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Mooloolaba foreshore central meeting place: Overview of coastal management and coastal engineering

1. Introduction

The Water Research Laboratory (WRL) of the School of Civil and Environmental Engineering at UNSW Sydney was engaged by Sunshine Coast Council (SCC) to provide an overview of the following with regard to the Mooloolaba foreshore central meeting place (from Mooloolaba SLSC to approximately 200 m north):

- Provide an overview of coastal management and options for Mooloolaba foreshore central meeting place
- Provide an overview of coastal engineering technical reports associated with the study – some of these reports were peer reviewed by WRL

2. Executive summary

2.1 History and setting

Mooloolaba Beach is approximately 1.8 km long. The training walls (breakwaters) at the south-eastern end were constructed in the late 1960s to early 1970s. A vertical seawall is present in the area near the surf life saving club (SLSC) building and was constructed in the 1960s. Without active management, it would be possible for the Mooloolah River to break out either further south-east or further west of its present mouth, and for storm erosion to reach into the public foreshore space and the SLSC building.

2.2 Measured data and observations

Modelling and calculations used in studies primarily rely on long term measured data, with computer modelling and desktop calculations used to transform the measured data to the proposed seawall at Mooloolaba.

Waves have been measured on the Point Lookout (Brisbane) wave buoy since 30 October 1976 (47 years) and Mooloolaba wave buoy since 20 April 2000 (24 years).

Tides have been measured on the Mooloolaba tide gauge since 1979 (45 years).

The beach profile has been measured on over 100 occasions at Mooloolaba within the Coastal Observation Program Engineering (COPE program) since 1985 and 14 times in Council surveys since 2014. Mooloolaba Beach has been stable since surveys were commenced in 1985, however, it changes with erosion events and has received an episodic sand nourishment feed from dredging of the river mouth and entrance shoals.

2.3 Erosion prone area

Short term erosion at Mooloolaba is generally temporary, with the beach recovering and accreting after storm events. Without a seawall, erosion of the beach under 1 in 100 year erosion conditions (BMT WBM, 2013 – not reviewed by WRL) could be expected to extend ("erosion prone area widths"):

- 2030: 51 to 63 m
- 2060: 73 to 86 m

2.4 Coastal management

Coastal management can adopt philosophies of:

- Protect
- Accommodate
- Retreat
- Advance

2.5 Seawalls

When the decision is made to pursue a protection strategy using a seawall, stepped/terraced seawalls are a favoured solution, as they maximise public amenity, connection between the beach and foreshore, and allow access for all including SLSC equipment. Stepped/terraced seawalls are popular at highly used and highly developed beaches.

Vertical seawalls remain widely used. They occupy the smallest footprint, but present day regulations mean that balustrading would be required where the potential fall height exceeds 1 metre. With or without the balustrade, they can create a disconnection between the foreshore land and the beach. The present seawall was constructed in the 1960s (almost 60 years old). It is near the end of its design life, does not meet contemporary engineering standards, and cannot be relied upon to withstand a major cyclonic storm wave event. A failure could damage the road, major community parkland and infrastructure and the SLSC clubhouse.

2.6 Coastal modelling report

A coastal modelling report was undertaken by JBP (Mooloolaba Central Meeting Precinct: Coastal modelling, Updated Final Report, April 2024). This report underwent multiple revisions (eight versions) due to peer review by WRL, collation of components and ongoing revisions. This report is of a good professional standard, however, physical modelling would further optimise the calculations undertaken. The report relied on measured data where possible to drive computer and desktop calculations. It consisted of four components

1. Extreme wave study
2. Extreme beach profile morphological study
3. Extreme wave overtopping study
4. Wave action study (forces on the structure)

Modelling was undertaken for events ranging from 1 in 1 year (operational) to 1 in 500 year (structural design) ARI. Modelling outputs were calculated for:

- Present day extremes
- 2074 - end of life of the structure, incorporating 0.5 m of sea level rise

The calculations in this study will be utilised by structural engineers to design a structure of sufficient strength to withstand the wave forces. Furthermore, the wave overtopping study will be used to manage community safety during major cyclone wave events.

3. Mooloolaba Beach

Mooloolaba Beach (the sandy portion) is approximately 1.8 km long (Figure 3.1). The training walls (breakwaters) at the south-eastern end were constructed in the late 1960s to early 1970s. Without active management, it would be possible for the Mooloolah River to break out either further south-east or further west of its present mouth (Figure 3.1).

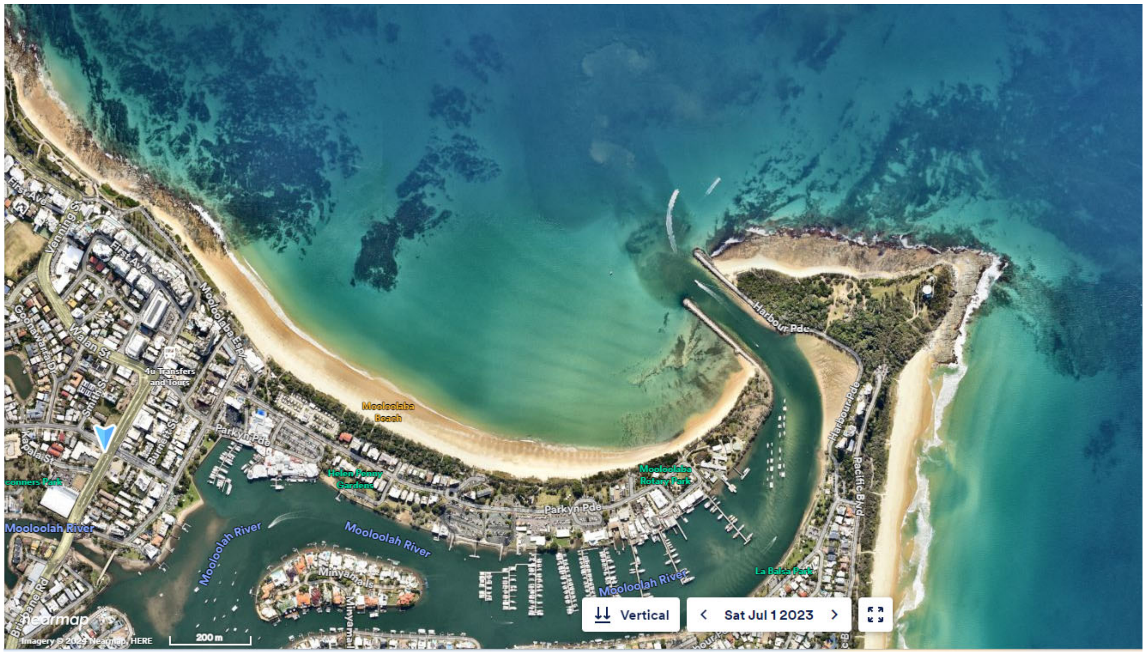


Figure 3.1 Mooloolaba Beach overview (Nearmap)

4. Coastal processes and hazards

4.1 Coastal processes

Coastal processes are normal natural processes. The main coastal processes are:

- Waves
- Tides
- Ocean currents (these are negligible nearshore at Mooloolaba Beach)
- Ongoing and future sea level rise

These natural processes can be the cause of coastal hazards when they adversely impact infrastructure and the built environment.

4.2 Measurement of coastal processes

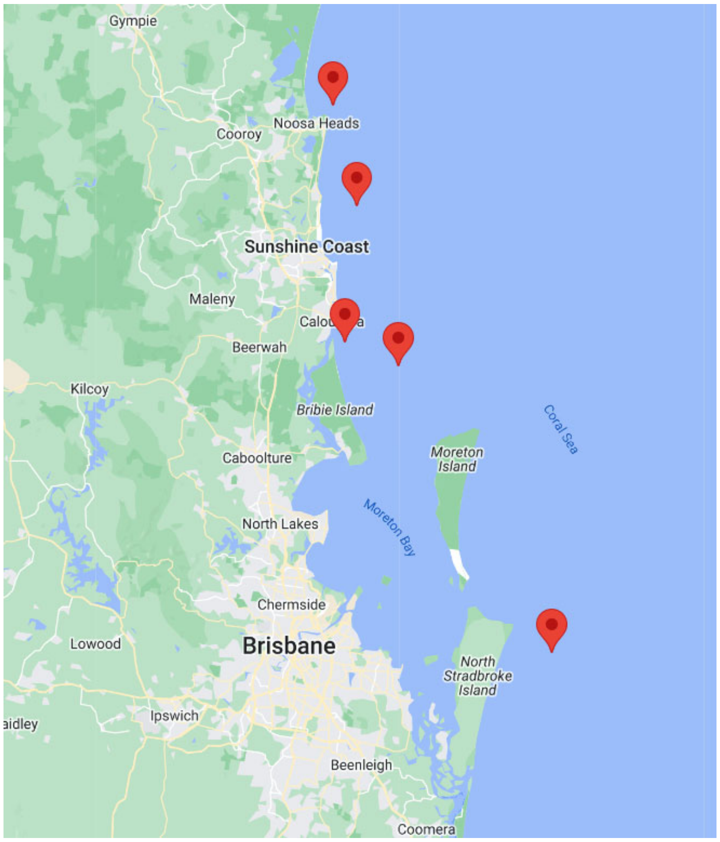
4.2.1 Wave measurement

The scientific measurement of waves is undertaken with a wave buoy (Figure 4.1).

Waves have been measured on the Point Lookout (Brisbane) wave buoy (Figure 4.2) since 30 October 1976 (47 years) and Mooloolaba wave buoy (Figure 4.1) since 20 April 2000 (24 years).

Source: https://www.qld.gov.au/environment/coasts-waterways/beach/monitoring/waves-faq

Figure 4.1 Mooloolaba wave buoy



Source: https://www.qld.gov.au/environment/coasts-waterways/beach/monitoring/waves-sites

Figure 4.2 Wave buoys relevant to Sunshine Coast

4.2.2 Tides and storm surges

Tides have been measured on the Mooloolaba tide gauge since 1979 (45 years).

4.2.3 Beach profile measurement

The beach profile has been measured on over 100 occasions (Figure 4.3) at Mooloolaba within the Coastal Observation Program Engineering (COPE program) since 1985 and 14 times in Council surveys (Figure 4.4) since 2014. Aerial photos are available since 1940 and were qualitatively analysed in BMT WBM (2013, not reviewed by WRL).These aerial photos would require additional work involving tidal correction for the waterline position if they were to be analysed quantitatively.

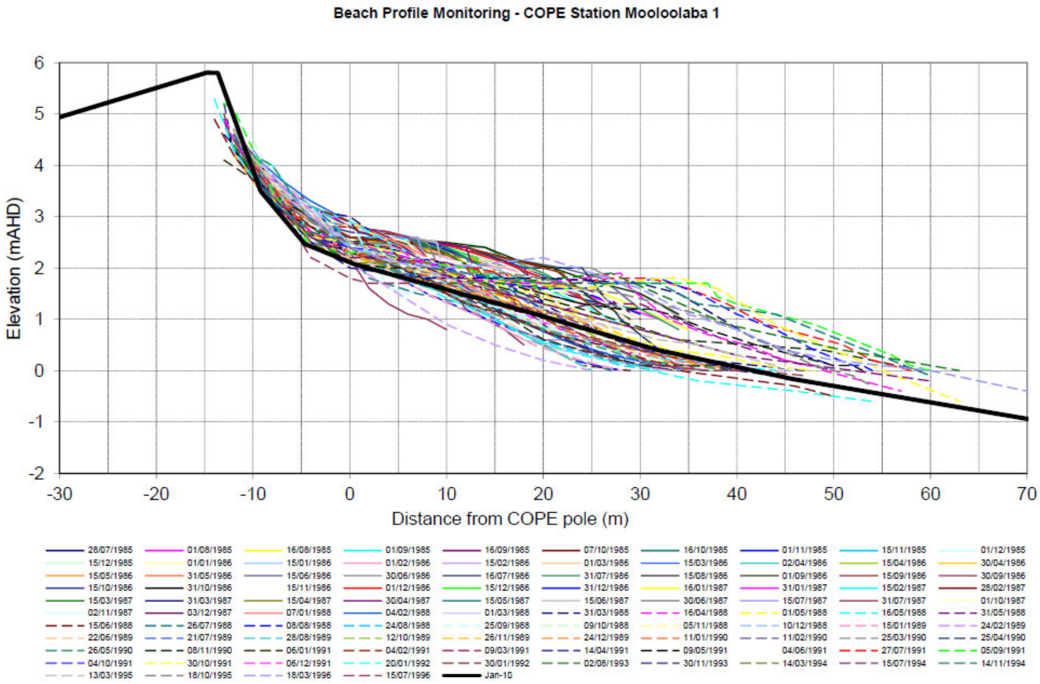


Figure 4.3 Envelope of beach profiles from 1985 to 2010 (Mooloolaba 1 COPE station)

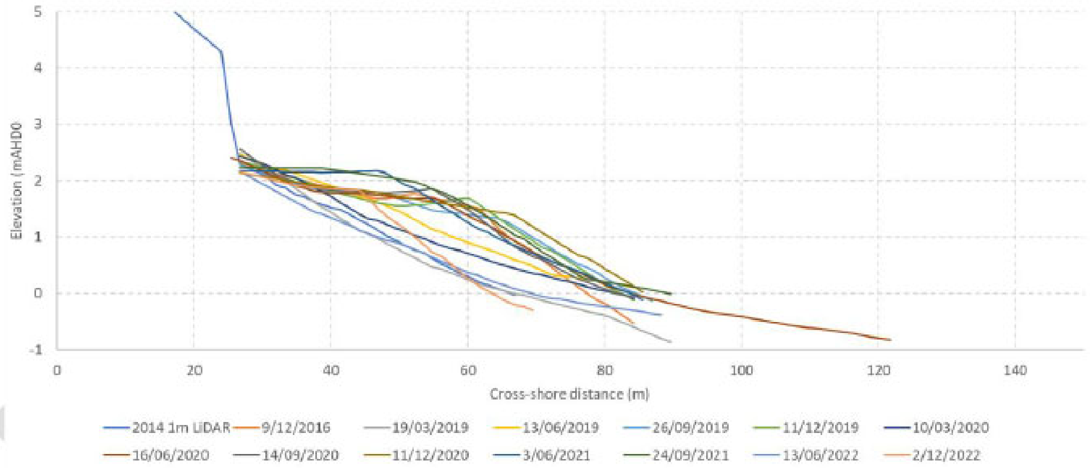


Figure 4.4 Sunshine Coast Council surveys adjacent to Mooloolaba SLSC (2014 to 2022)

4.3 Coastal hazards

The main coastal hazards that prevail on the open coast are:

- Erosion
- Recession due to:
    - Underlying processes
    - Ongoing and future sea level rise
- Inundation, especially from wave runup and overtopping

The river mouth and spit are inherently unstable features, however, these are now managed through the breakwaters at the river mouth.

4.4 Coastal hazards at Mooloolaba

4.4.1 Sea level rise

The BMT WBM (2013, not reviewed by WRL) study utilised the following future sea level rise (SLR) scenarios and consequent beach recession:

- 2030: 0.2 m SLR; 10 to 12 m recession
- 2060: 0.5 m SLR; 27 to 29 m recession

4.4.2 Erosion and recession

The most recent Coastal Processes Study and Shoreline Erosion Management Plan (BMT WBM, 2013; SCC, 2014, not reviewed by WRL) estimated the following components for coastal hazards at Mooloolaba:

- Storm erosion (nominally 100 year ARI): 16 to 35 m
    - noting that underlying bedrock/cliffs are present at the northern end of the site, but become deeper towards the south
- Underlying recession: 0 to 0.03 m/year

4.4.3 *Setback without a seawall*

The calculated "erosion prone area widths" including a dune scarp component and a factor of safety (BMT WBM, 2013) without a seawall are:

- 2030: 51 to 63 m
- 2060: 73 to 86 m

4.4.4 *Inundation, wave runup and overtopping*

Water level components are shown in Figure 4.5. Water levels can be expressed as relative to Chart Datum (CD) / Lowest Astronomical Tide (LAT) (as per tide tables) or to Australian Height Datum (AHD). AHD is approximately Mean Sea Level (MSL).

For Mooloolaba, mid tide, Highest Astronomical Tide (HAT) and the 1 in 100 year Average Recurrence Interval (ARI) water levels are shown in Table 4.1. Storm tides (such as the 1 in 100 year ARI water level) exceed HAT because of storm surge. Wave setup and wave runup elevate the water higher than this.

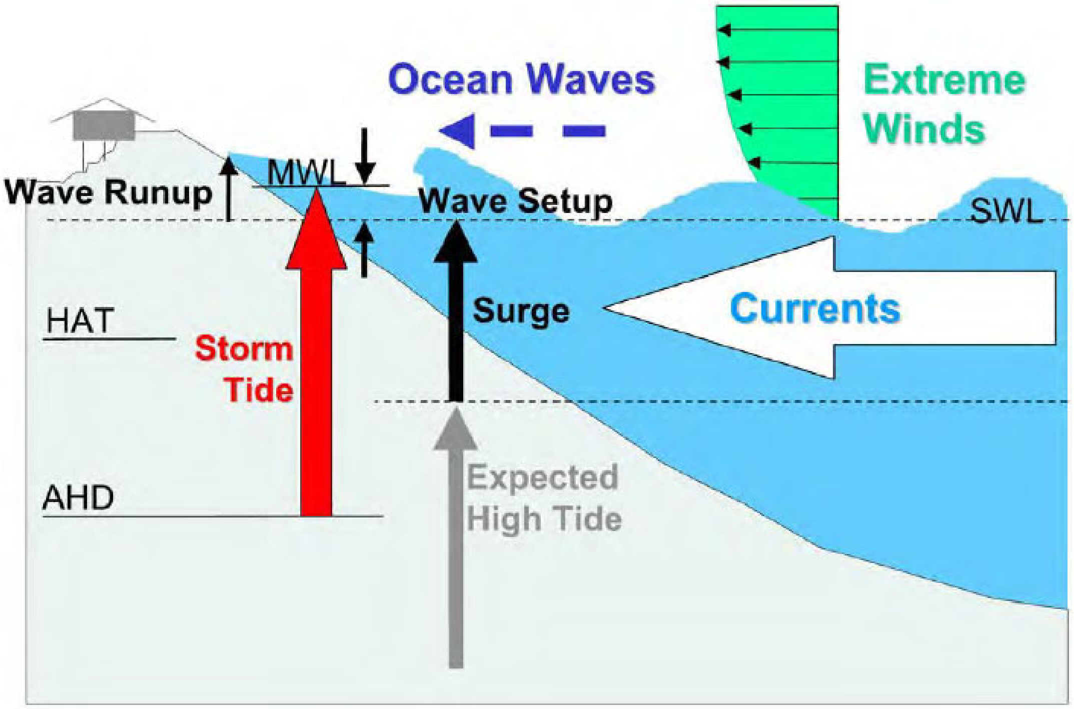


Figure 4.5 Overview of water level and storm tide components (BMT WBM, 2013)

Table 4.1 Average and extreme water levels for Mooloolaba

Water level	m LAT	m AHD
Mean Sea Level (MSL)	0.96	-0.03
Highest Astronomical Tide (HAT)	2.17	+1.18
1 in 100 year Average Recurrence Interval (excludes wave setup and wave runup)*	2.54	+1.55
1 in 100 year Average Recurrence Interval (including wave setup, excluding wave runup)*	3.36	+2.37

Source: Maritime Safety Qld (2010); BMT WBM (2013); SCC (2014)

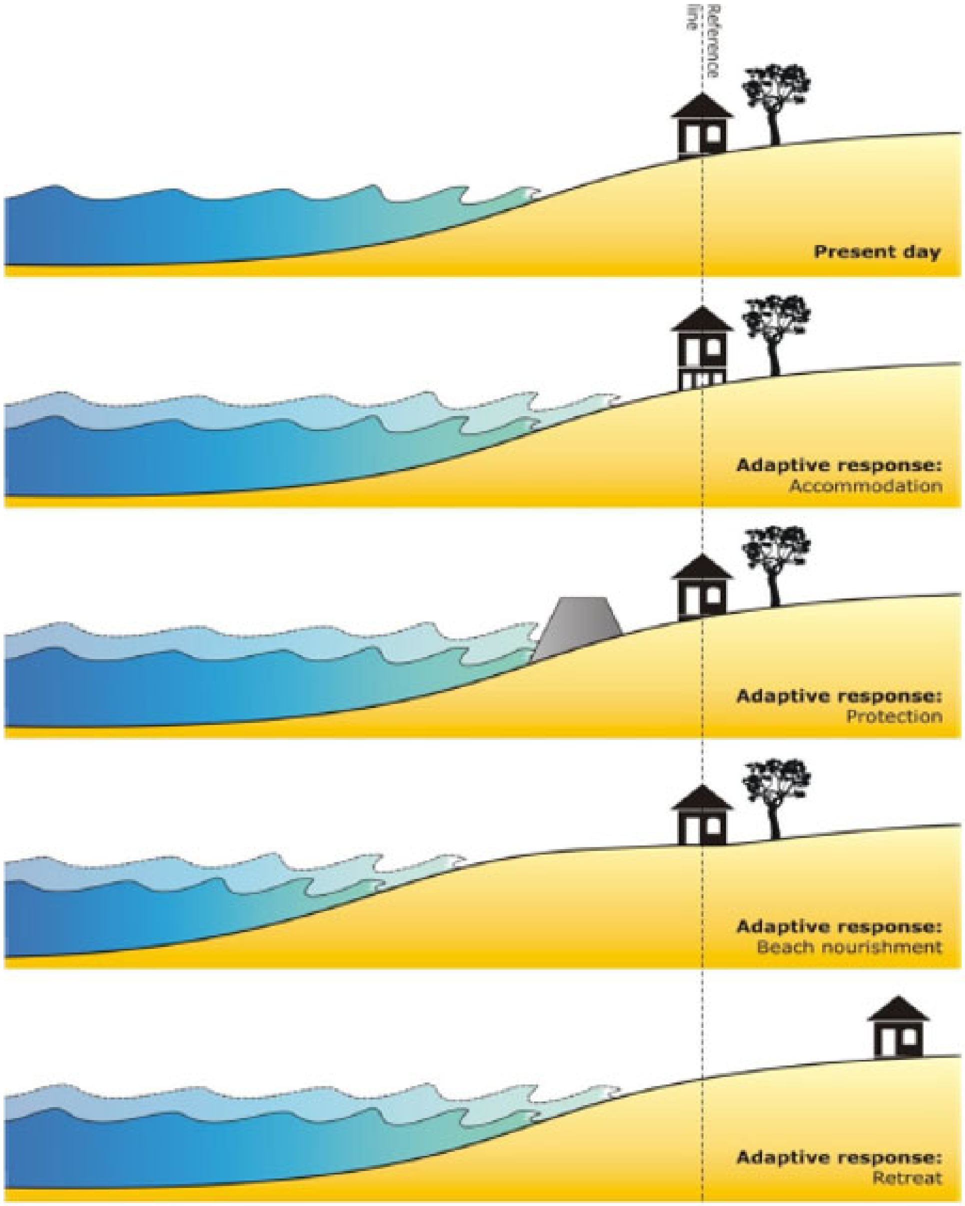
5. Coastal management

Coastal management can adopt philosophies of (Figure 5.1):

- Protect
- Accommodate
- Retreat
- Advance

Protection options can consist of:

- Seawalls
- Sand dunes and sand nourishment, including beach scraping and sand bypass plants
- Groynes
- Reefs and offshore structures



(Based on: CEM, 2006, Figure V-3-2)

Figure 5.1 Coastal management options

In practice, real world coastal management usually involves a combination of several of the above. Mooloolaba presently utilizes soft sand dunes for most of its frontage, with some sand nourishment from dredging the river mouth and shoal, and a vertical seawall fronting the SLSC and parkland (Figure 5.2 and Figure 5.3).

This seawall was constructed in the 1960s (almost 60 years old). The Australian Standard for maritime structures considers 50 years to be the design life for normal maritime structures. It is near the end of its design life, does not meet contemporary engineering standards, and cannot be relied upon to withstand a major cyclonic storm wave event. A failure could damage the road, major community parkland and infrastructure and the SLSC clubhouse.

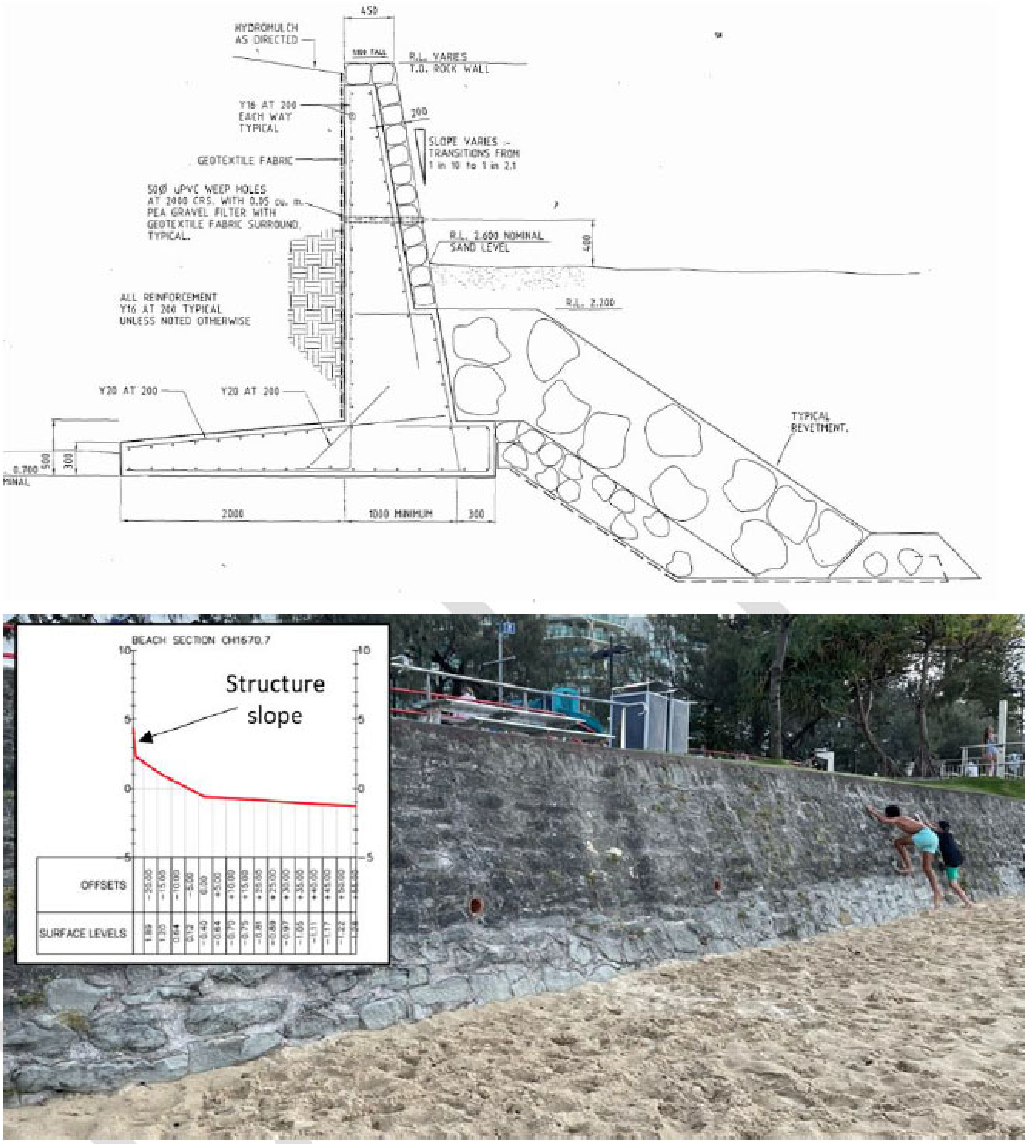


Figure 5.2 Cross section of existing seawall and view from beach

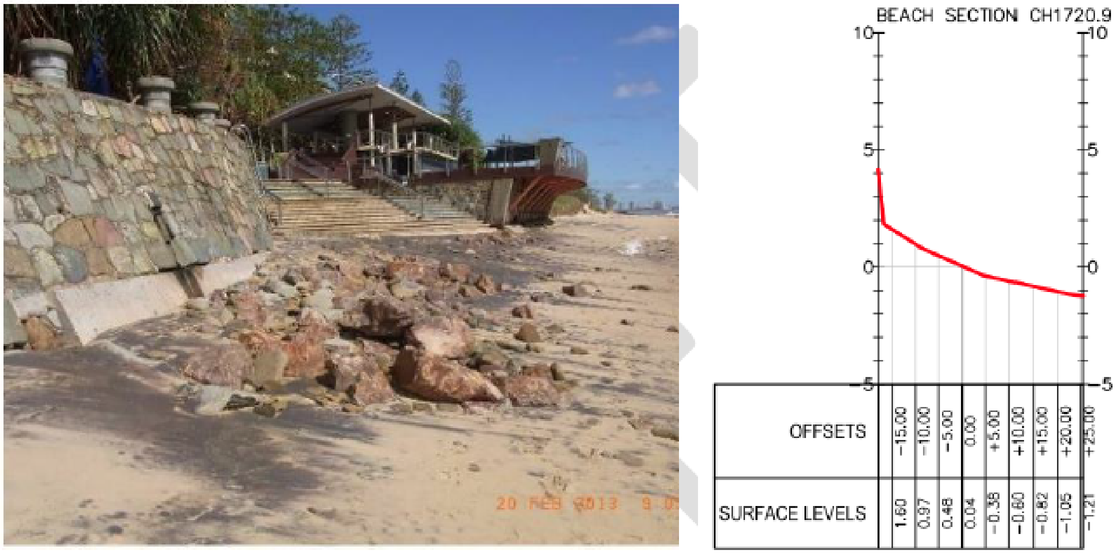


Figure 5.3 Present seawall following TC Oswald 2013

6. Seawalls

Seawalls (also termed revetments in some circumstances) are mostly of the following types, with the comparative examples shown for Wamberal NSW (Terras, 2021):

- Rock rubble (Figure 6.1, not Mooloolaba)
- Vertical (Figure 6.2, not Mooloolaba)
- Terraced/stepped (Figure 6.3, not Mooloolaba)
- The terraced/stepped seawall proposed for Mooloolaba is shown in Figure 6.4 and Figure 6.5

Figure 6.1 Rock rubble seawall option (not Mooloolaba, Terras, 2021)

Figure 6.2 Vertical seawall option (not Mooloolaba, Terras, 2021)

Figure 6.3 Terraced seawall option (not Mooloolaba, Terras, 2021)

Figure 6.4 Terraced seawall proposed for Mooloolaba from south (SCC, 2023)

Figure 6.5 Terraced seawall proposed for Mooloolaba from north (SCC, 2023)

There are approximately 80 separate seawall structures between Noosa QLD and Eden NSW. The majority of highly used beaches in developed areas incorporate seawalls. Most of these seawalls coexist with beach tourism, community beach use, surf life saving activities, recreational surfing and surfing contests.

Vertical seawalls remain widely used. They occupy the smallest footprint, but present day regulations mean that balustrading would be required where the potential fall height exceeds 1 metre. With or without the balustrade, they can create a disconnection between the foreshore land and the beach.

Stepped/terraced seawalls are popular at highly used and highly developed beaches. Examples include:

- Surfers Paradise
- Kingscliff
- Coffs Harbour
- South West Rocks
- Terrigal
- Dee Why (Figure 6.6)
- Manly (Figure 6.7)
- Coogee

Figure 6.6 Stepped seawall at Dee Why NSW (James Carley)

Figure 6.7 Stepped seawall at Manly NSW (James Carley)

When the decision is made to pursue a protection strategy using a seawall, stepped/terraced seawalls are a favoured solution, as they maximise public amenity, connection between the beach and foreshore, and allow access for all including SLSC equipment.

Coastal management in the vicinity of the SLSC at Mooloolaba was somewhat determined when the original roads and subdivisions were laid out, together with the construction of the vertical seawall in the 1960s.

The present proposal for Mooloolaba (Figure 6.4 and Figure 6.5) for a stepped/terraced seawall offers the following advantages:

- Provides an engineering level of protection (1 in 100 to 1 in 1000 year ARI, out to 2065) to the parkland, roads and SLSC clubhouse
- Provides visual and spatial connectivity between the parkland and the beach
- Allows beach access for people with low mobility and those with prams
- Allows beach access for SLSC and lifeguard equipment
- It is sufficiently set back from the waterline, such that under present day sea level, waves will only impact it on rare occasions - during large waves, high tides and eroded beach states

7. Coastal modelling report

A coastal modelling report was undertaken by JBP (Mooloolaba Central Meeting Precinct: Coastal modelling, Updated Final Report, April 2024). This report underwent multiple revisions (eight versions) due to peer review by WRL, collation of components and ongoing revisions. This report is of a good professional standard.

The report consisted of four components:

1. Extreme wave study
2. Extreme beach profile morphological study
3. Extreme wave overtopping study
4. Wave action study

Modelling was undertaken for events ranging from 1 in 1 year (operational) to 1 in 500 year (structural design) ARI. Modelling outputs were calculated for:

- Present day extremes
- 2074 - end of life of the structure, incorporating 0.5 m of sea level rise

7.1 Extreme wave study

JBP (2024) adopted extreme waves (from 1 in 1 year to 1 in 500 year ARI) from measurements at the Mooloolaba wave buoy.

JBP (2024) adopted extreme water levels (from 1 in 1 year to 1 in 500 year ARI) from measurements at the Mooloolaba tide gauge.

They then setup and ran a well accepted wave transformation model (SWAN and XBEACH) to transform the offshore storm waves to the -10 m depth contour (Figure 7.1 and Figure 7.2).

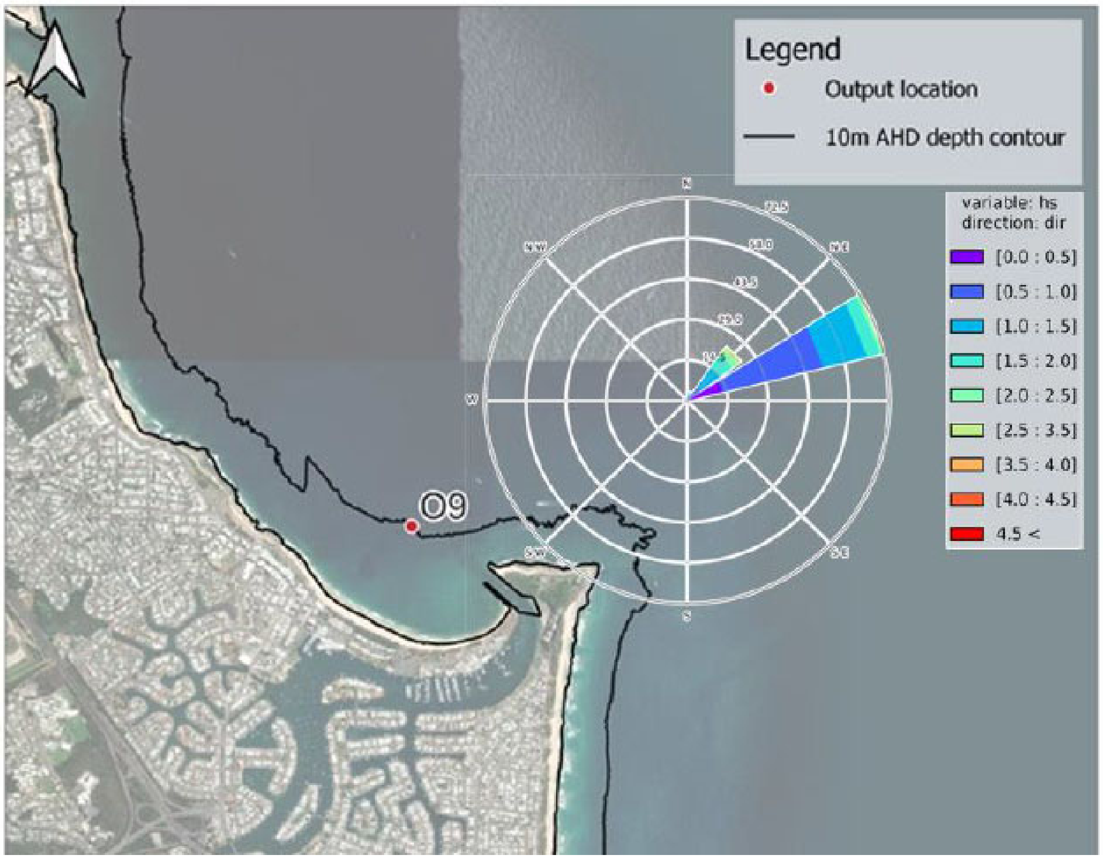


Figure 7.1 Wave modelling output point for Mooloolaba

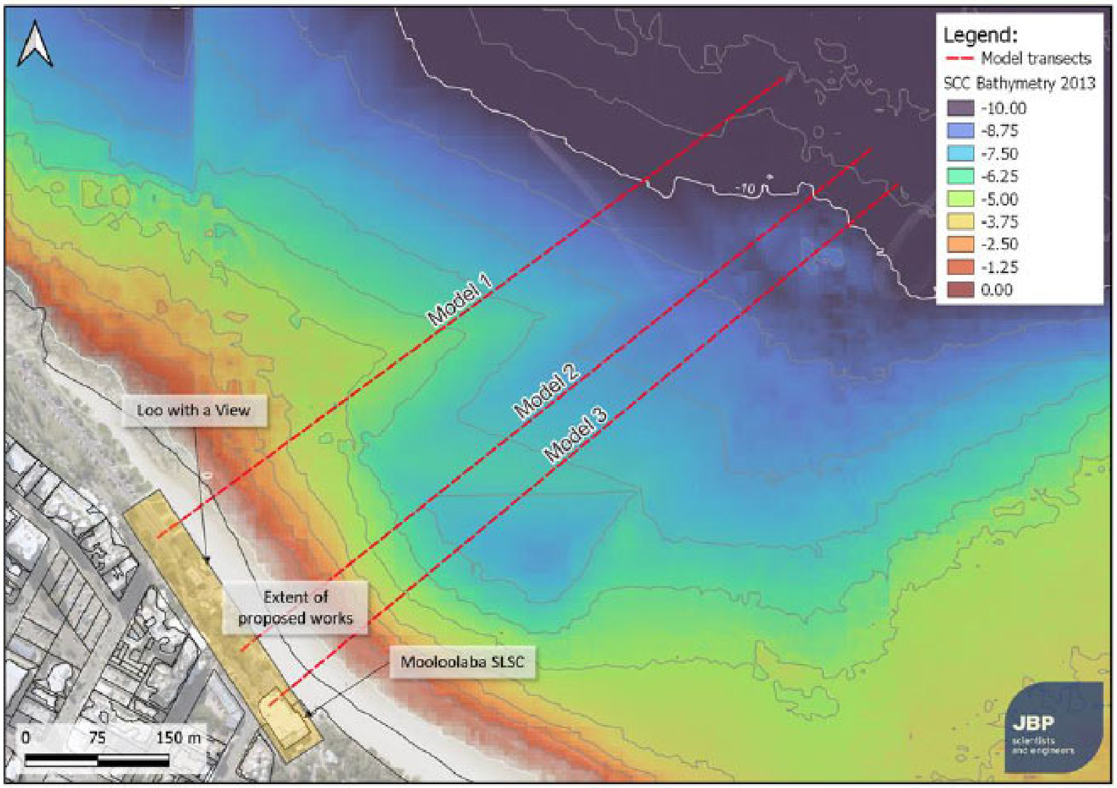


Figure 7.2 Wave modelling from -10 m contour to shore

7.2 Extreme beach profile morphological study

JBP used the measured/calculated storm waves to run a well accepted erosion model (XBEACH) to estimate beach erosion and sand scour fronting the seawall (Figure 7.3). The calculated erosion volumes were consistent with measurements from other beaches of the Australian east coast.

The modelled beach scour levels were modified by experienced coastal engineers based on observations and modelling from other sites on the Australian east coast.

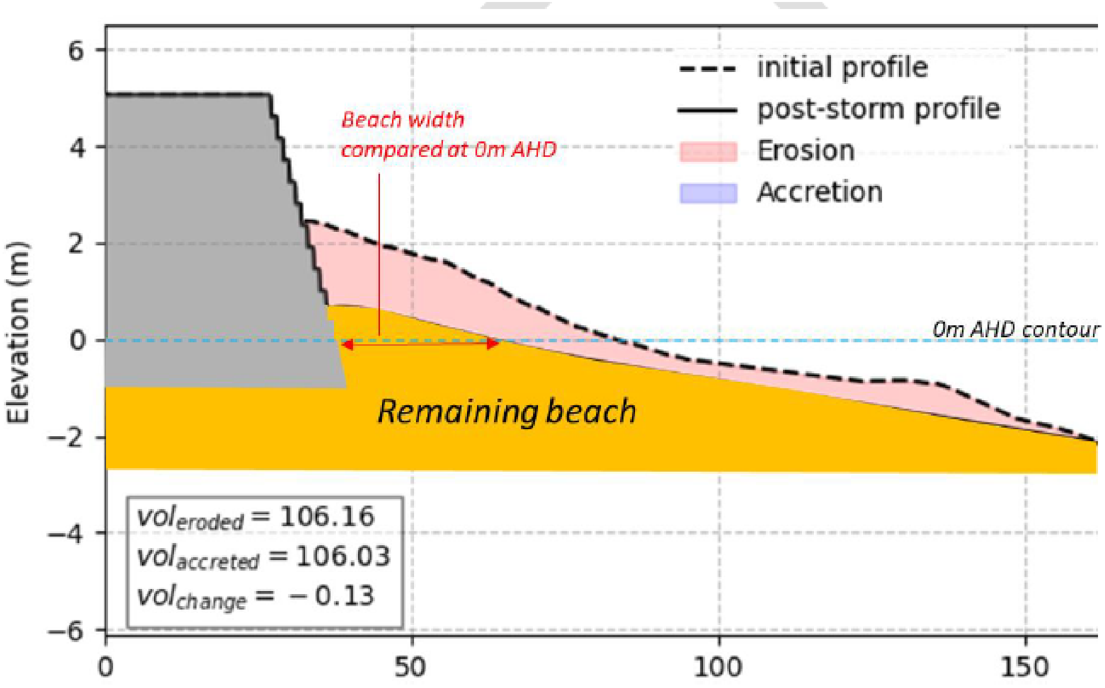


Figure 7.3 Erosion modelling

7.3 Extreme wave overtopping study

JBP used the measured/calculated storm waves at the structure to estimate wave runup and overtopping of the proposed cross section (Figure 7.4). This was undertaken by applying the most comprehensive tool available for desktop assessment, which is the EurOtop tool from Europe. The JBP work application of the EurOtop tool was peer reviewed. Moderate changes were recommended by the WRL peer reviewer and incorporated into revised modelling/reporting. Physical modelling could further optimise overtopping calculations, however, physical modelling has not been undertaken.

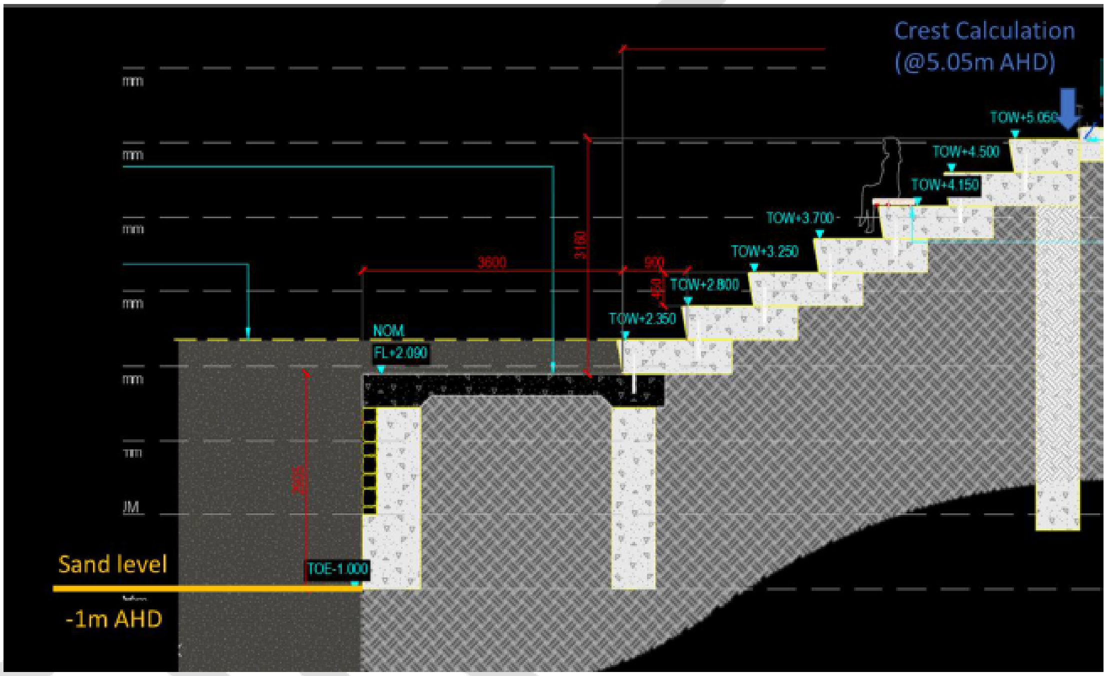


Figure 7.4 Overtopping modelling

7.4 Wave action study

JBP used the measured/calculated storm waves at the structure to estimate wave forces on the structure. This allows the structure to be designed to contemporary Australian engineering and building codes and standards. This was undertaken by applying published desktop methods. Moderate changes were recommended by the WRL peer reviewer and incorporated into revised modelling/reporting. Physical modelling could further optimise force calculations, however, physical modelling has not been undertaken.

The structure has also been designed to be sufficiently deep so as to not be undermined in an extreme cyclonic storm beach erosion event.

The calculations in this study will be utilised by structural engineers to design a structure of sufficient strength to withstand the wave forces. Furthermore, the wave overtopping study will be used to manage community safety during major cyclone wave events.

8. Summary

Thank you for the opportunity to provide this overview. Please contact James Carley should you wish to discuss the details raised in this letter further.

Yours sincerely,

Brett Miller
Director, Industry Research

9. References

BMT WBM 2013, Sunshine Coast Regional Council Coastal Processes Study for the Sunshine Coast Final Report, Revision 4, May 2013

CEM 2006, Coastal Engineering Manual, EM 1110-2-1100, US Army Corps of Engineers

JBP 2024, Mooloolaba Central Meeting Precinct Coastal modelling, Updated Final Report, April 2024, Ref: MO01 A1-C02.2 / 15 April 2024 (Eighth version)

Maritime Safety Queensland 2010, Queensland Tide Tables, https://www.msq.qld.gov.au (note that the 2010 version was used in BMT WBM (2013)

Sunshine Coast Council 2014, Shoreline erosion management plan

Sunshine Coast Council 2023, Mooloolaba Foreshore, Stage 2 Central Meeting Place, Project Update, September 2023

Terras 2021, Seawall options – illustrative renders for Central Coast Council, document issue date: 18.06.2021 job ref: 13597.5