Port Phillip Bay Coastal Hazard Assessment

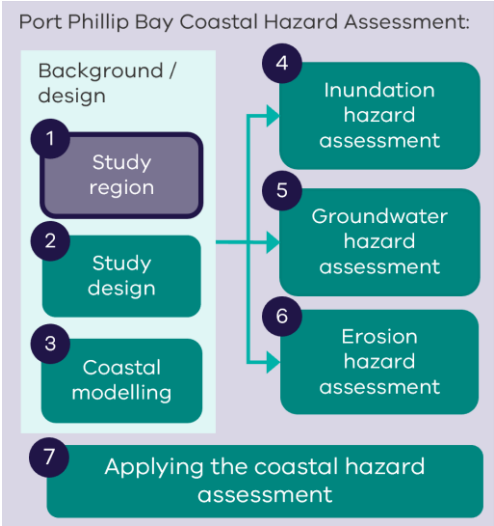
Summary #1: The study region

(Photo: Andrew Bray)

Overview

The Port Phillip Bay Coastal Hazard Assessment (PPBCHA) looks at likely coastal hazards around the Bay. Hazards include flooding, erosion and changes in groundwater. We explore these hazards for current and future climate and sea level scenarios. Results will help land and asset managers and the community to consider climate change in future planning.

This summary provides an overview of coastal processes, the study region, and potential hazards. This is the first in a series of summaries providing an overview of the PPBCHA technical work.



In this summary:

The Port Phillip Bay shoreline is home to 1.3 million Victorians. The coast is a major drawcard for living in the region. Natural coastal processes like erosion and inundation shape our unique coast.

These processes can sometimes become a hazard when they impact on coastal values and uses. Hazards may increase with changes in climate and sea levels.

Port Phillip Bay is a diverse and distinct landscape that attracts visitors and residents from all over the world. The Bay and its coastline support unique and special marine and coastal ecosystems, habitats and species.

From its creation thousands of years ago, to the shifting sands we see on our local beaches day-to-day, the Bay is always changing. Coastal processes cause these changes. Weather, climate, winds and waves on global, regional and local scales drive these coastal processes.

Sometimes these changes can impact things we value or the ways in which we use the Bay. With a changing climate and rising sea levels, we're expecting more changes and need to plan for the impacts they will have on what we value.

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Coastal hazards

When natural coastal processes impact on values, use, and assets of the coast, they become coastal hazards. These could be environmental, social, cultural or economic impacts.

Coastal hazards can include:

- permanent inundation (flooding) due to sea level rise
- temporary inundation associated with storms (storm tide inundation)
- short- and long-term erosion
- build-up of sand (accretion)
- changes in estuaries and other sand movement
- changes in groundwater depth and increasing salinity (saltwater moving into freshwater areas).

This PPBCHA focusses on storm tide inundation, changes in groundwater salinity and depth, and coastal erosion. Victorian definitions for these hazards are:

Category	Process / hazard	Settings
Erosion	**Short-term erosion** Event-based erosion of sediment (storm bite) and recovery **Long-term erosion (recession)** Progressive retreat of shoreline position over time	Sandy shorelines
		Low-earth scarp (very steep slope)
		Soft rock
		Hard rock
Flooding (inundation)	**Storm tide inundation** Temporary event-based inundation	All low-lying coastal land
	Permanent inundation Regular or persistent inundation by the regular tidal cycle	All low-lying coastal land
Saline intrusion (of groundwater)	Movement of saltwater into freshwater aquifers / groundwater	All low-lying coastal land

Bathing boxes (Photo: DEECA)

How these processes might change

With a changing climate, coastal hazards are likely to have an increased impact on the Port Phillip Bay region in the future. Expected future impacts of climate change on the region include:[1]

- increased average temperatures
- decline in average rainfall, especially in spring
- more extreme heat and days of extreme heat each year
- more intense extreme storm and rainfall events, but with high variability
- rising sea levels

Some of these climate impacts have a strong link to changes in coastal areas. For example, higher sea levels causing more flooding (inundation). Others are indirect. For example, lower rainfall may cause people to extract more groundwater, leading to lower groundwater levels.

It is difficult to capture every possible process and climate scenario. Linking different processes, and responses (natural or human) together is also hard. The projected changes thought to cause the greatest influence on coastal processes are the focus of this study. This includes changes in sea level and the changing effects of storm tides (including more intense storms) in future climates.

[1] Greater Melbourne Climate Projections - climatechange.vic.gov.au/__data/assets/pdf_file/0038/429878/Greater-Melbourne-Climate-Projections-2019_20200219.pdf

History of the Bay

The history of Port Phillip Bay, and how it has formed, can help us understand what may happen in the future. The landscape of the area has formed over the past 600 million years. Different rock types, tectonic movements and global sea levels have influenced its formation.

The Bay was generally dry and above sea level for the last 120,000 years. The Yarra River flowed all the way to the Port Phillip Heads, at Point Nepean. Around 10,000 years ago, after the last ice age, sea level rose and flooded the area. The broad shape and form of the current Bay developed around 6,000 years ago.

Changes in sea levels and climate over the last 3,000 years have affected the landscape. This has seen both periodic closure at the heads, to form a lake, and breaching of the entrance to flood the Bay. Over the last 1,000 years there has been an opening to the sea.

The resulting coastal processes have formed and reshaped the sandy coastlines and soft-rock cliffs we see today.

The Bay we see today

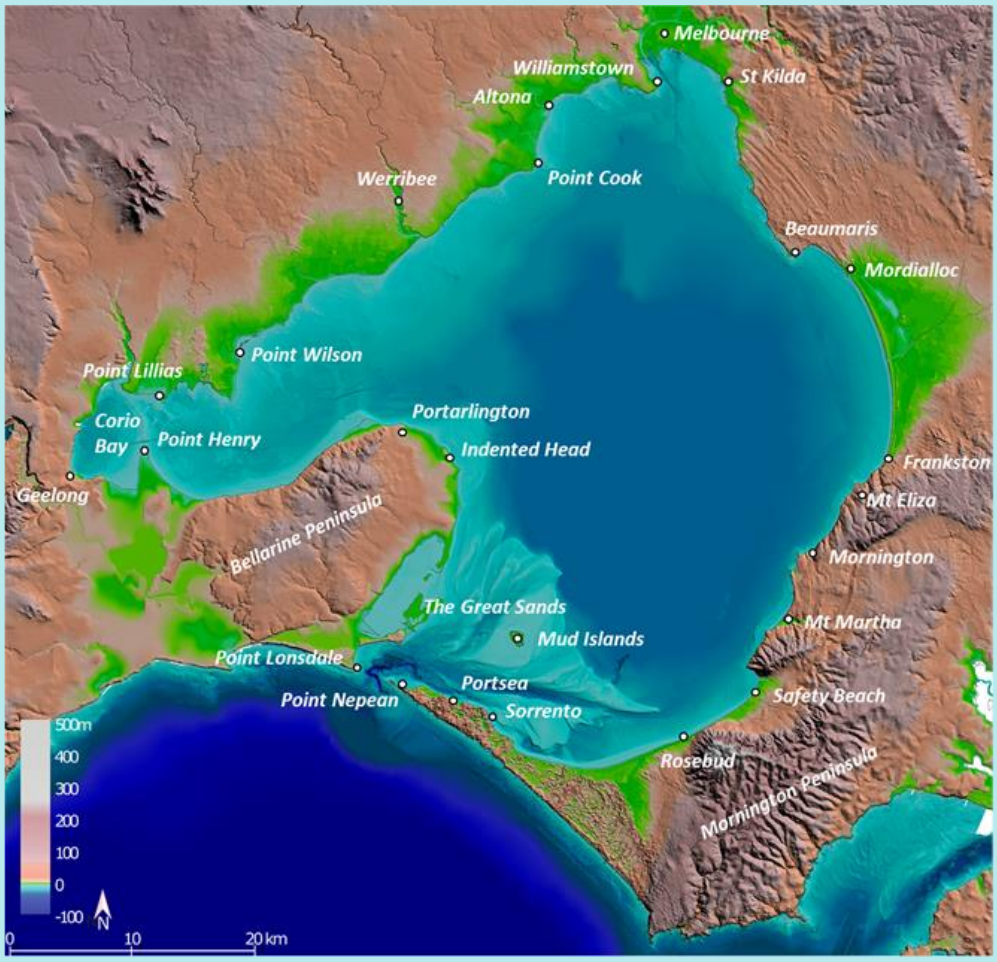
Setting, features and form

Today, Port Phillip Bay is large and shallow. Over half of the area is less than 8 metres deep.

Varied geology and features include sandy shores, rocky cliffs and dynamic estuary and wetland systems. Different parts of the Bay see sandy beaches backed by dunes or soft and hard rock cliffs. The southern and western parts also contain low-lying coastal wetlands.

The two sides of the Bay, divided at Williamstown, are different coastal compartments.

Coastal compartments divide the coast into areas of interest. Landscape features and coastal processes (including sediment transport) are the basis for compartments. Drawn at different scales, they can be a single beach or kilometres of coast. The two main compartments in Port Phillip Bay are the west (Point Lonsdale to Williamstown) and the east (Williamstown to Point Nepean).



- 333 kilometres of coastline
- average depth of 13 metres
- greatest depth of 24 metres
- 26.3 billion cubic metres in volume
- 1,934 square kilometres of Bay area
- 9,694 square kilometres catchment area
- 5.6 million people in Greater Melbourne and Geelong

Map of elevations across Port Phillip Bay (Source: CSIRO). Note the lower lying coastal areas in green.

The West is more sheltered from strong winds and large waves. It has some narrow sandy beaches between rocky shores. Sandy and soft rock shores dominate from Queenscliff to Geelong. We see hard basalt rock and soft sediment from Avalon to Williamstown. The east side has sandy beaches with cliffs or dunes behind.

Open ocean waves in Bass Strait don't have a big influence on the Bay. Rocky headlands at the Heads and areas of sand in the entrance ('The Great Sands') restrict these large waves from entering into the Bay. Local winds and currents control how water moves in and around the Bay. These winds produce greater wave energy across the east coast due to prevailing south-westerly winds.

Traditional Owners

Land and Sea Country around Port Phillip Bay is the lands of the people of the Kulin Nation. Traditional Owners have cared for this Country for over 30,000 years and maintain an ongoing connection to Country.

Traditional Owners of the Bay are the Wadawurrung People and the Bunurong/Boon Wurrung People. Registered Aboriginal Parties (RAPs) represent Traditional Owners. These are:

- **Wadawurrung Traditional Owners Aboriginal Corporation (WTOAC**) - Wadawurrung Country includes the west of the Bay, from Point Lonsdale to the Werribee River.
- **Bunurong Land Council Aboriginal Corporation (BLCAC)** - Bunurong Country extends east of the Werribee River, including the Mornington Peninsula and Point Nepean.

Coastlines are living places. Traditional Owners and their ancestors live, harvest, share meals, trade and practice ceremony across the Bay.

Sandy beaches, rock pools, rocky platforms and reefs were and continue to be places of plenty. This includes for harvesting food and resources like shellfish, crustaceans and kelp. Cliffs and headlands also provide a mosaic of colours for ochre pits.

Caring for Country, land, sky, and waters is core to Traditional Owners' identity.

Midden at Mount Eliza (Photo: Alluvium)

Post-colonial changes

Since European occupation in the 1830's, modifications to the Bay's coastline have occurred. These include:

- protection such as seawalls, revetments, and groynes
- artificial deepening near and offshore (to provide shipping and vessel passage)
- breakwaters, marinas and canal estates
- beach nourishment at around 30 sites
- reshaping of the coast for landfill, waste treatment, aerodromes, residential and other industries
- clearing native vegetation
- building on sandy dune systems

Williamstown (Photo: Alluvium)

Rivers and catchments also interact with the coast, bringing flows into the Bay. These surrounding and connecting catchments and their flows have also seen significant changes. These include:

- engineered and modified watercourses and flow paths
- creek and river training walls (to direct flows and aid navigation)
- altered (including drained) coastal wetlands and swamps
- increases in hard ground surfaces (impervious areas) that cannot absorb water
- engineered outlets and drains on the foreshores
- modified groundwater volumes and quality through human usage (bores).

Changes like this reshape extensive areas of the coast. These works often have an impact on natural coastal processes. This includes water levels, currents, wave conditions, and catchment flows. These all influence how sand and sediment move offshore, onshore and along shorelines.

Through development, usage and management, humans continue to influence the Bay's coastal and marine areas.

Drivers of change

Natural marine and coastal processes include many complex, changing and connected actions. Drivers of change such as wind, waves and tides work to move water and sand.

These processes shape the shoreline and adjacent coastal land, and include:

- flooding (inundation)
- sand movement including:
  - erosion (sand loss/shoreline retreat)
  - accretion (sand build up/shoreline advance).

These changes can be at either regional or local scales, and over long or short timeframes. These processes shift and evolve, creating dynamic and complex systems. Human behaviours, urbanisation and growing populations can also drive change on our coasts.

One of the more challenging aspects of the coastal landscape is that it experiences this constant and sometimes rapid change.

Sorrento (Photo: Alluvium)

Drivers of change:		For Port Phillip Bay:
Tides	The rise and fall of the daily tide can move sand off and onshore, into and out of tidal channels and along the coast. This shapes the beach and near-shore environment, influencing groundwater levels and coastal wetlands. Tides vary on different timescales, from daily cycles to those associated with climate, weather and the position of the sun and moon.	• Tides along Bass Strait, including the Bay are 'semi-diurnal'. This means there are two high tides and two low tides every day. • The difference between high tide and low tide (tidal range) within the Bay is around 0.4 to 0.6 metres. This is much smaller than in Bass Strait. The rocky headlands and sand banks near the Bay entrance limit water movement into and out of the Bay. • We call a small tidal range 'microtidal'. Tidal currents alone don't cause much sand movement within the Bay, compared to wave action and extreme storm events. • Currents created by tides ('tidal currents') vary around the Bay. Measurements show they are strongest at Port Phillip Heads, up to 3.5 m/s, and over 1 m/s in southern channels. For many parts of the Bay, they're less than 0.2 m/s, too small to move large sand volumes.
Wind and waves	Wind blowing across the water generates waves, both locally and across long distances. The distance wind blows across to form waves is called the 'fetch'. Wind, combined with the morphology (shape) of the sea floor, drives the size, frequency, duration and energy of waves. Wave energy has the potential to move sand off-shore, on-shore, along the coastline, and into and out of inlets. Wind and wave direction also affect the direction sand moves along the coast.	• Swell (ocean waves) form far out to sea and over long distances. The Heads and sands at the entrance protect most of the Bay, except the very south, from these waves. • Wind-generated waves are common in the Bay. They result from wind blowing across open water. A longer fetch can result in larger wind-generated waves. • Local winds form most of the waves in the Bay. Most wind (and waves) comes from the southwest. • Sediment movement and beach shape change at different times of the year in some parts of the Bay. Seasonal conditions (including wind conditions) drive these changes. • On the Bay's east side, waves from the south/southwest generally move sediment north in summer. In winter, winds reverse, and north/north-westerly winds move sediment south. The wave directions and timing are more complex on the west side of the Bay. • Areas of shallow water and the limited distance (fetch) across the Bay means most wave heights are below 1 metre but can reach 2 metres.

Drivers of change:		For Port Phillip Bay:
Climate	Local climate conditions (for example, wind patterns) and extreme events (storms, flooding), affect how the landscape develops and changes. Extreme weather events such as storms can cause major coastline changes (erosion) in a short period of time. Beaches rebuild over years/decades between extreme storm events unless sediment supply changes.	• Movements of air across Australia and the Southern, Pacific and Indian Oceans generate storms. This involves wind, rain and pressure changes. • The timing of these global air movements means low air pressure and resulting extreme high water levels (storm surges) are most frequent in winter. • Complex weather systems drive extreme weather events. Storm tides and rainfall associated with these events occur at different times. This means we rarely see large coastal flooding events and large catchment flooding events at the same time.
Sediment supply	Catchments, rivers, dunes and offshore environments deliver sediment (sand) to the coast. When historical sediment supplies reduce or stop, affected coastlines will be prone to sand loss (erosion). When sediment supply is abundant, coastlines will tend to remain stable or build seaward (accrete).	• The narrow entrance at Port Phillip Heads limits sediment supply into the Bay. Any sediment that does get into the Bay often settles in deep water. The Great Sands, a large 'sand bank' just inside the Heads, also traps sand. • Humans have modified sediment transport to, from and along the coast. This includes sand supply from rivers and catchments. Land use changes alter the type, size and amount of sediment delivered to coasts. Barriers built on or across beaches or at river mouths also stop sediment from moving in certain areas. • Beach nourishment works add sand to many beaches across the Bay.
Population growth and urbanisation	Growing populations put pressure on coastal land. This growth increases needs for housing, services and other industries. Demand for land often comes at the expense of natural systems and can impact on coastal processes. This includes increased runoff in rivers and creeks, modifications to the coast, sediment supply changes and construction of coastal infrastructure.	• The population of Greater Melbourne and Geelong is set to increase from 5.6 million people to 7.9 million by 2041.[2] This is an extra 2.3 million people that need homes and services. • Across the Melbourne region, around 1,100 km^2 is currently impervious. These are hard surfaces like roofs, roads and paved areas. This is set to increase to 1,750 km^2 over the next 50 years.[3] • Engineering works have modified much of the pre-1840s shoreline of Port Phillip Bay. This includes dredging, beach re-nourishment, seawalls, revetments, groynes and other works. • The changes in flows and sediment supply influence coastal processes

Seaford (Photo: DEECA)

[2] Victoria in Future - https://www.planning.vic.gov.au/land-use-and-population-research/victoria-in-future
[3] Port Phillip and Western Port Regional Catchment Strategy https://portphillipwesternport.rcs.vic.gov.au/themes/waterways/

Taking care of the Bay

Many people play an important role in looking after Port Phillip Bay's coastal and marine areas. These include:

- formal management agencies and organisations
- recreational beach and water users
- residents and visitors across the coast and catchment
- industries and commercial users
- volunteers and community members.

The Bay has a wide range of stakeholders. Each have an interest in understanding future coastal hazard changes, impacts and management.

Stakeholders partnering to deliver the PPBCHA project include:

- DEECA
- the Association of Bayside Municipalities (ABM)
- the ten local governments around the Bay
- local Traditional Owners (Bunurong Land Council and Wadawurrung Traditional Owners)
- Parks Victoria
- Melbourne Water.

These stakeholders work together to inform long-term planning and manage coastal hazards in the Bay.

Jawbone Conservation Reserve (Photo: Alluvium)

How does this understanding help us?

Climate change means coastal hazard events are happening more often. It also sees these hazard events increasing in size. This means possible impacts to nearby coastal areas and values may also rise.

We need to understand how these hazards might affect the Port Phillip Bay coastline, so we can plan appropriately. This is why the Victorian Government has completed a coastal hazard assessment for Port Phillip Bay. This assessment is the first of its kind for the Bay.

Understanding the history, drivers of change, potential future changes and people who manage the Bay is important. This helps us design an assessment that:

- is specific to the Port Phillip Bay environment
- captures the dominant coastal processes and drivers of change
- looks at key coastal hazard types most likely to impact the Bay
- assesses changes in climate and sea level relevant for the region
- is useful for management agencies, users and the community.

Find more information on the study design of the coastal hazard assessment in **Summary #2: Study Design**.

(Photo: DEECA)

We acknowledge Victorian Traditional Owners and their Elders past and present as the original custodians of Victoria's land and waters and commit to genuinely partnering with them and Victoria's Aboriginal community to progress their aspirations.

Accessibility

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