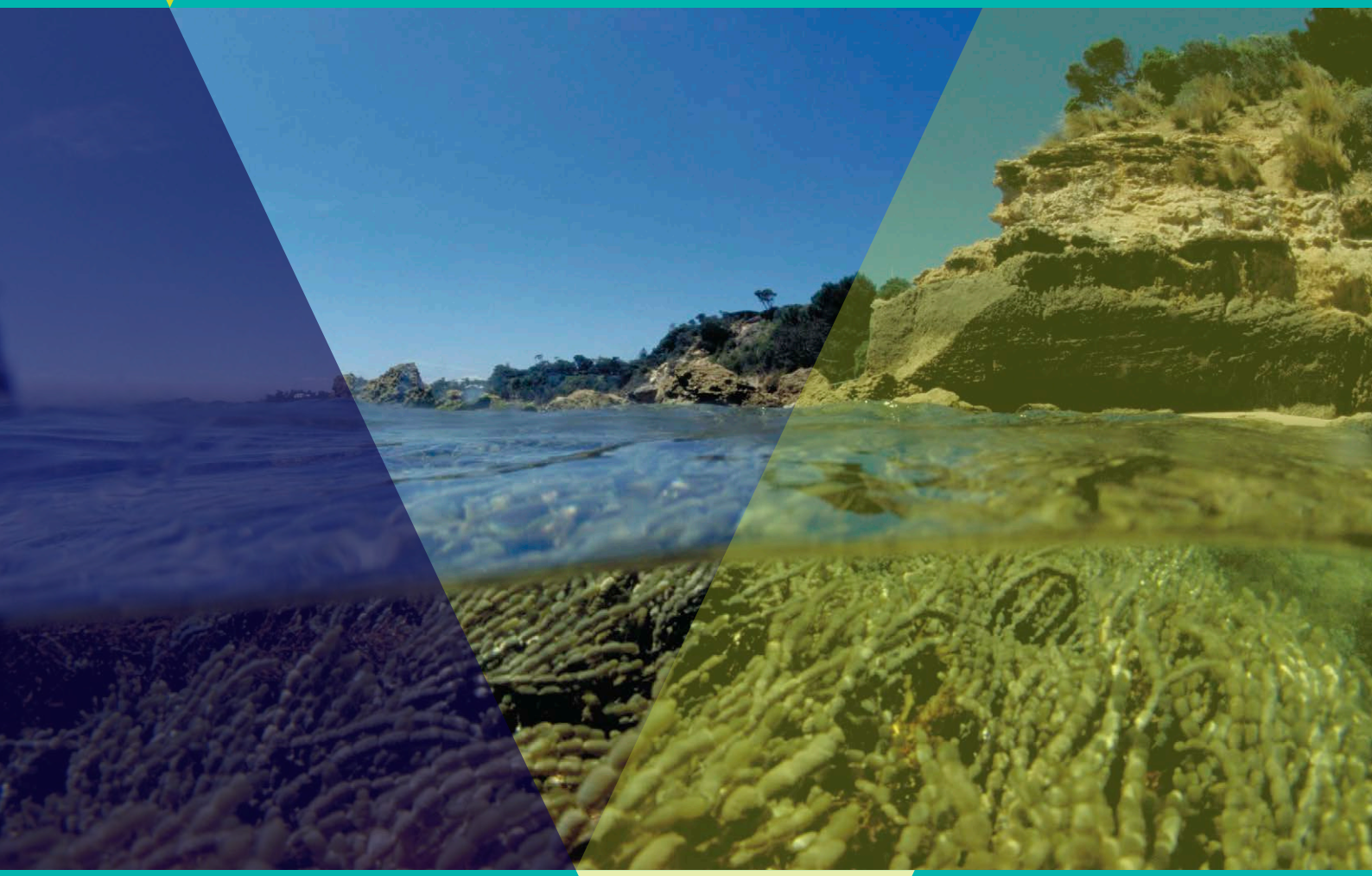
Draft Port Phillip Bay Environmental Management Plan 2017–2027

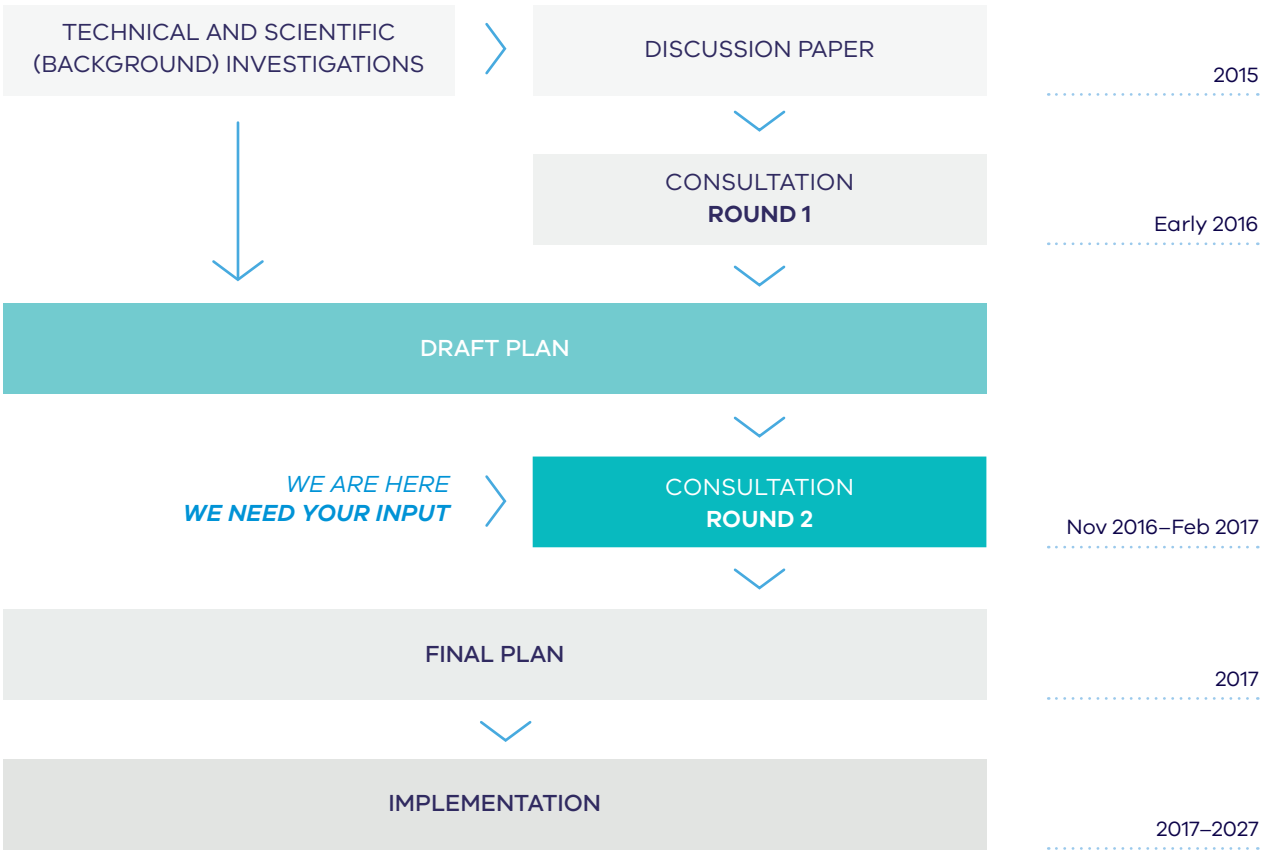
Supporting Document



November 2016

VICTORIA State Government | Environment, Land, Water and Planning

How the Plan is being developed



Have your say

The Victorian Government welcomes and encourages the involvement of all Victorians in helping shape the new Environmental Management Plan for Port Phillip Bay. Your ideas and input will help to inform the final plan, so that together we can take the right actions in the right places to achieve our vision for the Bay.

Public consultation on the draft Plan will be open until **10 February 2017**.

Cover photo – Parks Victoria

Contents

Giant Spider Crabs (*Leptomithrax gaimardii*) at Rye Pier. Photo – David Reinhard

1 Introduction

The Victorian Government is delivering on its commitment to protect and enhance the health of Victoria's marine and coastal environments by developing a new Environmental Management Plan for Port Phillip Bay.

This Plan is required under the *State Environment Protection Policy (Waters of Victoria) – Schedule F6 Waters of Port Phillip Bay (1997)*. This Plan applies to 'all the waters of Port Phillip Bay bounded by the high water mark, a line drawn between Point Lonsdale and Point Nepean and a line across the mouth of the Yarra River'. *Schedule F6* sets out what the environmental management plan must achieve. These requirements include:

- determining the priority management issues
- outlining actions that respond to priority issues
- identifying management responsibility for particular issues
- coordinating the management for protection of the Bay's beneficial uses and values
- identifying specific management actions for nutrients, suspended solids, pathogens, litter and marine pests
- providing a process for reviewing and reporting progress to the community.

The first Environmental Management Plan for the Bay, developed in 2001, has been an important guiding document, driving over $220 million of investment to address key risks to the Bay's health. Nutrient loads to the Bay have been significantly reduced, water quality parameters are being more closely monitored, and the marine pest program has helped to conserve marine life and bay processes. This investment has helped to ensure the continued health of the Bay.

This draft Plan identifies the tools and tasks needed to ensure that the Bay continues to be healthy and resilient in the face of population growth and climate change. This Plan will also help Victorians to recognise the multiple environmental, social and economic values that the Bay provides.

This draft Plan has been developed by the Department of Environment, Land, Water and Planning (DELWP) in partnership with Melbourne Water and the Environment Protection Authority (EPA) Victoria. It will be delivered over ten years, with annual reporting on progress and major evaluation at five-yearly intervals.

Development of this Plan has been informed by input and advice from government and industry through a project reference group, key stakeholders through targeted engagement, and the broader community through public consultation. This Plan has also been informed by investigations on the values of the Bay and threats to these values and their management.

Purpose of this document

This supporting document details the development of this Plan, highlighting key points from the background investigations and detailing proposed actions.

This document is designed to be a stand-alone companion document to complement the main document for this Plan – *Draft Port Phillip Bay Environmental Management Plan: 2017–2027* – and has been written for a more technically minded audience or for those who would like more detail on the Plan's context and how it was developed.

This draft Plan acknowledges the connection of Aboriginal people to the Bay and aims to improve their role in managing the Bay and preserving their cultural values.

For over 30,000 years, people of the Kulin nation lived, hunted and gathered on this great plain, which we now know as Port Phillip Bay (Rhodes, 2007). Evidence of occupation is provided in the many Aboriginal stories and archeological sites around the Bay. One of these stories is reproduced below; with acknowledgement that each of the Kulin nation tribes has their own stories to tell.

Boon Wurrung's Creation story of Port Phillip Bay:

Many years ago the biik (land) we now call greater Melbourne extended right out to the warreeny (sea). Nairm (Port Phillip Bay) was then a large flat grassy plain. The Yarra River, as it is known today, flowed out across this flat plain into the warreeny.

This large plain was covered in buath (grass) and tarrang biik (woodlands) on which the Boon Wurrung men hunted guyeem (kangaroo) and barramaeel (emu). The bagurrk (women) cultivated the murrnong (yam daisy). They collected food from the wurneet (creek) and the warreeny and harvested the iilk (eels) that migrated through there every year.

One day – many, many years ago – there came a time of chaos and crisis. The Boon Wurrung and the other Kulin nations were in conflict. They argued and fought. They neglected their biik. The murrnong was neglected. The animals were over killed and not always eaten. The gurnbak (fish) were caught during their spawning season. The iilk were not harvested.

As this chaos grew, the warreeny became angry and began to rise. The wurneet became flooded and eventually the whole flat plain was covered in baany (water). It threatened to flood their whole barerarerungar (country).

The people became frightened and went to Bundjil, their creator and spiritual leader. They asked Bundjil to stop the warreeny from rising.

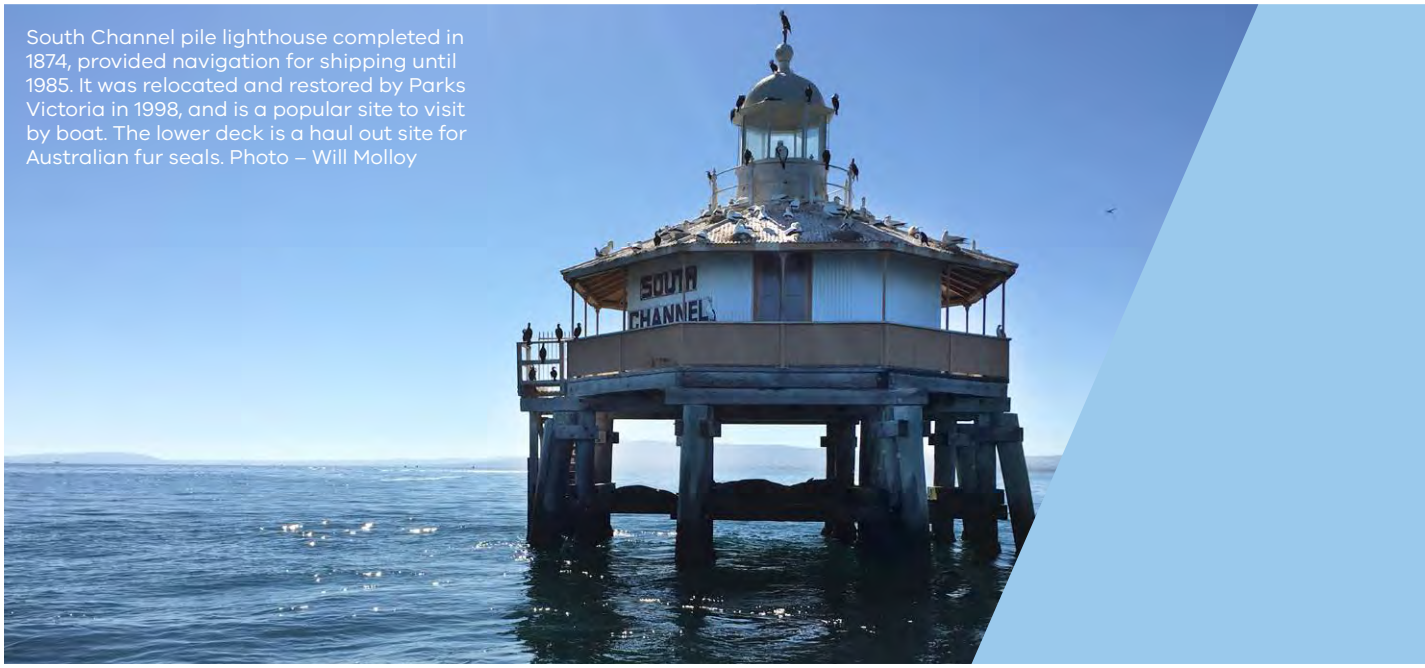
Bundjil was angry with his people, and he told them that they would have to change their ways if they wanted to save their land. The people thought about what they had been doing and made a promise to follow Bundjil.

Bundjil walked out to the warreeny, raised his tjeera (spear) and directed the warreeny to stop rising. Bundjil then made the Boon Wurrung promise that they would respect the laws.

The baany never subsided but stayed to create a large bay that the Boon Wurrung called Nairm. Today it is known as Port Phillip Bay. The warreeny took away much of the biik of the Boon Wurrung and much of their barerarerungar was reduced to a narrow strip of coastline.

The Boon Wurrung learnt from their mistakes. They returned to their old values and the laws of Bundjil. They took greater care of the biik of Bundjil and the bubup (child) of Bundjil.

Aboriginal creation story as told by Boon Wurrung Elder Carolyn Briggs, and published in *Nyernila - Listen Continuously* by the Victorian Aboriginal Corporation for Languages (2014).



South Channel pile lighthouse completed in 1874, provided navigation for shipping until 1985. It was relocated and restored by Parks Victoria in 1998, and is a popular site to visit by boat. The lower deck is a haul out site for Australian fur seals. Photo – Will Molloy

The Common Greenshank (*Tringa nebularia*) is a migratory shorebird that arrives in early spring to feed on intertidal and wetland invertebrates, prior to their arduous northward passage in early autumn. Photo – Dillon Wan

Port Phillip Bay and its management

Port Phillip Bay was formed some 8,000 years ago when rising sea levels at the end of the last ice age resulted in flooding of the delta of the Yarra and Werribee rivers. Prior to flooding from the sea, the wide expanses of the plains had been inhabited by Aboriginal communities for over 30,000 years. There remain many Aboriginal cultural heritage landscapes and places of significance recorded around the Bay. In more recent times the ecology of the Bay has been greatly modified by human activity, especially in the last 150 years following European settlement (Edmunds *et al.*, 2006).

Port Phillip Bay

The Bay is the largest marine embayment in Victoria. It covers an area of approximately 1,930 square kilometres, has a coastline of 333 kilometres and a catchment area of close to 10,000 square kilometres.

The Bay incorporates many smaller bays, sounds, bights, coves and inlets (such as Hobsons Bay and Corio Bay), which are all considered parts of the larger Port Phillip Bay. The Bay and its catchment are shown in Figure 1.

The Bay hosts a diversity of ecosystems and habitats including sandy beaches, rocky shores and saltmarsh within the intertidal zones; and un-vegetated soft sediments, seagrass beds, rocky reefs and open water in the sub-tidal areas.

These habitats are home to thousands of species of marine animals and plants, from the microalgae (phytoplankton) and microscopic animals (zooplankton) in the water column and on the bed of the Bay (microphytobenthos and zoobenthos) to seagrasses and seaweeds, fish, penguins, seals, dolphins and visiting whales (Harris *et al.* 1996).

Bay processes

The Bay receives freshwater inflows from two main sources: the Yarra River (with its major tributary the Maribyrnong River) and the Western Treatment Plant. Other freshwater sources include rivers and creeks, and hundreds of local stormwater drains. With the exception of the Western Treatment Plant, a large proportion of the inflows to the Bay occur following rainfall events in the catchment.

A conceptual model of the Bays and its processes is shown in Figure 2. It illustrates the complexity of the Bay's features, values, threats and processes that need to be considered in developing this Plan.

The Bay is semi-enclosed, with a narrow entrance (approximately 3.2 kilometres wide) at Port Phillip Heads. The narrow entrance limits water exchange between the Bay and Bass Strait and is significant to the way the Bay functions. The central basin is enclosed by sandy shoals (the Great Sands), beaches and fringing reefs.

The maximum depth in the Bay is 24 metres, but average depth is just 13 metres, with more than half the Bay shallower than 8 metres. Wind-driven currents are the primary source of vertical and horizontal mixing. This, together with the shallow depth, helps to ensure the Bay is well aerated (Harris *et al.* 1996).

Movement of water within the Bay is important for dispersing inputs from the catchments, including freshwater, nutrients and sediments. However, mixing and dispersal efficiency varies across the Bay. Areas nearer to the shore and in bays, such as Hobsons Bay and Corio Bay, have limited mixing. This affects the ability to process catchment runoff and waste discharges, which results in these parts of the Bay being more impacted by poor water quality.

Figure 1 Port Phillip Bay and catchment

VALUES

Port Phillip Bay provides a range of benefits to the community. These include:

- Recreation
- Tourism
- Aquaculture
- Wetlands
- Biodiversity
- Recreational Fishing
- Commercial Fishing
- Reef Habitat
- Seagrass Habitat
- Iconic Species
- Shipping/Navigation

Symbols courtesy of the Integration and Application Network, University of Maryland Center for Environmental Science (ian.umces.edu/symbols/).

THREATS/ISSUES

The functioning of the system could be compromised by a number of threats and issues:

Pollution Chemicals, pathogens, litter and nutrients from urban, industrial and agricultural sources (including stormwater and wastewater discharges) contribute to reducing water quality

Sea Level Rise Increase in sea levels due to climate change may significantly affect hydrodynamics and coastal processes

Flooding Flooding and seawater intrusion can occur due to increased intensity of rainfall and sea level rise

Algal Blooms Algal blooms in nearshore waters have serious impacts on commercial and recreation activities

Hypoxia Low oxygen in bottom waters due to consumption of oxygen by sediments affects marine life

Marine Pests Invasive species may out-compete native species for resources. Pests may be introduced as a result of biofouling and ballast water discharge.

PROCESSES

The Bay environment is controlled by a number of physical, chemical and biological processes:

Catchment Runoff/River Inflows deliver nutrients, pollutants and sediment to the Bay

Tidal Saline Water Exchange Seawater enters the system from Bass Strait

Sediment Resuspension, Erosion and Deposition Sediment is resuspended by water currents, wind and waves. This leads to increased turbidity and smothering

Thermodynamics/Evaporation Heating of the water surface leads to evaporation and increased salinity

Mixing Mixing of the water column is driven by wind and tidal generated currents

Atmospheric Exchange Oxygen, nitrogen and other chemicals are exchanged across the air water interface

Denitrification Nitrate is released from the system as gas due to microbial processes in the sediment

Benthic Algae Algal growth impacts on a range of sediment processes in the Bay

Climate Change A warming climate leads to higher sea levels, more frequent and intense storm events (with accompanying storm surges and rainfall), and higher water temperatures.

Figure 2 Conceptual model of Bay values, threats and processes (adapted from EPA)

Catchment and inflows

The volume and quality of inflowing waters is dependent on a range of factors, but principally land use and rainfall. Across the catchment there is significant variation in average annual rainfall, with catchments to the east of Melbourne being wetter than those to the north and west (Figure 3 from Jacobs and HydroNumerics 2015a). Stormwater runoff, particularly from urban areas, is a threat to the values in waterways and the Bay, and to public health because it carries sediments, nutrients, toxicants, pathogens and litter into the Bay (Melbourne Water 2013).

Figure 4 shows annual flow volumes since July 1990 for the Yarra River together with annual rainfall for the corresponding period. The graph highlights the variation in annual rainfall across the past 25 years and shows the strong correlation between the amount of rainfall and flows, including runoff. This means that loads of nutrients and other pollutants entering the Bay are highly dependent on rainfall, and will vary significantly between wet and dry years.

The Bay has a land catchment area of 9,694 square kilometres. Land use is approximately 32% urban, 46% rural land and 21% forested (Figure 5 from Jacobs and HydroNumerics 2015a). Melbourne, with a population in 2013 of 4.3 million people (Department of Transport, Planning and Local Infrastructure 2014), surrounds much of the Bay, with the central business district located near its northern edge. Geelong, with a population of approximately 200,000, borders the south-western shore of the Bay.

The Bay and its catchment are highly connected. Pollutants can flow to the Bay from any part of the catchment, via the drainage network. Therefore, actions to reduce pollutants entering drains or waterways in the catchment will benefit the Bay. Although for bioavailable compounds, such as nutrients, the benefits tend to decrease the further from the Bay that the intervention is undertaken.

A key area of concern is the increase in stormwater runoff associated with increased urbanisation and more intensive agriculture across the catchment, which are expected to be compounded by increased population and climate change. Concentrations of nutrients and sediment are also significantly higher during and following rainfall events.

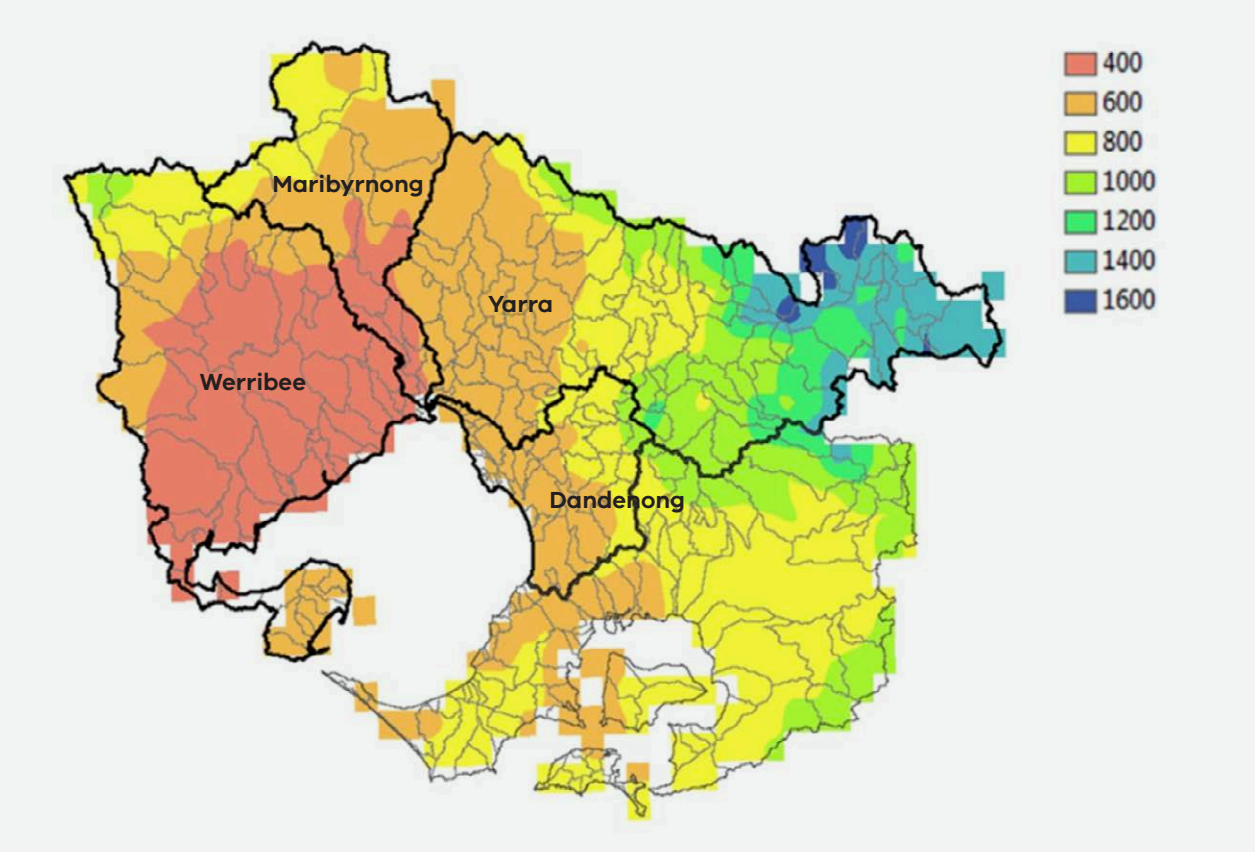


Figure 3 Mean annual rainfall (mm) (1970-2015) for Port Phillip Bay catchments

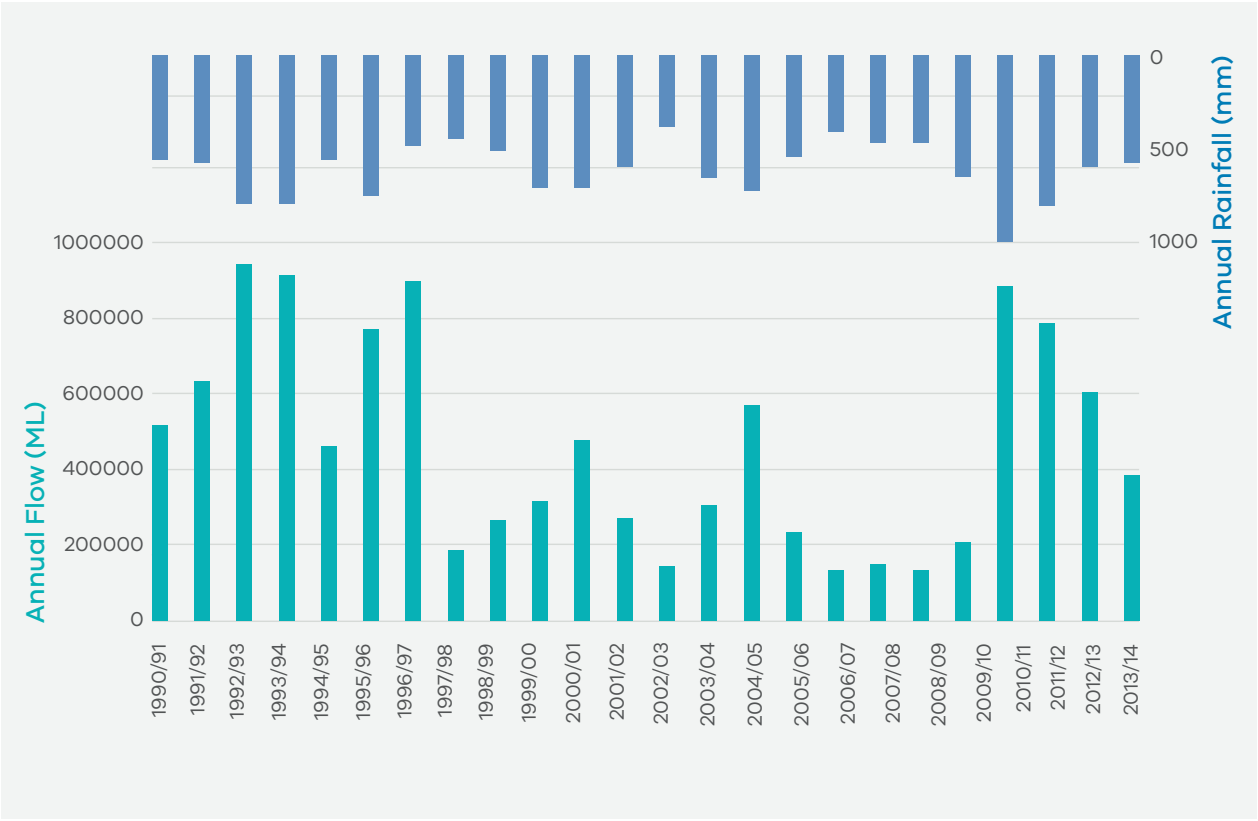
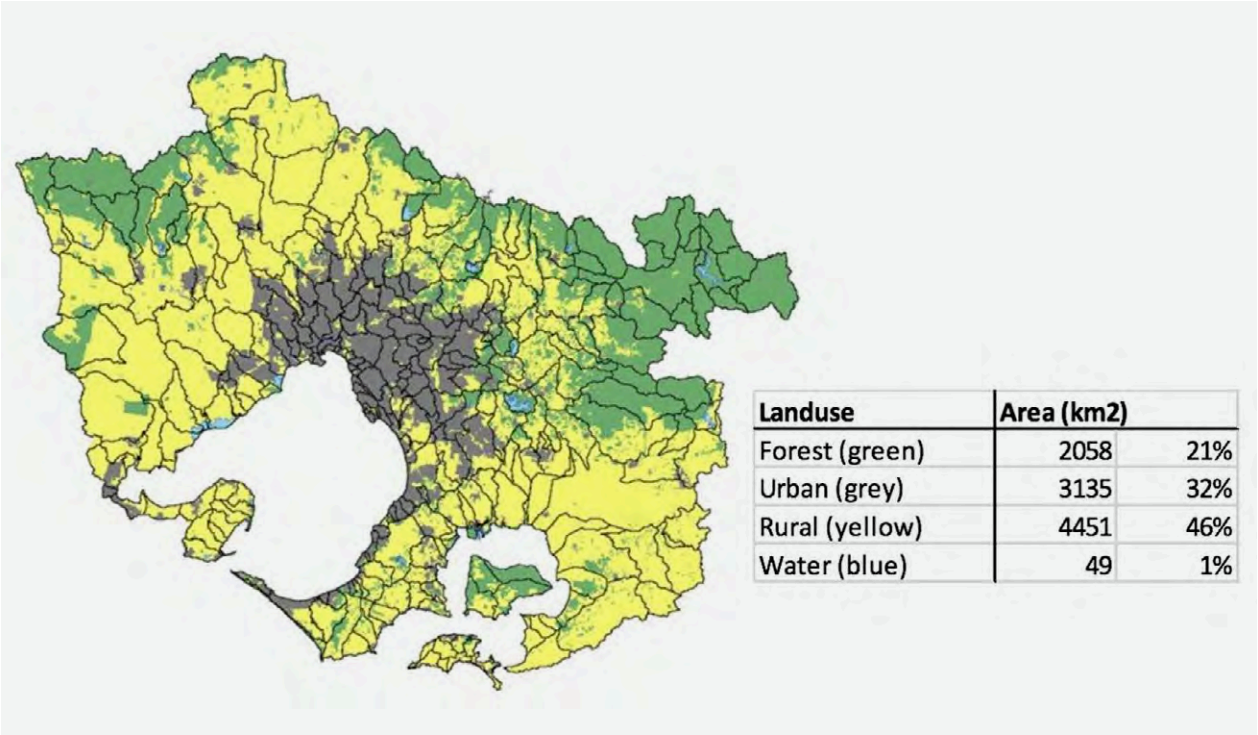


Figure 4 Annual rainfall for Melbourne (top) and annual flows (bottom) in the Yarra River measured at Chandler Highway, Kew



Landuse	Area (km2)	
Forest (green)	2058	21%
Urban (grey)	3135	32%
Rural (yellow)	4451	46%
Water (blue)	49	1%

Figure 5 Landuse map used for catchment modelling, which covers Port Phillip Bay and Westernport catchments. Table relates to areas of the catchment draining to Port Phillip Bay

Current health of the Bay

Environmental monitoring indicates that the Bay continues to show good water quality, which is safe for swimming and fishing, and supports a diverse range of marine life (DSE 2012, EPA 2012b, Hirst *et al* 2011, Hirst *et al* 2012, Longmore 2014, Woods and Edmunds 2014).

The EPA undertakes water quality monitoring monthly at eight sites across the Bay (and has done so for 30 years). Standard parameters monitored include nutrients, water clarity, dissolved oxygen, salinity, algae (chlorophyll-a) and some monitoring of metals. Using this data, a Water Quality Index score is calculated for each site based on the level of attainment against the water quality objective.

The Water Quality Index scores show that average water quality in the Bay is good with a general but small improvement over the period since 2001. However, there are localised variations that reflect proximity to catchment inflows. Sites remote from these inflows, and closer to The Heads, have better water quality.

While water quality in the western part of the Bay (Geelong Arm) is less frequently affected by stormwater, these areas can be impacted by wastewater discharge from the Western Treatment Plant.

Hobsons Bay, at the northern end of the Bay, is frequently affected by stormwater. Water quality there has varied between fair and good since 2001, with better water quality generally corresponding with periods of lower rainfall and stormwater runoff.

Pathogens are not included in the Water Quality Index. However, pathogen levels which indicate the potential risk of sickness, are measured by the EPA at 36 beaches around the Bay throughout summer (EPA 2016). During the 2015/16 summer, 97% of beaches around the Bay met end-of-season water quality objectives (as specified in *Schedule F6*) for swimming, with the remaining beach (Mentone) experiencing a higher number of days of poor water quality due to stormwater pollution issues. A similar pattern was displayed in the 2014/15 and 2013/14 summers, with over 90% of beaches meeting end-of-season objectives.

In previous summers (2011/12 and 2012/13), when higher rainfall events washed greater quantities of pollutants to the Bay, the number of beaches that met these objectives dropped below 60%.

It is important to note that monitoring and reporting on the Bay's health to date have been focused on understanding traditional water quality issues. There are other aspects of Bay health that have received less attention, such as assessments of litter and the condition of marine life and habitat. This Plan and the new *State of Bays* report to be released by the Office of the Commissioner for Environmental Sustainability will address these gaps in understanding.

Values and challenges

Bay values

The Bay provides and supports a wide range of uses, functions and features that have great social, economic and environmental importance. We refer to these collectively as values.

During development of this Plan, a list of marine values for the Bay was identified through a *Desktop Review of Victoria's Marine Values* (Hale and Brooks 2015). These marine values were adjusted to align with beneficial uses as defined in the *SEPP (Waters of Victoria)*. The resulting list of values, along with the broader benefits towards which they contribute are shown in Table 1.

Table 1 Marine values considered in developing this Plan

Value	Description
Primary contact recreation	This relates to people being in direct contact with, or immersed in, the water. This includes activities such as swimming, water-play and diving. Primary contact rates are significantly higher over the summer period.
Secondary contact recreation	This relates to people being in close contact with the water or water spray. This includes activities such as boating, kayaking and sailing. Boat ramps, marinas and jetties, which provide access to the Bay for fishing and sight-seeing, facilitate secondary contact.
Aesthetic enjoyment	Aesthetic enjoyment of the Bay is associated with the emotional enjoyment derived from vistas of the open water and coastal habitats. Beneficiaries include people who view the Bay from their offices, apartments and houses, as well as from cafes, restaurants, and other locations around the Bay.
Aquaculture	There are seven aquaculture fisheries reserves in the Bay that produce around 800–900 tonnes of mussels a year (DPI 2012). In addition there are onshore abalone farms that circulate water to and from the Bay.
Commercial fishing	Commercial fishing in the Bay includes the use of longlines, nets and other authorised gear types, with target species including Snapper, King George whiting, Flathead, Squid and Pilchards. The Bay also supports commercial diving for abalone, scallop and sea urchins.
Recreational fishing	Recreational fishing is popular and includes fishing from the shore, jetties and boats. Popular species for anglers include: Australian salmon, Bream, Flathead, Garfish, King George whiting, Leatherjacket, Silver trevally, Snapper, Squid and Yellow-eye mullet.
Seagrass	Seagrass in the Bay is predominantly *Zostera nigricaulis* and *Zostera muelleri* with smaller areas of *Halophila australis* and *Amphibolis antarctica*. Most of the seagrass (*Zostera* spp.) is located in the south and west of the Bay (Corio, Bay, Swan Bay, Mud Islands and Mornington Peninsula) in waters less than seven metres deep (Ball *et al.* 2014).
Intertidal and sub-tidal flats	This habitat includes the non-vegetated sands, silts and mudflats that occur in the shallow areas of the Bay. It supports productive microphytobenthos and benthic invertebrate communities (Poore and Rainer 1979; Beardall and Light 1997).
Intertidal and sub-tidal reefs	The Bay contains diverse intertidal and subtidal rocky reef habitat. This includes shallow habitats in the north and south centre of the Bay as well as the deep reef habitats at the entrance. These support a diversity of macro-algae, sponges, invertebrates and fish (Hart *et al.* 2005; Woods *et al.* 2013; Woods and Edmunds 2014).
Saltmarsh and mangroves	There are over 1800 hectares of saltmarsh and about 6 hectares of mangrove around the Bay, which provide important habitat for marine invertebrates and waterbirds. Key locations include Swan Bay, Geelong Arm and Werribee coastal regions (Boon *et al.* 2011).
Fish	The Bay supports a diverse fish community that includes iconic species such as the Weedy seadragon, as well as commercially and recreationally important species like Snapper and King George whiting.
Waterbirds	Over 130 species of waterbirds, includes seabirds, shorebirds and Little penguins as well as ducks and large waders, have been recorded within the Bay (Hale 2012). 47 species are listed under international migratory agreements. Important shorebird habitats exist in the north and west of the Bay. Mud Islands in the southern part of the Bay are an important breeding colony for ibis, terns and gulls. The St Kilda breakwater is home to a Little penguin colony.
Marine mammals	There are two species of resident dolphins in the Bay: Bottlenose and Common. The Common dolphins (*Delphinus delphis*) in the Bay are unusual in that they are an isolated population of about 30, which are resident in the Bay (Charlton-Robb *et al*. 2014, Mason *et al*. 2016). There are several haul out sites for Australian fur seal located in the south of the Bay, but the species does not breed in the Bay (Kirkwood *et al*. 2010). Several species of whales, including Humpback, Southern Right and Killer also visit the Bay.
Denitrification	Denitrification (the process of converting bioavailable nitrogen to nitrogen gas and subsequent loss to the atmosphere) is critical in maintaining water quality in the Bay (Harris *et al.* 1996; Longmore 2014).

Environmental values

The Bay supports a variety of habitats. Along the foreshore are sandy beaches, rocky intertidal reefs, mud flats and saltmarshes. Habitats within the Bay include seagrass meadows, rocky subtidal reefs, sponge gardens, and unvegetated soft sediments (sands and silts). Seagrass beds provide nurseries for many fish species and rocky reefs provide a substrate for hundreds of species of seaweed, and the unvegetated soft sediments are home to a diverse array of invertebrates. The generalised habitat map presented in Figure 6 draws together information from various datasets being compiled by Deakin University for DELWP.

There are four marine protected areas in the Bay, including the Port Phillip Heads Marine National Park, and Point Cooke, Jawbone and Ricketts Point Marine Sanctuaries. These areas have been established to protect a sample of Victoria's marine plants and animals and their habitats.

The Bay is home to a diverse range of marine plants and animals, many of which are found nowhere else. This includes many species of fish, molluscs, crustaceans, polychaete (bristle) worms, cnidarians (e.g. jellyfish and sea anemones) and sponges (Harris *et al.* 1996). The Bay also supports populations of marine mammals including seals, dolphins and visiting whales.

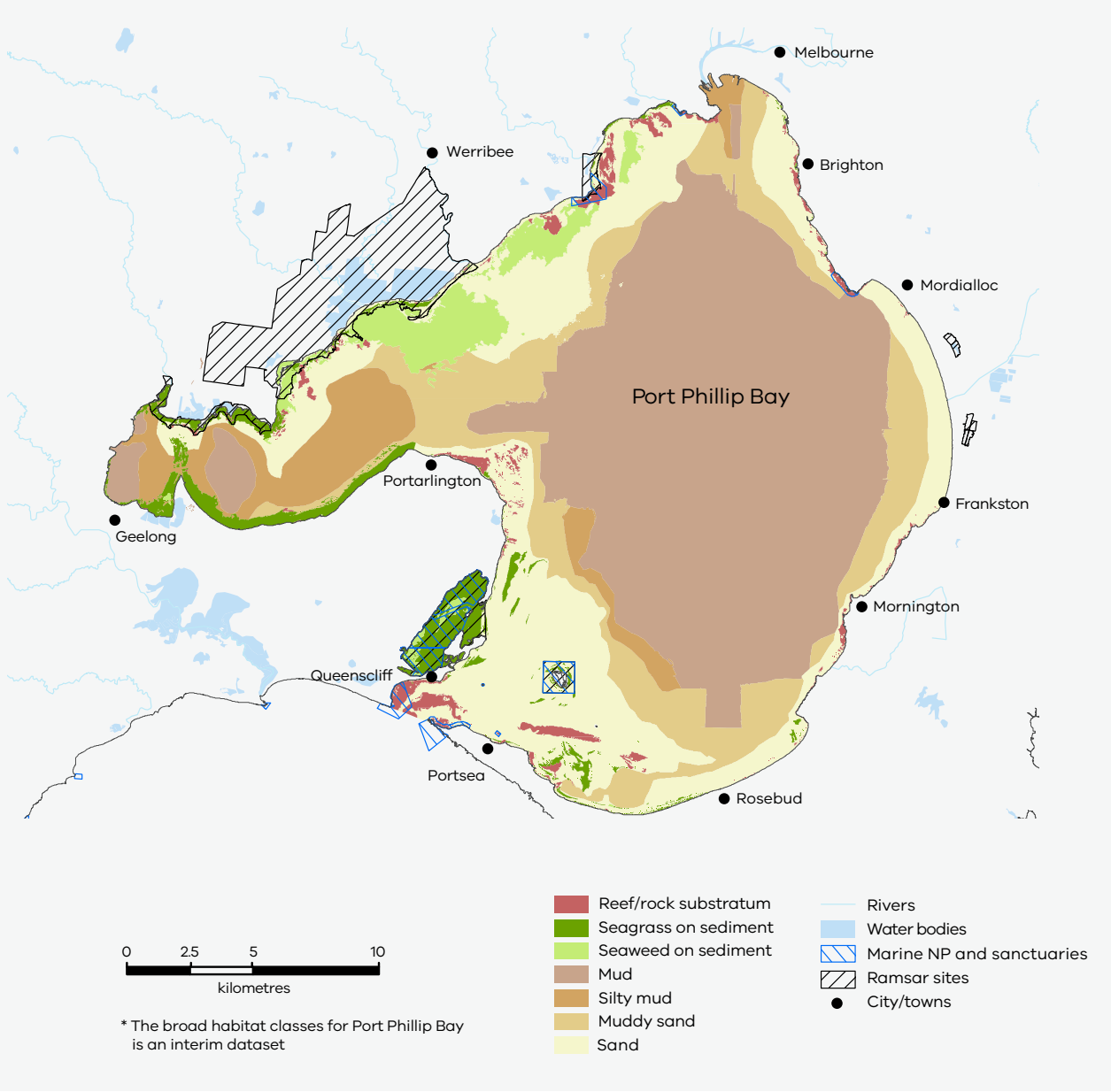


Figure 6 Port Phillip Bay habitat map

The Port Phillip Bay (western shoreline) and Bellarine Peninsula, and the Edithvale-Seaford Wetlands Ramsar sites are recognised for the quality of their wetlands and large numbers of Australian and internationally important migratory birds that use them for feeding and roosting. The diversity of wetlands range from former salt-works at Point Cook and the sewage ponds at Western Treatment Plant, to the seagrass meadows of Swan Bay.

Environmental values underpin many of the other values we have for the Bay. The water quality and diversity and abundance of marine life together determine our enjoyment of the social, cultural and economic benefits of a healthy marine system.

Social and cultural values

The Bay is one of Victoria's most popular recreational destinations and contributes significantly to Melbourne's livability. It is popular with local, regional, national and international visitors. Parks Victoria (2015) estimates that there are nearly 60 million visits per year to local port facilities in the Bay. The Bay is also appreciated from afar, providing visual and other amenity benefits to visitors and nearby residents.

The Bay and its beaches support a range of recreational activities including swimming, snorkelling, kite-surfing, scuba diving, fishing, sailing and boating as well as sand-play, walking, relaxing and socialising. There are 135 beaches in the Bay, which are patrolled by 27 lifesaving clubs. Many great locations to see the Bay's unique marine life by diving and snorkeling are found throughout the Bay including within the Marine National Park and the three Marine Sanctuaries.

Recreational fishing and boating are important values of the Bay, which deliver social and economic benefit to coastal communities through visitation and tourism. There are over 40 boating and sailing clubs around the Bay, and over 50 boat ramps that enable access to the Bay. Recreational fishing and boating participation is projected to increase with population growth.

The opportunities for recreation and socialising that the Bay provides are an important contributor to our health and wellbeing. There is growing evidence that time spent in natural places, including the Bay, is associated with positive long-term health outcomes.

The large number of community groups and individuals that actively contribute to management of the Bay and its foreshore, including 'Friends of' groups, Coastcare Victoria and Beach Patrol groups, reflects the strong connection that many people have to the Bay.

The Bay provides important cultural values that contribute to our sense of place and identity, including landscapes and sites of historical and cultural significance. Aboriginal tribes that live on and around the Bay include the Wathaurung, the Bunurong/Boon Wurrung, and the Wurundjeri. These tribes are all part of the Kulin nation. Through their cultural traditions, Aboriginal people maintain their connection to their ancestral lands and waters. It is important that this connection to Country is strengthened and that the Aboriginal values and interests in the Bay are recognised.

Victoria's first European settlement in the Bay was established in 1803 at Sullivan Bay, near Sorrento, 32 years before Melbourne was founded. There are also many shipwrecks and other heritage sites in the Bay associated with early seafaring days.

Economic values

The Bay supports Victoria's largest commercial ports. The Port of Melbourne is Australia's busiest container port, handling approximately 36% of national container trade, and around 3,000 ship visits (Port of Melbourne Corporation, 2015). The Port of Geelong is Victoria's largest regional port and its most important bulk commodities port. In 2014/15 the Port of Geelong managed a gross tonnage of 14.5 million and 639 ship visits (Victorian Regional Channels Authority, 2015).

Commercial fishing has operated in the Bay for over 170 years. Annual production of finfish between 1978 and 2012 averaged around 1,200 tonnes per year, and for 2009/10 the fish catch had a market value of about $3.5 million (DPI 2012). The value of the commercial catch will decline in future, as a result of a phasing out of netting and a buy-back of commercial licences. Aquaculture and commercial diving for abalone, scallop and sea urchins also take place in the Bay. Farming of Blue mussels is the predominant aquaculture activity, with seven aquaculture fisheries reserves located in the Bay. Production of mussels is around 900 tonnes per year (DPI, 2012). Recreational fishing is also an important contributor to the Victorian economy, with an estimated economic worth upwards of $420 million per year (derived from economic analysis by Ernst and Young 2015).

The Bay's natural features and recreational opportunities make it an important tourist destination and, with its associated industries, is a major contributor to the Victorian economy, with estimates at more than $320 million per year. Commercially operated boat tourism in the Bay offering wildlife watching experiences (dolphins, seals and penguins) and recreational diving is also an important contributor to the economy. Many bayside businesses, such as restaurants and cafes, are reliant on the amenity of the Bay.

The Bay provides important goods and services (collectively referred to as 'ecosystem services') that have economic value for our community. These include nutrient cycling, receipt of wastewater, storm protection, amenity and food (e.g. fish). The estimated values (non-additive) of some of these services include:

- **Nitrogen cycling:** the Bay naturally processes more than 5,000 tonnes of nitrogen per year from catchment runoff and treated wastewater discharge, thus preventing eutrophication (which leads to algal blooms, anoxia and other negative effects). This service is potentially worth $11 billion, based on a replacement cost of $2,250/tonne (Marsden Jacob Associates 2014), when compared to managing the nitrogen in the catchment through the construction of wetlands or new wastewater treatment plants.
- **Coastal protection:** saltmarshes, mangroves and wetlands provide in the order of $3 million per kilometre of coastal protection benefits, when compared to the alternative of having to construct seawall protection for communities (DELWP and Parks Victoria 2015).
- **Carbon storage:** each year the Bay stores in the order of 8,500 tonnes of carbon (PP&W CMA 2015). The economic value of this carbon capture is about $1 million each year. If all carbon stored in the saltmarsh, mangrove and seagrass habitats was released, the one-off cost to offset these emissions would be in the order of $6 to $25 million.

Challenges

While much is being done to conserve the health of the Bay, stressors associated with population growth and climate change are increasing pressures on its environmental assets.

Population growth

The Bay's catchment is home to over four million people, and includes the cities of Melbourne and Geelong. Growth forecasts are that the population of Melbourne will almost double over the next 35 years, and significant growth is predicted for regional centres around the Bay, including Geelong (DTPLI 2014). The associated increase in urbanisation and intensification of agriculture to sustain the increased population, will present as significant challenges for future management of the Bay.

This increase in population presents both challenges and opportunities, with more people using and enjoying the Bay in the future and taking an interest in its health. There will be a need for more services and facilities, including higher density living within established residential areas to accommodate a growing population.

Increased urbanisation will also require enlargement of drainage and sewage systems – if their discharges are not actively managed, it will affect the quality of the waters flowing into the Bay.

Stormwater

Under a changing climate there will be more years with less rainfall, but more intense rainfall events over summer. This will result in higher event-related flows to the Bay containing nutrients, sediments and other pollutants. This could lead to more frequent algal blooms and periods of poor water quality, potentially resulting in closures of popular beaches if not appropriately managed.

Research undertaken by Melbourne Water to support its 2015 Waterways and Drainage Investment Plan showed that households place high importance on protecting the Bay, and want increased government action to reduce runoff and pollutants.

Litter

Litter remains a significant challenge. It has a negative impact on visual amenity, reduces water quality and can kill or harm marine animals. Previous estimates were that about 95% of litter found on our beaches had been transported from suburban streets through the stormwater system (Melbourne Water 1993). However, concern has been raised that with more people using the Bay for recreation there is likely to be an increase in direct littering within the Bay and on its beaches.

Microplastics are an emerging issue of concern. These are small (< 5mm) pieces of plastics that come from broken-down plastic litter or from raw plastic manufacturing materials being washed off streets into the drains and waterways. They can be eaten by marine animals impacting their health (Duckett and Repaci 2015, Maillard *et al.* 2013). Microplastics also include small synthetic fibres from the breakdown of woven cloth, which can occur through the process of clothes washing.

Marine pests

Marine pests are an ongoing risk to the ecology of the Bay because they can compete with native species, alter habitats, reduce important fish stocks, and potentially disrupt nitrogen cycling processes (Barbee *et al.* 2016). The risk from marine pests is likely to increase because of the projected increases in shipping traffic and small vessel movements, which will increase the opportunity for marine pests being introduced to and exported from the Bay.

Climate change

Climate change is likely to exacerbate some existing problems and create new ones. Water temperatures will increase, leading to a change in species composition, and changing patterns of underwater and coastal plant and animal communities.

Sea levels will rise and storm surges will become more frequent, exposing the coastline to erosion and inundation, and squeezing coastal habitat between the sea and urban development. Under a changing climate there will be less rainfall, but more intense rainfall events in summer, causing flooding, erosion in the catchment, and transportation of higher sediment and nutrient loads to the Bay.

It is therefore vital that the Bay and its catchment are managed to be healthy and resilient in the face of these challenges. Collaborative, adaptive and ongoing management of the Bay and its catchment will be required to ensure the Bay can continue to support the values that are important to Victorians.

Responsibilities, legislation and policy for environmental management of the Bay

Management responsibilities

Appropriate and coordinated management of the Bay is crucial to ensure its ongoing health and capacity to support a diverse range of values and activities.

Most of the marine areas of the Bay are classified as unreserved Crown land under the *Land Act 1958*, and are under the administrative control of DELWP. DELWP is also responsible for leading and coordinating environmental management of the Bay, along with other roles including wildlife protection, incident response, planning and issuing permits for works.

Melbourne Water and the Corangamite Catchment Management Authority (CMA) have waterway management functions under the *Water Act 1989* for designated waterways within their respective areas. They have enabling functions within the Act, to develop and implement plans, carry out works, and activities to improve environmental values, typically in priority areas. The Port Phillip and Westernport CMA also has an important role in catchment management, helping to address issues that affect the health of waterways.

EPA is the environmental regulator and has responsibility for independent assessment, reporting and advice regarding environmental health issues affecting waterways and the Bay. The EPA is also responsible for administrating and enforcing the *SEPP (Waters of Victoria)* and other pollution regulations.

Park Victoria manages the Bay's marine national parks and marine sanctuaries that form part of Victoria's park and reserve system. Parks Victoria is also the port manager for local ports within the Bay under the *Port Management Act 1995* and is responsible for ensuring that local port operations are safe, efficient and effective; managing port infrastructure (including piers and jetties, navigational aids, moorings and berths); and preparing and implementing safety and environment management plans. Parks Victoria is also the waterway manager for the Yarra, Maribyrnong and Patterson Rivers under the *Marine Safety Act 2010*. This includes management of vessel activities, including control of navigation and vessel movement; removing and marking in-water obstructions; and channel maintenance within the local port area.

The Port of Melbourne is managed by the Port of Melbourne Corporation under the *Port Services Act 1995* and *Port Management Act 1995*. The Victorian Regional Channels Authority manages commercial navigation of the channels in the Bay and the waters of the Port of Geelong. Responsibilities of these commercial port operators include shipping control, channel management, the provision of navigation aids, and the development and implementation of safety and environment management plans (SEMP).

Other agencies with a role in conserving and caring for the Bay and its catchment include:

- Committees of management for Crown land reserves
- Department of Economic Development, Jobs, Transport and Resources (which includes Agriculture, Biosecurity, Fisheries and Tourism)
- Department of Health and Human Services
- Local government (including local councils, Municipal Association of Victoria, and Association of Bayside Municipalities)
- Office of the Commissioner for Environmental Sustainability
- Sustainability Victoria
- Transport Safety Victoria
- Victorian Coastal Council and Central Coastal Board
- Victorian Planning Authority
- Water corporations (Barwon Water, Central Highlands Water, City West Water, South East Water, Southern Rural Water, Western Water, and Yarra Valley Water)
- Zoos Victoria.

Aboriginal groups from the Kulin nation represent the views and understanding of Traditional Owners, and can provide valuable heritage and ecological knowledge in Bay management.

There are also a large number of non-government conservation and community organisations that play a significant role in protecting the health of the Bay through on-ground activities and research.

Policy setting for this Plan

Management of the Bay occurs within a network of state, regional and local strategies, plans and policies. Most of these relate indirectly to the Bay through activities that focus on stormwater, waterways, catchments and coastal areas, but which have impact upon Bay conditions. The key documents are set out in Figure 7. Further detail regarding key legislation and policies that directly influence the management are outlined below, along with a number of current Victorian Government initiatives.

Current legislation and policy

Management of the Bay is guided by a number of pieces of legislation and government policy that directly relate to marine and coastal environments. These are:

- *Environment Protection Act 1970* and *State Environment Protection Policy (Waters of Victoria)*

  State Environment Protection Policies (SEPPs) are subordinate legislation made under the provisions of the *Environment Protection Act 1970*. They aim to safeguard the environment and humans from the effects of pollution and waste.

  SEPP (Waters of Victoria) sets out Victoria's water quality expectations. It establishes the pathway for protecting and improving the quality of surface water environments in a context that supports economic and social development.

  Schedule F6 Waters of Port Phillip Bay provides the directive for this Plan. *Schedule F6* identifies values present in various parts of the Bay that need to be protected, and sets water quality objectives for various environmental quality indicators.

  The Victorian Government is currently reviewing the *State Environment Protection Policy (Waters of Victoria) and State Environment Protection Policy (Groundwaters of Victoria)* to ensure clear and relevant standards and legal obligations to protect and improve the health of our aquatic environments.

- *Land Act 1958, Crown Land Reserves Act 1978* and *National Parks Act 1975*

  The majority of the floor and overlying waters of the Bay is classified as unreserved Crown land under the *Land Act 1958*, and DELWP is the designated land manager for these areas.

  The Port Phillip Heads Marine National Park and three marine sanctuaries (Point Cooke, Jawbone and Ricketts Point) located in the Bay are established and managed under the *National Parks Act 1975*. The area within 200 metres of South Channel Fort is also reserved under the *National Parks Act 1975*. The Act establishes the statutory basis for the protection, use and management of these parks and reserves. Parks Victoria is responsible for the management of marine protected areas.

  The Bay foreshore includes the intertidal zone and the area immediately landward of it. Most of the foreshore is classified as reserved Crown land under the *Crown Land (Reserves) Act 1978* for a variety of purposes including the protection of the coastline, the preservation of species of native plants, and areas for public recreation. Management of this land is often delegated to committees of management, who are appointed by the Minister for Energy, Environment and Climate Change. Committees of management can be a government agency such as Parks Victoria, local councils, or voluntary community groups.

- *Coastal Management Act 1995*

  The *Coastal Management Act 1995* establishes the legislative framework for planning and managing the Victorian coast. The Act establishes the Victorian Coastal Council and Regional Coastal Boards, provides for the preparation and implementation of management plans for coastal Crown land, and provides a co-ordinated approach to approvals for the use and development of coastal Crown land.

  Coastal Crown land is generally all Crown land within 200m of the high tide mark and the seabed of Victorian coastal waters, including the Bay. All use or development of coastal Crown land by any party, including committees of management and local councils, requires consent under the Act.

  The Victorian Coastal Council is established under the Act. Its responsibilities include statewide strategic planning and preparation of the *Victorian Coastal Strategy*. The *Victorian Coastal Strategy 2014* provides a long-term vision for the planning, management and sustainable use of the coast and identifies high-level policies and actions to help achieve the vision, which is: 'a healthy coast, appreciated by all, now and in the future'.

The Central Regional Coastal Plan 2015–2020 is a statutory document endorsed under the *Coastal Management Act 1995* and prepared by the Central Coastal Board. It identifies eight regional priorities:

1 Population growth – balancing access and valuing the natural environment
2 Adapting to climate change and increased coastal hazards
3 Integrating coastal planning and management
4 Sustainable and equitable funding mechanisms for coastal infrastructure and management
5 Implementing the Recreational Boating Facilities Framework
6 Sustainable visitation and tourism infrastructure service through the development of a multi-level hierarchy
7 Protecting significant coastal and marine ecosystems and habitats
8 Promoting leadership, co-ordination and capacity building.

New legislation and policy

This Plan will be complemented by a number of new policies or revisions of existing ones. These include development of the *SEPP (Waters), Marine and Coastal* legislation, *Water for Victoria* plan and the first *State of the Bays* report. Further detail on these initiatives and how they relate to or may impact this Plan is provided below.

- *State Environment Protection Policy (Waters of Victoria)* review

  As part of the *State Environment Protection Policy (Waters of Victoria)* review, consideration is being given to setting load targets for catchment inputs to marine receiving waters. Water quality modelling and load projections undertaken by Jacobs and HydroNumerics (2015a, b) for this Plan is helping to inform government decisions on water quality objectives and policy targets. The new *SEPP (Waters)* is planned to be released by government in 2018.

- *Marine and Coastal Act*

  The Victorian Government is developing a new *Marine and Coastal Act*, which will see coastal and marine management better integrated within the same system for the first time. The new Act will provide the legislative framework to support the vision of a healthy coast and marine environment in the face of future long-term challenges. It will guide marine and coastal strategies and the reports that sit beneath it. The government is also looking to develop better management and oversight arrangements for coastal and marine environments as part of developing the new Act.

- *State of the Bays* reporting

  The Victorian Commissioner for Environmental Sustainability has committed to deliver the first *State of the Bays* report in late 2016. This report will provide a scientifically rigorous baseline report on the health of Port Phillip Bay and Western Port against which future reporting can be compared. The *State of the Bays* report will consider existing research and data, identify knowledge gaps, propose new data collection and monitoring priorities, and develop indicators for future reporting on the *State of the Bays*. Having an updated condition status for the Bay will provide a baseline for evaluating the effectiveness of this Plan. *State of the Bays* will also be an important part of the monitoring and reporting framework of this Plan.

- Port Phillip Bay Fund

  Some of the proceeds from the Port of Melbourne 50-year lease will support the new Port Phillip Bay Fund over the next four years. The fund, announced in March 2016, will support projects to protect and preserve the Bay including water quality improvement, dune stability, amenity upgrades and wetlands improvements.

- *Water for Victoria*

  Water for Victoria was released in October 2016, and plans for a future with less water as Victoria responds to the impacts of climate change and a growing population.

Strategic directions in the *Water for Victoria* plan will strengthen management of the Bay's health by:

  – Improving protection arrangements for urban waterways through improved landuse planning controls, and more comprehensive place-based integrated water management planning
  – Improving stormwater management through changes to planning and building regulations, use of catchment-based stormwater offsets, setting of water quality indicators that protect beneficial uses, and establishment of a risk-based framework to manage unlicensed pollution sources
  – Increasing community involvement in land, water and biodiversity management through greater recognition of Aboriginal values and ecological knowledge, and investment in citizen science programs for local waterways
  – Improving waterway management through aligned monitoring and reporting of waterway health, sharing of knowledge, and the use of scientific research to underpin evidence-based decision-making and adaptive management.

- Yarra River Protection Ministerial Advisory Committee

  A Ministerial Advisory Committee has been established to provide advice to the government on the key issues and opportunities for the Yarra River. The discussion paper, which was released in July 2016, identifies current and emerging issues that are impacting on environmental, cultural, social and economic values; and considers how statutory policies and planning mechanisms can be used to reduce impacts. Management of stormwater and reduction of pollutant loads from existing urban areas in the Yarra catchment will improve Bay health.

- Draft Biodiversity Plan, *Protecting Victoria's Environment – Biodiversity 2036*

  The Victorian Government's draft Biodiversity Plan, *Protecting Victoria's Environment – Biodiversity 2036*, is a long-term strategy that proposes a new direction for the management of biodiversity in Victoria. A key component of the draft plan is to encourage people to value and protect our natural environment.

- Review of the *Flora and Fauna Guarantee Act 1988*

  The government is reviewing the *Flora and Fauna Guarantee Act 1988*. The aim of the review is to improve the effectiveness and efficiency of the design and implementation of the Act in protecting Victoria's biodiversity, including threatened species and their habitats. The review will also consider how the Act can support implementation of the Biodiversity Plan and interact more effectively with other legislation relevant to biodiversity conservation.

- Independent Inquiry into the Environment Protection Authority (EPA)

  A Ministerial Advisory Committee has examined the EPA's role, powers and tools, governance and funding. The inquiry concluded on 31 March 2016 when the Ministerial Advisory Committee delivered its report to the then Minister for Environment, Climate Change and Water. The Victorian Government is now considering the report's findings and its recommendations. This Plan will need to take into consideration the outcomes of this inquiry as they become apparent.

- *Climate Change Framework and Adaptation Plan*

  The *Climate Change Framework* will articulate the government's long-term vision and approach to climate change in one policy document. It will draw together all of the work happening across government on climate change. This includes building on projects such as the *Our Coast* project, which is using the latest data on projected sea level rises and storm surges to help coastal communities and government agencies plan and respond to the impact of climate change.

- *Plan Melbourne Refresh*

  The government is undertaking a refresh of *Plan Melbourne*. Building on key concepts and commitments, with a strengthened focus on housing affordability and diversity, climate change and energy efficiency, and updating transport priorities. Plan Melbourne will create the blueprint for action that will define the future shape and sustainability of Melbourne and broader Victoria. It will provide a framework for supporting jobs and growth, while building on Melbourne's legacy of distinctiveness and liveability. It will also link Melbourne and regional Victoria – including a plan to support population and economic growth and connectivity across the state.

- *Victorian Government Aboriginal Inclusion Framework*

  The *Aboriginal Inclusion Framework* helps ensure services are accessible and inclusive for Aboriginal Victorians and provides for increased employment opportunities. The framework outlines the objective to provide policy makers, program managers and service providers with a structure for reviewing their practice and reforming the way they engage with and address the needs of Aboriginal people in Victoria.

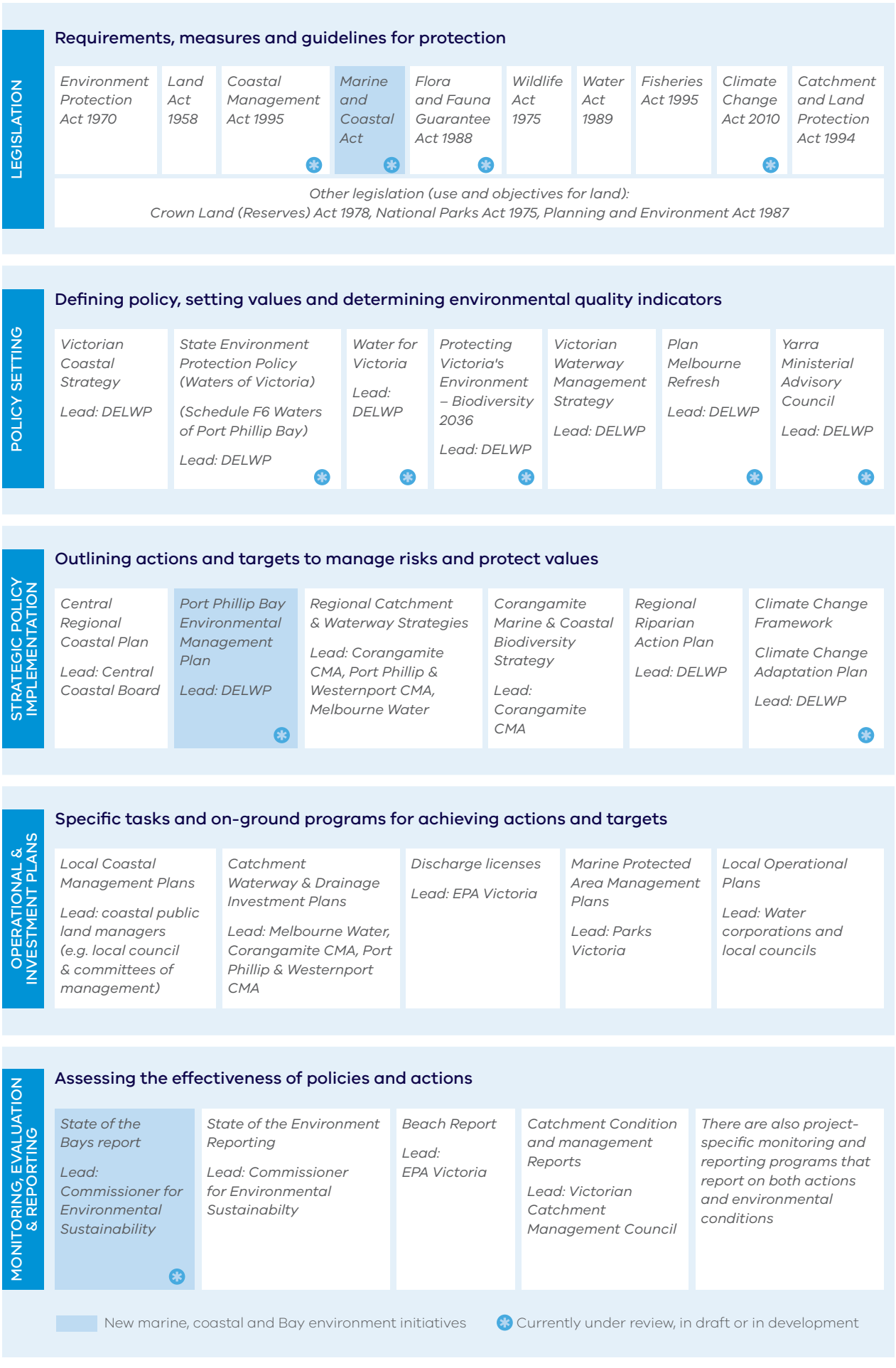


Figure 7 Policy context for environmental management of Port Phillip Bay

Achievements to date

The 2001 Plan was a major driver for new approaches and associated on-ground works to manage nutrients and marine pests. Further investment in major infrastructure was undertaken through implementation of the *Better Bays and Waterways* water quality improvement plan from 2009–2013. The *Victorian Coastal Strategy* and *Central Regional Coastal Plan* have also contributed to more informed outcomes for Bay health. Highlights of achievements of the 2001 Plan and other initiatives are summarised in Figure 8, and include:

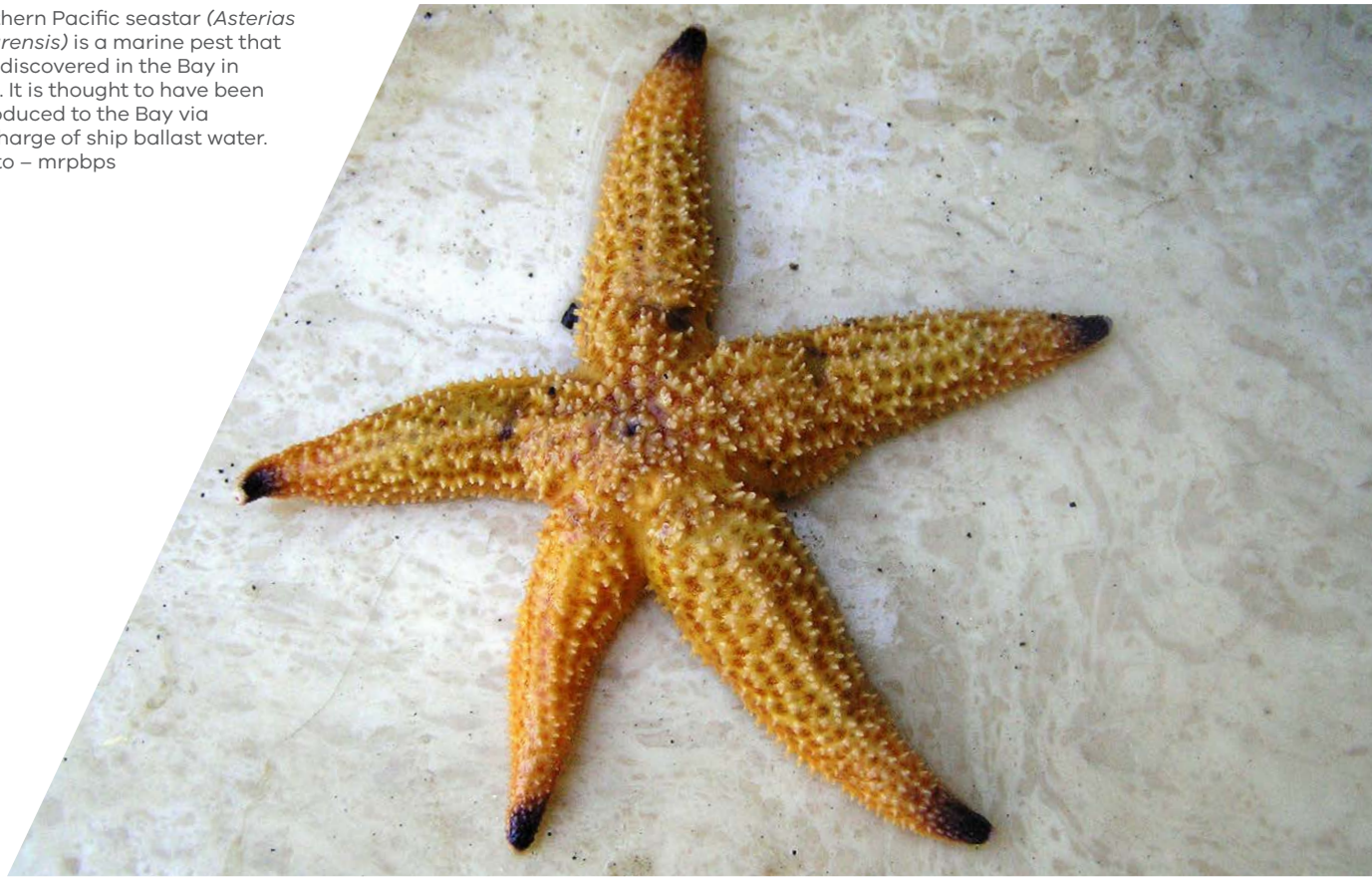
Nutrients

Objectives identified in the nutrients program of the 2001 Plan included a 500 tonne annual reduction in nitrogen load from the Western Treatment Plant and a 500 tonne annual reduction in load from catchment waterways.

Integrated modelling for the development of the new Port Phillip Bay Environmental Management Plan by Jacobs and HydroNumerics (2015a) has shown that the nitrogen load reduction target of 1,000 tonnes per year was met through a combination of upgrades to the Western Treatment Plant, implementation of water sensitive urban design to manage urban stormwater, and improved rural land management. Specific achievements included:

- The 500 tonne nitrogen reduction target for Western Treatment Plant inputs was met as a result of significant upgrades to the plant completed in 2004–05.
- Fifty-two wetlands were constructed in urban areas to prevent up to 109 tonnes of nitrogen from entering waterways.
- Programs to improve rural land management practices in the cropping, grazing and horticulture industries were developed and implemented. These programs focused on raising awareness and building capacity, encouraged landholders to adopt best practice land management approaches and provided assistance to landholders to restore degraded land and reduce nutrient runoff.
- Water sensitive urban design (WSUD) has been promoted heavily since 2001. Actions include the introduction of mandatory stormwater quality performance standards for new developments, revision of Clause 56 of the Victoria Planning Provisions to include stormwater quality objectives for sub-divisions, implementation of a development stormwater offset scheme, and preparation and implementation of Municipal Stormwater Management Plans.
- Measures were introduced to reduce nitrogen discharge from industrial, sewerage and aquaculture sources. These included upgrades to local sewage treatment plants, connection of small wastewater treatment plants to larger sewerage systems and increased reuse of wastewater.
- Water quality monitoring programs were established, including the nutrient cycling monitoring program and storm event monitoring program; and EPA's fixed site water quality monitoring program has continued.

Western Treatment Plant – activated sludge plants within the treatment lagoons have enhanced nitrogen removal. Photo - Melbourne Water



Northern Pacific seastar *(Asterias amurensis)* is a marine pest that was discovered in the Bay in 1995. It is thought to have been introduced to the Bay via discharge of ship ballast water. Photo – mrpbps

Marine pests

The objective of the marine pest program was to improve the management of vectors that lead to the introduction of marine pests, and to reduce the impact from introductions through early detection and rapid response. The 2001 Plan recognised that many risks associated with marine pests are most effectively addressed through nationally agreed arrangements and, in their absence, statewide programs. As a result, a number of initiatives (such as the national ballast water management system) to help improve management of marine pests have been, or are being, undertaken at a national or state level.

Achievements of the marine pest program included:

- The EPA released the *Waste Management Policy (Ships Ballast Water)* in 2004 and in 2006 published *Environment Protection (Ships Ballast Water) Regulations* to ensure that high-risk ballast water was not discharged into Victorian ports or waters.
- Engagement and communications programs were undertaken to educate small boat operators on simple steps to avoid translocating marine pests. The Boating Industry Association of Victoria implemented a communication program to reduce the risk of pest relocation by small vessel operators.
- *Victorian Guidelines for Assessing Translocations of Live Aquatic Organisms in Victoria* were completed to help control the risk of introduction and spread through aquaculture. Protocols developed under the guidelines included the *Victorian Protocol for the Translocation of Blue Mussels*; the *Victorian Abalone Aquaculture Translocation Protocol* and Management Plans for aquaculture reserves declared under the *Fisheries Act 1995*.

Other relevant achievements for the management of marine pests at the national level included:

- Introduction in 2001 of mandatory Australian Ballast Water Management Requirements for internationally sourced ballast water and trial of a national approach for ballast water management at the Port of Hastings.
- National System for the Prevention and Management of Introduced Marine Pest Incursions (the National System) was introduced in 2009.
- Series of national biofouling management guidelines were published under the National System between 2009 and 2013 for recreational vessels, non-trading vessels, commercial fishing vessels, the petroleum production and exploration industry, commercial vessels and the aquaculture industry.
- Australian marine pest monitoring guidelines and accompanying Australian marine pest monitoring manual were published in 2010 as part of the National System.
- National Control Plans were developed under the National System and published in 2009 for control of the Northern Pacific seastar (*Asterias amurensis*), Asian bag or Date mussel (*Musculista senhousia*), European green shore crab (*Carcinus maenus*), Japanese seaweed or wakame (*Undaria pinnatifolia*), European or basket shell clam (*Varicorbula gibba*) and European fan worm (*Sabella spallanzani*).
- The Commonwealth *Biosecurity Act 2015* replaced the *Quarantine Act 1908* and provides a framework for consistent national regulation of ballast water management. The timing for transition from state-based to national regulation of domestic ballast water is yet to be confirmed.

Research programs

Following the 2001 Plan, investment in research has continued to improve our knowledge and understanding of the Bay. The Seagrass and Reefs Program was a $5.5 million investment into research and management of seagrass and temperate reefs. Key outcomes include better understanding of ecological processes for seagrass and temperate reef habitat. The program also provided funding to Museum Victoria for development of a *Marine Taxonomic Reference Toolkit*. The toolkit includes images and taxonomic and habitat information for over 1,000 animal species that inhabit or have been recorded in the Bay.

While a lot of work and research has been done to help protect and enhance the health of the Bay since the 2001 Plan, there is still more to do to ensure the Bay remains healthy and resilient and responds to the pressures of a growing population and the challenges associated with climate change.

Subtidal rocky reef at Jawbone Marine Sanctuary, with native eleven-armed seastar *(Coscinasterias muricata)* and sea urchins *(Helliocidaris erythrogramma)*, over a bed of Blue mussels *(Mytilus edulis)*. Photo – Parks Victoria

Infrastructure

Achievement of the **500 tonne reduction target** in annual nitrogen loads to the Bay through investment of $160 million in upgrades to the Western Treatment Plant

$60 million invested to **remove 109 tonnes of nitrogen from waterways** through construction of 52 wetlands and other water sensitive urban design initiatives

Local planning

Introduction of **mandatory stormwater quality performances standards for new developments** through Clause 56 of the planning scheme

Implementation of a **stormwater offset service** for new developments which cannot meet best practice stormwater management under Clause 56

$20 million provided to councils in the Bay catchment to prepare and implement their **Municipal Stormwater Strategies**, including construction of raingardens, wetlands and other strategic water sensitive urban design projects

Education and incentives

More than **10 capacity building programs** in partnership with local government, community groups and landholders to develop and implement best management practices for reducing nitrogen inputs to waterways from rural areas

Incentives for landholders to **restore degraded land and reduce sediment and nutrient loads** to waterways and the Bay through fencing of stream frontages and revegetation

Engagement and communications programs with small boat operators to raise awareness and encourage adoption of simple steps to avoid translocating marine pests

Monitoring and research

A **Bay nutrient cycling monitoring program,** established in 2001/02

A **storm event monitoring program**, established in 2001/02

Undertook **research to better understand existing marine pest populations** and impacts on nutrient cycling processes in the Bay's sediments

Invested $5.5 million in **research on seagrass and temperate reefs**

Policy and guidelines

Publication of the **Waste Management Policy (Ships Ballast water)** and **Environment Protection (Ships Ballast water)** Regulations to reduce the risk of spreading marine pests through domestic ballast water

Contribution to the **National System for the Prevention and Management of Marine Pest Incursions** in collaboration with other governments

Figure 8 Highlights of environmental management for the Bay since 2001

Australasian Snapper *(Pagrus auratus)* at Ricketts Point. Photo – David Reinhard

Informing the new Plan

3

The approach for developing this Plan was to establish the long-term vision and goals for the Bay, and develop priority areas and actions that could achieve those goals and vision.

The vision, goals, priority areas and actions have been informed by background investigations, targeted stakeholder engagement and public consultation (Figure 9). Key reports from the background investigations are listed in Table 2.

Table 2 Background investigations completed for this Plan

Investigation	Output
Desktop review of Victoria's Marine values (Hale and Brooks 2015)	Identified and collated information on values (particularly relating to the SEPP beneficial uses) in Victoria's marine environment including Port Phillip Bay.
Prioritising Environmental Issues (Hale and Brooks 2016)	Identified pressures and stressors that pose the greatest risk to Bay values, and assessed priorities for further investigation and management.
Science Knowledge Synthesis (Barbee *et al.* 2016)	Collated current scientific knowledge on the status of nitrogen cycling, marine pests and pollutants in the Bay as a basis for developing management actions.
Catchment to Bay model (Jacobs and HydroNumerics 2015a, b)	Modelled estimates of nutrient, sediment and pathogen loads under different catchment scenarios, allowing for climate change and population growth, and their impact on water quality in the Bay.
Community and stakeholder consultation (DELWP 2016)	Provided snapshot of community and stakeholder's vision, values and challenges to consider in developing this Plan.

Other activities undertaken to inform this Plan included a review of the achievements and learnings from the 2001 Plan, a review of policies and programs, and an assessment of the economic benefits provided by the Bay and how these may change in the future.

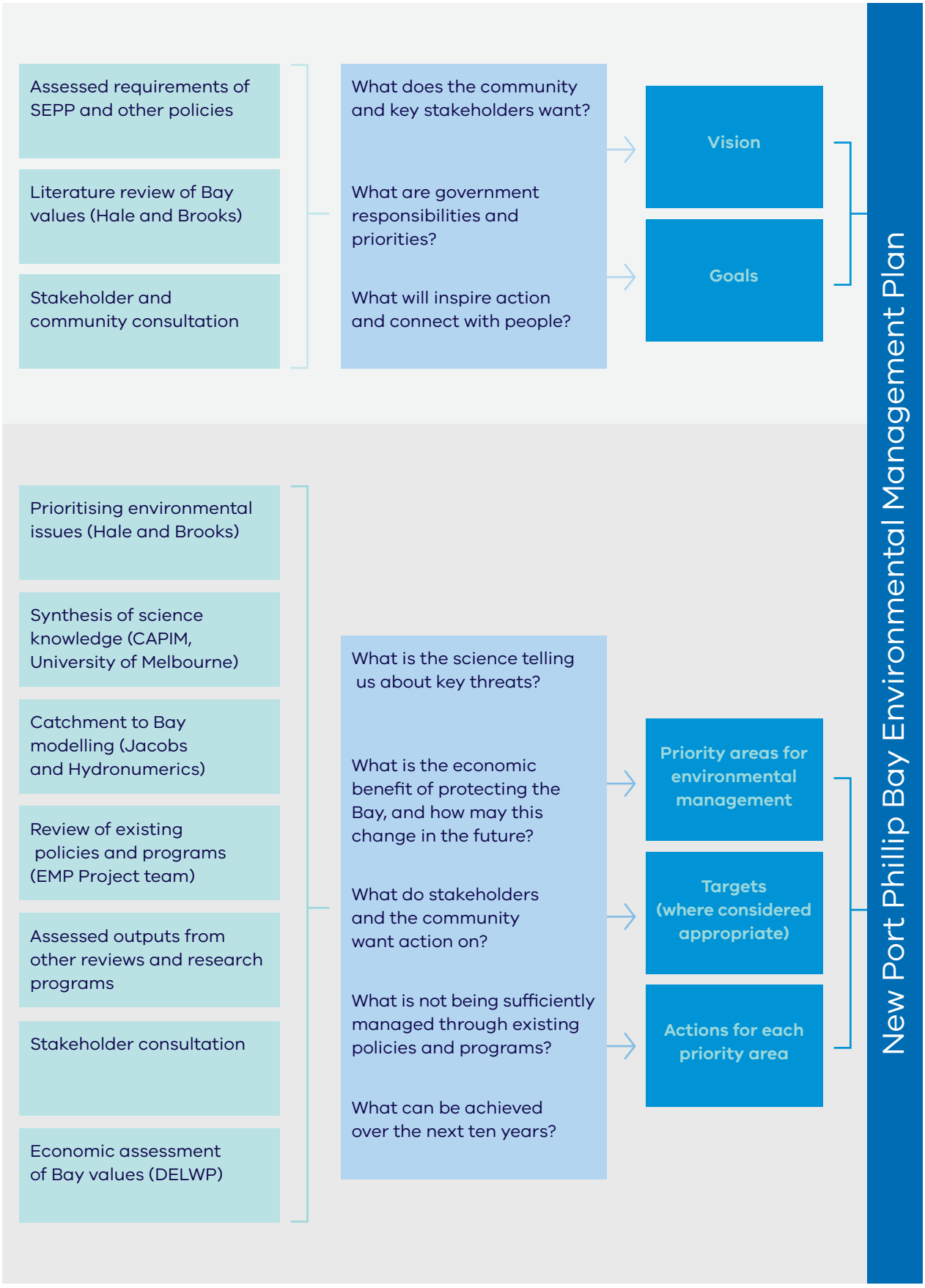


Figure 9 Process for developing the Environmental Management Plan

Community input

Public consultation was undertaken in January and February 2016 to inform the key directions of this Plan. Promoted under the theme 'What does a Healthy Port Phillip Bay mean to you?', consultation sought to understand:

- the values of the Bay that are important to community and key stakeholders
- key challenges associated with protecting the health of the Bay
- community and stakeholder aspirations for the future management of the Bay.

A range of consultation opportunities were provided to gain input from across the breadth of the community. These included:

- beachside listening post events (held at Rye, Elwood, Altona and Queenscliff), attended by approximately 430 people
- online survey completed by 1058 people
- formal submissions from 13 stakeholders.

Overall the consultation indicated a strong level of community interest in the care and management of the Bay. Further details on the consultation and key insights are presented in the *Consultation Summary Report*.

Beachside listening post events

Attendees spoke highly of the Bay and its importance to the state and the economy. They valued the Bay as a place for recreation and enjoyment. Many expressed an appreciation of its marine life, emphasising the need to educate the broader community about the Bay's natural features and measures needed to protect these.

Through discussions, drawings and vision statements, attendees outlined a desire to see comprehensive management of the Bay. Many commented on the connection between managing litter, ecosystem issues and stormwater to improve water quality and marine habitats.

Online survey

In the online survey, respondents prioritised litter management and water quality. People wanted improved water quality for better habitats and marine life, and less litter. Many respondents also wanted improved management of jet skis.

Formal submissions and stakeholder meetings

Formal submissions and meetings focused on more specific issues and aspirations; however, they offered that the vision should:

- articulate what success looks like
- ensure future generations can enjoy a healthy Bay
- be based on a hierarchy of values that puts the environment first followed by social and economic values (because the latter two depend on a healthy environment).

Beachside listening post at Queenscliff, February 2016.
Photo – Melbourne Water

Scientific input

The scientific investigations commenced with the *Desktop review of Victoria's marine values* (Hale and Brooks 2015). This was followed by an environmental risk assessment to prioritise issues for consideration in this Plan, and to identify those stressors that required further examination of available science (Hale and Brooks 2016). The science knowledge synthesis, which was undertaken by the Centre for Aquatic Pollution Identification and Management (CAPIM), examined the current state of knowledge of nutrients, marine pests and pollutants (including litter) in the Bay (Barbee *et al.* 2016). These issues were further assessed through development of an integrated catchment and bay water quality model (Jacobs and HydroNumerics 2015a, b).

Prioritising environmental issues

An environmental risk assessment was used as a screening tool to identify pressures (threatening activities) and stressors (the physical and chemical changes due to an activity) that pose the greatest risk to Bay values (Hale and Brooks 2016). Pressures and stressors included in the assessment, and their level of concern, are shown in Table 3.

Table 3 Pressures and stressors for the Bay and level of concern

Pressure	Level of concern
Climate change	Very high
Catchment inflows (including stormwater)	High
Western Treatment Plant	Medium
Invasive species	Medium
Biological resource use	Low
Recreational activities	Low
Shipping and navigation (oil spills)	Very low
Commercial development (dredging)	Very low
Disturbance of coastal acid sulphate soils	Very low

Stressor	Level of concern
Increased nutrients	Very high
Toxicants	Very high
Increased frequency and intensity of storms (erosion of shorelines)	High
Litter (including microplastics)	High
Increased sediments (resuspension by waves and dredging)	High
Increased droughts (increased salinity, decreased nutrients)	High
Sea level rise	High
Increased temperature	High
Marine pests (includes overabundant native species)	High
Ocean acidification	Medium
Hydrocarbons	Medium
Recreational fishing	Medium
Weeds	Medium
Pathogens	Medium
Commercial fishing	Low
Vehicles in intertidal areas	Low
Vessels	Very low
Increased carbon dioxide	Very low
Passive recreation on beaches and shorelines	Very low

Pressures rated as the highest level of concern in the risk assessment were climate change and catchment inflows. Catchment inflows (stormwater and rivers) were identified as one of the biggest pressures due to five stressors: increased nitrogen, sediment, toxicants, litter and pathogens. There are also a large number of stressors associated with climate change – including increased frequency and duration of drought, increased frequency and intensity of storms, sea level rise, increased temperature and ocean acidification.

Pathogens were rated as a medium level of concern as impacts for recreational use and aquaculture are generally localised and short-term in nature. However, the potential public health implications of pathogens and public expectations regarding being able to swim and collect shellfish in the Bay mean that this is a significant issue that requires ongoing management and consideration.

The environmental risk assessment was also used to identify values that are most at risk from the identified stressors. Four values were categorised as being at most risk: waterbirds (including seabirds and shorebirds as well as Little penguins), marine mammals, sub-tidal and intertidal rocky reefs, and fish.

Marine pests and overabundant species

The science knowledge synthesis highlighted that marine pests have a ubiquitous and permanent presence in the Bay. However, the Bay continues to support diverse and functioning ecosystems.

While there is limited knowledge of the current status of most pest species, the available evidence suggests that their impacts on nutrient cycling and biodiversity have been negligible and localised. However, marine pests still pose considerable risks to biodiversity, aquaculture, ecosystem function and recreational amenity. They have the potential to have significant impacts on the Bay and these values, particularly if there are changes to environmental conditions that are favourable for these species; for example, warmer water, increased availability of nutrients, or reduced predation by other species. This suggests that marine pests should be considered as a long-term and ongoing threat to the Bay.

The science knowledge synthesis and environmental risk assessment identified that the abundance of some native species (i.e. sea urchins) has increased in recent years. In some areas of the Bay, this is adversely impacting Bay values through reducing macroalgae coverage on sub-tidal rocky reefs, which then has detrimental impacts to other species.

The risk of marine pests being introduced to and spreading from the Bay, particularly via small (commercial and recreational) vessels, was also identified as a high-priority risk that should also be considered in this Plan.

Toxicants

Based on our current knowledge, many gaps still exist regarding the presence of different toxicants and their effects on Bay values (Barbee *et al.* 2016). The science knowledge synthesis concluded that toxicants, such as metals and organochlorine pesticides, are generally below guideline levels. However, increased levels are found in a few localised areas, including Hobsons and Corio Bays and where the Mordialloc and Kananook Creeks discharge into the Bay.

While the presence and sources of phosphorus and sediments are well described and the impacts of litter on key Bay values have been identified, there are a number of contaminants of emerging concern. These include endocrine-disrupting compounds (EDCs), pharmaceuticals, flame retardants, pesticides (other than organochlorines), and microplastics. These pollutants have not been monitored in the Bay in a systematic way, and in many instances their impacts on Bay values have not been well characterised.

Sediments can have a significant impact on aesthetic, recreational and ecological values, and are vectors for transporting toxicants. Modelling by Jacobs and HydroNumerics (2015a) showed that the Yarra Catchment is a major source of sediments, with annual loads closely correlated to rainfall (i.e. loads are higher in wetter years – see Figure 10). The split between urban and rural sources is about 50/50; despite the area of rural land being twice the size of urban land (Figure 5). Figure 10 also highlights the efficiency of the treatment at the Western Treatment Plant for removing sediments. Modelling results have identified the need for improved management within catchments (urban and rural) to reduce sediment loads and their associated toxicants from entering the Bay, especially in periods of high rainfall.

Nutrients

The *Port Phillip Bay Environmental Study* (Harris *et al.* 1996) found that most of the nitrogen entering the Bay is removed by a highly efficient microbial process (denitrification), which takes place on the sea bed. Maintaining the effectiveness of denitrification by limiting nitrogen loads to the Bay is important for maintaining a healthy marine ecosystem (Barbee *et al.* 2016).

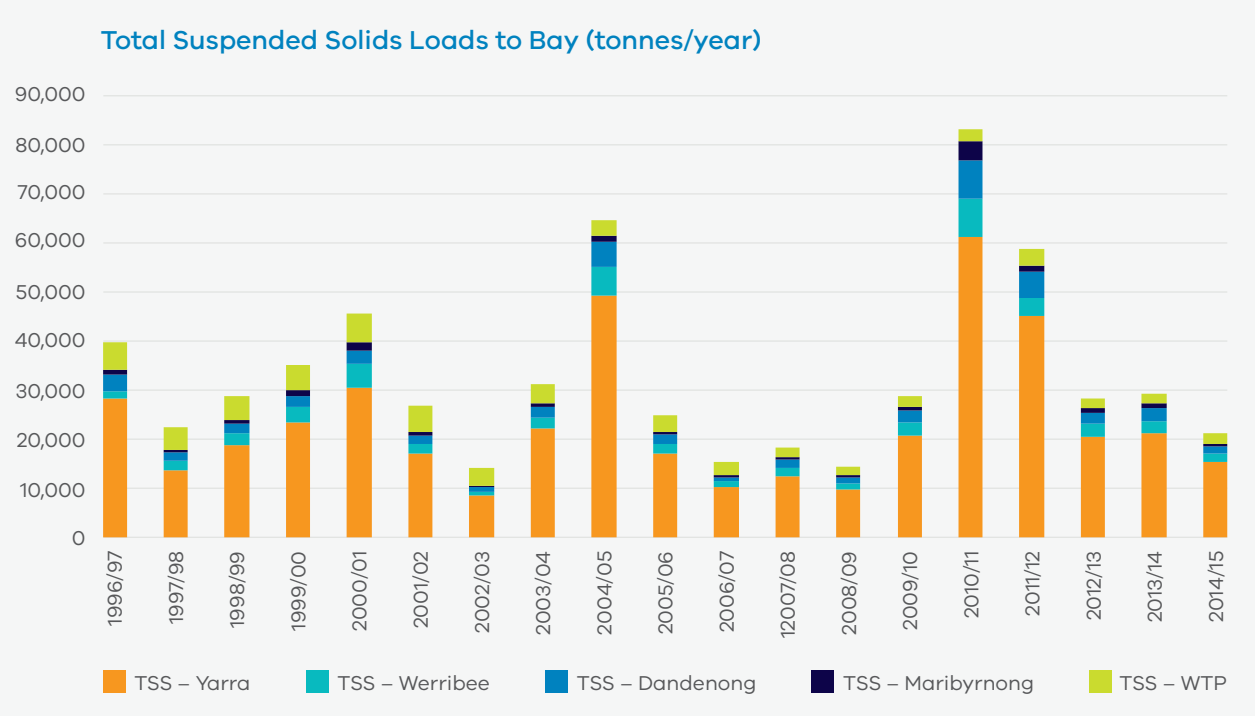


Figure 10 Estimated annual loads of sediment (total suspended solids, TSS) based on catchment modelling. Loads for Werribee and Dandenong include contributions from smaller rivers and creeks that discharge directly to the Bay in those regions.

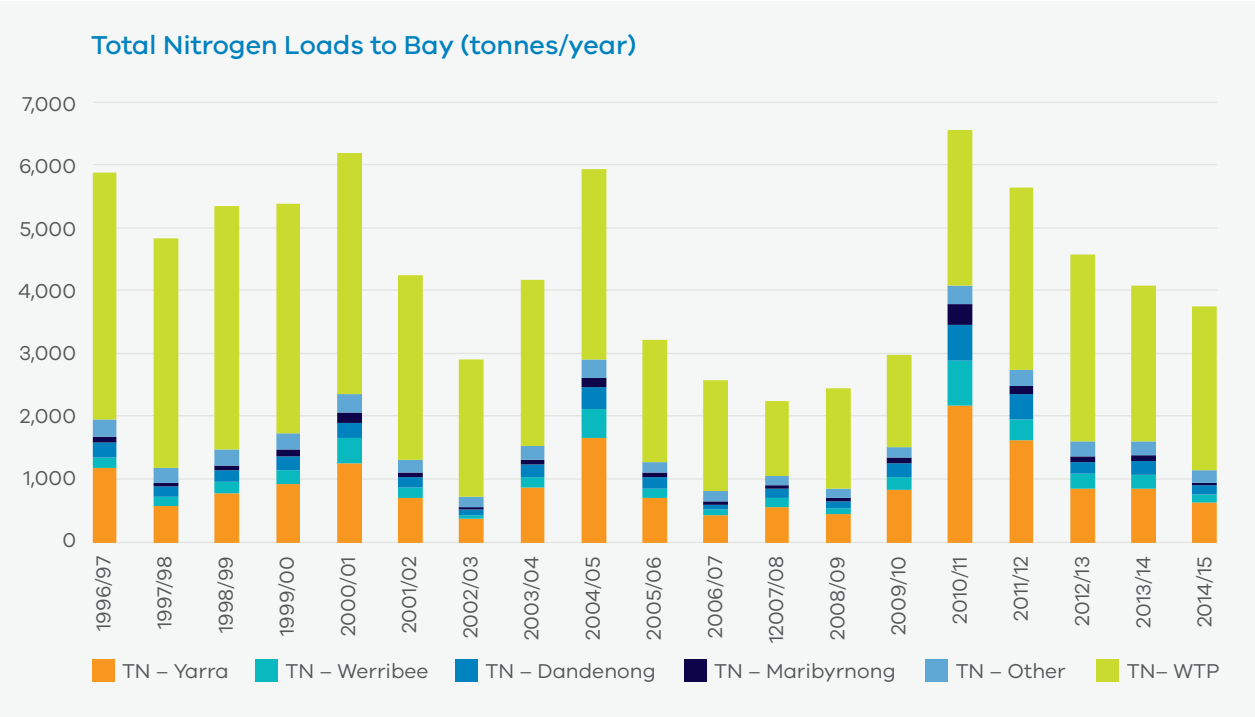


Figure 11 Estimated annual loads of total nitrogen (TN) based on catchment modelling. Loads for Werribee and Dandenong include contributions from smaller rivers and creeks that discharge directly to the Bay in those regions. Other, includes discharges from drains and minor waterways not included in the four major catchments/regions, direct discharge of groundwater and atmospheric deposition to the Bay.

The conceptual model of nutrient cycling in the Bay (Figure 12) is predicated on the following principles and observations (from Longmore 2014):

- Nutrient inputs stimulate plankton growth.
- Plankton growth is limited by the availability of nutrients, particularly nitrogen.
- Diatoms make up a significant proportion of the plankton, and settle to the seabed where they are decomposed by microbes.
- Microbial activity consumes oxygen and releases nutrients into the sediment and water column.
- Biogeochemical processes transport regenerated nitrogen between oxygen-rich and oxygen-poor zones in the sediment to facilitate sequential nitrification and denitrification.
- Denitrification is the key process limiting nitrogen availability and associated plant growth. It has high value as an ecosystem service, because it leads to the net loss of nitrogen from the system, preventing long-lived algal blooms.

Key factors with the potential to affect denitrification include:

- drivers for plankton growth (nutrient supply and physical conditions – light, temperature, salinity)
- oxygen regime at the sediment surface
- mechanisms (e.g. bio-irrigation by infauna) that affect nutrient transport through the sediment.

Continued low levels of nitrogen inputs help to ensure that the marine ecosystem remains robust and able to support a diversity of plants and animals.

Estimated annual loads of total nitrogen to the Bay from 1996/97 to 2014/15 are shown in Figure 11. The largest contribution of nitrogen is from the Western Treatment Plant. The second largest contribution is from the Yarra Catchment, which carries runoff from urban and rural land. Runoff for the Werribee, Maribyrnong and Dandenong catchments are also significant contributors, but vary significantly between years in response to flooding events (Jacobs and HydroNumerics 2015a).

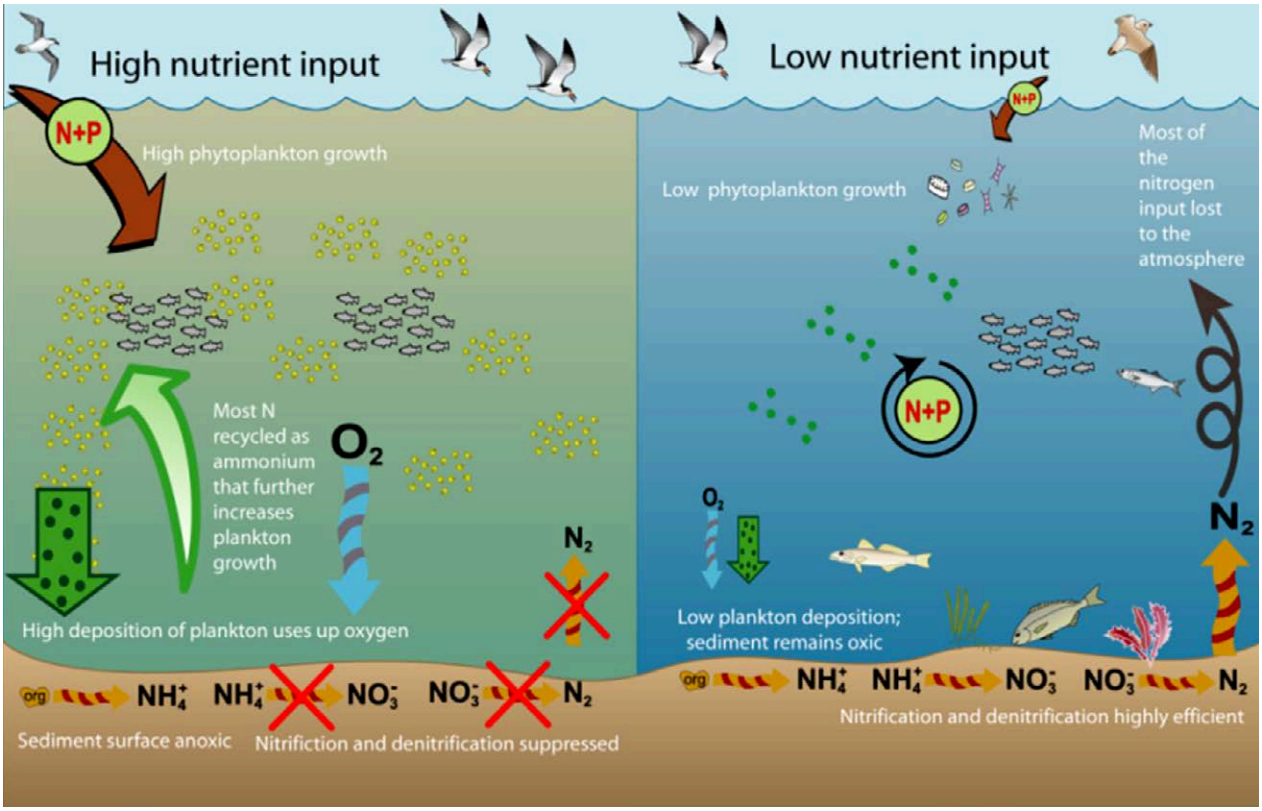


Figure 12 Conceptual model of nutrient cycling in Port Phillip Bay under low (left) and high (right) nutrient loadings

Since 2001, there has been a significant reduction in loads from the Western Treatment Plant due to improved treatment processes, reduced inflows, and increased recycling during drier periods. Loads from other sources (drains and minor waterways not included in the four major catchments, direct discharge of groundwater, and atmospheric deposition) contribute about 5% of the total load to the Bay (Figure 11).

An action from the 2001 Plan was to undertake monitoring of the nitrogen cycling process biannually at two sites in the Bay: Hobsons Bay and Bay Central (Longmore 2014). This monitoring has confirmed the continued efficiency of denitrification and the conceptual understanding of nitrogen cycling reported by Harris *et al*. (1996).

Integrated water quality modelling undertaken by Jacobs and HydroNumerics (2015a, b) for this Plan has verified the previous estimates for nitrogen loads to the Bay and the efficiency of the nitrogen cycling process that occurs within the Bay.

Western Treatment Plant: Discharges from the Western Treatment Plant are affected by the volume of sewage flowing to the plant (inflows), weather impacts on processes within the plant (including capacity to contain storm flows), and the amount of water recycled for other uses. Based on population forecasts and urban growth, inflows to the plant are expected to increase 45% by 2050.

Nitrogen loads discharged from the Western Treatment Plant have varied greatly over the past 50 years. During the early 1970s, discharge loads were estimated to be in the order of 6,000 tonnes of nitrogen per year. However, with the commissioning of the Eastern Treatment Plant in the mid-1970s, nitrogen loads were reduced significantly. Further operational changes and investment in new infrastructure between 2001 and 2005 were able to achieve higher rates of nitrogen removal, which resulted in a further step change in annual loads to the Bay. These changes, together with the reduced inflows associated with the drought, saw nitrogen loads reduced to less than 1,500 tonnes per year (Figure 11); and in the wetter years loads still remained well below the target of 3,100 tonnes per year (Jacobs and HydroNumerics 2015a).

Catchment inputs: Fletcher and Deletic (2006) undertook a review of water quality knowledge for the major catchments that drain to the Bay. They stated that urban areas within the Yarra catchment contribute 43% of total nitrogen, with rural pasture contributing 42%, and horticulture/cropping contributing 8% of total nitrogen respectively. Contributions from forested areas were only 8%. On a per hectare basis, the contribution from urban is greater. Results from modelling undertaken by Jacobs and HydroNumerics (2015a) aligned with the earlier analysis.

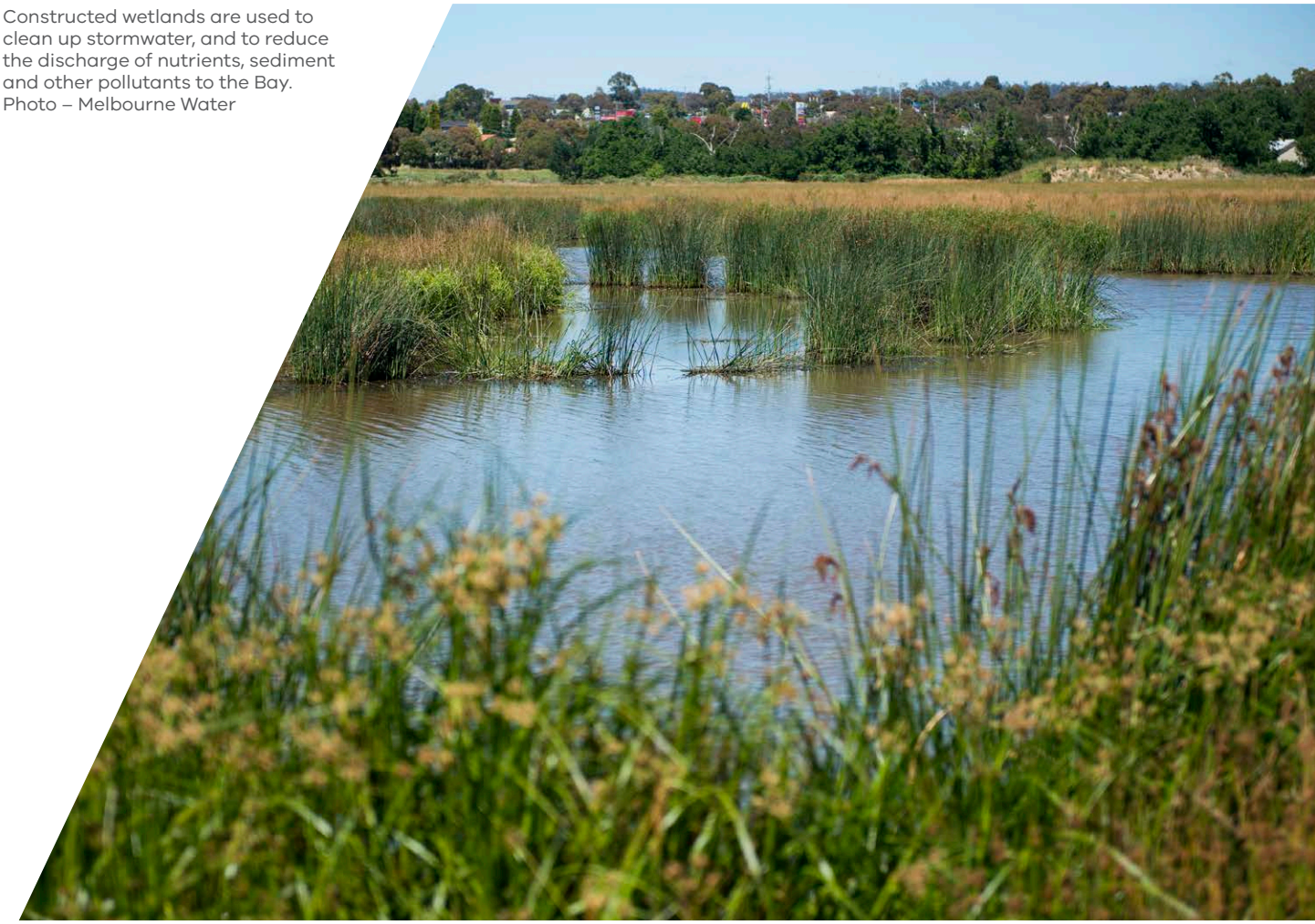
Scenario modelling

The catchment and bay model developed by Jacobs and Hydrodynamics (2015a, b) was used to assess the risk to Bay values from increased loads of nutrients, sediments and pathogens. Scenarios were modelled to analyse the predicted outcomes for a broad selection of management options under future environmental conditions (climate change and population projections out to 2030 and 2050). These scenarios included management interventions to reduce nutrient and sediment loads from urban and rural areas through improved stormwater management and better rural land management practices.

A key finding from the integrated modelling was that based on projections to 2050, if no changes are made to current operations at the Western Treatment Plant and stormwater management was not improved in the catchment, total nitrogen loads to the Bay could increase to 8300 tonnes/year, depending on whether annual rainfall was below or above average. The model showed that if nitrogen loads increase to this level, 75th percentile for chlorophyll 'a' (Chla) at the EPA's Hobsons Bay monitoring site could range between 6 and 8 µg/L. This level of Chla exceeds the 4 µg/L water quality objective derived from the EPA's fixed site monitoring over the past 25 years. With nitrogen loads this high, beaches along the north eastern shore would experience more frequent algal blooms.

The science knowledge synthesis and modelling both identified that on a baywide scale the Bay is currently functioning well in terms of denitrification as a key process for nitrogen loss from the system. Catchment modelling has indicated that the bulk (about 60%) of the nitrogen load comes from the Western Treatment Plant, with the remainder from diffuse sources across the catchment. The Yarra catchment contributes the highest loads of all the regional catchments, due to its larger area and higher rainfall. These were similar to findings in the *Port Phillip Bay Environmental Study (1996)*.

Constructed wetlands are used to clean up stormwater, and to reduce the discharge of nutrients, sediment and other pollutants to the Bay. Photo – Melbourne Water



The science knowledge synthesis indicated that current inputs are having important localised, small-scale effects in near-shore areas in the north and west of the Bay. However, further modelling and field work is required to confirm the scale at which Bay values are under threat, and what role nitrogen inputs actually play in threatening those values.

Economic analysis undertaken by DELWP to inform this Plan found that modelled increases in nitrogen, sediments and pathogen loads would have significant economic impacts. Increased loads will result in more persistent algal blooms and poor water quality at beaches, which will have the potential to reduce tourism contribution to the economy by at least $68 million per year and reduce the value of enjoyment locals and tourists derive from visiting the Bay by $39 million per year[1].

The modelling identified that further upgrades to the Western Treatment Plant will offer the greatest potential to reduce nitrogen loads to the Bay, which will lead to reduced algal productivity. However, there will be no significant reduction in sediments or pathogen loads, as the treatment plant has already reduced these to acceptable levels. In comparison, catchment management initiatives have the potential to reduce nitrogen, sediments and pathogen loads, which offer greater benefit to values for near-shore waters.

The modelling also highlighted the need to consider management of the Bay at both baywide and local scales to protect Bay values such as recreational use, visual amenity and rocky reef habitats in near-shore waters.

1. Analyses by DELWP were based on scenario modelling by Jacobs and HydroNumerics (2015b). The estimated change in benefits does not reflect the full suite of actions that may be implemented. Also, estimated values more likely understate than overstate the long-term economic benefits under the potential scenarios, compared to a 'do nothing more' base case.

Australian Fur-seal (*Arctocephalus pusillus*). Photo - chrisjansenimages.com

The new draft Plan

4

This section outlines the guiding principles for preparation of this Plan, the vision and goals that have been developed, and priority areas and actions needed to achieve those goals. These elements are visualised in the draft Environmental Management Plan framework.

The development of this Plan has been guided by the key principles outlined in the draft Victorian biodiversity plan, *Protecting Victoria's Environment – Biodiversity 2036*, and those in the *Water for Victoria* plan.

In developing this Plan it is recognised that:

- The Bay is in good health and supports a range of environmental, social and economic values.
- The Bay will be affected by future pressures such as climate change and population growth, and we need to plan and manage for a resilient Bay and work towards long-term sustainability.
- We need to recognise and build on past achievements made by the community, industry and government within the catchment and Bay to enhance values.
- We need to work collectively to:
  - address legacy and future impacts affecting the health of the Bay
  - engage citizens and communities in decisions that affect the health of the Bay
  - work together to align outcomes.
- We need to recognise and manage for Traditional Owner values and entitlements.
- We need to demonstrate to the community that water quality management systems are effective in protecting and enhancing the values and uses of the Bay.

A shared vision for the Bay

The vision describes the long-term aspirations for environmental management of the Bay, based on the identified values and threats to these values. It has been informed by input and advice from government agencies, stakeholder groups and the community. The statements and drawings from various sources highlight the importance of managing challenges to the health of the Bay, and the role we all have to play in caring for it. Words like 'clean' and 'healthy' were used by respondents to support the values of marine life and habitat, water quality, recreation and fishing and lead to the desired outcome of the long-term health of the Bay.

The vision also reflects the government's responsibility to protect the values of the Bay, as outlined in *Schedule F6*.

OUR COLLECTIVE VISION FOR THE BAY IS:

A healthy Port Phillip Bay that is valued and cared for by all Victorians

The Bay continues to support a wide range of community uses, diverse and abundant marine life, and the Victorian economy.

All Victorians care deeply for the Bay, enjoying the benefits that it provides, and being actively and enthusiastically engaged in ensuring the Bay and its marine life are thriving.

Government, business and the community work collaboratively to ensure that all contributions to maintaining a healthy Bay are complementary and aligned.

Management of the Bay responds to the pressures of population growth and climate change.

Setting goals

Three goals have been developed to achieve the long-term vision for the health of the Bay and are supported by a series of actions. These goals are consistent and aligned with the goal of the *Schedule F6* which is to protect the values of the Bay by minimising adverse impacts associated with human activity and the use of the Bay and its catchment. The goals are also consistent with other Victorian Government environmental policies.

Findings from the background investigations, stakeholder engagement, and public consultation have informed the goals for this Plan. The environmental risk assessment and scientific knowledge synthesis have informed the decision to prioritise improving water quality and habitats and marine life. This sentiment was echoed in feedback received through community consultation. Water quality was identified as the challenge most respondents (32%) would like to see managed followed by marine habitat (28%) and ecosystem issues, including marine pests (24%).

There are a large number of policies and strategies in place that directly and indirectly influence the health of the Bay. However, the community and stakeholders indicated that a comprehensive and consistent approach to management of the Bay was not apparent, and that there is a need for collaboration across sectors to look after the health of the Bay for people and biota. Feedback from community consultation also indicated a desire for more people to 'love the Bay' highlighting the need for stewardship of the Bay across all sectors. The goals of the draft Plan are therefore:

GOAL 1

Stewardship of the Bay is fostered across community, industry and government

This goal aims to enhance Victorians' appreciation for the Bay and support the development of partnerships between government, community and industry to improve the health of the Bay.

GOAL 2

Health and community enjoyment of the Bay is enhanced by best practice water quality management

This goal aims to ensure that the Bay continues to have good environmental and recreational water quality to support healthy and diverse ecosystems and the wide variety of human uses of the Bay, including swimming, boating and fishing.

GOAL 3

The Bay's habitats and marine life are thriving

This goal aims to support the health of the Bay's marine life and habitats, including preventing the introduction and spread of exotic marine pests.

The priority areas and actions

This Environmental Management Plan focuses actions on seven priority areas:

1 Connect and inspire

2 Empower action (work together)

3 Nutrients and pollutants

4 Litter

5 Pathogens (human health)

6 Habitat and marine life

7 Marine biosecurity.

Priority areas were identified based on the findings from the background investigations, stakeholder engagement, and public consultation; and were assessed against a range of criteria, which included:

- risk they pose to Bay health
- need and the opportunity to improve their management and coordination
- existing management controls (legislation, policy, regulation)
- community's level of concern
- ability to achieve a positive and significant outcome in the Plan's ten-year life.

Priority areas included in this Plan do not necessarily meet all of the above criteria. For example, 'Pathogens' was ranked as a medium risk in the environmental risk assessment based on the current use of *Escherichia coli (E.coli)* and enterococci as indicator bacteria for pathogen contamination of waters in the Bay. However, there is uncertainty in the reliability of these indicators as an adequate proxy for all pathogens contained in stormwater. Therefore, further action is needed to address knowledge gaps and provide direction for management. In addition, community consultation indicated that recreation, and particularly swimming and fishing, is of high value to the community and should be a priority for active management to minimise risks to human health.

In addition to the public consultation, a series of forums and discussion groups were used to help develop the priority areas and actions for this Plan.

Photo – Jessica Fernandes

As a result of evaluation and prioritisation, there are many issues and activities which are not featured in this Plan. These issues are nevertheless acknowledged to be significant in the eyes of the government and the community. Table 4 highlights some of the relevant mechanisms that provide environmental management for some of these out-of-scope issues.

Table 4 Out-of-scope issues and their management

Issue	Rationale
Coastal foreshore issues, including erosion and inundation	Managed through the *Victorian Coastal Strategy*, the *Central Regional Coastal Plan*, local coastal management plans, and regional and local climate change adaptation plans. In addition, the ten councils within the Association of Bayside Municipalities are undertaking the *Bay Blueprint*, a regional coastal adaptation framework for Port Phillip Bay.
Commercial and recreational fishing	DEDJTR (Fisheries) manages and regulates commercial and recreational fishing in the Bay under the *Fisheries Act 1995*. Commercial netting in the Bay is being phased out by 2022 and participation in recreational fishing will be encouraged with enhanced fishing opportunities and facilities.
Dredging	The creation and maintenance of shipping and boating channels for safe navigation requires dredging. Dredging is regulated via consents under the *Coastal Management Act 1995*. Major dredging operations may require additional approvals under the *Environment Effects Act 1978*. Those involved in dredging activities have a responsibility under the *Environment Protection Act 1970* to minimise environmental impacts. The *SEPP (Waters of Victoria)* and accompanying *Schedule F6* also contain specific provisions regarding dredging. Parks Victoria (as the designated local port manager under the *Port Services Act 1995*) is responsible for permitting and/or undertaking maintenance dredging for small boating facilities, including those at Queenscliff, Patterson River, Werribee River, St Kilda Pier and Mordialloc Creek. Port of Melbourne Corporation and Victorian Regional Channels Authority are responsible for dredging of commercial shipping channels and fairways in the Bay and port areas.
Marine vessels	Under the *Port Management Act 1995* and the *Port Management Amendment Act 2012*, managers of local and commercial ports are responsible for Safety and Environment Management Plans (SEMPs). Discharge of oil and other pollution to Victoria's waters is prohibited under the *Environment Protection Act 1970*. Spill management is overseen by DEDJTR, and occurs under the *National Plan for Maritime Environmental Emergencies*, the *Victorian Marine Pollution Contingency Plan* and any other relevant state or regional marine pollution contingency plans. DELWP is responsible for coordinating the response to wildlife impacted by maritime pollution under the *Wildlife Response Plan for Marine Pollution Emergencies*. EPA provides enforcement under the *Environment Protection Act 1970* and the *Pollution of Waters by Oil and Noxious Substances Act 1986*. Discharge of ballast water is also regulated through the *Environment Protection (Ships Ballast Water) Regulation 2006*. Transport Safety Victoria (formerly Marine Safety Victoria) regulates the safe operation of vessels (sailing, human-powered, and motor craft) on all state waters, under the *Marine Safety Act 2010*.

Understanding this Plan Framework

This framework focuses action and investment on priority issues affecting Bay health. Priorities were identified through background investigations, and community and agency consultation.

Goals, priority areas and actions in this framework are based on:

- what the science has identified as key threats to the health of the Bay
- what stakeholders and the broader community want action on
- which issues need more attention or coordination
- which actions will have the most impact on protecting long-term Bay health.

Following public consultation on this draft Plan, the final Plan will include a more detailed list of sub-actions, with clearly identified lead organisations. Actions will be implemented over the next ten years, and where possible, will follow an adaptive management approach. Specific interventions and activities will be aligned to, and in some cases delivered by, broader state or regional plans and strategies (such as whole of catchment planning or integrated water cycle management)

The following sections provide more detail regarding each of the priority areas. This includes background as to why the priority area has been chosen, gaps in management arrangements, and information on actions to address these priority areas.

The actions have been drafted through a consultative process but there is further opportunity to refine and reshape them to achieve the required outcomes.

Potential partner organisations for implementing actions are listed in alphabetical order. Lead organisations and support roles, budget and resources required, and timing of actions are also still to be confirmed.

VISION	**A healthy Port Phillip Bay that is valued**	
GOALS	Stewardship of the Bay is fostered across community, industry and government	
PRIORITY AREAS	**Connect and inspire**	**Empower action (work together)**
STRATEGIES	Improve appreciation and understanding of Bay values	Improve collaboration and partnerships across community, industry and government
PRIORITY ACTIONS	**1.1** Work with Aboriginal groups to improve understanding of Aboriginal cultural values and interests in the Bay and support connections to Country	**2.1** Build capacity and collaborations within community and industry networks
	1.2 Develop and deliver programs to inspire greater appreciation of the Bay's values	**2.2** Empower the broader community to get more actively involved in caring for the Bay
	1.3 Build understanding of management responsibilities and programs for the Bay and its catchment	**2.3** Support stronger partnerships across community, industry and government to ensure aims and outcomes are aligned

and cared for by all Victorians

Health and community enjoyment of the Bay is enhanced by best practice water quality management			The Bay's habitats and marine life are thriving	
Nutrients and pollutants	**Litter**	**Pathogens (human health)**	**Habitat and marine life**	**Marine biosecurity**
Nutrient and sediment loads do not exceed current levels and pollutant loads are reduced where practicable	Reduce litter loads to the Bay	Minimise risks to human health from pathogens	Conserve and restore habitats and marine life	Manage risks from marine pests
				
3.1 Effectively maintain existing stormwater infrastructure and programs to mitigate loads to the Bay, or secure via equivalent means	**4.1** Establish baseline estimate of the volume of litter entering the Bay and its impact, including accumulation points	**5.1** Improve understanding of links between pathogen concentrations and human health for swimming and consumption of shellfish	**6.1** Monitor Bay habitats at priority locations and improve habitat mapping tools	**7.1** Prevent introduction and dispersal of marine pests
3.2 Prevent increases in nutrient loads from wastewater systems and where practicable reduce loads of other pollutants	**4.2** Support capability and capacity building programs that target litter prevention, including reduction of microplastics	**5.2** Adopt a risk-based approach to mitigate sources of pathogens found in the Bay	**6.2** Improve understanding of ecological processes, threats and pressures	**7.2** Monitor priority locations for early detection of marine pest introductions
3.3 Ensure all urban and rural land use effectively controls impacts from stormwater and runoff, and that controls are in place to manage increases in loads	**4.3** Identify and prioritise litter hotspots around the Bay and undertake prevention and on-ground stormwater management actions to address sources	**5.3** Improve monitoring and reporting to better detect and communicate human health risks from pathogens	**6.3** Improve overall extent and condition of the Bay's natural ecosystems	**7.3** Respond rapidly to new introductions of marine pests

Monitoring, Evaluation, Reporting and Improvement

PRIORITY AREA 1

Connect and inspire

The aim of this priority area is to **improve the community's appreciation and understanding of Bay values** - environmental, economic and social. This includes improving awareness of Aboriginal cultural values, and understanding how to strengthen them through environmental management of the Bay.

Improved awareness of Bay values and of management agencies' roles and responsibilities (Priority area 2) will be an important step towards fostering a deeper connection between the Bay and its residents, broader community stewardship, and for inspiring greater everyday actions to reduce impacts on the Bay.

The *Victorian Coastal Strategy* highlights the important role of coastal heritage values in creating our sense of place and defining who we are. There are past and present traditions of Traditional Owners, places created by early and recent settlers, and customs, celebrations and special characteristics that build community pride and enhance social cohesion (Victorian Coastal Council, 2014).

Improving our collective understanding of Aboriginal cultural values of the Bay is an important feature of this Plan. During community and stakeholder consultation the project team heard that there is an opportunity to improve understanding of Aboriginal values by government, industry and the broader community.

There is an opportunity to empower the Aboriginal community to strengthen connections with their Sea Country, build traditional knowledge across the generations and undertake broader community education.

The people of the Kulin nation lived on and around the Bay for thousands of years prior to European settlement. These people have actively cared for the Bay and acquired extensive traditional knowledge of its flora, fauna and physical changes. It is important that their values, interests and traditional knowledge of the Bay are recognised and that people of the Kulin nation are empowered to continue their role as traditional custodians.

Aboriginal groups are committed to providing a secure future for their community by upholding the dignity of their ancestors, respecting their Elders and instilling a sense of cultural pride in their children. They are working towards providing opportunities for their people to connect with and preserve cultural heritage and to manage lands appropriately, including sites of significance.

Research commissioned by the Victorian Coastal Council found that the coast is an important part of the lives of many Victorians; 84% of those surveyed had made at least 1 day trip to the coast in the past 12 months, with the average number of day trips in the past 12 months being 23 trips (Ipsos, 2012).

There are over 400 known sites of Aboriginal significance around the Bay, such as shell middens, camps and burials. Many of these sites are threatened by coastal erosion.
Photo - Ashley Matic

The same study found the general consensus of respondents was that the Victorian coast is healthy. There was also strong agreement with the statement, 'The flora and fauna that live in marine environments are important to all Victorians' (with a mean rating of 8.4 on a zero to ten scale). However, when questioned about their knowledge of the marine and coastal environment, respondents gave an overall mean rating of 5.3. These responses indicate a high degree of awareness of the importance of the marine and coastal environment, but less confidence in their understanding or knowledge of it.

The report on community attitudes also indicated that coastal and marine management is generally not 'visible' to the community, leaving most unsure as to what is involved in actively managing these environments (Ipsos, 2012). The same report indicated that Victorians generally did not feel well informed about coastal planning and management. When people were unsure about who managed the coast, there was a greater tendency to assume that it was not being well managed (Ipsos, 2012).

Community groups providing submissions, survey respondents and people at the community listening posts also highlighted the importance of increasing awareness of the value provided by the Bay and the role of individuals in maintaining its health.

This was highlighted in the online survey with 115 mentions of 'educating and empowering community'. One respondent commented:

> … More education in the community about the Bay as a natural resource and how to protect it and restore it. Government should work closely with community environment groups and support and fund them to do citizen science and education for and in the community.

In their assessment of marine values, Hale and Brooks (2015) concluded that the Bay is important ecologically, economically and socially; however, the community's depth of understanding of these values (particularly the Bay's ecological values) is less certain. They suggested that education can improve the community's ability to participate in management and decision making processes for the Bay. An example of insufficient education hindering the community's participation, was prioritising environmental values. The community identified whales as a priority over saltmarsh and mangroves, despite the fact that, at the site in question, saltmarsh and mangroves provide habitat for many species and improve water quality (Hoye *et al.* 2008). This highlights the need to educate the community on the context in which decisions are made and the Bay values they aim to improve.

Visitors to the beachside listening posts wanted better communication of the Bay's values so more people understand why it needs to be looked after. Photo – Melbourne Water

Respondents to the online survey indicated a need for improved management of the Bay. Responses indicated that there was confusion over which agencies were responsible for management of the Bay. This was highlighted further by requests for clearer identification of agencies responsible for key issues such as litter prevention and jet ski behaviour. There was also a strong view for the need to communicate a whole-of-catchment view of the various actions being undertaken to protect the health of the Bay. As one respondent suggested:

> There is a need for community groups from the start of the catchment to the Bay to understand all the work that is going on to protect the catchment. For example, how do stormwater pollution prevention measures in Doncaster or Warrandyte relate to school education activities to monitor impacts on Bay beaches?

To improve understanding of Bay values, it is important to clearly communicate the roles and responsibilities of the various management agencies. This will help to identify who people should contact if they want to report an incident, seek information or get more actively involved in caring for the Bay.

An example to consider is developing common signage around the Bay that conveys consistent messaging about beach and Bay use and individual behaviour; for example, use of jet skis, disposal of waste from fish cleaning, and pet exercising. Signage might include guidance together with contact details for responsible agencies or organisations. Similarly, Bay-related information and directives provided on council and government agency websites should have a common look and feel to ensure consistent messaging.

The actions in Table 5 apply broadly to the delivery of this Plan. Actions requiring or supporting a specific behaviour change to reduce the impact of a particular issue on the Bay (such as litter) have been identified under the relevant priorities elsewhere in this Plan.

Table 5 Proposed actions to 'Connect and inspire'

Action	Potential partner organisations
ACTION 1-1: Work with Aboriginal groups to improve understanding of Aboriginal cultural values and interests in the Bay and support connections to Country	Registered Aboriginal Parties and other Aboriginal groups
ACTION 1-2: Develop and deliver programs to inspire greater appreciation of the Bay's values	CMAs, community groups, councils, DELWP, educational and research organisations, EPA, industry, Melbourne Water, Museum Victoria, non-government organisations, Parks Victoria, Registered Aboriginal Parties and other Aboriginal groups, Zoos Victoria
ACTION 1-3: Build understanding of management responsibilities and programs for the Bay and its catchment	CMAs, community groups, councils, DELWP, EPA, Melbourne Water, Parks Victoria, Registered Aboriginal Parties and other Aboriginal groups

ACTION 1-1: Work with Aboriginal groups to improve understanding of Aboriginal cultural values and interests in the Bay and support connections to Country

This action will provide greater acknowledgement of the importance of Aboriginal values and contributions to managing the health of the Bay. It will build on the work proposed in the government's *Water for Victoria* plan of recognising and managing for Aboriginal values (DELWP 2016).

This will increase government, industry and community awareness of Aboriginal history and cultural values of the Bay to inform future Bay management.

Activities in this action

- Undertake assessments of Aboriginal cultural values and interests (past and present) in Bay management across different regions. This may comprise desktop literature reviews and on-country interviews with elders.
- Support opportunities for people of the Kulin nation to strengthen connections with their cultural values. This will involve Aboriginal groups leading the delivery of this action and facilitating participation across all generations within their communities. This may involve supporting new business and employment opportunities.
- Undertake educational initiatives for government, industry and the broader community to improve understanding of Aboriginal cultural values and interests in the Bay. An example would be development of digital tools to support the communication of Aboriginal Bay values.

Kulin nation groups will be supported in leading the delivery of this action and associated activities. This action will draw on similar activities aimed at improving understanding of Aboriginal values, such as those being delivered in relation to the *Water for Victoria* plan and the *Healthy Waterways Strategy*.

The people of the Kulin nation have actively cared for the Bay and acquired extensive traditional knowledge of its flora, fauna and physical changes. This knowledge can inform future management of the Bay. Bunjil's Eggs, located on the Bayside Coastal Indigenous Trail, was created by sculptor, Glenn Romanis. Photo - Amber Perry

ACTION 1-2: Develop and deliver programs to inspire greater appreciation of the Bay's values

This action will improve understanding and appreciation of the Bay's values across government, industry and the community. While the social benefits of the Bay are well regarded by many, the economic and environmental values (i.e. its diverse marine life) of the Bay are often underappreciated. This action will inspire greater environmental stewardship toward the Bay, help the community understand the impact of their actions on the Bay's health and encourage them to act to conserve it.

This will build on learnings from the *Desktop Review of Victoria's Marine Values* (Hale and Brooks 2015), the community values research commissioned by the Victorian Coastal Council, and consultation for this Plan.

Support will be given to create community and non-government programs and build on existing successes in raising community awareness and engagement in issues affecting the Bay's values. Good program examples are currently being run by the Dolphin Research Institute, Port Phillip EcoCentre, Zoos Victoria and Museum Victoria.

Best practice approaches for connecting to nature and inspiring environmental stewardship will be explored. This will include programs that foster social learning and the building of long-term social capital. Examples include 'Kids Teaching Kids' approaches, and creation of community champions and youth ambassadors. Digital and multimedia tools can also be created to improve engagement and inspire action.

Citizen science will also play an important role in the implementation of this action. An example of a citizen science program is the Two Bays project, which has been successfully completed over the last ten summers. The project involves conducting marine research and marine education programs, which provides opportunities for dialogue and knowledge sharing on key environmental themes relevant to the Bay.

Activities in this action

- Conduct social and economic research to better understand community values and gaps in knowledge.
- Identify and promote the type of programs that are required, including approaches for connecting to nature and inspiring environmental stewardship.
- Build on existing awareness and education programs around the Bay and its waterways to align with the goals of this Plan (e.g. i sea i care, Baykeeper, Coastcare).

ACTION 1-3: Build understanding of management responsibilities and programs for the Bay and its catchment

This action will communicate key management roles and responsibilities to the community. It will provide the community with confidence that the Bay is being managed appropriately. It will require communicating roles and responsibilities for key issues, identifying gaps and overlaps that create confusion, and developing a range of communication strategies to reach target audiences.

Activities in this action

- Develop a plan to communicate roles and responsibilities for key issues, gaps and overlaps that create confusion, and suggestions on how to reach target audiences (e.g. common signage).
- Provide clear information on who to contact if there's a problem via consistent signage and online information and digital tools.
- Develop catchment-based maps and other communication tools of the various programs, projects and community groups actively working within each catchment and provide communication materials to explain how they interrelate.
- Establish regular forums on Bay issues for partner agencies and local councils to meet, share advice and strategies, and consider progress in various plans and actions.

PRIORITY AREA 2

Empower action

This priority area aims to **improve collaboration and partnerships across community, industry and government** to deliver on outcomes of this Plan.

Similar to 'Connect and inspire', the idea of empowering groups to take action was supported by all stakeholder groups. Stakeholders wanted more coordination across government and better partnerships with community groups.

There are numerous community groups around the Bay and within the catchments upstream who work tirelessly and voluntarily to improve the health of the Bay and its waterways. Helping these groups to achieve their local objectives will contribute to the wider goals and priorities of this Plan.

Capacity building typically includes access to technical advice, training, resources and tools on best practice science and management techniques, access to strategic advice on group administrative matters, governance and where to source funding, and fostering of peer-to-peer learning across groups.

Many capacity building programs exist to support community groups and individual volunteers. Examples include Coastcare, Waterwatch, Landcare, Port Phillip EcoCentre, Baykeeper, Riverkeepers, Reefwatch (within the Victorian National Parks Association), and programs run by other management organisations such as the CMAs. These programs have built a high degree of trust with their target audience over many years, which is vital for successful community capacity building.

This action will establish networks for supporting citizen science programs and local community groups, with consideration given to establishing regional support hubs. This could be undertaken on a catchment-by-catchment basis and help to identify any gaps in the existing network of capacity building programs and the best mechanisms to address these. Region-wide support programs are important but local community groups also need access to catchment-based support to provide connections to other local community groups and on-ground projects. As one key stakeholder group noted during the project consultation:

> More than mapping activities, or communication (e.g. Landcare network magazine), there is a need for a resource across the catchment to link all the regional community groups. Hubs like the Port Phillip EcoCentre provide the support and linkages to on-the-ground community groups. These community groups typically don't have the resources to connect to the wider network and are practically focussed on activities and outcomes in their 'patch'. A resource that can travel and link regional hubs and therefore connect to local community groups with face-to-face communication would provide the connection and some inspiration that all efforts across the catchment are making a difference.

Providing adequate support to local community groups will also enable these groups to be active across a number of issues and provide more interesting opportunities to attract more volunteers. As one key stakeholder group noted during the consultation:

> Supported citizen science activities also need to have a multiple focus – not everyone wants to count litter as their interaction with the environment. This provides flexibility in the choice of activity with the number of people involved and required. For example, a section of beach can be measured for erosion, sea level rise, micro-plastics, litter and inter-tidal species in one activity. This enables different groups to rotate through multiple activities, or the number of activities can be adjusted to those where more frequent data is worth recording, dependent on the numbers involved. Coastal erosion may be measured from the widest and narrowest points on the beach annually, inter-tidal species may be collected as a school holiday program educational activity, and beach litter data may be recorded more regularly (e.g. monthly) for a database.

A number of key stakeholder groups also suggested the need for consistent and rigorous methods for citizen science and opportunities to develop innovative digital tools (such as apps) to support citizen science and on-ground management activities. For example, apps have been developed to provide field guides for identification of native flora and fauna and pest species, for entering field data, and displaying easy to access environmental reports. An example is Birdlife Australia's 'Bird Conservation Portal' for citizen science data collection (web-based) and analytics.

Industry has the potential to reduce impacts on Bay values by adopting better management approaches and operations, but will need assistance in the form of capacity building to achieve these improvements. The term 'industry' covers all organisations whose activities impact Bay values, such as government agencies, local councils, water corporations, research institutes; and businesses (including land development and agriculture). Industries' capacity building needs are typically similar to those mentioned previously for community groups, such as access to technical guidelines, tools, training and advice, and opportunities for peer-to-peer learning and sharing knowledge.

There are a number of existing industry capacity building programs focused on improved urban stormwater and integrated water cycle management such as the Clearwater program hosted by Melbourne Water and the industry outreach activities of the CRC for Water Sensitive Cities, which are providing secondary benefits for reducing pollution to the Bay. Melbourne Water also provides support to local councils through their Living Rivers Program and to farmers through their Rural Land Program. Corangamite CMA and Port Phillip and Westernport CMA provide capacity building support to rural landholders to reduce their pollution run-off to waterways. There is an opportunity to build upon and enhance these programs, and/or establish new programs to align with the goals and priorities of this Plan. Strong partnerships with peak industry bodies will be needed to ensure success.

The actions in Table 6 to deliver on the outcome of this priority area have been identified through stakeholder consultation and review of other relevant policies and plans.

Table 6 Proposed actions for 'Empower action'

Action	Potential partner organisations
ACTION 2-1: Build capacity and collaborations within community and industry networks	CMAs, community groups, councils, DELWP, EPA, Melbourne Water, Museum Victoria, non-government environment organisations, Parks Victoria, peak industry bodies, research institutes.
ACTION 2-2: Empower the broader community to get more actively involved in caring for the Bay	CMAs, community groups, councils, DELWP, EPA, Melbourne Water, Parks Victoria, educational and research organisations, industry, non-government organisations, Registered Aboriginal Parties and other Aboriginal groups, Zoos Victoria
ACTION 2-3: Support stronger partnerships across community, industry and government to ensure aims and outcomes are aligned	CMAs, councils, DELWP, EPA, Melbourne Water, Parks Victoria, Registered Aboriginal Parties and other Aboriginal groups, and broader government, industry and community organisations

ACTION 2-1: Build capacity and collaborations within community and industry networks

This will support the long-term health of the Bay by improving community and industry's ability to contribute to Bay management and play a vital role in helping to achieve the goals of this Plan.

Capacity building needs of community and industry groups typically include access to technical advice, training, resources and tools on best practice science and management techniques; access to strategic advice on group administrative matters, governance and where to source funding; and fostering of peer-to-peer learning and networks between groups.

Activities in this action

- Establish region-wide and catchment-based frameworks for supporting citizen science programs and local community groups, including consideration of regional support hubs.
- Support existing community and industry capacity building programs and enhance where necessary to align with the goals and priority areas of the Plan.
- Develop innovative new tools, and expand use of existing tools, to support citizen science and on-ground community action.

ACTION 2-2: Empower the broader community to get more actively involved in caring for the Bay

This action will empower a greater cross-section of the community to get more actively involved in caring for the Bay. The focus will be on encouraging more people to get involved in on-ground activities, and educating people on the impacts of certain behaviours on Bay values.

According to the Victorian Coastal Council's report on community attitudes, one in three respondents expressed interest in volunteering to help improve and protect the coast (Ipsos, 2012). This action will aim to maximise this desire to get involved.

A challenge highlighted through consultation was that some community members are unable to volunteer their time to participate in citizen science projects or on-ground community-based activities, but they are interested in undertaking everyday actions in and around their home and workplaces to help care for the Bay. This highlights the need to promote existing programs that provide information on how individuals can help care for the Bay; for example, the Seal the Loop Bins by Zoos Victoria, AGL Marine Response Unit, and Bin not Bay by the Australian Marine Mammal Foundation. There is also an opportunity to build on these programs and others to ensure the community has access to sufficient information to empower actions that align with the goals of this Plan.

Activities in this action

- Identify needs and gaps in existing communication materials and strategies.
- Develop and clarify information on how to get involved in conserving the Bay, building on existing programs, campaigns and other communication initiatives.
- Communicate achievements of community actions more widely to attract interest and inspire action.

ACTION 2-3: Support stronger partnerships across community, industry and government to ensure aims and outcomes are aligned

This action will foster stronger partnerships across government, industry and community groups working to improve the health of the Bay and its waterways. There are many initiatives being undertaken by a range of groups and there is an opportunity, need and desire for a more joined-up approach for better management of the Bay. This was a strong theme from the consultation. Many local community groups expressed a desire to feel part of something bigger and receive acknowledgment of their contributions to the baywide management effort.

Activities in this action

- Identify mechanisms for ensuring strong collaboration between community, industry and government organisations in the implementation of this Plan.
- Improve mechanisms to ensure greater representation of Aboriginal groups in the implementation of this Plan.
- Identify and invest in opportunities to improve monitoring, data sharing and reporting of activities being undertaken across community, industry and government.

Cleanup day at Kerford Road Pier, Albert Park, organised by Tangaroa Blue Foundation. Over 75% of what is removed from our beaches is made of plastic. Photo: Tangaroa Blue Foundation (http://www.tangaroablue.org/).

PRIORITY AREA 3

Nutrients and pollutants

The aim of this priority area is to take action to ensure that **nutrient and sediment loads flowing into the Bay do not exceed their current levels and other pollutant loads are reduced where practicable**.

The nutrients nitrogen and phosphorus are elements, and are essential building blocks for plant and animal growth. They are conveyed to the Bay from catchment, atmospheric and oceanic sources. The Bay is considered to be nitrogen limited because the amount of phosphorus available in the Bay is in excess of the amount needed for plant growth. Therefore the amount of nitrogen that comes into the Bay controls how much plant growth can occur. When there is too much nitrogen the system is considered to be eutrophic and there is excessive algal growth resulting in persistent algal blooms.

Other pollutants include sediments and toxicants, which are further broken down to include heavy metals, pesticides, industrial chemicals, and chemicals of emerging concern (such as endocrine-disrupting compounds, pharmaceuticals and personal care products).

Freshwater flows carry nutrients, sediments and other pollutants sourced from various activities within the catchment. These flows include runoff from properties and roads, wastewater discharges from treatment plants, and seepage of contaminated groundwater. Up to 80% of the annual load of nutrients and sediments from the catchment is delivered via runoff during high flow storm events.

There are hundreds of stormwater drains that discharge directly to the Bay during and immediately after rainfall events. Other stormwater drains discharge into the rivers and creeks across the catchment, which then discharge to the Bay.

The Yarra River contributes the highest nutrient and sediment loads into the Bay compared with the other rivers. Nutrients and sediments from the Yarra typically impact along the eastern shoreline of the Bay (the typical flowpath of the Yarra plume) with concentrations fanning into the central part of the Bay over time due to currents and wave re-suspension of finer sediments.

Higher loads of sediments can reduce the amount of light available for seagrass growth and may also smother nitrogen cycling bacteria living on the bottom of the Bay (which are crucial for a healthy functioning Bay). Sediments also carry toxicants into the Bay. Most toxicants are sediment-bound and higher loads directly affect fish and invertebrates in inshore areas and affect marine mammals and waterbirds (through the food chain).

Management actions implemented since the 2001 Plan have stabilised increasing trends in discharges of nutrient and sediment loads to the Bay (Jacobs and HydroNumerics 2015a, b). Monitoring by the EPA has shown no significant deterioration of water quality or increased occurrence of algal blooms over the past decade.

Installing water sensitive urban design features, such as raingardens, can reduce the contribution of stormwater pollutants to waterways and the Bay. Photo – Melbourne Water

However, forecast population growth and changes in land use, together with climate change impacts are predicted to increase nutrient and pollutant loads to the Bay if no further action is taken to reduce these loads.

This Plan considers nutrients and pollutants to be a priority area for enhancing the Bay's health. Key points drawn from the background investigations include:

- **Population growth and climate change will increase nutrient, sediment and pollutant loads.** Estimates based on catchment modelling are that nitrogen loads to the Bay will increase by about half by 2050 unless actively managed. Future scenarios indicate that the Western Treatment Plant remains the major contributor of nitrogen to the Bay, and the Yarra catchment the major contributor of sediment to the Bay. The Werribee and Dandenong catchments are predicted to have the greatest proportional increase in nutrient and sediment loads due to future urban development. Other pollutants will also increase as a result of increased stormwater runoff (and increased production and use of toxicants in the catchment).
- **Higher loads of nitrogen will increase the risk of algal blooms and nearshore impacts.** Modelling has shown that a nitrogen load of 15,000 tonnes per year would result in algal blooms in the northern part of the Bay for most of the year. Near shore waters are likely to 'tip' at this level, meaning the nitrogen cycling processes may cease to function permanently. The science synthesis (and earlier 1996 *Port Phillip Bay Environmental Study*) recommended that nitrogen loads to the Bay should remain below 6000 tonnes per year. As loads increase beyond this level, risks to Bay values increase including the potential for more frequent and intense algal blooms. Modelling has shown that when nitrogen loads from the Western Treatment Plant move clockwise around the Bay and combine with loads from the Yarra, algal blooms are more likely to occur along the eastern beaches, which will have significant impacts on recreational and amenity values.
- ***SEPP (Waters of Victoria)* water quality objectives will be exceeded if no action is taken to mitigate increased loads of nitrogen**. Water quality modelling showed that when nitrogen loads exceed 6,000 tonnes per year, 75th percentiles values for chlorophyll 'a' in Hobsons Bay will exceed the *SEPP (Waters of Victoria)* water quality objective of 4 µg/L.
- **Ecological functions are tightly tuned to nitrogen.** Obtaining direct evidence of ecological effects from increased nitrogen is complex. For example, nutrient loads in the north of the Bay are thought to be affecting the diversity and condition of rocky reefs, leading to 'urchin barrens' (Carnell and Keough 2014). Conversely, reduced inputs of nitrogen during the 1998-2010 drought coincided with observed declines in seagrass beds and reduced fish recruitment (Parry and Hirst 2016). Hence, maintaining the Bay's ecological function is not as simple as removing all nitrogen loads, but rather obtaining a balance that sustains productivity and avoids eutrophic conditions.
- **Western Treatment Plant annual loads of nitrogen should not exceed 3,100 tonnes.** Nitrogen loads from the Western Treatment Plant are forecast to increase beyond the previous Plan's annual limit of 3,100 tonnes, to 3,800 tonnes by 2036/37, and 4,900 tonnes by 2051/52 as a result of increases in sewage flows. However, annual loads will vary significantly with rainfall. Years of above average rainfall will provide greater challenge for keeping loads below the 3,100 tonne limit. The water quality modelling showed that when 3,100 tonne limit is exceeded, chlorophyll 'a' in Hobsons Bay exceeds the *SEPP (Waters of Victoria)* water quality objective of 4 µg/L, which impacts beneficial uses.
- **Managing catchment inputs is as important as managing discharges from Western Treatment Plant.** The efficiency of the nitrogen cycling process across the Bay is impacted more by changes in Yarra/Maribyrnong flows than discharges from the Western Treatment Plant. This is because the process can be impacted by changes in climatic conditions, phytoplankton dynamics, and other factors that affect benthic microbial processes. Loads from rivers are also highly variable in comparison to treated wastewater discharges. Monitoring of nitrogen cycling in Hobsons Bay has shown that the efficiency of the process is reduced following high flow events. When this occurs there is increased likelihood of algal blooms.
- **Better knowledge of nutrient loads, both overall and between nitrogen species, can help target management actions.** Analysis of the different forms of nitrogen in waterways can indicate the likely source. This can then inform targeted interventions. For example, in Queensland nitrogen loads in rivers that discharge to the Great Barrier Reef are estimated to contain 80-85% of anthropogenic dissolved inorganic nitrogen, which comes from fertiliser. This knowledge has helped focus management actions on changing farming practices to reduce nitrogen loads to the reef.

- **Planning mechanisms can be used to control impacts of stormwater on waterway and Bay health.** Clause 56 of the *Victoria Planning Provisions* is the main mechanism for managing the impact of stormwater in new residential developments (it is not applied to development in areas that connect to existing drainage systems). Clause 56 requires the implementation of best practice environmental management (BPEM) guidelines for stormwater quality management. This includes retention of typical urban loads of total nitrogen (45%), total phosphorus (45%), total suspended solid (80%) and litter (100%). The guidelines have been important in promoting greater adoption of water sensitive urban design, such as wetlands and bio-retention systems, in new urban areas. However, for existing urban and industrial areas there is inconsistent application of improved stormwater management. Proportionally this area is far greater in size than the area of new urban development, and as such offers significant opportunity to reduce loads to waterways and the Bay.
- **Denitrification continues to be a critical process within the Bay, and should continue to be monitored**. Denitrification at both regional and baywide scales remains a highly efficient process at removing nitrogen from the Bay, and continues to assist in the maintenance of water quality.
- **Long-term impacts of toxicants on ecosystem components is a knowledge gap.** Toxicants are generally below guideline levels in the Bay, with increased levels found in a few localised areas. However, there is a need to better understand the short and long-term impacts of chemicals of emerging concern, such as endocrine-disrupting compounds, pharmaceuticals, flame retardants, pesticides (other than organochlorines), and microplastics.

Setting nutrient and pollutant targets

The 2001 Plan included a 1000 tonne reduction in the annual load of nitrogen by 2006. This was to be achieved by reducing annual loads from Western Treatment Plant by 500 tonnes and the catchment waterways annual load by 500 tonnes (with a split of 350 tonnes from the Yarra/Maribrynong Rivers and 150 tonnes from other waterways but focusing on the Dandenong catchment). To allow for reporting on progress, a calculation of the baseline levels (for the period 1991–1995) was confirmed immediately following the release of the 2001 Plan.

Having a clearly defined baywide target and a split between sources allowed agencies to implement specific actions.

The target also assisted more broadly in communicating the need for, and achieving the required reductions.

The desired 10-year outcome statement for nutrients and pollutants in this Plan (that 'the nutrient and sediment loads flowing into the Bay do not exceed their current levels and other pollutant loads are reduced where practicable') translates to a zero increase in nitrogen and sediment loads, and a need to actively mitigate forecast increases. For nitrogen the level of mitigation equates to about 2,500 tonne reduction over 30 years or an 800 tonne reduction over the next 10 years.

Actions will be required to mitigate forecast increases in loads from wastewater systems and stormwater. Reducing loads will ensure that the risk of algal blooms is minimised, and will allow marine ecosystems to function with the current levels of diversity of plants and animals. Actions to reduce loads of nitrogen and sediments in stormwater will also have benefits for values in waterways within the catchment.

The final Plan will include specification of the nitrogen and sediment load mitigations required for each major catchment. This will confirm whether all waterways need to maintain loads at current levels or whether different splits are needed to achieve the baywide outcome.

To achieve the nitrogen and sediment targets in a sustainable manner will require a paradigm shift for stormwater management.

Concepts of total catchment management and its role in managing urban runoff as discussed in the early 1990s (Collett, 1992) have evolved into current concepts of water sensitive urban design and integrated water cycle management. However, the key elements of managing the problem at source still require further development. The individual's opportunity to influence the outcome is lost with large and costly end-of-pipe solutions.

To improve outcomes in the Bay, there is a need to address runoff at the source. Regulatory arrangements and incentives supporting local solutions (involving developers and individuals) can drive improved behaviours at the allotment scale. For urban runoff this may mean altering drainage charges or building regulations to ensure that runoff can be sustainably managed and retained on the property. This approach would reduce nutrient and pollutant loads to the Bay, and minimise investment in large scale infrastructure.

The actions proposed for nutrients and pollutants (Table 7) have been designed to address reduction targets by strengthening existing controls for managing loads from both wastewater systems and stormwater. These actions address key knowledge gaps, develop methods of tracking performance, support catchment-based decision making, and align with the state's broader directions in the *Water for Victoria* plan.

Table 7 Proposed actions for 'Nutrients and pollutants'

Action	Potential partner organisations
ACTION 3-1: Effectively maintain existing stormwater infrastructure and programs to mitigate loads to the Bay, or secure via equivalent means	Councils, DELWP, EPA, Melbourne Water, and other asset owners
ACTION 3-2: Prevent increases in nutrient loads from wastewater systems and where practicable reduce loads of other pollutants	Councils, DELWP, EPA, Melbourne Water, other water corporations
ACTION 3-3: Ensure all urban and rural land use effectively controls impacts from stormwater and run-off and that controls are in place to manage increases in loads	CMAs, councils, DELWP, Melbourne Water

Yarra River plume after large rainfall event in February 2011. Photo – Fairfax Syndication

ACTION 3-1: Effectively maintain existing stormwater infrastructure and programs to mitigate loads to the Bay, or secure via equivalent means

This action will check that reductions in nutrient, sediment and pollutant loads achieved under the 2001 Plan can be sustained. It will include an assessment of existing stormwater management infrastructure, and evaluation of cost-effective means to achieve load reductions to the Bay.

Significant investment has been made as a result of the 2001 Plan by water corporations, local councils, land developers and road builders in constructing wetlands and other assets to reduce the environmental impact of stormwater. This includes constructed wetlands built by Melbourne Water and other stormwater assets built by developers and local councils (such as wetlands, raingardens and stormwater harvesting schemes). However, there has been limited evaluation as to whether individual assets are achieving their design intent for nitrogen and sediment load reduction.

For nutrient and sediment reduction targets to be sustained over the next 30 years, the effectiveness of these constructed wetland systems needs to be assessed, and maintenance undertaken to ensure their performance is sustained.

Part of the assessment must determine if wetland development and maintenance is the most cost-effective way to achieve nitrogen and sediment reduction targets for the Bay. This issue is also compounded by having limited capacity to build new large-scale wetland systems in existing urban areas.

This issue is not limited to wetlands managed by Melbourne Water; however, these selected wetlands provide an opportunity to assess their performance for nutrient and sediment reduction, and to gain insight as to how best to manage these types of assets into the future.

Activities in this action

- Undertake audit of selected stormwater management assets to assess whether they are meeting their design intent for nutrient, sediment and pollutant reduction.
- Identify other stormwater management assets within the catchment and classify their performance for nitrogen and sediment reduction – this will include large, medium and small-scale systems operated by Melbourne Water, local councils and other land managers.
- Develop and implement an investment plan for remediating those assets that are failing to meet their design intent and, where appropriate, building new infrastructure.
- Continue to characterise contaminants of emerging concern within stormwater and methods to reduce these contaminants.

Constructed wetlands require regular maintenance to ensure that they remove nutrients, sediments and other pollutants from stormwater. Photo – Melbourne Water

ACTION 3-2: Prevent increases in nutrient loads from wastewater systems and where practicable reduce loads of other pollutants

This action will address the challenges of urban growth and ensure that cumulative loads of nutrients to the Bay from wastewater systems do not exceed current levels. Additionally, this action aims to ensure that treatment processes continue to be improved where practicable to reduce the discharge of toxicants to receiving waters. This will include large and small wastewater treatment plants, and areas serviced by septic tanks.

The majority of urban areas within the Bay's catchment are connected to sewerage systems. Sewage and trade waste from properties is transferred through a network of pipes (sewers) to wastewater treatment plants. A combination of mechanical and biological processes cleans the wastewater to a standard suitable for reuse (recycling) or discharge to the environment. Properties that are not connected to sewerage systems operate onsite wastewater systems (e.g. septic tanks), which can collectively contribute to nutrient and pollutant loads to the Bay via groundwater systems and waterways. Treatment plants have operating licenses issued by EPA that set the allowable discharge quality and quantity to receiving environments. Onsite systems (e.g. septic tanks) are regulated by councils.

The Western Treatment Plant operated by Melbourne Water discharges 130 to 145 gigalitres of treated wastewater annually. Other local treatment plants that discharge to the Bay or waterways contribute about 15 gigalitres of treated wastewater per year.

The EPA license for Western Treatment Plant is concentration-based, with a maximum discharge flow. As the population grows, the sewage flows to the plant will increase, especially in wet years. Currently the plant can treat up to a certain flow and load; beyond this the concentrations and volume of nitrogen discharged to the Bay will increase. Eventually treatment systems will need to be upgraded so the ammonia discharge concentration of 10 mg/L and annual total nitrogen loads of 3,100 tonnes are not exceeded.

Upgrades may also be required for local wastewater treatment plants operated by other water corporations, especially in Melbourne's urban growth corridors to the north and northwest of Melbourne. At a baywide scale, reductions from local treatment plants are relatively small, but will provide local benefits as well as contribute to the overall targets for the Bay.

In areas where septic tanks and other onsite wastewater systems are impacting on water quality in receiving waters, stronger enforcement may be required to bring these systems into compliance. Alternatively, offsite treatment or networked sewerage systems may need to be built.

Activities in this action

- Confirm forecast volumes of nitrogen and other pollutants discharged from wastewater treatment plants and areas with onsite wastewater systems, and assess adequacy of investment plans to address growth.
- Implement compliance programs in areas serviced by onsite wastewater systems (e.g. septic tanks) to ensure systems are operating appropriately, and their discharge has minimal impact on receiving waters. These programs will inform the need and timing of investment in offsite treatment options.
- Obtain discharge monitoring data from individual wastewater treatment plants to assess against targets and to compile cumulative annual loads to the Bay.
- Continue to characterise contaminants of emerging concern within wastewater and methods to reduce these.

Sewage flows to Western Treatment Plant are forecast to increase in line with population growth. Further upgrades will be required to ensure the volume of nitrogen discharged does not exceed current limits. Photo – Melbourne Water

ACTION 3-3: Ensure all urban and rural land use effectively controls impacts from stormwater and run-off and that controls are in place to manage increases in loads

This action will investigate the suitability and coverage of planning mechanisms and building regulations for managing stormwater from urban, industrial and rural land.

It is likely that new planning mechanisms will be supported by integrated water management plans being considered by the State Government as part of the new *Water for Victoria* plan. Mechanisms are likely to be place-based and reflect the varying health of waterways discharging to the Bay.

It is compulsory under Clause 56 of the *Victoria Planning Provisions* to design and manage urban stormwater management systems for all new residential subdivisions to meet current BPEM objectives. However, it is unclear how well developers are implementing BPEM objectives, and whether built assets are performing as required.

Even with effective, widespread adoption of BPEM guidelines, forecast urban growth and climate change will result in increased loads that may make it difficult to maintain current Bay health. This is because the guidelines only set standards to reduce a proportion of the additional flows and loads that would reach waterways in comparison to flows and loads from undeveloped land. These residual flows and loads require planning mechanisms and investment in alternative stormwater control systems to manage the shortfall of BPEM.

For areas not subject to Clause 56, the application of improved stormwater management is inconsistent and varies between councils. These areas include existing residential, industrial and commercial and rural land. Some councils use alternative planning mechanisms to direct developers to implement water sensitive urban design and to achieve BPEM or better objectives. As such, development of consistent stormwater management approaches would reduce nutrient, sediment and pollutant loads to waterways and the Bay.

Action 14c in the *Victorian Floodplain Management Strategy* is to review how planning provisions, particularly Clause 56, could better manage the potential urban stormwater flood impacts from infill development, urban renewal and non-residential development within established areas.

This review could be expanded to consider management of stormwater to reduce nutrient and pollutant loads concurrently.

Activities in this action

- Review performance of existing controls (planning mechanisms, regulations and standards) and identify potential improvements – includes spatial analysis to support classification of controls and prioritisation for investment.
- Work with regulatory agencies, local councils and stakeholders (includes urban and industrial land developers) to improve understanding of requirements and to better enforce standards.
- Pilot new management approaches and evaluate their effectiveness.
- Design and implement an integrated program of management actions and planning controls.

Actions within this priority area will require development of a framework for reporting loads of nitrogen and sediments, and to support continued improvement in effective management practices.

Having a consistent and defensible method for estimating loads to the Bay will provide stakeholders with confidence that investment in management actions is justified. Without this, it will be difficult to track the progress of actions implemented through this Plan.

The catchment and Bay model developed by Jacobs and HydroNumerics (2015a, b) will require further development so that it can be used for monitoring and evaluating progress towards meeting load reduction targets and water quality outcomes. This includes better calibration of the catchment model, better calibration/verification of chlorophyll predictions, and further testing to determine the spatial and temporal sensitivity of denitrification estimates to changing nitrogen loads.

Stakeholders have also commented that ideally the models should be developed to enable catchment-based decision making within an adaptive management framework.

PRIORITY AREA 4

Litter

The aim of this priority area is to deliver actions that **reduce the amount (volume and count) of litter delivered to the Bay** to conserve amenity and marine life.

Litter constitutes any solid or liquid domestic or commercial waste that is deposited inappropriately. The community perceive litter as harmful (non-biodegradable and/or hazardous) and less harmful (biodegradable) (VLAA 2014). Harmful litter includes cigarette butts, plastics, nappies, broken glass, dog faeces, and fast-food wrappers. Non-harmful litter includes paper, cardboard and fruit scraps. Plastics, particularly microplastics and nurdles, are a concern to the community (VLAA 2015).

The 2001 Plan incorporated litter into the nitrogen program, where litter reduction benefits were gained through broader stormwater management initiatives. For example, government funded the installation of gross pollutant traps through the Victorian Stormwater Action Program (DSE 2003).

According to the 2014/15 National Litter Index, industrial and retail sites are the most littered sites in Victoria. Industrial sites were noted as generating the highest volume of litter, while retail sites generated the highest count of litter items.

Beaches were next on the list with moderate numbers and volumes of litter. Other public places and recreational sites were associated with smaller numbers and volumes of litter. Overall the index shows a continuing trend of reduced rates of littering across Victoria. However beaches are still prominent locations for the accumulation of litter, and are concern for the community.

Beach Patrol, a volunteer-based organisation who organise litter clean-up days at twenty Bay beaches, have collected 18,660 kg of rubbish since 2009 – 2,543 kg for the first quarter of 2016. From this, 75,217 cigarette butts were collected (Beach Patrol 2016).

In 2014/15, EPA issued over 13,000 fines, with 60% of infringement notices issued for lit cigarettes. The City of Melbourne is also actively involved in managing cigarette butt litter through installation of special butt bins in high-use areas and collection of butts for recycling into shipping pallets.

Currently, litter management in the Bay is a mix of clean-up and prevention activities. Bayside councils (in some cases with the assistance of community groups and committees of management) are responsible for removing litter along the foreshores, for removing suburban litter, and reducing the likelihood of litter being discharged to the Bay.

While most activities focus on capturing litter (e.g. through gross pollutant traps, street sweeping, bins in public places, beach sweeping), some councils have developed litter prevention strategies to reduce the incidence of littering.

To assist more councils and the community to reduce littering behaviour, the Victorian Government has developed the draft *Community and Business Waste Education Strategy 2015–2020* (led by Sustainability Victoria). The draft strategy identifies six strategic directions in relation to waste and litter. Strategic direction four is to 'reduce litter and illegal dumping'.

In addition the Metropolitan Waste and Resource Recovery Group manages the Litter Hotspots Program, as part of *A Cleaner Yarra River and Port Phillip Bay – A Plan of Action*. The program provides funding to local governments, businesses and community partnerships to target priority litter areas in the Bay and the Yarra River.

Litter on the bank of the Yarra River. Much of the litter on our streets washes into drains that flow to the Bay.

Photo – Tangaroa Blue Foundation (http://www.tangaroablue.org/)

In coordinating best practice litter prevention, the Victorian Litter Action Alliance (VLAA) has developed a best practice model (Figure 13) based on behaviour change theory and built around the following three elements:

- **Education:** Includes information, incentives and communication to explain the issues associated with litter and encouraging how to correctly dispose of litter appropriately in any given situation.
- **Infrastructure:** Includes bins and signs in appropriate public places to enable people to correctly dispose of litter.
- **Enforcement:** Provides consequences and penalties for those that litter and provides a deterrent and powerful message that littering is unacceptable.

An evaluation of the Litter Hotspots Program found that most projects followed the VLAA best-practice model for litter prevention, with community projects largely focusing on 'education' and council projects focusing more on 'infrastructure' and 'enforcement'. It was also deemed that many inter-organisation relationships were developed and strengthened. The program also improved the amenity of public spaces that impact upon the water quality of the Yarra River and the Bay (Alluvium 2016).

Since the 2001 Plan, research and monitoring has commenced into the impact of microplastics in the Bay. Citizen science projects have sampled sediment for microplastics (Two Bays and the Clean Bay Coalition project). Research specific to the Bay is being conducted at RMIT and the EPA. The Litter Hotspots Program has funded initiatives such as Operation Clean Sweep (led by Tangaroa Blue Foundation) to educate and change practices in managing loss of nurdles from manufacturing sites. Additionally, the Federal Government has initiated a voluntary phase-out, by July 2018, of microbeads in personal care products, with the proposal to ban microbeads if voluntary adoption rates are low.

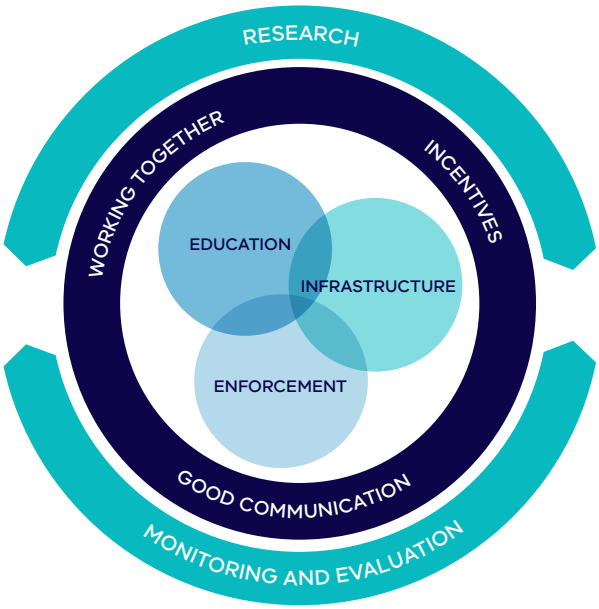


Figure 13 Victorian Litter Action Alliance best practice model

Beach clean-up day at Altona organised by Melbourne Water and the Bay Keeper (http://www.bay-keeper.com/). Photo – Melbourne Water

This Plan considers litter to be a priority area. The background investigations, risk assessment and consultation support this decision, as outlined here:

- **Litter poses a risk to Bay values.** The environmental risk assessment identified litter (including microplastics) as a high risk to Bay values. The assessment noted large amounts of litter are still being discharged to the Bay, affecting the amenity and use of beaches and marine life.
- **Litter is a threat to marine life.** The science knowledge synthesis reiterated the threat of litter to marine life that was noted in the environmental risk assessment. The impact of large plastic material on marine life such as birds and seals is well established. However, research is increasingly highlighting microplastics as a major issue for litter management. Smaller sized plastic particles can be ingested by marine life and have a large surface area to absorb and release toxicants.
- **Litter loads to the Bay are likely to increase with population growth.** The science knowledge synthesis and environmental risk assessment both emphasised the effect population growth and increased urbanisation will have on litter loads to the Bay.
- **Stormwater is the primary vector for litter entering the Bay.** It was estimated that up to 95% of litter polluting the Bay is transferred through the drainage network. The 1991–1993 *Tagged Litter Study* showed that potentially all litter that enters the drainage network could reach the Bay (Melbourne Water 1993). However, the final volume reaching the Bay is dependent on the characteristics of the drain (natural or constructed), proximity to the Bay, and interventions (litter traps). Travel time is related to size of rainfall events and flow patterns within waterways.
- **Litter is a concern to the community.** In the online survey, litter was mentioned 373 times in free text comments; plastic, microplastic and nurdles were mentioned 167 times. Various sources of litter were mentioned including industry, anglers, smokers, visitors and festivals/events. Stakeholders and the community were concerned about the impact of litter on both water quality and the cleanliness of beaches.
- **Littering behaviour has improved, but is still a significant issue.** In 2013/14, 10,240 m^3 of litter, silt and debris were removed from waterways around Melbourne (Melbourne Water 2014). *The Victorian Litter Report 2013* notes that littering behaviour, although less than in 2003, plateaued between 2011 and 2013. Littering behaviour at waterfront precincts and easement sites improved, while littering behaviour at beaches, markets, public buildings, parks, malls and shop areas deteriorated (Sustainability Victoria 2014).
- **Litter clean-up costs are significant.** In 2012–2013, litter and street cleaning maintenance cost Victorian local councils over $94 million (Sustainability Victoria 2015). The majority of this cost was directed at clean-up activities.

The actions proposed for this Plan for litter (Table 8) have been designed to connect and strengthen the efforts already proposed as part of the government's draft *Community and Business Waste Education Strategy*, as well as build on the efforts of community groups and government agencies, particularly:

- Link-in with existing funding opportunities to address knowledge gaps, particularly for microplastics.
- Support current efforts to change littering behaviour.
- Support and strengthen existing efforts to clean up grossly littered areas around the Bay and at strategic points on waterways that discharge to the Bay.
- Improve monitoring and reporting of catchment litter loads.

Table 8 Proposed actions for 'Litter'

Action	Potential partner organisations
ACTION 4-1: Establish baseline estimate of the volume of litter entering the Bay and its impact, including accumulation points	Community groups, councils, DELWP, EPA, Melbourne Water, Parks Victoria, Sustainability Victoria, VLAA
ACTION 4-2: Support capability and capacity building programs with a focus on targeting litter prevention, including reduction of microplastics	Community groups, councils, DELWP, EPA, Melbourne Water, Parks Victoria, Sustainability Victoria, VLAA
ACTION 4-3: Identify and prioritise litter hotspots around the Bay and undertake prevention and on-ground stormwater management actions to address sources	Community groups, councils, DELWP, EPA, Melbourne Water, Parks Victoria, Sustainability Victoria, VLAA

ACTION 4-1: Establish baseline estimate of the volume of litter entering the Bay and its impact, including accumulation points

This action will improve knowledge of litter sources and volumes of litter entering the Bay and address key knowledge gaps in understanding the impact of litter on Bay values.

The volume of litter within the Bay, including that which is buried in the sediments, is a knowledge gap. There is also a need to improve understanding of major sources of litter and the types of land use that are having the greatest impact on litter loads discharged to the Bay.

Having good measurements of the types, volume and sources of litter, and generation rates will help to identify hotspots. This data will also support investment in capacity building and enforcement measures. Creating a baseline for litter, will also enable better reporting to the community of progress and achievement in litter reduction strategies.

This action will commence with a review of methods suitable for establishing baseline volumes and distributions within the Bay and on beaches. The review will draw on the research and monitoring being undertaken by community-based groups such as Port Phillip EcoCentre and Baykeeper.

This action will also provide an opportunity for some of the knowledge gaps of litter impacts to be addressed. Particularly, knowledge gaps on the impact of microplastics on marine life. It is also an opportunity to build partnerships with existing community groups that are currently collecting, or have previously collected, data on litter loads.

ACTION 4-2: Support capability and capacity building programs with a focus on targeting litter prevention including reduction of microplastics

This action will support capacity building programs that will lead to a reduction in generation of litter and littering. The focus will be on litter that enters the Bay through stormwater drains, creeks and rivers.

As stated previously, the government has released its draft *Community and Business Waste Education Strategy 2015–2020*, which includes funding for the Victorian Litter Plan. This includes the delivery of the Litter Innovation Fund which provides the opportunity for organisations to apply for grants for innovative solutions to litter management.

ACTION 4-3: Identify and prioritise litter hotspots around the Bay and undertake prevention and on-ground stormwater management actions to address sources

This action will involve cleaning-up Bay beaches and preventing litter through on-ground activities. Changing littering behaviour is an ongoing challenge, which requires continued effort. In the interim, it is important that beaches are kept clean.

This action was identified through stakeholder consultation. Although the government focus for litter management is on prevention, the impact of any prevention initiatives will not be immediate. There are still likely to be litter hotspots on beaches and at key locations on waterways that discharge to the Bay. This action may involve Melbourne Water working in partnership with councils to install litter traps on waterways and drains identified as major contributors to litter on beaches.

This action will support councils, businesses and community partnership projects to prevent litter from hotspots entering the Bay. This will also help to understand where significant volumes of litter are deposited, the key sources, and the behaviours to change at these hotspots.

PRIORITY AREA 5

Pathogens (human health)

The aim of this priority area is to **minimise risks to human health from pathogens**, and to ensure the Bay's water quality supports the community's recreational uses. It also aims to provide assurance that shellfish collected from the Bay are not contaminated by human pathogens.

Pathogens are microscopic organisms including viruses, bacteria, fungi and parasites. Contamination by pathogens can make water unsafe for swimming as they may lead to infections and illness in humans. The presence and concentration of pathogens is a key measure of recreational water quality.

Pathogens are also a risk to aquaculture and for harvesting of shellfish by the public. This includes Blue mussels, a bivalve mollusc that is grown commercially in fishery reserves in the Bay, and other bivalves that may be collected from the Bay. Mussels, like other bivalves, are filter feeders that extract phytoplankton, bacteria and suspended organic and inorganic particles from the surrounding water as their food supply. As a consequence of their ability to bioaccumulate pathogens and toxins derived from contaminated waters, and because they are often eaten raw or only lightly cooked with the gastrointestinal tract intact, bivalves have been associated with numerous outbreaks of human disease (ASQAAC 2009).

Sources of pathogens

In dry weather, sources of pathogens entering the Bay include spills of sewage as a result of blockages and leakage from sewers, cross-connections between the sewerage and stormwater system, poor house-keeping in industrial and retail sites, unregulated discharge from onsite wastewater systems (septic tanks), animals (e.g. animal faeces, aquaculture), direct discharge of waste from marine vessels, and bather shedding (shedding of bacteria from the skin of people in the water).

In wet weather, pathogen concentrations are likely to increase, due to temporary discharge of sewage from the sewerage systems and runoff from urban and rural land. Infiltration and inflow into the sewerage system during wet weather events can exceed the capacity of the sewer and result in overflows.

Rather than these overflows occurring in a residential property, sewerage systems are designed with emergency relief structures to release this diluted sewage into areas of lower risk in the environment, such as waterways. *SEPP (Waters of Victoria)* requires sewerage infrastructure to be designed to contain flows associated with a 1 in 5 years rainfall event. The expectation is that when overflows occur during such rainfall events, there is sufficient dilution to minimise the impact on beneficial uses. However, not all sewerage infrastructure in the catchment currently meets this standard.

Other known sources of pathogens include discharges from wastewater treatment plants and onsite domestic wastewater systems such as septic tanks. Wastewater treatment plants ensure that sewage is treated and disinfected to reduce risks where effluent is discharged to receiving waters. Similarly, onsite systems require proper maintenance to prevent the transport of nutrients, pathogens and other pollutants to surface waters and to prevent any impacts on groundwater.

SEPP (Waters of Victoria) and nationally MARPOL (which is the International Convention for the prevention of pollution from ships), regulate the discharge of wastewater from vessels. This means that sewage produced on board a boat or ship must not be discharged into the Bay.

One of the highest risks to recreational water quality is from discharges or flows from stormwater drains or waterways during dry weather that contain high concentrations of faecal contamination (EPA 2012b). As there are often no apparent reasons for these higher concentrations, the associated risks cannot be forecast and communicated to the public. Weekly water quality sampling is unlikely to detect these unexpected discharges or flows, and only detects them if they occur on the day of sampling. If these incidents occur during summer there is greater likelihood of beach users being at risk of sickness. Some work tracking pathogens at Mornington and Frankston has been completed by the EPA to help identify and manage sources.

Using risk profiles to set water quality objectives for pathogens

The intent of recreational water quality objectives in *SEPP (Waters of Victoria)* was to set pathogen levels that protect beneficial uses of primary and secondary contact, and seafood consumption. These objectives were not based on relationships of pathogen concentrations and health outcomes.

For primary and secondary contact, objectives linked to health outcomes are available in more recent national guidelines, but are based on an overseas epidemiological study conducted over ten years ago. Future water quality objectives would benefit from being based on accurate representation of health risks for the Bay and other Victorian marine waters.

It is also unclear whether the legislative requirements in place for reporting and collating information on swimmer-related illnesses are providing suitable data to inform the health risk from swimming. Another consideration is that Bay users can modify their behaviour in response to potential or known contamination, and this may have flow-on effects when developing risk profiles.

If receiving water quality objectives are set at a higher level than is needed to protect human health there is potential for water corporations and other stakeholders to over-invest in mitigations, with no increase in health benefit for Bay users. Improving the quantification of human health risks will support:

- Decisions on investment in mitigation of faecal sources (e.g. sewer or treatment upgrades, council integrated water plan actions) to be based on evidence of health risk, with less investment needed where health risk is low.
- Recreational water quality objectives to be more protective of public health, set at the microbial levels linked to health outcomes, and will result in better management of faecal sources and communication of risk.

Communicating risk to beach users

As part of the Beach Report program, EPA monitors water quality in the Bay. Water samples are collected weekly at 36 beaches. *Enterococci*, which is used as the indicator for bacteriological water quality in marine waters, is a group of bacteria found in the intestinal tracts of mammals (including humans), and is strongly associated with faecal waste (i.e. sewage).

EPA's Beach Report provides recreational water quality information to the public, so they can make informed decisions about when and where it's safe to swim in the Bay. The Beach Report also provides EPA and catchment managers with water quality data to inform on immediate risk to beach users during the summer, and to inform where management is needed to protect and improve water quality.

Current end-of-season reporting for the last five years shows that approximately half of the Bay's beaches met objectives between 2011/12 and 2012/13 (due to wetter summers), with 94–97% of beaches meeting objectives in the last two summers (EPA 2016). The Department of Health and Human Services has not reported any outbreaks of water-borne illnesses from recreation in the Bay during this period.

There has been considerable development in approaches and technologies to improve Beach Report's capability to monitor and inform on water quality risk to the public, and to assist catchment managers mitigate risk. Examples of this are microbial techniques with faster analysis times, better source tracking and real-time water quality information. This could also include monitoring linked to changes in flows in local drains and waterways.

Stormwater drain at St Kilda East.
Photo – Tangaroa Blue Foundation
(http://www.tangaroablue.org/)

The EPA's current forecast model provides basic information on water quality risk but it could be improved by using the latest modeling techniques. The current model is also not easily automated for increased timeliness of forecasts.

Communication of Beach Report forecasts and beach advisories is via the Yarra and Bay website and EPA Twitter account. This communication could benefit from improved adoption of digital technologies and other strategies that result in behaviour change. The program's communication and detection of risk could also be further improved by inclusion of citizen science to communicate and gather data.

Developing actions to reduce risk from pathogens

The 2001 Environmental Management Plan identified pathogens as a risk to Bay values. However, no specific actions were proposed. Despite not ranking as a high risk in the environmental risk assessment (Hales and Brooks 2015), this Plan has included recreational water quality as a priority area for the following reasons:

- **Current standards and indicators for recreational water quality are being reviewed**. The *SEPP (Waters)* review includes a component of work reviewing water quality standards required to protect the beneficial uses for primary and secondary contact for recreational users.
- **The community's use of the Bay is impaired after storm events**. Beach Report recommends people avoid swimming near stormwater or river outlets 24–48 hours after heavy rain. This is due to the associated risk of contamination.
- **Better information on sources of faecal contamination would enable more targeted improvement strategies.** Faecal contamination sources are likely to be from diffuse sources and are difficult to isolate. As a result the relative contribution of various sources and their impact on the recreational water quality in the Bay is unknown.
- **The community's top three values for the Bay are recreational.** When asked to select the three things they value most about the Bay, survey respondents' top three values were: a healthy marine habitat and wildlife (26%); opportunities for relaxation, socialising and recreation (21%); and swimming (17%). Many survey respondents also used the free text comments to elaborate on their desire for clean water to swim in with fewer impacts after wet weather and less risk of illness from swimming.

The actions (as listed in Table 9) will contribute to protecting the beneficial uses of primary and secondary contact, and seafood consumption in the Bay.

Table 9 Proposed actions and foundational activities for 'Pathogens (human health)'

Action	Potential partner organisations
ACTION 5-1: Improve understanding of links between pathogen concentrations and human health for swimming and consumption of shellfish	Councils, DELWP, DHHS, EPA, Melbourne Water, research organisations, water corporations
ACTION 5-2: Adopt a risk-based approach to mitigate sources of pathogens found in the Bay	Councils, DHHS, EPA, Melbourne Water, research organisations, water corporations
ACTION 5-3: Improve monitoring and reporting to better detect and communicate human health risks from pathogens	Councils, DHHS, EPA, Melbourne Water, research organisations, water corporations

ACTION 5-1: Improve understanding of links between pathogen concentrations and human health for swimming and consumption of shellfish

This action will improve our understanding of human health risks from sources of faecal contamination and inform investment in mitigation activities.

Collecting locally relevant data to establish the risk relationship between pathogen concentrations and human health associated with swimming-related activities and consumption of seafood taken from the Bay, will provide better evidence of health risk. This will support prioritisation and investment by water corporations and local councils in actions to mitigate faecal sources.

To develop health-based water quality objectives, quantitative microbial risk assessments (QMRA) and epidemiological studies are used to quantify human health risks. For swimming, an epidemiological study provides a direct measure of human illness rates for swimmers that are exposed to recreational waters. The results inform policy and regulatory guidance via the association between these illness rates and regular sampling of water quality indicators at the site. In addition, QMRAs provide information on the risk from different faecal sources and mitigation strategies. However, QMRAs have limited value in measuring health risk for swimming as they characterise pathogens present in the water, but this may not represent health risk because there is uncertainty about how infective pathogens are. QMRAs are currently the best assessment for characterising risk from seafood consumption.

Activities in this action

Activities will include conducting integrated QMRAs and epidemiological studies to directly measure risk to health from swimmer-related activities in the Bay. These studies would be best undertaken as part of a greater research partnership/project, with part funding from national bodies because the outputs would have broad benefit across Australia. There may also be a need to conduct QMRAs to characterise and indirectly measure health risk from consumption of seafood such as commercially grown mussels and species of shellfish harvested from the Bay.

ACTION 5-2: Adopt risk-based approach to mitigate sources of pathogens found in the Bay

This action will inform water corporations and local councils on what the highest risk faecal sources (transported via stormwater drains or located directly at beach) are, where they are located, their likely risk to human health and best approaches for mitigating the risk.

Activities in this action

- Investigate whether dry weather flows from drains are occurring at high-risk beaches (i.e. popular beaches) by including a short-term drain monitoring project during summer.
- Develop modelling (and supporting on-ground investigations) to:
  - Predict what level of flow and microbial concentration from drains and waterways contributes to the increased health risk at beaches
  - Predict volume of sewage (e.g. sewer leaks or spills, cross connections) and other contributions of faecal pollution in stormwater runoff for rain events and dry weather discharges/flows
  - Predict risk to swimmers from local beach sources (e.g. bather shedding, sediment resuspension)
  - Understand other faecal sources that may be a risk to aquaculture
  - Identify locations or high risk areas for faecal sources
  - Either add to existing water quality models or create new modelling tools that can support water corporations and councils in managing pathogens risks from stormwater.
- Trial and evaluate source tracking and control methods for mitigation of faecal sources (includes end-of-pipe solutions, capital infrastructure, or source control).
- Review outcomes from activities above, and ensure that water corporations and local councils have in place appropriate management plans to ensure that faecal sources are monitored and managed proactively.

ACTION 5-3: Improve monitoring and reporting to better detect and communicate human health risks from pathogens

This action will improve the existing Beach Report program by using the latest forecast and monitoring methods and technologies to improve accuracy of forecasting poor water quality, triggering management responses, and communicating risk. Other processes to inform management will rely on support from the community through citizen science programs for collecting local information on conditions and risk factors. This action will establish a strong foundation for adopting risk reduction behaviours (for example, better housekeeping in retail and industrial sites, discharge of wastewater from vessels).

Activities in this action

- Develop more accurate and timely forecasting of microbial water quality.
- Adopt water quality technologies, techniques and modelling approaches to better detect and communicate risks to managers and community.
- Conduct short-term drain monitoring projects to assess dry weather discharges/flows from high risk drains (i.e. at popular beaches).
- Set up citizen science programs and reporting systems for community-led communication and detection of risk factors.
- Improve Beach Report communication to increase awareness and influence behaviour change e.g. digital technology and social research.

During summer beach users can access the EPA's Beach Report to get daily forecasts for recreational water quality at popular beaches around the Bay. Photo – Parks Victoria

PRIORITY AREA 6

Habitat and marine life

The aim of this priority area is to **conserve and restore habitats and to ensure conditions are suitable for marine life to thrive**.

The Bay is home to a diverse array of marine plants and animals, with many of these species only found in southern Australia. Over 1,300 species are documented in the *Taxonomic Toolkit for Marine Life of Port Phillip* (http://portphillipmarinelife.net.au).

The fauna of the Bay includes more than 300 species of fish and several hundred species of each of the following: molluscs (e.g. Blue mussels, periwinkles and limpets), crustaceans (shrimp, crayfish, krill and barnacles), polychaete (bristle) worms, cnidarians (e.g. corals, jellyfish and sea anemones) and sponges (Harris *et al*. 1996). The Bay also supports populations of marine mammals including the Australian fur seal, and Common and Bottlenose dolphins. A number of whale species, including Humpback, Southern Right and Killer, which are occasional visitors to the Bay, as are sea turtles. Migratory birds are also seasonal visitors to the Bay.

There are more than 20 species found in the Bay that are listed as threatened under the *Victorian Flora and Fauna Guarantee Act 1988*. These include a number of birds, fish, mammals (including the *Burrunan Dolphin*), echinoderms, as well as one crustacean (Southern hooded shrimp, *Athanopsis australis*), one reptile (Leatherback turtle, *Dermochelys coriacea*), one mollusc (Chiton, *Bassethullia glypta*) and one plant (Sea water-mat, *Lepilaena marina*). These species are a mix of resident and transient species.

Habitats include seagrass meadows, rocky intertidal and subtidal reefs, sponge gardens and soft sediments. Plants found in the Bay include phytoplankton (single-celled algae that live in the water column and move with the currents), microphytobenthos (microscopic algae that live and form mats on the sea floor), seaweeds and seagrasses.

The marine community of the Port Phillip Bay Entrance Deep Canyon is located in a 100-metre deep canyon reef complex at the entrance of the Bay. It includes a diversity of sessile invertebrates, including more than 271 species of sponges, 115 of which are known only from the Port Phillip Heads (Edmunds *et al*. 2006). The Deep Canyon community is listed as threatened under the *Flora and Fauna Guarantee Act 1988*.

Saltmarsh within the Jawbone Marine Sanctuary provides critical habitat for many waterbirds. Saltmarsh is also very effective at carbon sequestration. Photo – Parks Victoria

The Bay has four marine protected areas that were established as 'no take' areas in 2002. Port Phillip Heads Marine National Park is comprised of six separate sections (Point Lonsdale, Point Nepean, Popes Eye, Mud Island, Portsea Hole and Swan Bay) and covers an area of 3,475 hectares. It contains a number of habitat types including rocky intertidal and subtidal reefs, sandy beaches, mud flats, seagrass meadows and sponge gardens, which in turn support a diversity of plants and animals. There are also three marine sanctuaries in the Bay: the Point Cooke (290 hectares), Jawbone (30 hectares) and Ricketts Point (115 hectares). These marine parks and sanctuaries have been established to protect representative examples of Victoria's unique and diverse marine environments, and the plants and animals they support.

There are two Ramsar-listed wetland sites in the Bay. The Port Phillip Bay (western shoreline) and Bellarine Peninsula Ramsar site is recognised for the quality of its natural wetlands and the large numbers of waterbirds that utilise its natural and constructed wetlands, particularly migratory shorebirds. Up to 50% of the critically endangered Orange-bellied parrot (*Neophema chrysogaster*) population utilises the site for winter feeding habitat, and it also provides an important drought refuge for waterbirds. The second Ramsar site, the Edithvale-Seaford Wetlands on the east coast of the Bay, supports a rich diversity of Australian and migratory birds. These wetlands are the last remnants of the Carrum Carrum Swamp and assist with flood protection in the Dandenong catchment.

Artificial structures in the Bay are important for a number of species. Shipwrecks provide important habitat, and artificial reefs (located at Portarlington, Altona, Aspendale, Carrum, Seaford and Frankston) support recreational fishing. Rock walls and breakwaters provide homes for a variety of wildlife. For example, the St Kilda Breakwater is home to a colony of Little penguins and Rakali (native water rats), and some of the old channel marker structures are used as haul-out sites for Australian fur seals.

This Plan takes an active role in conserving and restoring habitats and allowing marine life to thrive. Including it as a priority area is supported by the following points drawn from the background investigations and consultation:

- **Habitats and marine life are key values of the Bay:** *Schedule F6* identifies ecosystems - natural, substantially natural with some modifications and highly modified - as protected beneficial uses of the Bay. This Plan recognises that the conservation of all habitats and marine life in the Bay is required to maintain environmental values.
- **Healthy habitats and marine life are key factors in delivering economic benefits:** The value of habitats was not specifically assessed in the economic work valuing the benefits provided by the Bay, but the Bay's habitats directly underpin services such as commercial and recreational fishing, aquaculture, and tourism.
- **The community values the Bay's habitats and wants to see them conserved:** The online survey identified 'maintain and improve marine life and habitat' as equal top challenge (36% of respondents). The top value of the Bay was 'a healthy marine habitat and wildlife' (26%). Support for habitat and marine life at the community listening post events was also high. The consultation also identified jet skis as a key challenge. Respondents were concerned about the potential dangers of jet skis on marine life, as well as swimmers and impacts of noise and petrol leaks.
- **Bay habitats and marine life are at risk:** The environmental risk assessment (Hale and Brooks 2015) identified waterbirds, marine mammals, sub-tidal and intertidal reefs, and fish as most at risk, including:
  - **Waterbirds:** changes in habitat through erosion of shorelines and sea level rise.
  - **Marine mammals:** entanglement in marine debris, toxicants and disturbance by marine vessels (out of scope).
  - **Sub-tidal and intertidal reefs:** increased nutrients, leading to a decline in the diversity of macroalgae (seaweeds), and loss of habitat forming kelps.
  - **Fish:** effects of sea urchin barrens and loss of habitat; and increased fishing pressure on target species (out of scope).

- **Research is needed to understand the spatial distribution of habitats and impact of stressors:** Hutchinson *et al.* (2011) in their *Temperate Reefs Literature Review*, stated that further research is required to understand the ecology of reefs, particularly sub-tidal reefs. Gaps identified included understanding of species composition, and the effect of spatial and temporal variation on assemblages. Current understanding is limited to particular sampling sites and times of year. Basic data on species composition, behaviour and ecology is lacking for sub-tidal reefs, while the potential impacts of sedimentation, pollutants, and sea level rise on intertidal reefs is largely unknown.
- **Climate change is likely to have a significant impact on Bay habitats and marine life:** The science knowledge synthesis makes reference to a decline in fish biomass (up to 69% in the deep centre) during the drought from 1997 to 2010 (Parry and Hirst 2016). This was based on data from the Port Phillip Bay Annual Trawl Program (which ceased in 2011) and is further supported by observations of reduced algal growth and development of urchin barrens during this period especially in the north of the Bay. The decline in fish stocks was attributed mainly to a reduction in algal productivity during the drought period. Warry and Hindell (2009) in their *Review of Victorian Seagrass Research*, identified climate change (as well as population pressures along the coast) as a significant threat to seagrass habitats.
- **Elevated sea urchin densities are a threat to the integrity of kelp beds on rocky reefs:** Grazing by large populations of the native sea urchin, *Heliocidaris erythrogramma*, has been implicated in the loss of macroalgal cover on reefs (particularly the once-dominant canopy-forming macroalga, *Eklonia radiata*) (Carnell and Keough, 2014). Urchin barrens have been formed on more than 90% of the reefs in the western and northern parts of the Bay. This is thought to have negatively affected reef-associated fish that depend on the macroalgae for food and shelter. The Reef Ecosystem Evaluation Framework (REEF) program for restoring the macroalgal canopy in the Bay, which was developed as part of the Seagrass and Reefs program, suggested that urchin densities be reduced to help rehabilitate kelp beds on rocky reefs (Johnson *et al.* 2015). However, as information is limited an adaptive management approach is most appropriate.
- **Seagrass habitat is important to the enhancement of key fish stocks in the Bay and maintaining the value of fishing:** Seagrass beds provide important nurseries for many fish species, including species fished commercially and recreationally. Analysis by Blandon and Ermgassen (2014) estimated that seagrass habitat enhances the stock of King George whiting at a rate of 5 kilograms/hectare/year, which for commercial fishing has an economic value of $5.6 million per year. The value of other target species, such as Snapper is also enhanced by seagrass habitat.
- **Bay activities are known to have damaged key habitats in the past:** Water pollution, marine pests, and commercial fishing for scallops by dredging have significantly impacted shellfish reefs and other habitats in the Bay. Scallop dredging in the Bay was stopped in 1996 after over 30 years of operation, and there has been continuing effort to reduce water pollution and marine pests. Effort is now being invested in restoring some of these impacted habitats. Examples include the shellfish reef restoration projects being undertaken by The Nature Conservancy in partnership with Fisheries Victoria, The Thomas Foundation and the Albert Park Yachting and Angling Club.

The Seagrass and Reef research program on the ecology and management of seagrass and temperate reefs in the Bay had two components: 'targeted science' and 'using science to inform management'. The 'targeted science' component involved the development of the *Marine Biodiversity Science and Research Strategy* (a framework to guide future investment into priority marine areas across Victoria) and the marine research studies administered through a grants process were targeted towards informing practical management tools. The findings from this research have informed this priority area and shaping of actions.

The Victorian Government's *State of the Bays* report will provide valuable information on objectives, targets and timelines that should be monitored to assess the change in condition of key habitats across the lifespan of this Plan, as well as identify data gaps that this Plan could address through supporting targeted research by government agencies, universities and community groups.

Community based education and research programs

There are a number of government, community and citizen science programs that promote healthy bay habitats and marine life. The actions of this Plan will help to provide support for these programs, which include:

- **Reef Watch** is a citizen science program run by the Victorian National Parks Association (VNPA) in partnership with Museum Victoria. The program encourages divers and snorkelers to monitor marine life at their favourite dive sites. Current Reef Watch projects include the Great Victorian Fish Count, Dive In, Buddy up with a Blue Devil and Feral or in Peril. Reef Watch is also assisting with The Nature Conservancy reef restoration project.
- **Sea Search** is a Parks Victoria program that encourages and provides opportunities for community participation in marine data collection and surveillance within Victoria's marine national parks and marine sanctuaries. Sea Search assists in improving understanding of natural assets and processes, in the early detection of change, identification of threats, and provides meaningful opportunities for citizens to make an active and welcome contribution to the management of marine parks and sanctuaries.
- **'i Sea, i Care'** is a marine ambassador program run by the Dolphin Research Institute. The program has focused on primary school aged students (grades 5 and 6) and currently has more than 450 ambassadors in over 100 schools. The key messages of the program are that our marine life is too precious to lose and that diffuse pollution from the catchment is one of the biggest issues for the marine environment. i sea, i care focuses on peer learning to increase marine stewardship and leadership. The program also includes partnerships with local councils. These partnerships have assisted with local government decision making regarding stormwater issues. The Dolphin Research Institute is currently expanding the program to work with secondary school students, community groups and business.
- **Port Phillip Eco Centre** facilitates events that build community awareness on key habitat values of the Bay as well as highlighting issues that are impacting on these habitats. The Eco Centre runs a number of activities including snorkeling, cycling and twilight walking tours that showcase the diversity of plants and animals in the Bay. These activities facilitate the sharing of information about conservation and management issues, and what people can do to help care for the Bay. The Port Phillip Baykeeper is a community program run by the Port Phillip Eco Centre. The Baykeeper brings together stakeholders from across the government, research and business sectors as well as schools and the community to undertake projects that help to conserve and improve the health of the Bay. Activities facilitated by the Baykeeper include shoreline shell surveys, beach profiling activities and live mollusc surveys.
- **Marine Care Ricketts Point** is a community group which supports the well-being of the Ricketts Point Marine Sanctuary. The group has approximately 250 members and works closely with Parks Victoria (as the Sanctuary Manager), Bayside City Council and other interested groups. Marine Care Ricketts Point runs a Marine Education Centre and a range of activities that help to conserve and preserve the natural environment, and educate the community about the role and values of the sanctuary. Activities include mapping, monitoring and recording of marine life.
- **Coastcare Victoria** is a government program that supports thousands of community volunteer groups working to protect and enhance Victoria's coastline. Volunteer groups help to maintain marine and coastal environments, through activities such as revegetating coastal areas, building tracks and boardwalks, fencing, monitoring native shorebirds and animals, presenting education and awareness raising sessions and protecting cultural sites. One of the Coastcare Victoria programs, delivered as a partnership between DELWP and Parks Victoria with support from local volunteers and experts, is Summer by the Sea.
- **Summer by the Sea** is an annual program that provides a great opportunity for the community to connect with the rich and diverse natural and cultural values of Victoria's marine and coastal environments. Activities range from coastal discovery walks, rockpool rambles and snorkelling to junior ranger and responsible fishing activities. Through these activities, the program promotes respect for coastal and marine environments and understanding of the impacts our actions can have on these environments.

The actions in Table 10 address key concerns raised by the community and build on existing government and non-government programs to address the management needs and knowledge gaps of this priority area. The impacts to marine animals through entanglement and other litter-related issues are addressed in the 'litter' priority area of this Plan.

Table 10 Proposed actions for 'Habitat and marine life'

Action	Potential partner organisations
ACTION 6-1: Monitor Bay habitats at priority locations and improve habitat mapping tools	Community and industry groups, DEDJTR, DELWP, EPA, Parks Victoria, research organisations
ACTION 6-2: Improve understanding of ecological processes, threats and pressure	DEDJTR, DELWP, EPA, Parks Victoria, research organisationss
ACTION 6-3: Improve overall extent and condition of the Bay's natural ecosystems	Community and industry groups, DEDJTR, DELWP, EPA, Parks Victoria, research organisations

ACTION 6-1: Monitor Bay habitats at priority locations and improve habitat mapping tools

This action will improve knowledge and understanding of what and where habitats occur in the Bay and will inform understanding of changes to habitats that require management intervention. This will also help to improve the community's appreciation and understanding of the Bay's habitats, ecosystems and biodiversity.

Monitoring will focus on key areas, including those that are likely to be impacted by climate change, and include sites that are part of existing monitoring programs, such as Parks Victoria's Marine Protected Area program. Monitoring of sand movement and stability will also be included to inform beach management works, such as beach re-nourishment.

The information collected will be used to help to demonstrate the effectiveness of our management interventions, including in reports such as the Plan's five-yearly evaluation report and future *State of the Bays*.

Citizen science will support the implementation of this action, including working with and supporting non-government organisations and community groups to undertake monitoring. There are a number of citizen science programs that promote healthy bay habitats and marine life including the Victorian National Parks Association's Reef Watch program, Parks Victoria's Sea Search program and the Port Phillip Baykeeper's shoreline shell surveys and live mollusc surveys. These activities help to increase the skills and knowledge of volunteers and provide the community with opportunities to participate in natural resource management and contribute to local decision-making.

This action will link closely with the 'Connect and inspire' and 'Empower action' priority areas in this Plan, particularly the actions to develop and deliver programs to inspire greater appreciation of the Bay's values and empower the broader community to get more actively involved in caring for the Bay.

ACTION 6-2: Improve understanding of ecological processes, threats and pressures

This action will increase understanding of how ecosystem processes are affected by key threats and pressures. We need to understand which threats and pressures pose the greatest risk to Bay habitats and marine life and prioritise management actions, focusing on those that are most likely to have successful outcomes. To do this, we need to have a good understanding of the linkages between threats, environmental change and on-ground management interventions.

This action will follow a similar approach to the Western Port environment scientific review, which provided a strategic assessment of scientific knowledge and identified priority areas for research (Melbourne Water 2011). The review considered changes to the ecosystem, threats to this ecosystem and the scientific knowledge needed to effectively manage these threats into the future. Considerations included:

- What are the knowledge gaps?
- Which knowledge gaps are critical to underpin management decisions and agency prioritisation?
- What research will fill these critical knowledge gaps?

Issues for investigation include:

- Consequences of changes in nutrient regimes on ecosystem structure and function, including further examination of other nutrient sources (e.g. groundwater)
- Impacts of climate change on key ecosystem structure and function, including intertidal reefs and low-lying coastal areas.

This action will be guided by the outcomes of the *Reef Ecosystem Evaluation Framework* (REEF), developed as part of the Seagrass and Reefs program, and issues identified for further investigation through habitat monitoring. These investigations will also inform development of models of ecological processes and threats to guide management interventions.

This action will also provide an opportunity to use Aboriginal cultural heritage data in a more cross-disciplinary manner to facilitate a greater understanding of the Bays environmental condition. For example learning more about fish species and selection from shell midden deposits , which could provide further information about the condition of the Bay prior to European occupation.

ACTION 6-3: Improve overall extent and condition of the Bay's natural ecosystems

This action will conserve, build resilience in and restore natural ecosystems across priority locations. It will be informed by the outcomes of other actions, which will identify locations where habitat restoration activities are needed. This will include areas of significant ecological and recreational value (e.g. seagrass meadows, intertidal reefs, important sea and shore bird sites and popular dive sites) and those areas likely to be impacted by climate change and sea level rise (e.g. intertidal areas).

There are a number of potential activities that have already been identified. These include:

- Restoration of degraded habitats. An example is the reef restoration work currently being undertaken by The Nature Conservancy. The Nature Conservancy has partnered with the DEDJTR (Fisheries Victoria), The Thomas Foundation and the Albert Park Yachting and Angling Club to restore shellfish reefs in the Bay. Geelong (Wilsons Spit Reef), Hobsons Bay (Margaret's Reef) and Chelsea are the first reefs being restored through the program.
- Developing and piloting approaches to manage marine life issues. One example being discussed is development of a science-based approach, using recreational divers, to reduce overabundant and damaging native sea urchins in key areas of the Bay. Elevated densities of the native sea urchin *Heliocidaris erythrogramma* have been identified as a threat to kelp beds on rocky reefs in the Bay. The aim of the proposed pilot is to support the recovery of these kelp beds. This proposal will be subject to discussions with commercial fishers and the relevant permits being secured.
- Habitat augmentation techniques, including eco-engineering. Artificial structures, such as piers, groynes, seawalls and jetties, often provide minimal viable habitat for native species. They can be less hospitable to native species and may lead to localised declines in species diversity. Eco-engineering can provide opportunities to support native species and habitats through innovative techniques for the development of multipurpose structures that are both functional and beneficial to the local ecosystem.

PRIORITY AREA 7

Marine biosecurity

The aim of this priority area is to **manage the risks to Bay values from marine pests.**

Marine pests are non-native plants or animals that can establish themselves in a new environment by producing large numbers of spore or offspring. They are 'ecosystem engineers' as they change the dynamics of the ecosystem. Marine pests can seriously affect habitats, food chains, the ecosystem and our enjoyment of the marine environment. Some marine pests may pose a risk to human health and have potential to affect the social and economic benefits provided by the marine environment including aquaculture, recreational and commercial fishing and domestic and international shipping.

The last systematic survey of the Bay for introduced marine species was completed in 2003 (Hewitt *et al.* 2004). The authors suggested that the Bay with over 160 introduced species was the most invaded ecosystem in the southern hemisphere. The most conspicuous species that have received the most attention are the Northern Pacific seastar (*Asterias amurensis*), Japanese kelp (or Wakame) (*Undaria pinnatifida*), European fan worm (*Sabella spallanzanii*), European clam (Corbula gibba) and European green shore crab (*Carcinus maenas*). A more recent species to be identified is the red algae *Grateloupia turuturu*, which has been recorded in the Point Cooke Marine Sanctuary.

The 2001 Plan acknowledged that risks associated with marine pests are most effectively addressed by nationally agreed arrangements and, in their absence, statewide programs. The 2001 Plan's marine pest program, therefore, aimed to address key Bay-focused tasks and form an additional layer to the relevant statewide and national programs. Specifically, the objective of the 2001 Plan was, 'Continue to improve the management of vectors that lead to the introduction of marine pests to the Bay, reduce the impact from introductions through early detection and rapid response action where possible, and reduce the impact on the Bay from established pest populations where technically feasible'.

The background investigations support continued specific management of marine pests in this Plan because:

- **Marine pests may pose a risk to Bay values.** While the Bay has been relatively resilient to the impacts of marine pests to date, the environmental risk assessment (Hale and Brooks 2015) identified that marine pests remain a high risk to the values, with the greatest risk posed to denitrification, intertidal and sub-tidal reefs and primary contact recreation.
- **Excursions of marine pests from the Bay have occurred since the 2001 Environmental Management Plan.** The science knowledge synthesis notes marine pests endemic to the Bay have invaded other Victorian waters/embayments since the development of the 2001 Plan (e.g. *Undaria pinatifida* has been present at Apollo Bay since 2009).
- **Boat traffic will increase in the future.** Shipping traffic will increase in the future to meet the growing demand for goods of a growing population. Small vessel movements are also likely to increase. Consequently the opportunity for marine pests being introduced to and spread from the Bay is also likely to increase unless appropriately managed at both ports and marinas.
- **Future incursions are likely if not managed appropriately**. Repeat invasions are very likely due to the voracious nature of many of the marine pests endemic to the Bay, and in many cases will require management interventions.
- **Current governance arrangements and records are hindering effective management.** Performance audits of the management of marine protected areas (VAGO 2011) and terrestrial parks (VAGO 2010) note that complicated, unclear governance arrangements and outdated records have hindered effective, coordinated management of invasive species and marine pests.
- **Marine vessels are the primary vector for marine pests entering, leaving and travelling within the Bay.** Vessels can transport marine pests externally through the growth and accumulation of aquatic organisms (biofouling) and internally through the uptake and discharge of ballast or bilge water. Larval dispersals are another vector path.
- **Biofouling is controlled by applying an anti-fouling agent to the vessels exterior.** Its effectiveness in preventing spread of marine pests relies on regular and appropriate maintenance. The Commonwealth guideline *Anti-fouling and in-water cleaning guidelines* (2013) describes 'best practice approaches for the application, maintenance, removal and disposal of anti-fouling coatings and the management of biofouling and invasive aquatic species on vessels' (described as any craft that operates in an aquatic environment) (Commonwealth 2003). However, the Victorian Government is yet to be a signatory to these guidelines due to concerns over the in-water cleaning prescriptions.

- **Biofouling on aquaculture equipment is also a potential vector for marine pest transfer.** Translocation of mussel ropes occurs within the Bay and to and from Western Port, increasing the risk of movement of marine pests to new locations. To address this issue, *Guidelines for Assessing Translocations of Live Aquatic Organisms* in Victoria were completed in 2003 and updated in 2009. Protocols developed under the guidelines include the *Victorian Protocol for the Translocation of Blue Mussels*, the *Victorian Abalone Aquaculture Translocation Protocol and Management Plans* for aquaculture reserves declared under the *Fisheries Act 1995*.
- **Spread of marine pests through ballast water is controlled through appropriate boat hygiene.** Ballast water is water used by ships to improve stability and safety under variable load conditions. It is taken up and discharged from the vessel when cargo is loaded or unloaded, or when a vessel requires additional stability in bad weather. This water can contain marine pests and therefore unregulated discharge can result in marine pest populations being transferred to unaffected waters. High-risk ballast can be dealt with during a journey by 'exchanging' at sea with uptake of waters distant from the coast (where there are no pests).
- **Community and stakeholders are concerned about the potential risk of marine pests.** At the listening posts, 'Ecosystem issues' received 28% of nominations. There were 44 mentions of marine pests and invasive species in the survey. Invasive species were mentioned in formal submissions and interviews, with some stakeholders highlighting the lack of funding as a barrier to proper management.
- **Further work and follow up required on original Environmental Management Plan actions.** While many of the actions in the 2001 Plan relied on action at a national or state level, work is still required to ensure the full intent of these actions is realised. This particularly relates to actions 2.3 (Vector Management – Fouling of Small Vessels – To improve management of biotic fouling of small vessels to reduce the risks of introduction and dispersal of marine pests), 2.5 (Early Detection – To monitor priority locations within the Bay for new marine pest introductions) and 2.6 (Mitigate Effects of Introductions – To respond rapidly to new introductions of marine pests and reduce the impact of established populations on the Bay's management objectives, where technically feasible and environmentally, socially and economically beneficial).
- **There is a lack of monitoring data regarding marine pests.** Parks Victoria undertake monitoring of subtidal reefs and intertidal areas in the marine parks and sanctuaries, which includes documenting the presence of known marine pests (e.g. Woods and Edmunds 2014). There have also been localised surveys of specific pest species associated with smaller research projects. There has been no systematic monitoring or surveys of marine pests in the Bay since 2003.
- **Marine pest management arrangements in Australia are currently being reformed.** The Commonwealth Government has introduced new legislation which will affect marine pest management in Victoria. Currently, the protection of Victorian waters from the introduction of marine pests is supported by three key items of subordinate legislation: the *Environmental Protection (Ships Ballast Water) Regulations 2006*, the *Waste Management Policy (Ships Ballast Water)*, and the protocol for environmental management '*Domestic ballast water management in Victorian state waters*'.
- **The *Waste Management Policy and Protocol for Environmental Management* set out responsibilities for ship owners to manage domestic ballast water to reduce environmental risk in Victorian waters.** Vessels are required to complete a risk assessment of ballast water contained onboard. High-risk ballast water cannot be discharged within Victorian state waters (DAWR 2011). The ballast water regulations establish offenses for discharging ballast water without written authorisation and for failing to complete reporting requirements. They also set fees and the process for collection. EPA conducts random inspections of boats entering the Bay for compliance with these regulations. As of 2012, EPA has not found a ship to be non-compliant (EPA 2012c).
- **The *Commonwealth Biosecurity Act 2015* will commence on 16 June 2016, however commencement of the domestic ballast water provisions has been deferred.** When the ballast water provisions commence, the new national framework for regulation of ballast water will protect domestic waters from the introduction and spread of marine pests.

Consistent with the directions of the 2001 Environmental Management Plan, this Plan acknowledges that marine pests are best managed through nationally agreed arrangements. However, there are actions that can directly assist management of marine pests in the Bay.

The proposed actions (Table 11) have been developed based on the recommendations and key findings from the science knowledge synthesis and review of the marine pests program in the 2001 Plan. The actions identified focus on reducing the risks of introduction of marine pests, early detection of marine pests and mounting a rapid response to any identified marine pest incursion.

Table 11 Proposed actions for 'Marine biosecurity'

Action	Potential partner organisations
ACTION 7-1: Prevent introduction and dispersal of marine pests	Commonwealth Government, community and industry groups, DEDJTR, DELWP, EPA, Parks Victoria
ACTION 7-2: Monitor priority locations for early detection of marine pest introductions	Commonwealth Government, community and industry groups, DEDJTR, DELWP, EPA, Parks Victoria
ACTION 7-3: Respond rapidly to new introductions of marine pests	Commonwealth Government, community and industry groups, DEDJTR, DELWP, EPA, Parks Victoria

ACTION 7-1: Prevent introduction and dispersal of marine pests

This action will minimise the risk of marine pests being introduced to and spreading from the Bay.

This action recognises that prevention is better than cure when it comes to managing marine pests. And that ballast water and biofouling are recognised as the primary vectors of marine pest introduction and spread.

Activities in this action

Activities to reduce risks associated with these vectors are the focus of this action and implementation is likely to include:

- Working with the Commonwealth Government as domestic ballast water management arrangements transition from state to Commonwealth regulations.
- Working with the Commonwealth Government to develop programs to improve management of biofouling on large vessels.
- Improving awareness of small boat users about the risks of spread of marine pests from biofouling and ways to reduce this.
- Ensuring that aquaculture guidelines, protocols and management plans are current and reflect best practice approaches and best available scientific knowledge to help reduce the risk of marine pest introduction and spread.

ACTION 7-2: Monitor priority locations for early detection of marine pest introductions

This action will include research and monitoring using a risk-based approach to focus on detection of any new pests. This will help to establish baseline information regarding the distribution and abundance of existing marine pest species within the Bay.

Early detection of marine pest introductions is critical for effective management. Once established, marine pests are near impossible to eradicate and can affect habitats, food chains, the ecosystem, and our enjoyment of the marine environment. Ongoing monitoring and surveillance are therefore important for managing marine pest risks.

Australian marine pest monitoring guidelines and an accompanying *Australian marine pest monitoring manual* were developed in 2010 as part of the *National System for the Prevention and Management of Introduced Marine Pest Incursions*. The guidelines established a National Monitoring Network of eighteen locations around Australia, including the Port of Melbourne, and outline the nationally agreed processes, procedures and standards for marine pest monitoring programs. The Commonwealth also provided funding for development of specific monitoring plans. Monitoring of the Victorian sites has not commenced as cost-sharing arrangements are still to be agreed with industry. This action will involve resolution of these arrangements so that monitoring can commence.

Regular monitoring of other priority locations within the Bay for new marine pest introductions will also be important. Monitoring should focus on areas that are high-risk locations for primary introductions to the Bay or spread (e.g. marine parks and sanctuaries). This could include piloting new rapid assessment tools (e.g. eDNA sampling, settlement plates) that make a step change in making information available. There is also opportunity to use citizen science to assist in monitoring for marine pest introductions.

ACTION 7-3: Respond rapidly to new introductions of marine pests

This action focuses on emergency management through rapid response to new introductions. The *Emergency Management Act* (*1986* and *2013*) provides the legislative framework for emergency management in Victoria. Under this sits the *Emergency Management Manual Victoria* (EMMV) which contains policy and planning documents for emergency management and provides details about the roles different organisations play. Marine pest incursions are listed as a declared emergency in the EMMV.

In addition to emergency response, this action includes development of an operational manual to build capacity and preparedness to rapidly respond to any newly identified introductions of marine pests prior to becoming established.

Implementing actions to mitigate the impact of established pests may also be considered in the longer term where technically feasible and environmentally, economically and socially beneficial.

5 Delivering the Environmental Management Plan

This Plan has been developed with an understanding that its implementation will be a collaborative effort between government, industry and the community.

The vision and goals are considered to be long-term aspirations, and will be progressively worked towards over time. This plan outlines 21 actions, across 7 priority areas, which will be delivered over the next 10 years.

Arrangements for delivery of this Plan will be confirmed through discussion between the lead agencies involved in its development and those parties that will be actively engaged in implementing the actions. There will be a need to establish governance and coordination arrangements, to ensure that actions are suitably resourced and remain on track to deliver the required outcomes.

Monitoring, evaluation, reporting and improvement

To be consistent with the approach and principles of the international standard ISO 14001:2015 for environmental management systems, regular evaluation of the plan will be required to refine and improve its implementation. To achieve this, a Monitoring, Evaluation, Reporting and Improvement (MERI) Strategy is being developed to support implementation of this Plan. The MERI strategy will adopt a flexible approach to enable agencies to determine the most efficient and effective ways to implement the actions.

Preparation of the MERI strategy will be an iterative process, ensuring that actions within this Plan are designed in a manner that allows evaluation and reporting of progress. The MERI strategy will assist in identifying the level of detail needed in sub-actions for each priority area. It will focus on key elements that will support an adaptive management framework.

Annual reports will be used to inform government agencies on progress with delivery actions. These annual reports will include activities undertaken, costs and progress to date, highlights, and proposed adjustments if required. The primary audience for the annual reports is the overseeing body for implementation of this Plan, and partner agencies responsible for oversight and delivery of actions. The annual reports will potentially be the basis for annual adjustment of actions within this Plan.

Evaluation reports will be prepared on a five-yearly basis. These will be a more significant piece of work that builds on the information collected for the annual reports. They will be outcome focused, outlining actions that have been undertaken and the level of progress towards achieving the desired ten year outcomes of the Plan for each of the priority areas. The evaluations will use a multiple lines of evidence approach and the use of a Program Logic to look for progress in any intermediate outcomes. The evaluations will draw on the monitoring and reporting undertaken by other programs, such as the five-yearly State of the Bays and EPA's water quality monitoring program together with targeted reporting undertaken as actions within this Plan.

International standard ISO 14001 for Environmental Management Systems

This Plan is consistent with the approach and principles of ISO 14001:2015 for environmental management systems. ISO 14001 is one of a family of environmental management standards prepared by the International Organization for Standardization (ISO). The standard outlines criteria for an environmental management system (EMS) that provides 'a framework to protect the environment and respond to changing environmental conditions in balance with socio-economic needs'.

An EMS is a framework for managing environmental impacts, both positive and negative, providing a structured approach to plan and implement activities that help protect the environment, and monitor environmental performance. An environmental management system can help to enhance environmental performance, fulfil compliance obligations and achieve environmental objectives.

The ISO 14001 approach is based on the Plan-Do-Check-Act (PDCA) model, which provides an iterative process for achieving continuous improvement.

- **Plan:** establish environmental objectives and processes to meet agreed goals and objectives
- **Do:** implement actions
- **Check:** monitor and measure progress and report on the results
- **Act:** take actions for further improvement.

This approach and how the Plan aligns with it is shown in Figure 14.

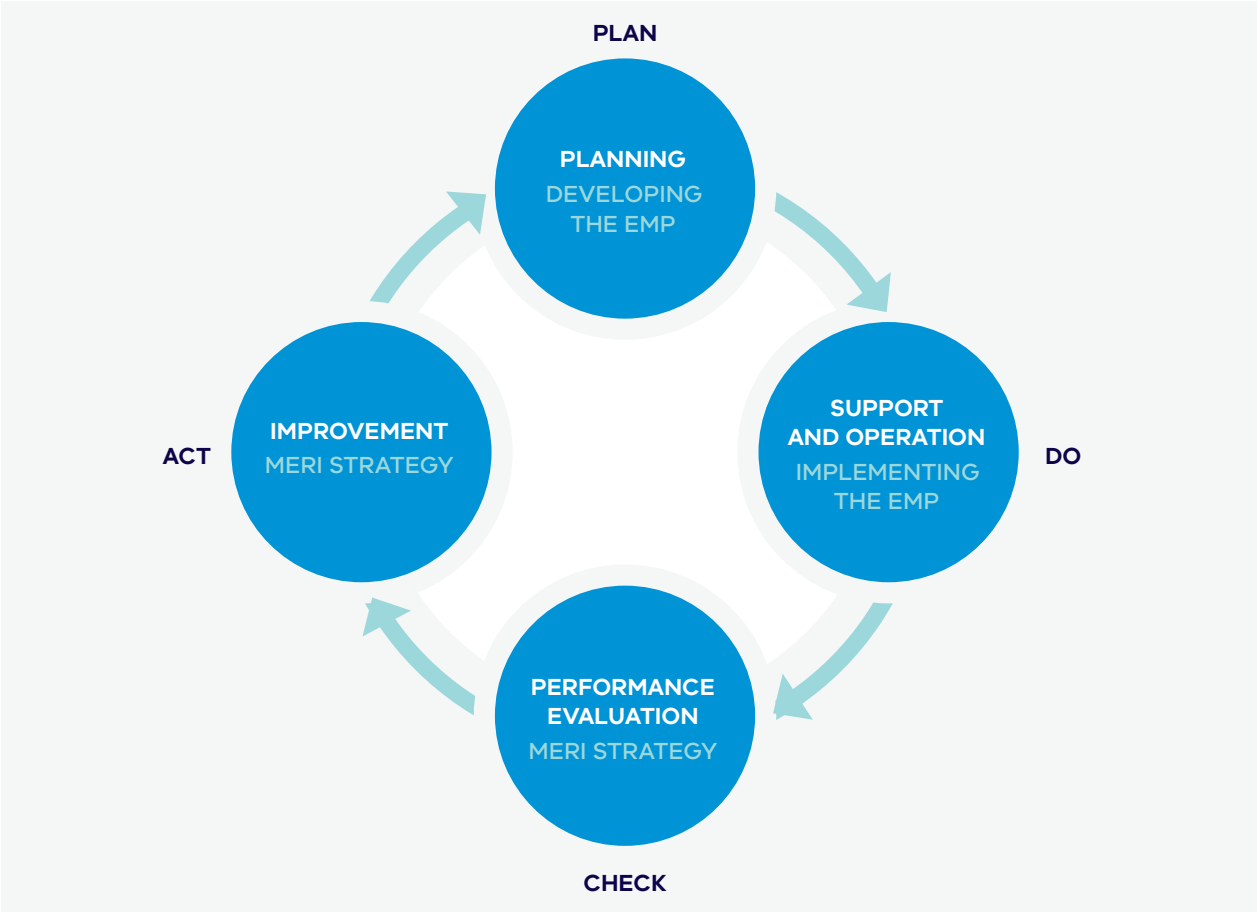


Figure 14 The ISO 14001:2015 framework for environmental management systems – plan, do, check and act

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Acronyms and abbreviations

Abbreviation	Definition
ASQAAC	Australian Shellfish Quality Assurance Advisory Committee
BPEM	Best Practice Environmental Management guidelines
CAPIM	Centre for Aquatic Pollution Identification and Management
Chla	Chlorophyll a
CMA	Catchment Management Authority
CRC	Cooperative Research Centre
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DAWR	Commonwealth Department of Agriculture and Water Resources
DEDJTR	Department of Economic Development, Jobs, Transport and Resources
DELWP	Department of Environment, Land, Water and Planning
DHHS	Department of Health and Human Services
DPI	Department of Primary Industries
DSE	Department of Sustainability and Environment
EDC	Endocrine Disrupting Compound
eDNA	environmental DNA (genetic material left behind in the environment)
EMMV	Emergency Management Manual Victoria
EMP	Environmental Management Plan
EMS	Environmental Management System
EPA	Environment Protection Authority, Victoria
ISO	International Organization for Standardization
MARPOL	International Convention for the Prevention of Pollution from Ships
MERI	Monitoring, Evaluation, Reporting and Improvement
PP&W CMA	Port Phillip & Western Port Catchment Management Authority
QMRA	Quantitative Microbial Risk Assessment
REEF	Reef Ecosystem Evaluation Framework
RMIT	Royal Melbourne Institute of Technology University Melbourne
SEPP (Waters of Victoria)	State Environment Protection Policy (Waters of Victoria). *These are the existing regulations*
SEPP (Waters)	State Environment Protection Policy (Waters). *These are new regulations, currently being developed*
µg/L	Micrograms per litre
VACL	Victorian Aboriginal Corporation for Languages
VAGO	Victorian Auditor-General's Office
VLAA	Victorian Litter Action Alliance
VNPA	Victorian National Parks Association
WSUD	Water sensitive urban design

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