MORPHOLOGICAL CHANGES TO THE PORTSEA (VICTORA) COASTLINE FOLLOWING SHIPPING CHANNEL DEEPENING

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INTRODUCTION

Portsea Beach is located on the south side of Port Phillip Bay approximately 55 km south of Melbourne and 6 km east of Point Nepean at the Entrance to the Bay (Figure 1).

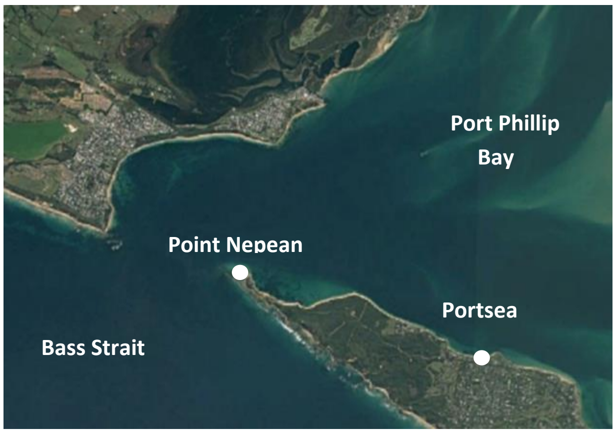

Figure 1 – Location of Portsea Beach

Portsea Beach experienced significant erosion in 2009 and 2010. The erosion occurred shortly after the dredging that was carried out as part of the Port of Melbourne's "Channel Deepening Project" to deepen the shipping channel that provides access to the Port of Melbourne. The erosion at Portsea did not occur in isolation. Since 2009, there has also been significant on-going erosion along Nepean Bay Beach to the west, and significant accretion along Shelley Beach and Point King Beach to the east.

EROSION AT PORTSEA

Most of the concern in relation to the changes in the coast has been related to the loss of public amenity at Portsea Beach. Here, erosion of the western end of the beach resulted in a rapid anti-clockwise realignment that was threatening residential properties adjacent to the coast. The development of the coastline can be seen in Figure 2.

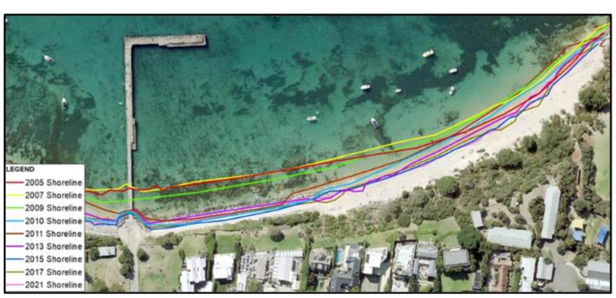

Figure 2 – Portsea Beach shoreline changes 2005-2021

A sandbag wall was constructed in 2010 to protect the western end of the beach from further erosion while a more permanent solution was developed (Figure 3).

Figure 3 – The sandbag wall at the western end of Portsea Beach

Although there have been minor variations from one year to another, there has been no significant net change in the location or alignment of Portsea Beach since about 2010 (Figure 1). There has, however, been some additional "terminal scour" at the eastern end of the sandbag wall that has occurred since about 2016.

CHANGES TO COASTAL PROCESSES

The coastal processes in the region area are driven by a combination of swell waves propagating in from Bass Strait, locally generated wind waves, and variations in tidal currents and tidal water levels. In this respect, its noted that Channel Deepening has had little effect on local wind waves and tidal currents.

Swell waves in the area are a result of the prevailing south-west storm waves and swells that propagate in from Bass Strait and the Southern Ocean. Offshore, the median significant wave height is around 1.5m. The maximum significant wave height in any given year is typically in the range of 5.5m to 6.5m. Peak wave periods are typically in the range of 10s to 16s.

Initially, Cardno (2011) used ray tracing based on spectral wave model results to show that *"wave rays reaching the Portsea area did not pass over areas which were dredged"*. At the time, there appeared to be no mechanism by which the channel deepening could directly affect the action of swell waves at Portsea Beach. As such, it had been concluded that it was "implausible" that the Channel Deepening Project could have caused the erosion.

Later, Water Technology (2013) used high resolution spectral wave modelling to show that increased refraction and internal reflections caused by Channel Deepening increased the amount of wave action trapped along the south side of the shipping channel as shown in Figure 4.

This has resulted in an increase in wave heights along Nepean Bay Beach of around 5%. Further, there appears to have been some focussing of this increased wave action toward Portsea by Nicholson Knoll, an underwater sand ridge on the south side of the channel. This has resulted in an increase in the swell wave heights at Portsea Beach of 7.5% to 10%. It is considered that these increases in swell wave energy have resulted in the on-going erosion at Nepean Bay, the erosion at Portsea, and the accretion along the beaches to the east.

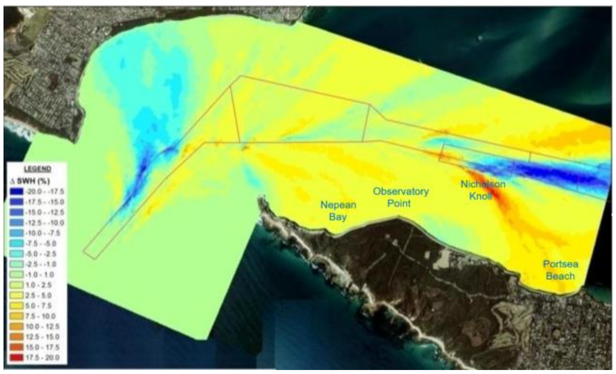

Figure 4 - Modelled changes in swell wave heights due to Channel Deepening (Water Technology, 2013)

MORPHOLOGICAL CHANGES

Comparisons of aerial LiDAR surveys from 2007 and 2018 have been used to provide estimates of the changes that have occurred over this period. The survey comparisons only included the changes that have occurred above mean sea level. As such, they are likely to have underestimated the actual changes that have occurred.

Four main sections of coastline have been considered, as shown in Figure 5. These are: Nepean Bay Beach; Quarantine Station Beach; Portsea Beach; and Shelley / Point King Beach.

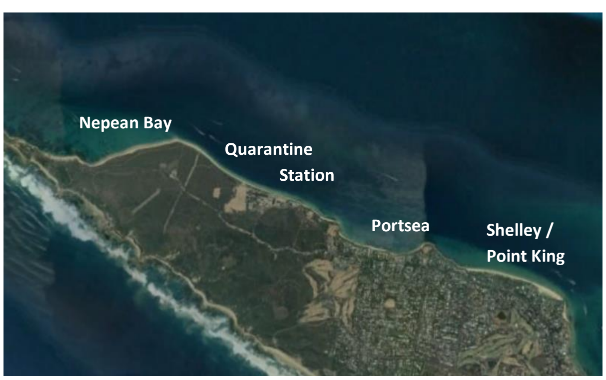

Figure 5 - Sections of coastline under consideration

Nepean Bay Beach: is the highest energy beach under consideration. Here, the swell wave heights are typically around 50% of those offshore. A pre-existing trend to erosion along this beach has continued, with the higher swell waves resulting in higher wave set-up and wave run-up. This has resulted in more wave action attacking the base of the dunes. Sand from the dunes then collapses onto the beach where it is transported offshore by cross-shore processes. The dune sand is then transported away by longshore processes and the strong tidal currents in the area. Between 2007 and 2018, dunes up to 7m high have receded by 15m to 20m, with a total loss of 135,000 m^3 of sand removed from above mean sea level. Most of this sand has been lost to the system.


Figure 6 - Dune erosion along Nepean Bay Beach

Quarantine Station Beach: is aligned roughly with the direction of propagation of the incoming swells. As such, the coastal processes are driven mainly by locally generated wind waves and tidal currents. An ebb-dominated tidal channel runs along this section of coastline, with the 10m depth contour typically less than 100m offshore. This channel is gradually migrating shoreward. A tendency towards erosion along this section of coast is continuing, with 10,000 m^3 of sand lost from above mean sea level between 2007 and 2018.


Figure 7 - Eroded beach and seawall in front of the old Quarantine Station

Portsea Beach: is affected by a combination of wind waves and swell. The heights of the swell waves are typically 15% to 20% of the wave heights offshore. The increase in height of the swell waves has caused the realignment of the beach described above. 15,000 m^3 of sand has been lost from above mean sea level between 2007 and 2018. Most of this sand has been transported eastward around Point Franklin to Shelley Beach. Additionally, the increase in swell heights will have increased the shoreward transport of sand under the crests of these long period waves. As a result, the overall amount of sand lost from this section of coast and transported eastward is like to be significantly greater than the 15,000 m^3 lost from the beach itself.

Figure 8 – Terminal scour at the eastern if the sandbag wall at Portsea Beach

Shelley Beach and Point King Beach: are relatively protected from residual swells by Point Franklin. Here local wind waves become more important. Sand transported around Point Franklin has built up initially along Shelley Beach and has been gradually transported eastward by locally generated wind waves. The beaches have built out by up to 65m, with some of the private jetties in the area being left high and dry at high water. Shelley Beach and Point King Beach have gained an additional 45,000 m^3 of sand above mean sea level between 2007 and 2018.

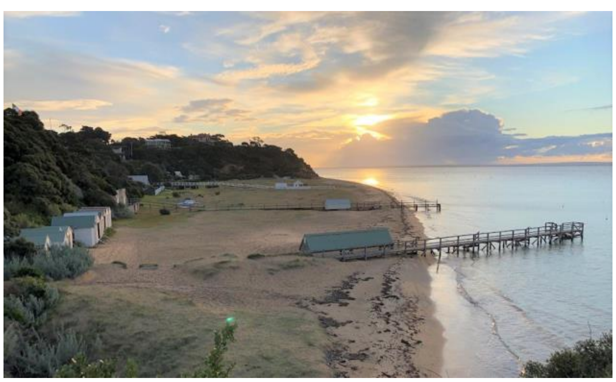

Figure 9 – The build-up of sand along Point King Beach

The changes in volume of beach sand above mean seal level have been summarized in Figure 10. Overall, there has been a net loss of 115,000 m^3 from the beaches between Point Nepean in the west to Point King in the east.

MITIGATION OPTIONS

Most of the focus on mitigating the affects described above has been on restoring the public amenity of Portsea

Figure 10 – Changes in volumes of beach sand in m^3 between 2007 and 2018

Beach. In this respect, it is noted that Advisian (2016) carried out a detailed assessment of a wide range of mitigation options. Of these, configuration dredging combined with renourishment was the preferred option. This option had the advantage that it would also reduce the incoming wave heights to before dredging conditions. It was, however, unacceptably expensive.

As an alternative, the present authors have evaluated the effects of the construction of a relatively short 65m at Point Franklin. It has been found that, in conjunction with beach nourishment, the groyne would allow the beach to build-out approximately 35m from the currently stable alignment of the beach. This approach will provide the most cost-effective approach to restoring Portsea Beach.

Figure 11 – Schematisation of the proposed groyne and renourished beach.

There are currently no proposals for mitigating the effects of Channel Deepening at the other beaches in the area.

REFERENCES

Advisian (2016). *Portsea Front Beach Remediation: Long Term Options Assessment*, Department of Environment, Land, Water and Planning.

Cardno (2011), *The Great Sands and Adjacent Coast and Beaches*, Port of Melbourne Corporation

Water Technology (2013), *Review of Wave Transformation Processes Through Port Phillip Heads*, Department of Sustainability and Environment