarine and littoral habitats such as saltpans, coastal lagoons and sheltered inshore waters. Recent records within 5 km of SUZ1, and suitable habitat may occur in study area.	2000	PMST
Biziura lobata	Musk Duck	Ma		vu	N	Aquatic species, generally preferring deep water on large, permanent swamps, lakes and estuaries with abundant aquatic vegetation. Less commonly recorded in small or shallow waters, such as billabongs, sewage ponds, freshwater rivers and densely vegetated farm dams. Recent records within 5 km of SUZ1, and suitable habitat may occur in study area.	1990	PMST
Botaurus poiciloptilus	Australasian Bittern	EN	L	en	Lo	Occurs in wetlands with tall, dense vegetation in permanent freshwater habitats, particularly when dominated by sedges, rushes and reeds. No recent records within 5 km of SUZ1, but suitable habitat may occur in study area.	-	PMST
Calidris canutus	Red Knot	Mi, Ma		nt	H	Non-breeding migrant to Australia during the austral summer. Typically occurs on intertidal mudflats, sandflats and sandy beaches of sheltered coasts, and a range of other coastal and near-coastal environments such as lakes, lagoons, pools and pans, sewage ponds and saltworks. Inland lakes and swamps less commonly used. No recent records within 5 km of SUZ1, but suitable habitat likely to occur in study area.	-	PMST
Calidris tenuirostris	Great Knot	Mi, Ma	L	en	H	Non-breeding migrant to Australia during the austral summer. Mainly found on intertidal mudflats, sandflats and sandy beaches. No recent records within 5 km of SUZ1, but suitable habitat likely to occur in study area.	-	PMST

Scientific name	Common name	EPBC Act 1999	FFG Act 1988	DEPI Advisory list	Likelihood of occurrence :	Notes	Most recent database record	Other records
Charadrius leschenaultii	Greater Sand Plover	Mi, Ma		vu	Lo	Non-breeding migrant to Australia during the austral summer. Uses exposed sandflats and mudflats. High tide roost sites are often located on beaches. This species has been recorded at Mud Islands within Port Phillip Bay, and Reef Island in Western Port. No recent records within 5 km of SUZ1, but suitable habitat likely to occur within study area.	-	PMST
Charadrius mongolus	Lesser Sand Plover	Mi, Ma		vu	Lo	Non-breeding migrant to Australia during the austral summer. A Uses exposed sandflats and mudflats. High tide roost sites are often located on beaches. This species has been recorded at Mud Islands and Western Treatment Plant within Port Phillip Bay, and Reef Island within Western Port. No recent records within 5 km of SUZ1, but suitable habitat likely to occur within study area.	-	PMST
Coturnix ypsilophora	Brown Quail			nt	H	Occurs in rank grasses near wetlands, drains, pastures, crops and stubble. Also found in coastal heaths and areas with dense ground cover. Recent records within 5 km of SUZ1, and suitable habitat may occur within study area.	2000	
Egretta garzetta	Little Egret	Ma	L	en	H	Mudflats, estuaries, wetlands. Recent records within 5 km of SUZ1, and suitable habitat likely to occur within study area.		
Gallinago hardwickii	Latham's Snipe	Mi, Ma		nt	H	Non-breeding migrant to Australia during the austral summer. Uses a wide variety of permanent and ephemeral wetlands, generally freshwater wetlands with cover. Also recorded along creeks, rivers and floodplains. Forages in soft mud at edge of wetlands and roosts in a variety of vegetation around wetlands including tussock grasslands, reeds and rushes, tea-tree scrub, woodlands and forests. Recent records within 5 km of SUZ1, and suitable habitat may occur within study area.	2001	PMST
Haematopus fuliginosus	Sooty Oystercatcher			nt	H	Coastal resident in Victoria. Rocky shorelines. Recent records within 5 km of SUZ1, and suitable habitat likely to occur within study area.		

Scientific name	Common name	EPBC Act 1999	FFG Act 1988	DEPI Advisory list	Likelihood of occurrence :	Notes	Most recent database record	Other records
Haliaeetus leucogaster	White-bellied Sea-Eagle	Mi, Ma	L	vu	H	Occurs in coastal and marine habitats and large terrestrial wetlands, including deep freshwater swamps, lakes, reservoirs, billabongs and rivers. Uses tall trees in or near water for breeding. No recent records within 5 km of SUZ1, but suitable habitat occurs within study area.	-	PMST
Hydroprogne caspia	Caspian Tern	Mi, Ma	L	nt	H	Occurs on exposed ocean beaches, sheltered coastal embayments including harbours, lagoons, inlets, estuaries and river deltas, usually with sandy or muddy margins. Breeds in a variety of coastal habitats including banks, ridges and beaches of sand and shell, often in open or among low or sparse vegetation. Previous records within 5 km of SUZ1, and suitable habitat occurs within study area.	1996	PMST
Hylacola pyrrhopygia	Chestnut-rumped Heathwren		L	vu	Lo	Occurs in shrubland and heathland areas, and in dense scrubby areas of forests and woodlands. Shy species that typically forages on or near the ground and therefore requires habitat with suitable structure. Previous records within 5 km of SUZ1, but not for more than 30 years, and suitable habitat may occur within study area.	1980	
Larus pacificus	Pacific Gull	Ma	I	nt	H	Occurs along sandy and rocky coasts, usually in areas protected from ocean swells, such as bays, estuaries and lagoons. Breeds in a variety of coastal habitats including rocky outcrops, small hillocks, ridges, sides of cliffs and sometimes low-lying beaches. Sometimes occurs up to 10 kilometres inland, especially at rubbish tips and wetlands. Recent records within 5 km of SUZ1, and suitable habitat occurs within study area.	2008	
Lathamus discolor	Swift Parrot	EN, Ma	L	en	N	Winter migrant to Victoria (and other parts of SE Australia) from breeding areas in Tasmania. In Victoria, prefers dry, open eucalypt forests and woodlands, especially Box Ironbark Forest in north-central Victoria. Occasionally recorded in urban parks, gardens, street trees and golf courses with flowering ornamental trees and shrubs. No records within 5 km of SUZ1, and suitable native habitat unlikely to occur within study area.	-	PMST

Scientific name	Common name	EPBC Act 1999	FFG Act 1988	DEPI Advisory list	Likelihood of occurrence :	Notes	Most recent database record	Other records
Lewinia pectoralis	Lewin's Rail		L	vu	Lo	Inhabits densely vegetated wetlands, including swamps, farm dams, saltmarshes, lakes and small pools that can range from fresh to saline water. May also use riverine forest. No records within 5 km of SUZ1 for more than 30 years. Suitable habitat may occur within study area.	1980	
Neophema chrysogaster	Orange-bellied Parrot	CR, Mi, Ma	L	cr	N	Winter migrant to coastal Victoria and South Australia from breeding areas in south-west Tasmania. Forages in coastal or near-coastal areas such as saltmarshes, coastal dunes, pastures, shrublands, estuaries, islands, beaches and moorlands. No records within 5 km of SUZ1, but suitable habitat likely to occur within study area.	-	PMST
Numenius madagascariensis	Eastern Curlew	Mi, Ma		nt	H	Non-breeding migrant to Australia during the austral summer. Uses a variety of sheltered coastal habitats including harbours, inlets and coastal lagoons, usually with large sand flats or intertidal mudflats with seagrass. Occasionally on coastal rock platforms. Recent records within 5 km of SUZ1, and suitable habitat likely to occur within study area.	2008	PMST
Numenius phaeopus	Whimbrel	Mi, Ma		vu	H	Non-breeding migrant to Australia during the austral summer. Typically found in coastal environments including mudflats, sandy shores and rock platforms. Rarely recorded inland. No records within 5 km of SUZ1, but suitable habitat likely to occur within study area.	-	PMST
Nycticorax caledonicus hillii	Nankeen Night Heron	Ma		nt	H	Occurs in a variety of estuarine and terrestrial wetlands, foraging in shallow still or slow-moving water or on exposed banks, mudflats and within swamp vegetation. Also uses wet meadows and pastures, urban wetlands and ponds, preferring areas with swampy fringing vegetation and nearby trees for roosting. Recent records within 5 km of SUZ1, and suitable habitat likely to occur within study area.	2000	
Oxyura australis	Blue-billed Duck		L	en	N	Aquatic species preferring deep, large permanent freshwater wetlands with stable conditions and abundant aquatic vegetation. Occasionally on river frontages, billabongs and flooded depressions. Historical records within 5 km of SUZ1, but not in the past 20 years. Suitable habitat may occur within study area.	1993	

Scientific name	Common name	EPBC Act 1999	FFG Act 1988	DEPI Advisory list	Likelihood of occurrence :	Notes	Most recent database record	Other records
Phalacrocorax varius	Pied Cormorant			nt	H	Inhabits marine, coastal and freshwater environments, including beaches, coastal lagoons, estuaries, rock platforms, terrestrial wetlands, rivers, lakes and billabongs. Breeds and roosts in trees or bushes along the edges of water body, as well as on artificial structures such as pylons. Recent records within 5 km of SUZ1, and suitable habitat likely to occur within study area.	2010	
Platalea regia	Royal Spoonbill			vu	H	Uses permanent and ephemeral waters, foraging in shallow water. Prefers terrestrial wetlands and wet grassland areas, particularly large expanses of water such as lakes, swamps or lagoons and large rivers, but also recorded in coastal habitats such as estuaries, inlets and intertidal mudflats. Recent records within 5 km of SUZ1, and suitable habitat may occur within study area.	2010	
Pluvialis fulva	Pacific Golden Plover	Mi, Ma		nt	H	Non-breeding migrant to Australia during the austral summer. Usually occurs in a range of coastal habitats including mudflats, sandflats rocky shores and saltmarsh. No records within 5 km of SUZ1, but suitable habitat likely to occur within study area.	-	PMST
Pluvialis squatarola	Grey Plover	Mi, Ma		nt	H	Non-breeding migrant to Australia during the austral summer. Habitat includes mudflats, saltmarsh, tidal reefs and estuaries. No records within 5 km of SUZ1, but suitable habitat likely to occur within study area.	-	PMST
Rostratula australis	Australian Painted Snipe	VU, Ma	L	cr	Lo	Generally uses shallow, terrestrial freshwater wetlands with rank, emergent tussocks of grass, sedges and rushes. Occurs also in well vegetated lakes, swamps, inundated pasture, saltmarsh and dams. No records within 5 km of SUZ1, but suitable habitat may occur within study area.	-	PMST
Stagonopleura guttata	Diamond Firetail		L	vu	N	Occurs mostly in grassy woodlands with tree cover and an undisturbed grassy ground layer. Generally in the lowlands and foothills north of the study area. No records within 5 km of SUZ1 for more than 100 years.	1908	

Scientific name	Common name	EPBC Act 1999	FFG Act 1988	DEPI Advisory list	Likelihood of occurrence :	Notes	Most recent database record	Other records
Sternula albifrons	Little Tern	Mi, Ma	L	vu	H	Mostly recorded in sheltered coastal environments, including bays, lagoons and estuaries. Nests on sandy substrates containing much shell-grit. No records within 5 km of SUZ1, but suitable habitat likely to occur within study area.	-	PMST
Sternula nereis	Fairy Tern	VU, Ma	L	en	H	Inhabits coastal environments including intertidal mudflats, sand flats and beaches. Nests above high-water mark on sandy shell-grit beaches. No records within 5 km of SUZ1, but suitable habitat likely to occur within study area.	-	PMST
Thinornis rubricollis	Hooded Plover	Ma	L	vu	N	In Victoria, prefers sandy, broad, flat ocean beaches. Prefers beachcast seaweed for feeding activities and sparsely vegetated back dunes for shelter and nesting. No records within 5 km of SUZ1, and suitable habitat unlikely to occur within study area.	-	PMST
Tringa brevipes	Grey-tailed Tattler	Mi, Ma	L	cr	H	Non-breeding migrant to Australia during the austral summer. Occurs in estuaries, tidal mudflats, mangroves, wave-washed rocks and reefs and shallow river margins coastal and inland. No records within 5 km of SUZ1, but suitable habitat likely to occur within study area.	-	PMST
Tringa glareola	Wood Sandpiper	Mi, Ma		vu	H	Non-breeding migrant to Australia during the austral summer. Inhabits well vegetated shallow freshwater wetlands with emergent aquatic plants and dense fringing vegetation. Occasionally in intertidal habitats, including mangroves. No records within 5 km of SUZ1, but suitable habitat likely to occur within study area.	-	PMST
Xenus cinereus	Terek Sandpiper	Mi, Ma	L	en	H	Non-breeding migrant to Australia during the austral summer. Mainly found on saline intertidal mudflats in sheltered estuaries, embayments, harbours and lagoons. No records within 5 km of SUZ1, but suitable habitat likely to occur within study area.	-	PMST

Scientific name	Common name	EPBC Act 1999	FFG Act 1988	DEPI Advisory list	Likelihood of occurrence :	Notes	Most recent database record	Other records
Reptiles								
Lissolepis coventryi	Swamp Skink		L	vu	H	Occupies swamp scrub habitat in cool, temperate, low-lying wetlands, river margins, lakes, swamp margins and estuarine areas with a dense shrub layer, particularly in near-coastal areas across southern Victoria. Often associated with stands of paperbark and tea-tree, , usually in heathy or scrubby areas. Historical records within 5 km of SUZ1, and suitable habitat may occur within study area.	2000	
Pseudemoia rawlinsoni	Glossy Grass Skink			en	M	Uses swamp and lake edges, saltmarshes and boggy creeks with dense vegetation. Records near the study area, and suitable habitat likely to occur in study area,		
Frogs								
Litoria raniformis	Growling Grass Frog	VU	L	en	Lo	Occupies a variety of permanent and semi-permanent water bodies generally containing abundant submerged and emergent vegetation, within lowland grasslands, woodlands and open forests. Historical records within 5 km of SUZ1. Suitable habitat may occur within study area.	1999	PMST
Pseudophryne semimarmorata	Southern Toadlet			vu	M	Occupies a variety of habitats in south-eastern Australia, such as open forests, lowland woodlands and heathlands where adults shelter beneath leaf litter and other debris in moist soaks and depressions. Historical records within 5 km of SUZ1, but not in past 30 years. Suitable habitat may occur within study area.	1980	
Fishes								
Galaxiella pusilla	Dwarf Galaxias	VU	L	vu	Lo	Occurs in relatively shallow still or slow flowing water bodies including streams, wetlands, drains, that in many instances are ephemeral and partially dry up over summer. Typically requires abundant marginal and aquatic vegetation. No historical records within 5km of SUZ1, and suitable habitat considered unlikely to occur within study area.	-	PMST

Scientific name	Common name	EPBC Act 1999	FFG Act 1988	DEPI Advisory list	Likelihood of occurrence :	Notes	Most recent database record	Other records
Mugilogobius platynotus	Pale Mangrove Goby		L	vu	H	In Victoria it is found almost exclusively in the tidal mangrove forests of estuaries. Recent records within 5 km of SUZ1, and suitable habitat likely to occur within study area.	2009	
Prototroctes maraena	Australian Grayling	VU	L	vu	N	A diadromous species which spends most of its life in freshwater habitats, typically rivers and streams with cool, clear waters and gravel substrates, but occasionally also in turbid waters. Juveniles inhabit estuaries and coastal seas. No historical records within 5 km of SUZ1, and suitable habitat considered unlikely to occur within study area.	-	PMST
Invertebrates								
Synemon plana	Golden Sun Moth	CR	L	cr	N	This small diurnal moth inhabits grassy woodlands and grasslands. Once thought to be a specialised species inhabiting grasslands dominated by Wallaby-grasses, it is now recognised that this species can occur in exotic grasslands dominated by Chilean Needle Grass *Nassella neesiana*. No historical records within 5 km of SUZ1, and suitable habitat considered unlikely to occur within study area.	-	PMST

Appendix C Threatened flora species relevant to marine and intertidal areas of Western Port

This table identifies flora known (VBA) or predicted to occur (PMST) within marine and intertidal areas of Western Port (i.e., excluding terrestrial areas). Flora relevant to the SUZ1 (i.e., terrestrial habitats) are shown in Appendix B.

Key

EPBC	Listed under the *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act)
FFG	Listed under the *Flora and Fauna Guarantee Act 1988* (FFG Act)
k	Poorly known under the Victorian Advisory List for Rare or Threatened Species
r	Rare Victorian under the Victorian Advisory List for Rare or Threatened Species
H	High probability of occurrence
M	Moderate probability of occurrence

Scientific name	Common name	EPBC Act 1999	FFG Act 1988	VRoTS 2005	Saltmarsh	Mangrove	Mudflats	Subtidal	Deep Water	Likelihood	Habitat Description	Source
Amphibolis antartica	Sea Nymph			r					x	H	Found in the oceanic section of the western entrance	Chidgey *et al*. 2013; VBA (DEPI, 2012)
Atriplex paludosa subsp. *paludosa*	Marsh Saltbush			r	x					M	Locally common on fringes of coastal and near coastal saltmarshes west from Wilsons Promontory (Walsh and Entwisle 1996). Nearest known occurrence Tyabb (< 1km 1999)	VBA (DEPI, 2012)
Avicennia marina subsp. *australasica*	Grey Mangrove			r		x	x			H	Locally common on tidal mudflats from the western half of Port Phillip bay to Corner Inlet (Walsh and Entwisle 1996). Found within study area in 2009.	Venosta *et al.* 2009; VBA (DEPI, 2012)
Halophila ovalis	Oval Sea-wrack			k					x	H	Occurs in sparsely populated beds in the deeper and lower light waters of parts of Western Port.	Chidgey *et al*. 2013; VBA (DEPI, 2012)
Juncus revolutus	Creeping Rush			r	x					H	Was thought to be restricted to damp saline or subsaline communities near the coast, with a small number of outlying populations around saline lakes on the volcanic plains (Walsh and Entwisle 1994). Found within study area in 2009.	Venosta *et al.* 2009; VBA (DEPI, 2012)
Lachnagrostis robusta	Salt Blown-grass			r	x					H	Found within study area in 2009.	Venosta *et al*. 2009
Lawrencia spicata	Salt Lawrencia			r	x					M	An occasional component of saltmarsh communities along the coast, rare in saline depressions and around salt lakes of south-western Victoria (Walsh and Entwisle 1996). Nearest known occurrence (5km).	VBA (DEPI, 2012)

Scientific name	Common name	EPBC Act 1999	FFG Act 1988	VRoTS 2005	Saltmarsh	Mangrove	Mudflats	Subtidal	Deep Water	Likelihood	Habitat Description	Source
Lepidosperma canescens	Hoary Rapier-Sedge			r	x					M	Scattered on damp saline soils near salt-lakes, and forming part of herbfield in coastal saltmarshes (Walsh and Entwisle 1996). Nearest known occurrence (5km).	VBA (DEPI, 2012)
Limonium australe	Yellow Sea-lavender			r	x					H	In Victoria apparently confined to mangrove and saltmarsh communities near Point Lonsdale, Western Port, Shallow Inlet and Corner Inlet. Found within study area in 2009.	Venosta *et al.* 2009; VBA (DEPI, 2012)
Triglochin minutissima	Triglochin minutissima			r	x					M	Scattered on damp saline soils near salt-lakes, and forming part of herbfield in coastal saltmarshes (Walsh and Entwisle 1996). Nearest known occurrence (5 km)	VBA (DEPI, 2012)
Zostera muelleri	Eel Grass			k			x			H	Occurs on intertidal mudflats	Chidgey *et al*. 2013; VBA (DSE,2011)
Zostera nigricaulis	Australian Grass-wrack			k			x	x		H	Occurs in shallow subtidal and lower intertidal habitats in the north and east of Western Port,;	Chidgey *et al*. 2013; VBA (DEPI, 2012)

Appendix D Threatened Vertebrate and Invertebrate Fauna Species relevant to marine and intertidal areas of Western Port

This table identifies vertebrate and invertebrate fauna known (VBA) or predicted to occur (PMST) within marine and intertidal areas of Western Port (i.e., excluding terrestrial areas). Fauna relevant to the SUZ1 (i.e., terrestrial habitats) are shown in Appendix B.

Key

EPBC	Listed under the *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act)
FFG	Listed under the *Flora and Fauna Guarantee Act 1988* (FFG Act)
DEPI	Victorian Advisory Lists for Threatened Vertebrate (DEPI 2013) or Invertebrate (DEPI 2009) Fauna Species (Department of Environment and Primary Industries)
CR/cr	Critically endangered under the EPBC Act / DEPI list
EN/en	Endangered under the EPBC Act / DEPI list
VU/vu	Vulnerable under the EPBC Act / DEPI list
Ma	Listed as Marine under the EPBC Act
Mi	Listed as Migratory under the EPBC Act
L	Listed as threatened under the FFG Act
I	Nominated for listing as threatened under the FFG Act, but not yet accepted
nt	Near threatened under DEPI list
dd	Data deficient under DEPI list
H	High probability of occurrence
M	Moderate probability of occurrence
Lo	Low probability of occurrence
N	Negligible probability of occurrence

Scientific name	Common name	EPBC	FFG	DEPI	Migratory	Marine	Saltmarsh	Mangroves	Mudflats	Subtidal seagrass	Deep water	Likelihood of occurrence	Notes	Most recent database record	Other records
Mammals															
Arctocephalus forsteri	New Zealand Fur Seal			vu		Ma					x	H	Breeds on islands off the southern Australian coast.	2007	PMST
Arctocephalus pusillus	Australian Fur Seal					Ma					x	H	Once common along the south-east mainland and Tasmanian coastline. Uncontrolled sealing activity last century eliminated all but nine breeding colonies, all of which are in Bass Strait, including one large colony at Seal Rocks at the western end of Phillip Island. Individuals currently roam wildly within the species' historical range, often resting along coastal areas.	-	PMST
Arctocephalus tropicalis	Subantarctic Fur Seal	VU				Ma					x	N	Widely distributed in the Southern Ocean, records on Victoria's central coast are thought to be part of an influx of stranded individuals in southern Australia since 1986.	1998	
Balaenoptera edeni	Bryde's Whale			dd	Mi						x	N	Reported from Victorian waters on less than 5 occasions	-	PMST
Balaenoptera musculus	Blue Whale	EN	L	cr	Mi						x	N	Found throughout the Southern Ocean, though migration paths appear to be diffuse and widespread. Often enters coastal waters, including Victoria (particularly the smaller subspecies Balaenoptera physalus).	-	PMST
Balaenoptera physalus	Fin Whale	VU		dd	Mi						x	N	Occurs worldwide with populations in the southern hemisphere undergoing extensive north-south migrations. Only one record in Victoria.	1956	
Caperea marginata	Pygmy Right Whale				Mi						x	N	Circumpolar range in temperate to subantarctic oceans. Very rarely recorded in Victorian waters. Appears to generally use deep waters, rare near coast.	1989	PMST
Eubalaena australis	Southern Right Whale	EN	L	cr	Mi						x	N	Migrates between summer feeding grounds in the Southern Ocean to warmer northern waters over winter, where it can be found along the Victorian coastline.	2003	PMST
Hydrurga leptonyx	Leopard Seal					Ma					x	L	Breeds in Antarctica, but regular visitor to southern Australia, including Victorian coast, mostly as sub-adult. Pelagic. Solitary. Eats wide variety of marine fauna, including penguins and seals.	2003	
Lagenorhynchus obscurus	Dusky Dolphin				Mi						x	N	Appears to have disjunct populations in southern oceans. First confirmed report from Australian waters, off eastern Tasmania, in 2000, but none from Victoria	-	PMST
Megaptera novaeangliae	Humpback Whale	VU	L	vu	Mi						x	N	Migrates between summer feeding grounds in the Southern Ocean to Northern waters where birthing and mating occurs. Increasingly recorded along the Victorian coast, occasionally entering Port Phillip and Western Port.	2010	PMST

Scientific name	Common name	EPBC	FFG	DEPI	Migratory	Marine	Saltmarsh	Mangroves	Mudflats	Subtidal seagrass	Deep water	Likelihood of occurrence	Notes	Most recent database record	Other records
Mirounga leonina	Southern Elephant Seal	VU				Ma					x	N	Return to land to moult from December to February, preferring sandy beaches adjacent to Poa tussock. Victorian records likely to be of stragglers, which have been found along the entire Victorian coast, including Port Phillip and Hobsons Bay.	1985	
Neophoca cinerea	Australian Sea Lion	VU				Ma					x	N	Marine habitat is the continental sea off south-western and southern Australia, with the few Victorian records found west of Petersborough.	1998	
Orcinus orca	Killer Whale				Mi						x	L	Recorded along Victorian coast. Records from near Phillip Island and Kilcunda areas.	2010	PMST
Physeter macrocephalus	Sperm Whale				Mi						x	N	Stranded individuals have been recorded from the Wonthaggi area on a number of occasions. However, Victorian waters are considered not to offer suitable habitat. Sperm Whales that stray into Bass Strait are thought to do so by accident and do not remain long.	1984	
Birds															
Actitis hypoleucos	Common Sandpiper			vu	Mi	Ma	x	x	x			H	Migrates to Australia from Eurasia in August where it inhabits a wide variety of coastal and inland wetlands with muddy margins before departing north in March.	2011	PMST
Anas rhynchotis	Australasian Shoveler			vu								H	Prefers large, permanent lakes and swamps with deep water, stable conditions and abundant aquatic vegetation. Less commonly recorded in small or shallow waters, such as billabongs, sewage ponds, freshwater rivers and densely vegetated farm dams. Forages in open water but nests in densely vegetated freshwater wetlands, where fringing vegetation may be an important habitat feature.	2012	
Anseranas semipalmata	Magpie Goose		L	nt		Ma	x					M	Uses aquatic and terrestrial habitat, although most activity occurs on wetlands such as those associated with flood plains. Historically occurring in south-eastern Australia, however, loss of wetland habitats meant the species became extinct in Victoria in the early 1900s. Re-introduction attempts have had mixed results.	2007	
Apus pacificus	Fork-tailed Swift				Mi	Ma	x	x	x	x	x	H	Aerial species, occurring over a wide range of environments, predominately over open countryside but sometimes over forests and urban landscapes.	2007	PMST
Ardea intermedia	Intermediate Egret		L	cr		Ma	x	x	x			L	Breeds in flooded or fringing trees alongside wetlands. Forages more widely.	2012	

Scientific name	Common name	EPBC	FFG	DEPI	Migratory	Marine	Saltmarsh	Mangroves	Mudflats	Subtidal seagrass	Deep water	Likelihood of occurrence	Notes	Most recent database record	Other records
Ardea modesta	Eastern Great Egret		L	vu	Mi	Ma	x	x	x			H	Usually found in terrestrial wetland, estuarine and wet grassland habitats particularly permanent well-vegetated water bodies but also use freshwater meadows, channels and larger dams. Forages by wading on shallow open water, generally avoiding dry or deeply flooded areas preferring moist, low-lying, poorly drained pasture, especially near hollows and ditches and where tussocks of long grass are present. Uses estuarine mudflats as summer-autumn or drought refuges.	2012	PMST
Ardenna carneipes	Flesh-footed Shearwater				Mi	Ma					x	L	Rare visitor to Victoria, including Bass Strait, and Tasmania.	1981	PMST
Ardenna grisea	Sooty Shearwater				Mi	Ma					x	L	Predominantly a New Zealand species. Uncommon winter visitor to Victoria, including Bass Strait.	1977	
Ardenna tenuirostris	Short-tailed Shearwater				Mi	Ma					x	H	Breeds nearby at Phillip Island. Likely to forage across nearby oceans and pass through on annual migrations	2011	PMST
Arenaria interpres	Ruddy Turnstone				Mi	Ma	x	x	x			H	Non-breeding migrant, regular to Victoria. Typically coastal, on intertidal mudflats, sandflats and sandy beaches, rocky shores and intertidal reefs.	2011	PMST
Aythya australis	Hardhead			vu								H	Mainly aquatic, preferring large, deep freshwater environments with abundant aquatic vegetation, including slow moving areas of rivers. Also occurs in brackish wetlands and can be found in deep dams and water storage ponds. Occasionally in estuarine and littoral habitats such as saltpans, coastal lagoons and sheltered inshore waters. Avoids main streams or rivers, except in calm reaches where aquatic flora is developed.	2012	
Biziura lobata	Musk Duck			vu		Ma						H	Largely aquatic, preferring deep water on large, permanent swamps, lakes and estuaries with abundant aquatic vegetation. Often occurs in areas of dense vegetated cover within a wetland. Less commonly recorded in small or shallow waters, such as billabongs, sewage ponds, freshwater rivers and densely vegetated farm dams.	2012	
Botaurus poiciloptilus	Australasian Bittern	EN	L	en			x	x				H	Occurs in wetlands with tall, dense vegetation where it forages in shallow water at the edges of pools or waterways. Prefers permanent freshwater habitats, particularly when dominated by sedges, rushes and reeds.	2007	PMST
Bubulcus ibis	Cattle Egret				Mi	Ma	x	x	x			H	Sociable and commonly seen foraging around stock in paddocks and pastures. Also occurs in wetlands, tidal flats and altered environments such as drains and rubbish tips.	2010	PMST

Scientific name	Common name	EPBC	FFG	DEPI	Migratory	Marine	Saltmarsh	Mangroves	Mudflats	Subtidal seagrass	Deep water	Likelihood of occurrence	Notes	Most recent database record	Other records
Calidris acuminata	Sharp-tailed Sandpiper				Mi	Ma	x	x	x			H	Prefers muddy edges of shallow fresh or brackish wetlands with inundated or emergent low vegetation. Occasionally use flooded paddocks and other ephemeral wetlands but leave when they dry.	2012	PMST
Calidris alba	Sanderling			nt	Mi	Ma	x	x	x			H	Summer migrant to Victoria, with some non-breeding individuals remaining over winter. The species is typically found on sandy beaches and foraging among piles of seaweed.	2007	
Calidris canutus	Red Knot			nt	Mi	Ma	x	x	x			H	Non-breeding migrant, typically occurs on intertidal mudflats, sandflats and sandy beaches of sheltered coasts, and a range of other coastal and near-coastal environments such as lakes, lagoons, pools and pans, and recorded on sewage ponds and saltworks; inland lakes and swamps are less commonly used.	2008	PMST
Calidris ferruginea	Curlew Sandpiper				Mi	Ma	x	x	x			H	Regular summer migrant to Victoria. Occurs in a variety of wetland habitats with fringing mudflats including bays, coastal lagoons, lakes, swamps, creeks, inundated grasslands, saltmarshes and artificial wetlands.	2011	PMST
Calidris melanotos	Pectoral Sandpiper			nt	Mi	Ma	x	x	x			H	Occurs in a variety of wetland habitats with fringing mudflats including bays, coastal lagoons, lakes, swamps, creeks, inundated grasslands, saltmarshes and artificial wetlands. Mostly recorded from Port Phillip Bay and Murray River Valley region.	2004	
Calidris minuta	Little Stint				Mi	Ma	x	x	x			N	Rare summer vagrant to Australia, including Victoria. Occurs in intertidal mudflats and saltmarshes.	2001	
Calidris ruficollis	Red-necked Stint				Mi	Ma	x	x	x			H	Regular summer migrant to Victoria. Occurs in a variety of wetland habitats with fringing mudflats including bays, coastal lagoons, lakes, swamps, creeks, inundated grasslands, saltmarshes and artificial wetlands.	2012	PMST
Calidris subminuta	Long-toed Stint			nt	Mi	Ma	x	x	x			H	Occurs on a variety of terrestrial freshwater or brackish wetlands such as lakes, swamps, river floodplains, streams, lagoons, sewage ponds and reservoirs. The species is commonly observed on muddy fringes of drying ephemeral lakes and swamps. It is less commonly found on tidal estuaries, saline lakes, saltponds and bore swamps.	1980	
Calidris tenuirostris	Great Knot		L	en	Mi	Ma	x	x	x			L	Mainly found on intertidal mudflats, sandflats and sandy beaches.	2008	PMST

Scientific name	Common name	EPBC	FFG	DEPI	Migratory	Marine	Saltmarsh	Mangroves	Mudflats	Subtidal seagrass	Deep water	Likelihood of occurrence	Notes	Most recent database record	Other records
Cereopsis novaehollandiae	Cape Barren Goose			nt		Ma	x					H	Mostly breeds on offshore Victorian islands with immature birds dispersing to mainland areas to feed, though have been increasingly observed across mainland areas. Mainly terrestrial, they graze on short green herbage including grass, pasture and crops.	2012	
Ceyx azureus	Azure Kingfisher			nt								H	Found in association with well vegetated freshwater wetlands and slow-flowing creeks and rivers, including artificial wetlands and drains, of open riverine or swamp forest or woodland environments and occasionally among mangroves in sheltered coastal areas. Usually perches in shady, overhanging vegetation, nest in burrows tunnelled into banks above the floodline and generally forage by plunge-diving from a perch into the water body.	2008	
Charadrius bicinctus	Double-banded Plover				Mi	Ma	x	x	x			H	Breeds in New Zealand. Regular winter migrant to Victoria. Occurs in a variety of habitats including bays, mudflats, saltmarshes.	2011	PMST
Charadrius leschenaultii	Greater Sand Plover			vu	Mi	Ma	x	x	x			H	Migratory species that forages on exposed sand and mudflats. High tide roost sites are often located on beaches. This species has been recorded at Mud Islands within Port Phillip Bay, and Reef Island within Western Port.	2008	PMST
Charadrius mongolus	Lesser Sand Plover			vu	Mi	Ma	x	x	x			H	Migratory species that forages on exposed sand and mudflats. High tide roost sites are often located on beaches. This species has been recorded at Mud Islands within Port Phillip Bay, and Reef Island within Western Port.	2008	PMST
Charadrius ruficapillus	Red-capped Plover					Ma	x	x	x			H	Breeding resident in Victoria. Occurs in a variety of wetland habitats with fringing mudflats including bays, coastal lagoons, lakes, swamps, creeks, inundated grasslands, saltmarshes and artificial wetlands.	2011	PMST
Chlidonias hybrida	Whiskered Tern			nt		Ma	x					H	Breeding migrant to Australia from September to March where it occurs in wetlands, lakes, swamps, rivers, and other water bodies with submerged and emergent vegetation such as grasses, sedges, reeds and rushes. Rarely recorded along rivers or creeks.	2011	
Chlidonias leucopterus	White-winged Black Tern			nt	Mi	Ma	x	x	x	x	x	L	A seasonal migrant that occurs in coastal, subcoastal and terrestrial wetlands including bays, estuaries, swamps and floodplains. Majority of records in Victoria are from the Gippsland Lakes and the western shoreline of Port Phillip Bay.	1974	
Chroicocephalus novaehollandiae	Silver Gull					Ma	x	x	x	x	x	H	Resident and abundant.	2012	PMST

Scientific name	Common name	EPBC	FFG	DEPI	Migratory	Marine	Saltmarsh	Mangroves	Mudflats	Subtidal seagrass	Deep water	Likelihood of occurrence	Notes	Most recent database record	Other records
Circus approximans	Swamp Harrier					Ma	x	x	x			H	Resident in Victoria, including coastal areas. Inhabits swamps, wetlands, coasts, saltmarshes.	2012	
Circus assimilis	Spotted Harrier			nt								M	Inhabits open and wooded country of inland and sub-inland Australia, where they hunt over flat or undulating country with low vegetation cover. Most common over the Murray Valley with occasional visits to coastal Victoria.	1997	
Daption capense	Cape Petrel					Ma				x	x	H	Breeds in Antarctica and sub-Antarctic Islands. Regular winter visitor to offshore waters in south-east Australia, including Victoria.	1986	
Diomedea epomophora	Royal Albatross	VU	L	vu	Mi	Ma					x	N	Pelagic bird that occurs across the waters off southern Australia at all times of year, but especially between July and October. Rarely occurs in near-shore waters.	1976	PMST
Diomedea exulans	Wandering Albatross	VU	L	en	Mi	Ma					x	L	Pelagic bird that occurs in southern oceans, breeding on subantarctic islands. Principally forages in pelagic and/or continental shelf waters, rarely occurs in near-shore waters.	1983	PMST
Diomedea exulans amsterdamensis	Amsterdam Albatross	EN			Mi	Ma					x	N	Pelagic bird that breeds only on Amsterdam Island in the Indian Ocean. Vagrants may rarely enter Australian waters.	-	PMST
Diomedea exulans exulans	Tristan Albatross	EN			Mi	Ma					x	N	Pelagic bird that occurs in southern oceans. It breeds on subantarctic islands. One record from Australian waters, near Woollongong, N.S.W	-	PMST
Diomedea gibsoni	Gibson's Albatross	VU	L		Mi	Ma					x	N	Frequents the Tasman Sea and South Pacific Ocean. Individuals occur offshore in south-east Australian waters from Coff's Harbour in the north to Wilson's Promontory in the south	-	PMST
Diomedea sanfordi	Northern Royal Albatross	EN			Mi	Ma					x	N	Pelagic bird that occurs across the waters off southern Australia but are principally birds of the continental shelf regions. Rarely occurs in near-shore waters.	-	PMST
Egretta garzetta	Little Egret		L	en		Ma	x	x	x			H	Occupies a wide range of wetlands and typically prefers the shallows of wetlands for foraging activities. Occasionally they will forage in small waterways or wet grassland areas.	2009	
Eudyptes chrysocome	Rockhopper Penguin					Ma				x	x	N	Breeds on sub-Antarctic islands. Regular winter visitor to southern Australia, including Victoria.	1981	
Eudyptes pachyrhynchus	Fiordland Penguin					Ma				x	x	L	Breeds in New Zealand. Uncommon winter visitor to south eastern Australia, probably including Victoria.	1984	
Eudyptula minor	Little Penguin					Ma				x	x	H	Breeding resident in southern Victoria. Large colony at western end of Phillip Island, at entrance to Western Port.	2012	PMST

Scientific name	Common name	EPBC	FFG	DEPI	Migratory	Marine	Saltmarsh	Mangroves	Mudflats	Subtidal seagrass	Deep water	Likelihood of occurrence	Notes	Most recent database record	Other records
Fregata minor	Great Frigatebird				Mi	Ma				x	x	N	Tropical and sub-tropical species. Rare vagrant to Victoria.	1902	
Fregetta grallaria grallaria	White-bellied Storm-Petrel (Tasman Sea)	VU				Ma				x	x	N	Rare vagrant only to Australian waters	-	PMST
Fulmarus glacialoides	Southern Fulmar					Ma	x	x	x	x	x	L	Breeds in Antarctica. Uncommon, irregular winter visitor to southern Australia.	2007	
Gallinago hardwickii	Latham's Snipe			nt	Mi	Ma	x					H	A migrant to Australia from July to April occurring in a wide variety of permanent and ephemeral wetlands. Prefers open freshwater wetlands with nearby cover, but also recorded on the edges of creeks and rivers, river-pools and floodplains. Forages in soft mud at edge of wetlands and roosts in a variety of vegetation around wetlands including tussock grasslands, reeds and rushes, tea-tree scrub, woodlands and forests.	2008	PMST
Gallinago megala	Swinhoe's Snipe				Mi	Ma	x					N	Rare, non-breeding summer migrant to northern Australia.	-	PMST
Gallinago stenura	Pin-tailed Snipe				Mi	Ma	x					N	Rare, non-breeding summer migrant to Western Australia.	-	PMST
Garrodia nereis	Grey-backed Storm-Petrel					Ma				x	x	N	Breeds in New Zealand. Regular summer visitor to offshore southern Australian waters, but rare in Bass Strait.	1986	
Gelochelidon nilotica	Gull-billed Tern		L	en		Ma	x	x	x	x	x	M	Usually occurs on shallow terrestrial wetlands, less often using sheltered embayments, estuaries, tidal mudflats and beaches. In Australia mainly breeds in inland areas following major flooding events.	2011	
Glareola maldivarum	Oriental Pratincole				Mi	Ma	x	x	x			L	Breeds in northern hemisphere. Summer migrant to northern Australia. Rarely in south-east.	1974	
Haematopus fuliginosus	Sooty Oystercatcher			nt			x	x	x			H	Marine species typically inhabiting rocky shorelines, including cliff and reef areas, and sandy beaches between rocky headlands.	2012	
Haliaeetus leucogaster	White-bellied Sea-Eagle		L	vu	Mi	Ma	x	x	x	x	x	H	Occurs in marine habitats and terrestrial wetlands along or near coastal areas in eastern Victoria, particularly around large open wetlands such as deep freshwater swamps, lakes, reservoirs and billabongs. Uses tall trees in or near water for breeding.	2012	PMST
Haliastur sphenurus	Whistling Kite					Ma	x	x	x	x	x	H	Breeding resident throughout Australia. Typically along wooded watercourses, also in tall woodland, swamps, tidal inlets, mudflats, estuaries.	2012	
Halobaena caerulea	Blue Petrel	VU				Ma				x	x	L	Marine species, usually pelagic but sometimes observed over shallow waters. Occurs in Australian waters in winter and spring.	2000	PMST

Scientific name	Common name	EPBC	FFG	DEPI	Migratory	Marine	Saltmarsh	Mangroves	Mudflats	Subtidal seagrass	Deep water	Likelihood of occurrence	Notes	Most recent database record	Other records
Himantopus himantopus	Black-winged Stilt					Ma	x	x	x			H	Breeds in south-east Australia. Typically in freshwater and saltwater wetlands, coasts, salt lakes, saltmarshes, tidal inlets, mudflats, estuaries.	2012	PMST
Hirundapus caudacutus	White-throated Needletail				Mi	Ma	x	x	x	x	x	H	Almost exclusively aerial within Australia, occurring over most types of habitat, particularly wooded areas. Less often seen over open farm paddocks but has been recorded in vineyards flying between the rows of trees.	2010	PMST
Hydroprogne caspia	Caspian Tern		L	nt	Mi	Ma	x	x	x	x	x	H	Occurs on exposed ocean beaches or in sheltered coastal embayments including harbours, lagoons, inlets, estuaries and river deltas usually with sandy or muddy margins and breeds in a variety of coastal habitats including banks, ridges and beaches of sand and shell, often in open or among low or sparse vegetation.	2012	
Larus dominicanus	Kelp Gull					Ma	x	x	x	x	x	H	Found throughout New Zealand. In Australia, mostly occurs in sheltered coastal areas such as bays, estuaries and inlets, sandy or rocky beaches, mudflats and rock platforms. Roosts in a variety of habitats including rock stacks, beaches, playing fields and low scrub.	2012	PMST
Larus pacificus	Pacific Gull		I	nt		Ma	x	x	x	x	x	H	Occurs along sandy and, less often, rocky coasts usually in areas protected from ocean swells, such as bays estuaries and lagoons. Breeds in a variety of coastal habitats including rocky outcrops, small hillocks, ridges, sides of cliffs and sometimes low-lying beaches. Sometimes occur up to 10 kilometres inland, especially at rubbish tips and wetlands.	2012	PMST
Lathamus discolor	Swift Parrot	EN	L	en		Ma						H	Migrates to south-east mainland Australia during the winter months. On mainland, prefers dry, open eucalypt forests and woodlands, especially Box Ironbark Forest in north-central Victoria. Has also been recorded in urban parks, gardens, street trees and golf courses with flowering ornamental trees and shrubs.	2011	Yes
Leucophaeus pipixcan	Franklin's Gull					Ma	x	x	x	x	x	N	Chiefly American species. Rare vagrant to Australia. Generally not in Victoria.	2004	
Lewinia pectoralis	Lewin's Rail		L	vu	Mi		x	x				H	Inhabits densely vegetated wetlands, including swamps, farm dams, saltmarshes, lakes and small pools that can range from fresh to saline water. May also use riverine forest.	2011	
Limicola falcinellus	Broad-billed Sandpiper				Mi	Ma	x	x	x			M	Rare non-breeding summer migrant to coastal Australia. Visits tidal mudflats, reefs, saltmarshes.	1997	PMST
Limosa lapponica	Bar-tailed Godwit				Mi	Ma	x	x	x			H	Common non-breeding summer migrant to coastal and inland Australia. Visits tidal mudflats, reefs, saltmarshes, estuaries.	2012	PMST

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Limosa limosa	Black-tailed Godwit			vu	Mi	Ma	x	x	x			H	Primarily occurs in coastal environments such as bays, estuaries and lagoons with large intertidal mudflats or sandflats; occasionally found on rocky coasts or coral islets. Also recorded in shallow and sparsely vegetated, near-coastal, wetlands; and less commonly inland in the environs of shallow, freshwater and saline lakes, swamps, dams and bore-overflows.	2012	
Lophoictinia isura	Square-tailed Kite		L	vu								L	Typically inhabits coastal forested and wooded lands of tropical and temperate Australia.	1983	
Lugensa brevirostris	Kerguelen Petrel					Ma				x	x	N	Breeds on sub-Antarctic islands. Winter visitor to offshore waters around southern Australia.	1981	
Macronectes giganteus	Southern Giant-Petrel	EN	L	vu	Mi	Ma				x	x	L	Frequently observed along the southern coast of Australian waters during winter and spring.	1985	PMST
Macronectes halli	Northern Giant-Petrel	VU	L	nt	Mi	Ma				x	x	L	Frequently observed along the southern coast of Australian waters throughout the colder months. Often seen around sewer outfalls or seal and penguin colonies.	1996	PMST
Morus serrator	Australasian Gannet					Ma				x	x	H	Usually occurring in marine areas within the limits of the continental shelf where they feed in shallow waters. Approximately 32 pairs roost on a breakwater at Popes Eye, less than five kilometres from Queenscliff.	2011	
Neophema chrysogaster	Orange-bellied Parrot	CR	L	cr	Mi	Ma	x					L	Annual migrant (approximately March to October) to coastal Victoria from breeding grounds in south-west Tasmania. Forages in coastal or near-coastal habitats such as saltmarshes, coastal dunes, pastures, shrublands, estuaries, islands, beaches and moorlands.	2007	PMST
Neophema chrysostoma	Blue-winged Parrot					Ma	x					H	Breeds in south-eastern Australia. Uncommon to common visitor to most parts in Victoria, including coasts. Uses saltmarshes, coastal scrub.	2011	
Neophema pulchella	Turquoise Parrot		L	nt								L	Occupies woodlands and open forests in the foothills of the Great Dividing Range, in areas supporting a ground-cover of grasses and understorey of low shrubs. Individuals typically forage amongst grasses on or near the ground.	1982	

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Numenius madagascariensis	Eastern Curlew			nt	Mi	Ma	x	x	x			H	Migratory, arriving in Australia from Russia and China from August and departing around February. Occurs in a variety of sheltered coastal habitats including harbours, inlets and coastal lagoons, usually with large sand flats or intertidal mudflats with seagrass. Occasionally observed on coastal rock platforms.	2012	PMST
Numenius minutus	Little Curlew				Mi	Ma	x	x	x			H	Common non-breeding summer migrant to northern Australia. Casual visitor to south-east.	-	PMST
Numenius phaeopus	Whimbrel			vu	Mi	Ma	x	x	x			H	Summer migrant to Victoria. Typically found in coastal environments foraging in mudflats, sandy shores and the crevices of rock platforms. Rarely recorded inland.	2012	PMST
Nycticorax caledonicus hillii	Nankeen Night Heron			nt		Ma	x	x	x			H	Occurs in a variety of estuarine and terrestrial wetlands where it forages on the margins in shallow still or slow-moving water or exposed banks, mudflats and swamp vegetation of these environments. Also uses wet meadows and pastures, urban wetlands and ponds and preferring wetland areas with swampy fringing vegetation and nearby trees for roosting.	2012	
Onychoprion fuscata	Sooty Tern					Ma	x	x	x	x	x	N	Tropical marine tern. Rarely in south-east.	-	PMST
Oxyura australis	Blue-billed Duck		L	en								H	A largely aquatic species preferring deep, large permanent wetlands with stable conditions and abundant aquatic vegetation, including Melaleuca swamps. Occurs less commonly on river frontages, billabongs and flooded depressions. Secretive bird, rarely venturing far from dense vegetative cover in wetland areas.	2010	Yes
Pachyptila belcheri	Slender-billed Prion					Ma				x	x	L	Uncommon non-breeding winter visitor to Australian waters, including south-east.	2007	
Pachyptila desolata	Antarctic Prion					Ma				x	x	L	Primarily uses off-shore waters	1998	
Pachyptila salvini	Salvin's Prion					Ma				x	x	N	Uncommon non-breeding winter visitor to Australian offshore waters, including south-east.	2000	
Pachyptila turtur	Fairy Prion			vu		Ma				x	x	H	Portion of population breeds on Bass Strait, Wilsons Promontory and other Victorian islands. Mainly pelagic but over in-shore waters during rough weather.	2008	
Pachyptila vittata	Broad-billed Prion					Ma				x	x	L	Rare winter visitor to off-shore water	1986	
Pandion cristatus	Eastern Osprey				Mi	Ma	x	x	x	x	x	N	Widespread along Australian coastline, but now rare or absent from much of south-east, including Bass Strait, Victoria and Tasmania.	2002	PMST

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Pelagodroma marina	White-faced Storm-Petrel			vu		Ma				x	x	N	Breeding colonies occur on Mud and South Channel Islands in Port Phillip Bay. In Victoria they feed off the coast in pelagic and inshore waters.	2010	
Pelecanoides urinatrix	Common Diving-Petrel			nt		Ma				x	x	H	Occurs in inshore and pelagic waters off the Victorian coast and breeds on coastal islands.	2008	
Pelecanus conspicillatus	Australian Pelican					Ma	x	x	x	x	x	H	Common along Australian coastline and larger waterbodies inland. Uses freshwater and marine habitats.	2012	
Phalacrocorax fuscescens	Black-faced Cormorant			nt		Ma	x	x	x	x	x	H	Occurs in marine and estuarine habitats and forages over inshore waters and reefs, rarely entering small inlets or bays. Roost on islands, offshore rocks, sandbanks and jetties.	2012	
Phalacrocorax varius	Pied Cormorant			nt			x	x	x			H	Mainly inhabits marine environments and coastal waters including beaches, coastal lagoons, estuaries and rock platforms. Also found in terrestrial wetlands with open expanses of permanent water including rivers, inland lakes and billabongs. Breeds and roosts in trees or bushes along the edges of water body, as well as on artificial structures such as pylons.	2012	
Philomachus pugnax	Ruff				Mi	Ma	x	x	x			H	Regular but uncommon non-breeding summer migrant to coastal Australia, including south-east.	1998	
Platalea regia	Royal Spoonbill			vu			x	x	x			H	Often seen around permanent and ephemeral waters in the arid interior of east Australia foraging in shallow waters. Prefers terrestrial wetlands and wet grassland areas, particularly large expanses of water such as lakes, swamps or lagoons. Also utilises rivers for its feeding activities and has regularly been recorded in coastal habitats such as estuaries, inlets and intertidal mudflats .	2012	
Plegadis falcinellus	Glossy Ibis			nt	Mi	Ma	x	x	x			L	Usually found foraging in wet pasture environments and low lying wetland areas. Rarely recorded in Victoria. Prefers freshwater wetlands especially permanent or ephemeral water bodies on floodplains but also found in sheltered coastal environments.	2006	
Pluvialis fulva	Pacific Golden Plover			nt	Mi	Ma	x	x	x			H	Migratory shorebird that usually occurs in small flocks and occupies a range of coastal habitats including mudflats, sandflats rocky shores and saltmarsh.	2011	PMST
Pluvialis squatarola	Grey Plover			nt	Mi	Ma	x	x	x			H	Summer migrant to Australia; habitat includes mudflats, saltmarsh, tidal reefs and estuaries.	2001	PMST
Porphyrio porphyrio	Purple Swamphen						x					H	Common and widespread resident in south-eastern Australia. Mainly in freshwater habitats.	2012	

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Porzana pusilla	Baillon's Crake		L	vu		Ma	x	x	x			H	Occurs in a variety of densely vegetated terrestrial and coastal wetlands including billabongs, swamps, creeks and rivers, including freshwater, brackish and saline environments. Occasionally recorded in grassed or vegetated areas (parks, gardens, golf courses) and marine environments (saltmarshes, coastal dunes and mudflats).	2011	
Porzana tabuensis	Spotless Crake					Ma	x	x	x			H	Generally in freshwater wetlands with tall dense vegetation. Also saltmarshes and mangroves. Uncommon, nomadic, migratory.	2011	
Pterodroma lessonii	White-headed Petrel					Ma				x	x	L	Uncommon winter visitor to offshore waters surrounding southern Australia.	1982	
Pterodroma leucoptera	Gould's Petrel					Ma				x	x	N	Breeds on offshore NSW island. Uncommon to rare visitor to Victorian waters, generally not in Bass Strait.	1972	
Pterodroma macroptera	Great-winged Petrel					Ma				x	x	L	Breeds on offshore islands including south-west WA. Common to abundant in offshore Victorian waters, but not common close to shore.	1986	
Pterodroma mollis	Soft-plumaged Petrel	VU				Ma				x	x	M	Pelagic bird that occurs in southern oceans and is a common winter visitor to southern Australian seas.	-	PMST
Puffinus gavia	Fluttering Shearwater					Ma				x	x	L	Breeds on offshore New Zealand islands. Common winter visitor to Australian waters, including Victoria.	2008	
Puffinus huttoni	Hutton's Shearwater					Ma				x	x	N	Breeds in New Zealand. Common in offshore Australian waters, including Victoria.	2006	
Recurvirostra novaehollandiae	Red-necked Avocet					Ma	x	x	x			H	Breeds in inland Victorian and NSW. Uses freshwater, brackish and saline lakes, wetlands and coastal areas.	2011	PMST
Rostratula australis	Australian Painted Snipe	VU	L	cr		Ma						L	Generally found in shallow, terrestrial freshwater wetlands with rank, emergent tussocks of grass, sedges and rushes. Can occur in well vegetated lakes, swamps, inundated pasture, saltmarsh and dams.	1974	PMST
Spheniscus magellanicus	Magellanic Penguin					Ma				x	x	N	South American species. One vagrant record for Victoria.	1976	
Stercorarius parasiticus	Arctic Jaeger				Mi	Ma	x	x	x	x	x	H	Breeds in northern hemisphere. Regular summer visitor to coastal Australian waters, including Victoria.	2007	
Stercorarius pomarinus	Pomarine Jaeger				Mi	Ma	x	x	x	x	x	N	Most common over waters of the continental shelf, only occasionally recorded entering sheltered harbours and bays. Rarely observed resting on beaches .	1977	

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Stercorarius skua	Great Skua					Ma	x	x	x	x	x	L	Breeds in Antarctica. Sparse, uncommon but regular winter visitor to coastal Australian waters, including Victoria.	1965	PMST
Sterna hirundo	Common Tern				Mi	Ma	x	x	x	x	x	H	Breeds in northern hemisphere. Regular summer migrant to offshore and coastal Australian waters, including Victoria.	2004	
Sterna paradisaea	Arctic Tern					Ma	x	x	x	x	x	H	Breeds in northern hemisphere. Regular summer migrant to offshore and coastal Australian waters, including Victoria.	1960	
Sterna striata	White-fronted Tern			nt		Ma	x	x	x	x	x	H	Regular migrant from March to October, where it can be found in Victoria's offshore waters, bays, reefs and Islands.	2007	
Sternula albifrons	Little Tern		L	vu	Mi	Ma	x	x	x	x	x	H	Mostly recorded in sheltered coastal environments, including bays, lagoons and estuaries. Nests on sandy substrates containing much shell-grit, which provides good camouflage for their eggs.	2008	PMST
Sternula nereis	Fairy Tern	VU	L	en		Ma	x	x	x	x	x	H	Inhabits coastal environments including intertidal mudflats, sand flats and beaches. Nests above high-water mark on sandy shell-grit beaches.	2011	PMST
Stictonetta naevosa	Freckled Duck		L	en								H	Usually found on densely vegetated freshwater wetlands. During dry conditions the birds move from ephemeral wetlands to large areas of permanent open water, particularly lakes and reservoirs.	2006	Yes
Thalassarche bulleri	Buller's Albatross	VU	L		Mi	Ma				x	x	L	Occurs primarily over the shelf and slope waters off Southern New Zealand. Occasionally in south-eastern Australian waters, mainly between January and April.	-	PMST
Thalassarche cauta	Shy Albatross	VU	L	vu	Mi	Ma				x	x	H	Pelagic seabird that occurs throughout the southern oceans. In winter, leaves breeding areas to forage in pelagic and/or continental shelf waters including southern Australian waters. Frequently occurs in near-shore waters.	2009	PMST
Thalassarche chlororhynchos	Yellow-nosed Albatross	VU	L	vu	Mi	Ma				x	x	L	The most common albatross in the Great Australian Bight, central Bass Strait and Australian mainland coast north to Coff's Harbour.	1981	Yes
Thalassarche chrysostoma	Grey-headed Albatross	EN	L	vu	Mi	Ma				x	x	L	Regular visitor to open waters of Australia, especially in winter. Seen at sea occasionally in Victorian waters	1974	PMST
Thalassarche melanophris	Black-browed Albatross	VU	I	vu	Mi	Ma				x	x	H	In Australian waters, forages along the southern coasts, sometimes entering bays and harbours. Sub-adults observed in Australian waters all year round.	2008	PMST

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Thalassarche melanophris impavida	Campbell Albatross	VU			Mi	Ma				x	x	L	Occurs in Antarctic and sub-Antarctic waters and in the subtropical South Pacific Ocean. Non-breeding birds often forage over the continental shelf around Tasmania, Victoria and New South Wales	-	PMST
Thalassarche salvini	Salvin's Albatross	VU			Mi	Ma				x	x	M	Small numbers of non-breeding adults regularly cross the Tasman Sea from New Zealand to south-east Australian waters, where may occur in near-shore waters.	-	PMST
Thalasseus bergii	Crested Tern					Ma	x	x	x	x	x	H	Mostly coastal, particularly or in sheltered embayments such as bays, inlets, estuaries and lagoons . Breeds on offshore islands.	2012	PMST
Thinornis rubricollis	Hooded Plover		L	vu		Ma	x	x	x			H	In south-east Australia, prefers sandy ocean beaches, especially those that are broad and flat, with a wide beach zone for feeding. Prefers beachcast seaweed for feeding activities and sparsely vegetated back dunes for shelter and nesting.	2012	PMST
Threskiornis molucca	Australian White Ibis					Ma	x	x	x			H	Resident in Victoria and other parts of Australia. Common to abundant in inland and coastal areas.	2012	
Threskiornis spinicollis	Straw-necked Ibis					Ma	x	x	x			H	Resident in Victoria and other parts of Australia. Common in inland and coastal areas. Often on wet paddocks.	2012	
Todiramphus sanctus	Sacred Kingfisher					Ma	x	x	x			H	Regular spring/summer breeding migrant to southern Australia, including coastal Victoria. Uses broad variety of habitats, including mangroves and saltmarshes.	2011	
Tringa brevipes	Grey-tailed Tattler		L	cr	Mi	Ma	x	x	x			H	Summer migrant to coastal Australia it occurs in estuaries, tidal mudflats, mangroves, wave-washed rocks and reefs and shallow river margins coastal and inland.	2011	PMST
Tringa glareola	Wood Sandpiper			vu	Mi	Ma	x	x	x			H	Inhabits well vegetated shallow freshwater wetlands with emergent aquatic plants and dense fringing vegetation. Migratory species from Eurasia with only a small number reaching Australia.	2003	PMST
Tringa incana	Wandering Tattler				Mi	Ma	x	x	x			L	Rocky islands, reefs, cays. Wave-washed rocks. Uncommon by probably regular summer non-breeding migrant to eastern Australia. Rarely to Victoria.	-	PMST
Tringa nebularia	Common Greenshank				Mi	Ma	x	x	x			H	Regular, widespread, summer non-breeding migrant to Australia, including coastal Victoria. Mainly coastal, but inland sometimes. Uses river margins, mudflats, estuaries, saltmarshes.	2012	
Tringa stagnatilis	Marsh Sandpiper				Mi	Ma	x	x	x			H	Regular, summer non-breeding migrant to Australia, including coastal Victoria. Uses river margins, mudflats, estuaries, saltmarshes.	2006	PMST

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Tryngites subruficollis	Buff-breasted Sandpiper				Mi	Ma	x	x	x			L	Rare, summer non-breeding migrant to Australia, including Victoria. Mostly in freshwater habitats. Occasionally in intertidal habitats.	1953	
Turnix velox	Little Button-quail			nt								N	Summer migrant to Victoria mostly occurring in riverine areas but with scattered records throughout the north and west of the state. Occurs in a variety of habitats including dense grasslands, grassy woodlands and the margins of wetlands, as well as modified habitats such as pastures, crops and stubble.	1969	
Xenus cinereus	Terek Sandpiper		L	en	Mi	Ma	x	x	x			M	Mainly found on saline intertidal mudflats in sheltered estuaries, embayments, harbours and lagoons.	2011	PMST
Reptiles															
Caretta caretta	Loggerhead Turtle	EN			Mi	Ma				x	x	N	Forages widely in the waters of coral and rocky reefs, seagrass beds and muddy bays throughout eastern, northern and western Australia. Nesting occurs in coastal environments of northern WA, NT and QLD. Rarely in southern Victoria	-	PMST
Chelonia mydas	Green Turtle	VU			Mi	Ma				x	x	N	Marine species with a pan-tropical distribution throughout the world. More abundant along the tropical coasts of Australia and the Great Barrier Reef. Green Turtles spend their first five to ten years drifting on ocean currents. Rarely in southern Victoria	-	PMST
Dermochelys coriacea	Leathery Turtle	EN	L	cr	Mi	Ma				x	x	L	Marine species usually sighted along the eastern seaboard often in bays, estuaries and rivers. No major nesting events have been recorded in Australia. Rarely in southern Victoria	-	PMST
Fish															
Carcharodon carcharias	Great White Shark	VU	L	vu	Mi						x	M	Widely distributed, and located throughout temperate and sub-tropical regions in the northern and southern hemispheres. Primarily found in the coastal and offshore areas of the continental and insular shelves and offshore continent. Known to occur off Phillip Island	-	PMST
Galaxiella pusilla	Dwarf Galaxias	VU	L	vu								L	Freshwater species. Occurs in relatively shallow still or slow flowing water bodies including streams, wetlands, drains, that in many instances are ephemeral and partially dry up over summer. Typically requires abundant marginal and aquatic vegetation.	2008	PMST

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Heraldia nocturna	Eastern upside-down pipefish					Ma				x	x	M	Occurs from the central coast of Victoria to southern Western Australia in protected bays and estuaries down to a depth of about 20 m, where it is usually seen in pairs in caves and under ledges.	-	PMST
Hippocampus breviceps	Short-snouted seahorse					Ma				x	x	L	Sargassum, sponge reefs in deeper water, or rock reef covered in macro algae.	-	PMST
Hippocampus minotaur	Bullneck seahorse					Ma				x	x	L	Known from only three specimens trawled in relatively deep waters off south-eastern Australia.	-	PMST
Histiogamphelus briggsii	Briggs' Crested Pipefish					Ma				x	x	L	Usually occurs on sandy areas near rocks, seagrass or in algal beds and also shelter amongst decaying leaves of the eelgrass *Posidonia* between 3-20 m.	-	PMST
Histiogamphelus cristatus	Macleay's crested pipefish					Ma				x	x	L	Usually occurs in shallow sub-tidal seagrass beds in estuaries, including patchy sea grasses adjacent to open sand and rubble substrates	-	PMST
Hypselognathus rostratus	Knife-snouted pipefish					Ma				x	x	M	Occurs in seagrass beds and has been recorded at depths form 1-55 m. In Port Phillip Bay, Victoria, commonly seen in association with large jellyfish when oceanic waters run into the Bay.	-	PMST
Kaupus costatus	Deepbody Pipefish					Ma				x	x	M	Occurs in sheltered intertidal areas with algae and seagrass, especially in species Zostera, often near mangroves, to 10 m.	-	PMST
Lamna nasus	Porbeagle				Mi						x	L	Oceanic.	-	PMST
Leptoichthys fistularis	Brushtail Pipefish					Ma				x	x	M	Occurs in inshore sheltered shallow seagrass beds, mainly amongst the seagrass Zostera in which it is well camouflaged, but also in *Posidonia* beds and below 1 m.	-	PMST
Lissocampus caudalis	Smooth Pipefish					Ma				x	x	M	Occurs in shallow inshore bays and estuaries, inhabiting low algal covered rubble reefs, macroalgal beds, seagrass beds (*Amphibolus, Heterozostera, Posidonia, Zostera*), tidepools, rocky outcrops, and under jettys and on artificial reefs and wrecks. The species usually lives in depths between 0.5–37 m.	-	PMST
Lissocampus runa	Javelin Pipefish					Ma				x	x	M	Occurs in tidepools and sheltered bays, usually in seagrass and algal beds and on rocky and shelly rubble substrates to about 20 m.	-	PMST
Maccullochella peelii peelii	Murray Cod	VU	L	en								N	Freshwater species. Found within the Murray River catchment usually in sluggish turbid rivers, in deep holes or amongst fallen timber and other debris. Also occurs in upper reaches of rivers where water is clear and there is little fallen timber.	1980	

Scientific name	Common name	EPBC	FFG	DEPI	Migratory	Marine	Saltmarsh	Mangroves	Mudflats	Subtidal seagrass	Deep water	Likelihood of occurrence	Notes	Most recent database record	Other records
Macquaria australasica	Macquarie Perch	EN	L	en								N	A riverine fish preferring deep holes, its natural distribution extends north of the Great Dividing Range in tributaries of the Murray River. Early this century it was introduced to many waters south of the Great Dividing Range, but only recorded in the Yarra with any regularity since.	1970	
Maroubra perserrata	Sawtooth pipefish					Ma				x	x	L	Occurs in coastal rocky reefs at 3-25m, sheltering beneath ledges and in caves during day.	-	PMST
Mitotichthys mollisoni	Mollison's pipefish					Ma				x	x	M	Occurs amongst brown macroalgae on rocky reef at 7-45 m. Recorded at Rhyll Channel.	-	PMST
Mitotichthys semistriatus	Half-banded pipefish					Ma				x	x	H	Occurs in small groups in shallow seagrass and eelgrass beds in less than 10 m, preferring tall seagrasses in very protected areas, usually just below the intertidal zone. Present in eelgrass year round in Western Port.	-	PMST
Mugilogobius platynotus	Pale Mangrove Goby		L	vu				x	x	x	x	H	In Victoria, found almost exclusively in the tidal mangrove forests of estuaries.	2009	
Phyllopteryx taeniolatus	Weedy sea dragon					Ma				x	x	H	Occurs in seagrass, macroalgae and kelp-covered rocky reefs at depths from about 1 m to 50 m.	-	PMST
Prototroctes maraena	Australian Grayling	VU	L	vu								L	A diadromous species which spends most of its life in freshwater within rivers and large creeks. Juveniles inhabit estuaries and coastal seas. Adults occur in freshwater habitats, typically rivers and streams with cool, clear waters and gravel substrates, but occasionally also in turbid waters.	-	PMST
Pugnaso curtirostris	Pugnose Pipefish					Ma				x	x	H	Occurs in shallow seagrass, eelgrass and algal habitats in sheltered bays and estuaries to about 11m. Juveniles often found amongst decaying seagrass leaves. Recorded at Flinders.	-	PMST
Solegnathus robustus	Robust spiny pipehorse					Ma				x	x	L	No habitat information for this species.	-	PMST
Solegnathus spinossimus	Australian spiny pipehorse					Ma				x	x	M	Occur across a wide depth range of 3-640m on the continental shelf and slope, usually above 250m. Specimens have been collected from muddy, silty, shelly and rubble substrates, and rocky reefs, and may be washed ashore after storms. One record in Western Port.	-	PMST
Stigmatopora argus	Spotted Pipefish					Ma				x	x	M	Occur in shallow seagrass and macroalgal beds in sheltered bays and estuaries, in depths to 10 m.	-	PMST
Stigmatopora nigra	Wide-bodied Pipefish					Ma				x	x	H	Common in sheltered seagrass and algal beds from intertidal depths to 35 m. Many records in Western Port	-	PMST

Scientific name	Common name	EPBC	FFG	DEPI	Migratory	Marine	Saltmarsh	Mangroves	Mudflats	Subtidal seagrass	Deep water	Likelihood of occurrence	Notes	Most recent database record	Other records
Stipecampus cristatus	Ring-backed Pipefish					Ma				x	x	H	Occurs in sheltered reef and rubble areas, living in sparse algal and seagrass habitats (*Amphibolis* and *Posidonia*), often near channels in large estuaries and bays in 3-12 m. Recorded in Western Port.	-	PMST
Urocampus carinirostris	Hairy Pipefish					Ma				x	x	H	One of the most common estuarine pipefishes in eastern Australia, occurring year-round in seagrass beds in Western Port.	-	PMST
Vanacampus margaritifer	Mother-of-Pearl Pipefish					Ma				x	x	L	Occurs in shallow estuarine and coastal waters in seagrass beds including *Zostera*, *Posidonia* and *Halophila*), macroalgae (*Ecklonia* and other brown algae), rocky reef, boulder, rubble, sandy and muddy habitats between 2–15 m.	-	PMST
Vanacampus phillipi	Port Phillip Pipefish					Ma				x	x	H	Commonly found among seagrasses (including *Halophila, Heterozostera, Posidonia, Ruppia* and *Zostera*) and macroalgae in low reefs on sand in shallow estuaries and protected bays to 25 m. Particularly common in Western Port.	-	PMST
Invertebrates															
Amphiura triscacantha	Brittle Star species		L	vu						x	x	L	Historically reported from northern Western Port, but given the changes that have occurred within the bay over the last 30 years, this population is possibly extinct.	1976	
Apsolidium handrecki	Sea Cucumber 5052		L	vu						x	x	L	Only known from a few specimens from widely scattered locations. Restricted to shallow water rock platforms. Only one isolated population known from Victoria despite a 10 year search. This population is located in vulnerable bay habitat, on an eroding coastline, adjacent to a popular beach.	1989	
Eucalliax tooradin	Ghost shrimp		L	vu						x	x	M	Rare, apparently endemic to shallow water in Port Phillip Bay and Western Port. Although burrowing habit may make collection difficult, this species is still likely to be rare given the intensity of collection over the past 40 years in Western Port and Port Phillip Bay. The Crib Point habitat was recorded as fine sand. Its potential dependency on seagrass is unknown. Potential threats possibly include industrial and port development around Crib Point and poor water quality in Western Port and Swan Bays.	1965	
Michelea microphylla	Michelea Species 5256		L	vu						x	x	M	Rare, apparently endemic to Western Port. Only known from one specimen. Comments same as for *Eucalliax tooradin*.	1965	
Platydoris galbana	Marine opisthobranch		L	vu						x	x	H	Occurs in San Remo Special Management Area	1990	

Appendix E BioSites within 10 km of Western Port

The following table displays BioSites located within 10 km of Wester Port.

Biosite Number	Name	Significance Level	Area_Ha	Intercepted Western Port	Intercepted SUZ1
1553	Primary foraging areas of waders in Westernport Bay	National	0.8	Y	
1554	Yallock Creek Mouth	National	0.0	Y	
1555	Settlement Road	National	0.0	Y	
1558	North-west and southern coasts of Phillip Island.	National	0.0		
1565	Tooradin and surrounds	National	1263.5	Y	
4648	Reef Island (old Site Id 1556)	National	68.8	Y	
4660	Quail Island	National	862.9	Y	
4661	Seal Rocks (old Site Id 1559)	National	1.0	Y	
4723	French Island - Chilcott Rocks	National	733.8	Y	
4724	French Island - Barralliar Island and reefs to north	National	473.0	Y	
4725	French Island - Bullock and Decoy Swamps	National	11.9	Y	
4728	Jam Jerrup/Stockyard Point, Western Port	National	154.6	Y	
4729	Bunyip River to Yallock Creek, Western Port	National	230.0	Y	
4730	Phillip Island - Observation Point	National	96.3	Y	
4731	French Island - Blue Gum Point	National	230.3	Y	
4732	French Island NP - Rams Island	National	3.7	Y	
4733	French Island NP - Tortoise Head	National	353.0	Y	
4734	Yallock Creek to Jetty Rd, Western Port (old Site Id 1555, Settlement Rd)	National	143.0	Y	
4735	Phillip Island - Southern and Western ocean beaches	National	0.8	Y	
4737	Red Bluff Creek, Pioneer Bay and Queensferry	National	0.8	Y	
4739	Phillip Island - Churchill Island	National	56.0	y	
4865	Mornington Peninsula National Park - Greens Bush	National	11.4		
4922	South Gippsland Clyde Manks Rd Rail Reserve	National	24.1		
5155	Phillip Island - Little Penguin and Shearwater Breeding Sites	National	0.8		
5228	BHP Bushland, Tyabb	National	0.8	Y	Y

Biosite Number	Name	Significance Level	Area_Ha	Intercepted Western Port	Intercepted SUZ1
5233	Warneet and surrounds	National	1421.1	Y	
6976	Greater Pakenham Habitat	National	1405.7		
7107	Stony Point Railway Line	National	0.0	Y	
7142	Crib Point - Milne St	National	0.0		
7144	Junction Road A Merricks North	National	0.0		
7145	Junction Road B Merrricks North	National	0.0		
7469	French Island NP - Red Bill Road north	National	0.0		
7657	French Island NP - The Link north-east of Clump Lagoon	National	0.0		
7658	French Island NP - north of Mount Wellington	National	0.0		
7659	French Island - south of Mount Wellington	National	0.0		
7660	French Island NP - south-west end of Ridge Track	National	0.0		
7661	French Island NP - Causeway Road/Ridge Track east	National	0.0		
7662	French Island NP - park boundary west of The Rest	National	0.0		
7663	French Island NP - south-east of Macleod Road/Overpass Road intersection	National	0.0		
7664	French Island NP - hinterland west of Blue Gum Point	National	0.0	Y	
8256	Gurdies NCR	National	0.0		
8914	SBB South Central	National	0.0		
1564	Secondary foraging areas of waders in Westernport Bay	State	0.8	y	
1566	Bass River Mouth	State	0.0	Y	
1567	Secondary breeding areas on the coast of Phillip Island and Swan Lake	State	0.8		
1568	Phillip Island - Rhyll Swamp and Koala Reserves	State	262.8		
4637	Flinders Jetty to Picnic Point (coastline)	State	350.5	Y	
4691	Brokil Creek	State	9.9		
4722	Lang Lang Heathlands	State	1221.0		
4726	Long Island, Western Port	State	0.8	Y	
4727	Sandy Point - HMAS Cerberus, Western Port	State	1390.3	Y	

Biosite Number	Name	Significance Level	Area_Ha	Intercepted Western Port	Intercepted SUZ1
4736	Phillip Island - Cape Woolamai	State	414.5		
4738	Phillip Island - Swan Lake	State	79.6		
4843	Buckleys Nature Reserve, Balnarring	State	41.9		
4915	Moorooduc Quarry Flora and Fauna Reserve	State	37.2		
4916	The Pines Flora and Fauna Reserve	State	4.0		
4917	Langwarrin Rail Reserve	State	29.0		
4918	Arthurs Seat State Park	State	19.5		
5094	Langwarrin Flora and Fauna Reserve	State	221.6		
5095	Royal Botanic Gardens - Cranbourne Annexe (old Site Ids 1562 and 3535)	State	351.8		
5097	Grantville State Nature Reserve	State	538.3		
5127	Hopetoun/Norfolk Reserves/Mt Martha Golf Course	State	3.3		
5128	Devil Bend and Bittern Reservoirs and Creek	State	298.7		
5129	Woods Reserve	State	160.0		
5169	Mornington Rail Reserve - Nepean Hwy to Wooralla Dve	State	3.8		
5234	Yaringa Bushland (old Site Id 1563)	State	0.8	Y	Y
6855	Bayles and surrounds	State	51.3		
6974	Lang Lang Natural Features Reserve and surrounds	State	64.5		
7108	Lorimer St Crib Point	State	0.0	Y	
7987	Muddy Gates Lane private grassland	State	0.0		
8525	Devil Bend Creek	State	0.0		
4636	Point Leo Surf Beach to Flinders Jetty (coastline)	Regional	470.7	Y	
4658	Frankston Reservoir	Regional	95.1		
4716	Lang Lang - The Gurdies - Grantville	Regional	0.8		
4717	Coolart (Wetlands and Wildlife Reserve)	Regional	115.0	Y	
4720	Jacks Beach - Stony Point to south Hastings	Regional	76.6	Y	
4721	Crib Point	Regional	0.8		

Biosite Number	Name	Significance Level	Area_Ha	Intercepted Western Port	Intercepted SUZ1
4740	Phillip Island - Conservation Hill State Wildlife Reserve	Regional	194.1	Y	
4813	Cranbourne Woodland	Regional	42.0		
4886	Bald Hill Flora Reserve, Red Hill	Regional	22.8		
4919	Kernot Loch Road	Regional	0.9		
4920	Mt Lyall Road, Heath Hill	Regional	0.0		
5105	Paratea Flora and Fauna Reserve, Frankston South	Regional	5.8		
5150	Bunaroung Park, Frankston	Regional	12.5		
5151	Robinsons Rd Forests, Langwarrin Sth	Regional	0.8		
5167	Old Coast Manna Gum, Hastings (Victoria St)	Regional	0.8		
5172	Warringine Creek and Heritage Park, Bittern	Regional	0.8		
5173	Dromana Flora Reserve	Regional	0.8		
5175	Endeavour Fern Gully	Regional	0.8		
5203	Unthanks Reserve, Somerville	Regional	2.3		
5204	Somerville West Bushland (inc. Somerville Bushland Reserve)	Regional	16.6		
5205	Main Ridge Flora Reserve	Regional	159.0		
5206	Hanns Creek Reserve and streamline, Balnarring	Regional	38.0	Y	
5207	Tubberubba Reserve, Merricks North	Regional	5.7		
5208	Warringine Headwaters South Bushland, Balnarring	Regional	0.8		
5209	Little Boggy Creek Bushland, Langwarrin	Regional	0.8		
5210	Baxter/Pearcedale Bushland	Regional	0.8		
5211	Centreville Bushland (inc. Morning Mist Reserve), Cranbourne Sth	Regional	0.8		
5212	Devil Bend Golf Course	Regional	74.7		
5213	Dunns South Bushland, Red Hill	Regional	0.8		
5214	Dunns North Bushland, Merricks North	Regional	0.8		
5215	Merricks Creek North Bushland	Regional	0.8		
5216	Red Hill South Bushland	Regional	0.8		

Biosite Number	Name	Significance Level	Area_Ha	Intercepted Western Port	Intercepted SUZ1
5217	Bulldog Tubberubba Bushland, Dromana	Regional	0.8		
5218	Coolart Creek Bushland and Streamline, Merricks	Regional	52.3		
5219	East Creek (Catchment) Bushland and Streamline North	Regional	0.8		
5220	East Creek (Catchment) Bushland and Streamline South	Regional	0.8		
5221	Shoreham Village and Buxton	Regional	7.5	Y	
5222	Balcombe mid-catchment Riparian, Mornington/Mt Martha	Regional	57.2		
5223	Mt Eliza Bushland (inc. residential areas)	Regional	0.8		
5224	Stony Creek Bushland and Streamline (Shoreham to Red Hill)	Regional	0.8		
5225	Musk/Mantons Creek Bushland (Catchment) and Streamline	Regional	0.8		
5227	Myers Water Reserve, Bittern	Regional	8.0		
5229	Olivers Creek Bushland (inc. Tyabb Reserve)	Regional	29.2		
5230	Emu Plains (inc. Racecourse and adj. Bushland)	Regional	0.8		
5231	Kings Creek, Hastings	Regional	0.8		
5232	Upper Warringine Creek	Regional	0.8		
5242	Tea-tree Creek, Cranbourne	Regional	0.8		
5249	Range Rd and Moorooduc Rd roadsides, Tuerong	Regional	0.8		
5277	Derril Road, Moorooduc	Regional	6.6		
5278	Slopes of Mount Eliza	Regional	52.4		
5279	Kirton Reserve, Mornington	Regional	8.1		
5280	Mount Eliza Regional Park	Regional	36.2		
5611	Clyde	Regional	0.0		
5612	Mc Donald's Road Rail Reserve - Lang Lang	Regional	49.8		
6888	Cardinia Creek - lower	Regional	89.8		
6978	South Gippsland Koo Wee Rup Rail Reserve	Regional	51.1		
7006	Ballarto Rd/Tooradin Station Rd, Cardinia	Regional	22.0		
6898	Yallock Creek	Local	0.0		

Biosite Number	Name	Significance Level	Area_Ha	Intercepted Western Port	Intercepted SUZ1
6980	Bunyip River - lower	Local	167.8		
7062	San Remo	Yet to be determined	0.0	y	
7071	Lorna's Triangle Bushland Reserve	Yet to be determined	0.0		

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