HOBSONS BAY CITY COUNCIL

Altona Foreshore Coastal Processes Assessment

General Report

January 2018

AW Maritime Pty Ltd
8/3 Westside Ave
Port Melbourne
VIC 3207

Executive Summary

This report evaluates the coastal processes of wind and wave effects and their interactions with the natural and manmade environment along the stretch of coastline from Altona Pier to Cresser Reserve.

The key focus of the study is whether sand is likely to build up or erode at Millers Road. The study considered a range of processes that act on the shoreline of the study area, including tides, storm surge, and waves.

The assessment confirmed that the quantity of sand moving along this stretch of coastline is relatively small. Overall the annual movement of sand is from west to east and there is limited movement of sand into the Millers Road/Flemings Pool area. Storm events are likely to erode a significant portion of any sand that does accumulate at Millers Road.

This erosion is likely to worsen into the future as climate change predictions include an increased likelihood of storm events and high storm surges. These findings should be considered carefully when designing the Millers Road access point at Flemings Pool in order to maximise pubic access and amenity.

Contents

Document Revision Status				
Date	Rev	Status	Author	Approved
14/12/2017	A	Issue for information	TFW	TRA
11/01/2018	B	Including comments from HBCC	TFW	TRA
23/01/2018	C	Final	TFW	TRA

Glossary

Term	Definition
ABM	Association of Bayside Municipalities
AEP	Annual Exceedance Probability. The probability of an event occuring in any year
AHD	Australian Height Datum. A reference line for measuring vertical heights and is approxiamtely the average sea level
ARI	Average Reccurance Interval. The average time period between exceedances of a given event
SLR	Sea-level rise
Accretion	Gradual build-up of matter, such as sand
Astronomical tide	Tide levels resulting from gravitational effects from the Earth, Sun and Moon without any atmospheric influences
Basalt	Dark dense rock formed from cooled lava flow
Coastal processes	Natural wind, wave and tidal actions on a coastline and seabed
Cross-shore	The cross-section taken perpendicular to the beach
Datum	Reference line for levels and height measurements
Depth-limited wave	The largest possible wave that can exist in a given water depth
Foreshore	Part of the shore between water level and land
Gross	The total amount of matter (sand) movement for a given period of time
Groyne	A structure perpendicular to the foreshore that manipulates sand movement
Longshore	Parallel and along the shoreline
Nearshore	The zone close to the shoreline
Net	The amount of lost or gained matter (sand) for a given period of time
Offshore	The zone beyond the nearshore zone where waves are generated
Rocky outcrop	Visible exposed rock
Sediment (sand) size	The diameter of individual grains of sediment
Sediment transport	The movement of sediment due to water movement
Shoreline	The line along which the water meets the land

Term	**Definition**
Significant wave height, **Hs**	Average wave height, from trough to crest, of the highest 33% of waves measured in metres
Storm surge	Rise in sea level from low atmospheric pressure and/or strong onshore winds
Storm tide	The combined tide level due to astronomical tide and storm surge
Wave climate	Long-term average of wave, heights period and direction at a location
Wave period, **Tp**	The time for two waves to pass a fixed point measured in seconds
Wave power (flux)	The amount of energy from incoming waves

1 Introduction

Hobsons Bay City Council (HBCC) engaged AW Maritime Pty Ltd (AWM) to undertake an investigation of coastal processes between Altona Pier and Cresser Reserve. This investigation aimed to better understand the long and short-term effects of coastal processes to inform foreshore management.

The assessment included:

- A feature and level survey to confirm the present sand depth and volume
- Sea bed probing to confirm the thickness of sand that sits on top of the natural rocky reef.
- An assessment of the:
    - Local coastal processes of wind, wave and tidal action on sand movement including the effects of sea-level rise
    - Coastal hazards of long/short term erosion, seawall wave overtopping from sea-level rise and damage to existing structures and;
    - Natural and manmade marine structures including beaches, reefs, rock groynes, stormwater outfalls, seawalls, piers and jetties.

1.1 Study area and description

The stretch of coastline in the study area is approximately two kilometres in length from Altona Pier to Cresser Reserve and includes sandy beaches, rocky basalt outcrops (from Bayview Street to the Altona Yacht Club) and manmade structures such as stormwater outfalls encased in rock, seawalls, piers and jetties.

The existing beach from Altona Pier to Bayview Street is generally stable with a variable beach width from 35-60m. At Bayview Street there is an existing stormwater outfall encased in rock constructed in 2011 as part of the Altona Beach renourishment. The Seaholme rock reef extends eastward from this groyne around the coastline to Cresser Reserve at the end of the study area.

The section from Bayview Street to Millers Road (known also as Flemings Pool), where there is an existing access ramp, has an unstable beach with a width of 0-15 m. Further along from Millers Road to Cresser Reserve there is very little beach. This area has limited accessibility due to natural basalt reefs and the rock seawall that protects Cresser Reserve from further erosion.

The study area location and its key features are shown in Figure 1.

Figure 1 – Study area location and key coastal features. Aerial image from Nearmap dated 23 November 2017

2 Local coastal processes review

2.1 General

The following Coastal Process Assessment is in line with process identified in *Engineers Australia, Coastal Engineering Guidelines for working with the Australian coast in an ecologically sustainable way, 2nd edition 2012*. The coastal processes considered include:

- Waters levels (tides and storm surge)
- Waves (offshore and nearshore)
- Cross-shore sediment transport (i.e. the movement of sand perpendicular to the coast)
- Longshore sediment (i.e. the movement of sand parallel to the coast)
- Impacts on the study area

2.2 Water levels

Astronomical tide levels are caused by gravitational effects of the sun and moon. The astronomical tide range at Altona has a relatively small range, however extreme water levels are also affected by storms. Storms have high winds and associated low atmospheric pressure, which can cause the water level to be much higher than the predicted tides. This is known as storm surge.

Storm surges can do significant damage to coastal infrastructure, particularly when they occur at the same time as large waves. Storm surges therefore require careful consideration in present day and future foreshore management, for example when assessing seawall heights and coastal hazard vulnerabilities.

Future climate change and sea-level rise is expected to increase storm tide levels. The Victoria Coastal Strategy 2014 by the Victorian Coastal Council (VCC) recommends consideration of sea level rise in accordance with the following:

- 0.2 metres by 2040 in urban infill areas
- 0.4 metres by 2070
- 0.8 metres by 2100

A number of studies assessing storm tide and climate change have been completed over the years. The 2009 study, *The Effect of Climate Change on Extreme Sea Levels in Port Phillip Bay* by CSIRO, considered a range of climate change and sea-level rise conditions in order to predict storm tide water levels for the years 2030, 2070 and 2100. In 2014, The Association of Bayside Municipalities reviewed the 2009 CSIRO study and recommended that for locations north of the Great Sands (say a line from Rosebud, Mornington Peninsula to St Leonards, Bellarine Peninsula), the present-day storm tide levels of 1.1m (for a 1-in-50-year storm) and 1.2m (1-in-100-year storm) should be used for design and planning purposes. CSIRO in 2015 then provided updated sea-level rise projections to the Australia's natural resource management centres, which were slightly less than the 2009 predictions by typically around 10% of the 2009 predicted values.

Climate Change Scenario 2 in the McInnes (2009) report, which includes elevated water levels and wind speeds, is broadly consistent with the recommendations of VCC (2014), and this scenario was considered in the analysis. These water levels considered are shown in Table 1 and in Figure 2. The values shown are in metres and are relative to 0.0m AHD (Australian Height Datum), the Australian Height Datum is approximately the mean sea level.

Table 1 – Predicted storm tide and levels for Altona (CSIRO, 2009)

Year	Storm tide (storm surge + astronomical tide)
Present day	1.1 m
2040	1.4 m
2070	1.8 m
2100	2.2 m

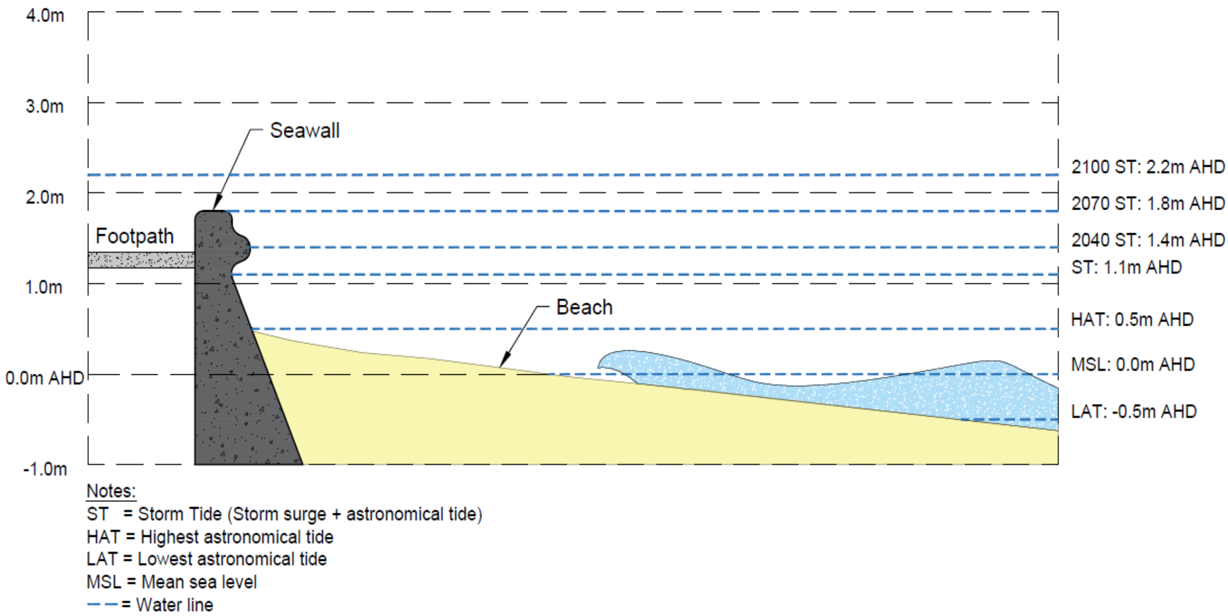


Figure 2 – Indicative Flemings Pool beach section from December 2017 survey with astronomical and storm tide water levels including sea-level rise from CSIRO (2009)

2.3 Waves

The movement of sand along the Altona Foreshore is caused by waves. Waves are generated in deeper waters (offshore waves) before arriving at the shallow coastline waters (nearshore waves). It is the nearshore waves that drive sand movement along a coastline.

2.3.1 Offshore waves

Computer modelling can be used to estimate wave conditions at any given site. Key model inputs include seabed depths relative to the study and the wind conditions relevant to the site. The models give an understanding of the expected wave heights, period (time between waves passing through a fixed point) and direction. Results were extracted from the model at a point offshore of the study site in deep water.

The waves that impact the study site can be generated by southerly winds that blow over the full extent of Port Phillip Bay. A model of the whole of Port Phillip Bay was therefore used for the study, shown in Figure 3.

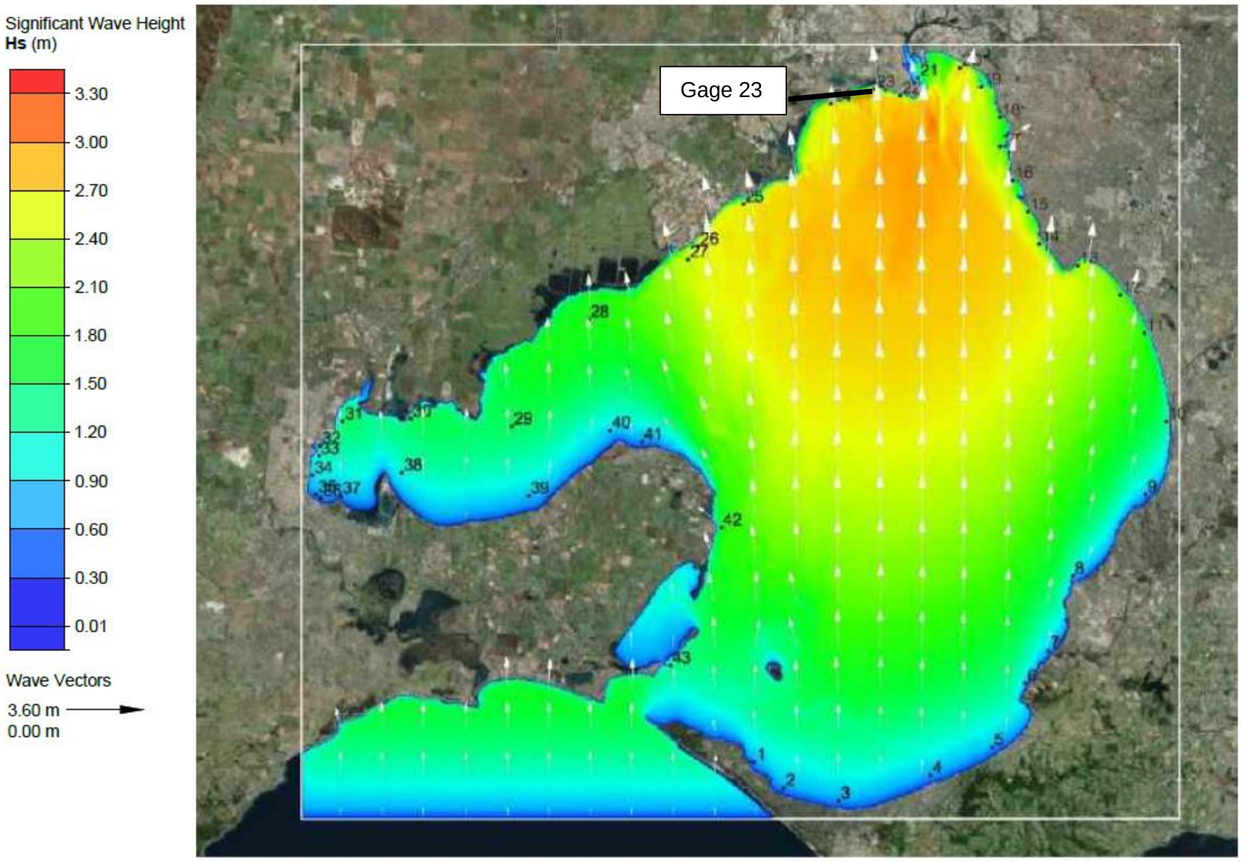


Figure 3 – Model results for 100-year wind speed from the south including sea-level rise (SLR)

The wind conditions considered included 10 years wind records from Fawkner Beacon and extreme wind speeds in accordance with the relevant standards. A summary of approximate offshore wave conditions is provided in Table2*.

*Note: Refer to the glossary for Table notation and definitions.

Table 2 – Approximate offshore wave conditions at Gage 23 (ref. figure 3). Wave heights are significant wave heights with max wave heights approximately 1.8xHs

	Present day		2070 incl. SLR	
ARI	**Hs (m)**	**Tp (s)**	**Hs (m)**	**Tp (s)**
50yrs	2.2	5.4	2.3	5.6
100yrs	2.3	5.7	2.4	5.7
200yrs	2.5	5.9	2.5	5.9

2.3.2 Nearshore waves

Wave conditions change as they arrive from deeper offshore water to the shallow nearshore waters. The strength and the angle the waves break along the beach is caused by, in general, two factors:

- The winds that generate the waves (strength) and;
- The profile (depth and slope) of the seabed the waves are approaching.

In the case of the Altona Foreshore, wave heights and strength are limited by the long shallow seabed profile. These are known as "depth-limited" waves. The prediction of depth limited waves often involves a large degree of inherent uncertainty, however the effects of the waves on nearshore features can be generalised based on the existing physical structures. For example, at the Millers Road beach access, the vertical, impermeable seawall will cause reflection of wave energy that can sometimes modify incoming waves making wave conditions difficult to predict. As a rough indication, depth limited wave heights at the seawall could be expected to be in the order of those shown in Table 3.

Table 3 – Indicative nearshore wave heights (m) at Flemings Pool

ARI	Present day	2040	2070
50 yrs	0.8 m	1.0 m	1.2 m
100 yrs	0.8 m	1.0 m	1.2 m

The shallow seabed profile also causes waves to refract or "bend" towards the shoreline. This bending effect of the waves reduces their capacity to move sand along the beach known as longshore sediment transport (sand movement), which is discussed in further detail in the next section.

2.4 Longshore sand movement

Longshore sand movement is a relatively long-term process that also depends on seasonal weather and associated wind and wave effects that drive the sand movement. Sand movement along foreshores can alter the width (size) of a beach and therefore the usability and recreational value of a beach area. In addition to this, changing foreshores can pose management problems such as access and amenity issues.

Longshore sediment transport depends on wave period, wave height, sediment size and the angle at which the wave breaks relative to the seabed contours. An example diagram of how waves drive longshore transport can be seen in Figure 4 below.

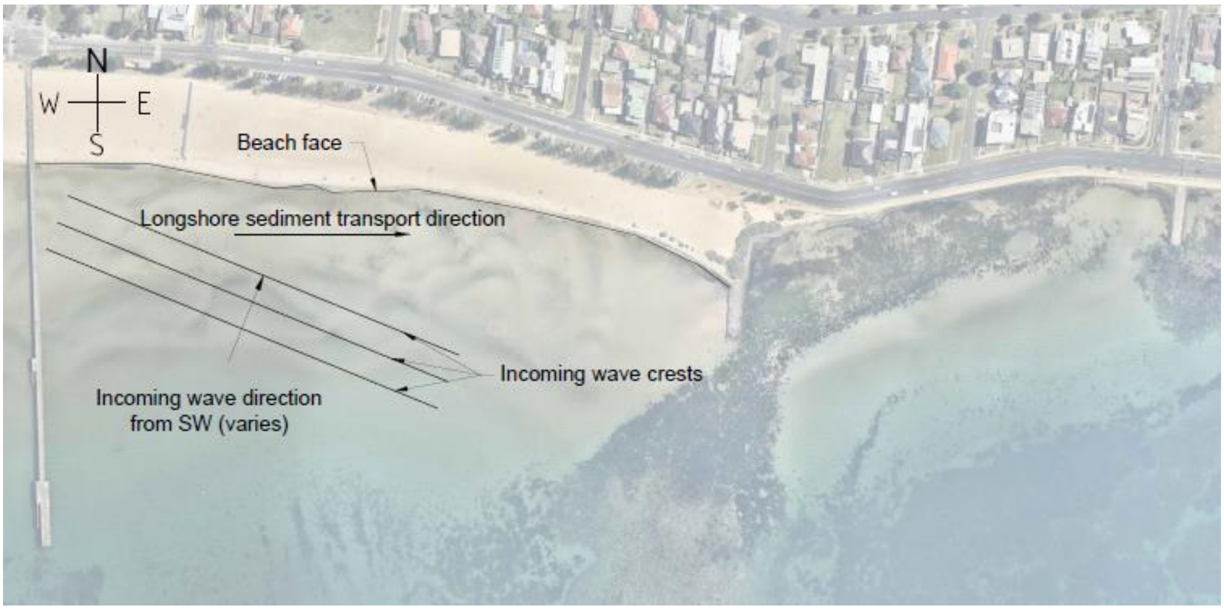


Figure 4 – An example of longshore sediment transport from waves approaching at an angle to the beach

A more general diagram from a study by Eric Bird in 2011 shown in Figure 5 below further demonstrates general sand movement around the coastline of Port Phillip.

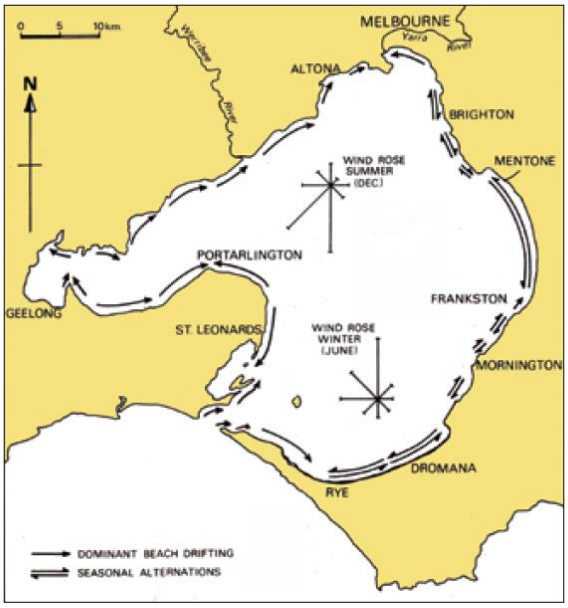


Figure 5 – Bird (2011) demonstrated a net west to east longshore transport at Altona

AW Maritime's previous experience along this stretch of coastline indicates that longshore transport is relatively modest, with a tendency to run from west to east on an annual basis. This is supported by the observations of the easterly direction of sand spit growth in front of Laverton Creek, and observations of sand accumulation on the western side of the groynes and drains along the Altona foreshore, including on the western side of Altona Safe Boat Harbour.

These observations have been supported by the following studies:

- In 2003, the *Preliminary Design for Priority Beach Nourishment Projects, Altona Beach Report* by CES (Coastal Engineering Solutions Pty Ltd) considered a study area immediately adjacent to the Altona Pier at Altona Beach. The report estimated the **annual net longshore capacity** at the western end near Apex Park was approximately 800 m^3 per year. This means that in any given year the amount of sand that moves from west to east (typically in summer months) is about 800 m^3. Further around at the eastern end of Altona Beach (close to the Millers Road access point / Flemings Pool) it was predicted that annual net longshore transport would be almost nil. The **gross amount** of longshore sand transport ranges from 5,000 m^3 to 10,000 m^3
- A more general report, *Changes on the Coastline of Port Phillip Bay,* by Eric Bird in 2011 also indicated a net west to east longshore transport along the Altona foreshore.
- More recently in 2014, the *Port Phillip Bay Wave Climate* report prepared by Cardno also indicated a west to east longshore transport for the same area. The study also included the longshore component of wave power acting along the entire coastline of Port Phillip Bay. The longshore component of wave power (or flux) is essentially the amount of energy from the incoming waves which is directed along the shoreline, which is what drives longshore currents and sand movement. Flux gives a good idea of the potential amount and direction of sand movement from a wave, but it is also important to consider the supply and size of sand it moves. In the case of Altona foreshore to Cresser reserve, there is generally a low amount of sand supply.

Estimates of longshore sediment transport potential within the study site showed that at Flemings Pool the net annual transport is virtually zero, with some variance in net annual direction within the study area due to the varying shoreline orientation. It was typically found to have a minor west to east bias in sediment transport. Other key findings include:

- The long, shallow seabed profile causes waves to approach perpendicular to the shoreline, reducing the effects of longshore transport capacity
- The majority of sediment transport activity occurs in the summer months due to the prevailing southerly winds; and
- Sediment transport at the site is supply-limited from either direction by manmade stormwater outfalls encased in a rock groyne (east) and rocky outcrops (west)

2.5 Cross-shore sand movement

As well as there being sand movement along the foreshore by the waves, there will be some sand movement offshore and onshore, also known as cross-shore sediment transport (sand movement). Cross-shore transport is a more rapid and short-term form of erosion and sand movement when compared to longshore sand movement and is generally caused by storm events. This can pose difficult foreshore management issues due to the random and unpredictable nature of storm events.

The extent of cross-shore sand movement depends greatly on the size of the sand particles at the beach, the beach profile (depth and slope) and the storm conditions. In order to asses this issue the US Army Corps of Engineers Coastal Engineering Design & Analysis System software, SBEACH, was used to predict the response of the beach to a storm event. SBEACH simulates cross-shore beach, berm (flatter sections of beaches) and dune erosion produced by storm waves and water levels. This preliminary investigation was based on 1-in-1-year storm conditions and an assumed mean grain (sand) size of 0.25 mm.

A general sketch of beach cross-section and related terminology is shown below in Figure 5.

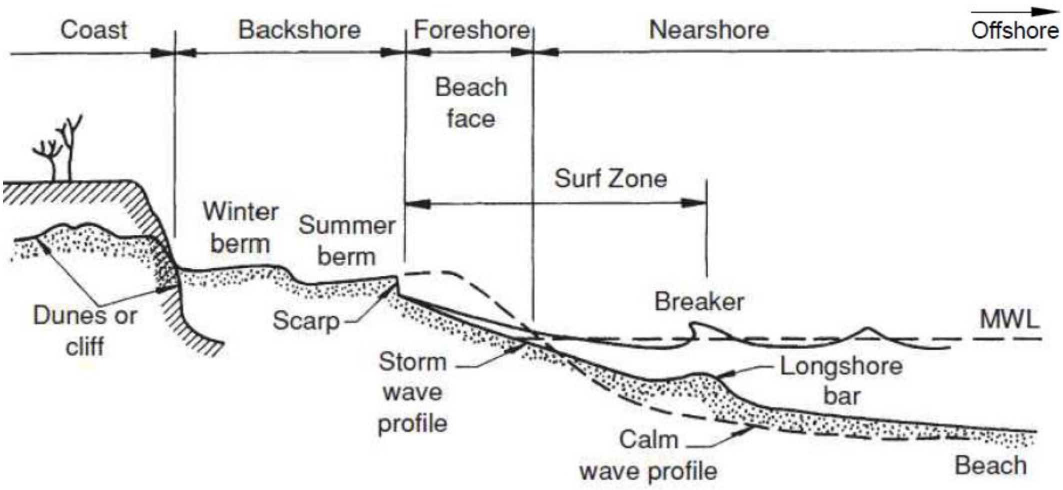


Figure 5 – Generalised beach profile (vertical scale is exaggerated) and terminology (Sorenson, 2006)

The analysis showed that cross-shore transport has the potential to transport sand over 100 m offshore, which is not surprising given the shallow sea-bed profile and the reflected wave energy from the vertical seawall. This cross-shore transport is also expected to increase with sea-level rise as increased water depths allow larger waves to impact along the Altona Foreshore and at Millers Road/Flemings Pool, meaning any significant accretion is unlikely. Evidence of the dynamic changes in the sea-bed profiles can be seen in the photo table of past aerial imagery in Appendix A.

2.6 Sea-level rise

As mentioned earlier in this report, sea-levels are expected to rise by 0.4 m over the next 50 years. Water levels are very important when considering the effects of foreshore erosion and stability and should therefore be considered in any short or long-term foreshore management plan. However, due to large degree of uncertainty with predictions beyond 2070 it would be inappropriate to develop management plans beyond this timeline.

3 Key findings

The coastal processes review of the Altona Foreshore from the Altona Pier to Cresser Reserve has confirmed the following key findings:

- The Altona Foreshore consists of natural fine sandy beaches (Altona Pier to Bayview Street) and rocky outcrops from Bayview Street to the Altona Yacht Club at Seaholme.
- Net longshore movement of sand is from the west to the east, although the amount of sand movement is considered small when compared to other areas in Port Phillip.
- There is limited transportation of sand to the Millers Road access ramp known as Flemings Pool. Climate change predictions of rising water levels and more frequent storm activity are likely to limit long-term beach stability.
- Sediment (sand) transport at Flemings Pool is also limited by sand supply by the stormwater outfall encased in rock groyne to the east and the rocky outcrops to the west.
- Much of the sand movement activity occurs in the summer months from the dominant southerly winds.
- Cross-shore sediment transport at Flemings Pool has the potential to transport sand over 100 m offshore, reducing the chances of sand accumulating in the area.
- The long, shallow seabed profile also causes waves to break at the same angle to the beach, which reduces sand movement along the shoreline.

In conclusion the findings of the coastal processes study can be summarised and broken down into specific areas as follows:

Altona Pier to Bayview Street

- The beach width ranges from 35-60 m and is currently stable.
- The beach benefits from a modest natural sand supply that is transported from west to east and accumulates at the Bayview Street stormwater outfall.

Bayview Street to Millers Road (Flemings Pool)

- There is a narrow beach width of 0-15 m and generally rocky in nature.
- Flemings Pool sea bed probing on 11/12/2017 found thin sand cover.
- The seawall is prone to wave attack and the access ramp is in a poor condition and will likely require more maintenance.
- The stormwater outfall encased in a rock groyne at Millers Road traps limited sand from longshore transport due to having a limited natural sand supply from the west.
- The likelihood of storm events eroding any accumulated sand is high. Sea level rise is likely to increase this storm erosion by allowing larger waves to reach the site.
- As a result of the above, the likelihood of significant beach forming at Flemings Pool is low.

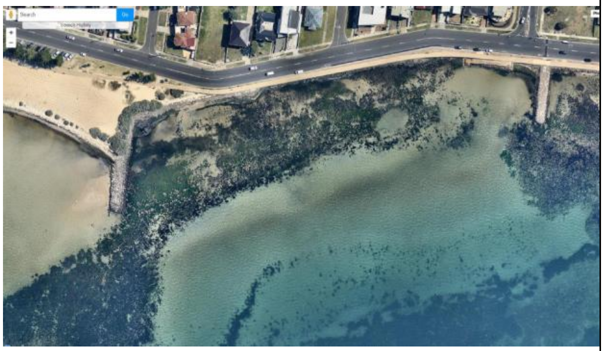
Millers Road to Cresser Reserve

- There is almost no beach from Millers Road to Cresser Reserve.
- A rock revetment at Cresser Reserve has been constructed to reduce ongoing foreshore erosion.
- Seaholme reef, a rocky basalt outcrop limits longshore transport and supply of sand to this area.
- As a result, there is very low chance of longshore transport of sand to this area and any beach developing.

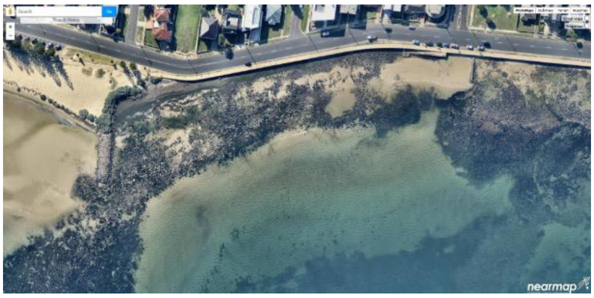
4 References

1. Bird 2011, Changes on the Coastline of Port Phillip Bay, Office of the Environmental Monitor
2. Cardno 2015, Port Phillip Bay Wave Climate
3. Cardno 2014, Port Phillip Sea Level
4. Coastal Engineering Solutions (CES) 2003, Beach Nourishment Preliminary Designs Volume 1: Altona Beach, Department of Natural Resources and Environment
5. CSIRO and Bureau of Meteorology 2015, Climate Change in Australia Information for Australia's Natural Resource Management Regions: Technical Report, CSIRO and Bureau of Meteorology, Australia
6. Engineers Australia 2012, Coastal Engineering Guidelines for working with the Australian coast in an ecologically sustainable way, 2nd edition 2012
7. McInnes 2009, The Effect of Climate Change on Extreme Sea Levels in Port Phillip Bay, CSIRO
8. Melbourne Water 2012, Planning for sea level rise
9. Sorenson 2006, Basic Coastal Engineering, Springer Science + Business Media, Inc, New York, USA
10. Victorian Coastal Council 2014, Victorian Coastal Strategy 2014

APPENDIX A – AERIAL IMAGERY



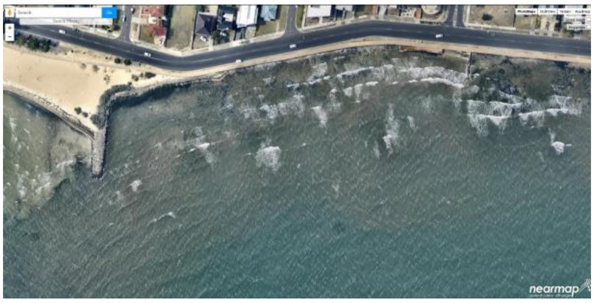
23 November 2017



4 May 2017

29 October 2016

20 April 2016

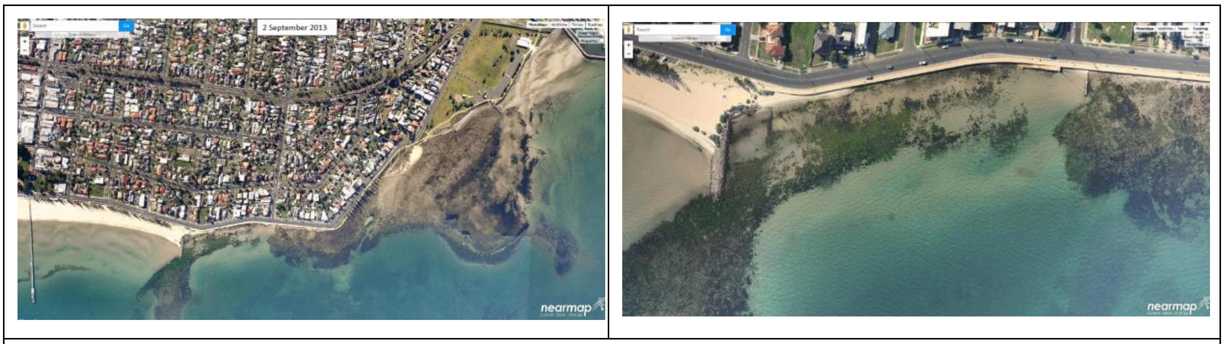


14 December 2015

17 May 2015

21 October 2014

15 May 2014



2 September 2013

5 April 2013

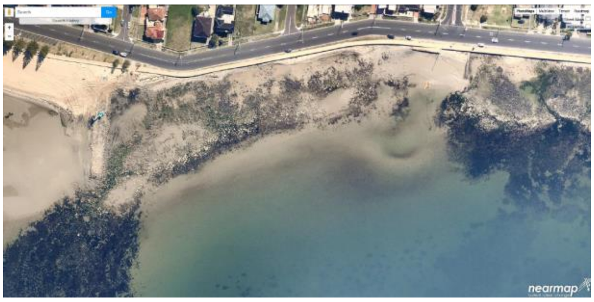
26 December 2012

12 April 2012

9 December 2011

9 December 2011

20 August 2011 (After completion of Bayview Street stormwater outfall encased in rock groyne)



7 April 2011

28 October 2010

21 June 2010

16 April 2010

7 January 2010

12 October 2009

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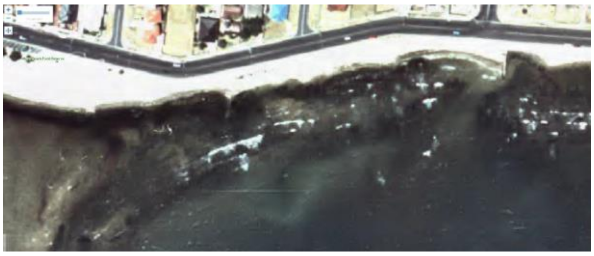

1998

1992