4.2 Coastal fabric – shoreline changes (west)

Medium Term

Foul Bay
Yorke Peninsula (South Coast)
Cell YP49.1
Shoreline changes

Foul Bay (West)
Year: 2015

The black dotted line indicates the position of the shoreline in 1981.

Note: The erosion trend acting on Mud Alley (western end) is 'oblique' (Illustrated with yellow dashed line). The waves wrap around the rocky headland and interact with the coastline in an oblique way. In this time interval, the coast begins to erode at the T-Junction.

The erosion pattern is likely to reflect a realignment (rotation) of the coastline around Hillier Drive as the centre point and accretion taking place east at Diosma Drive.

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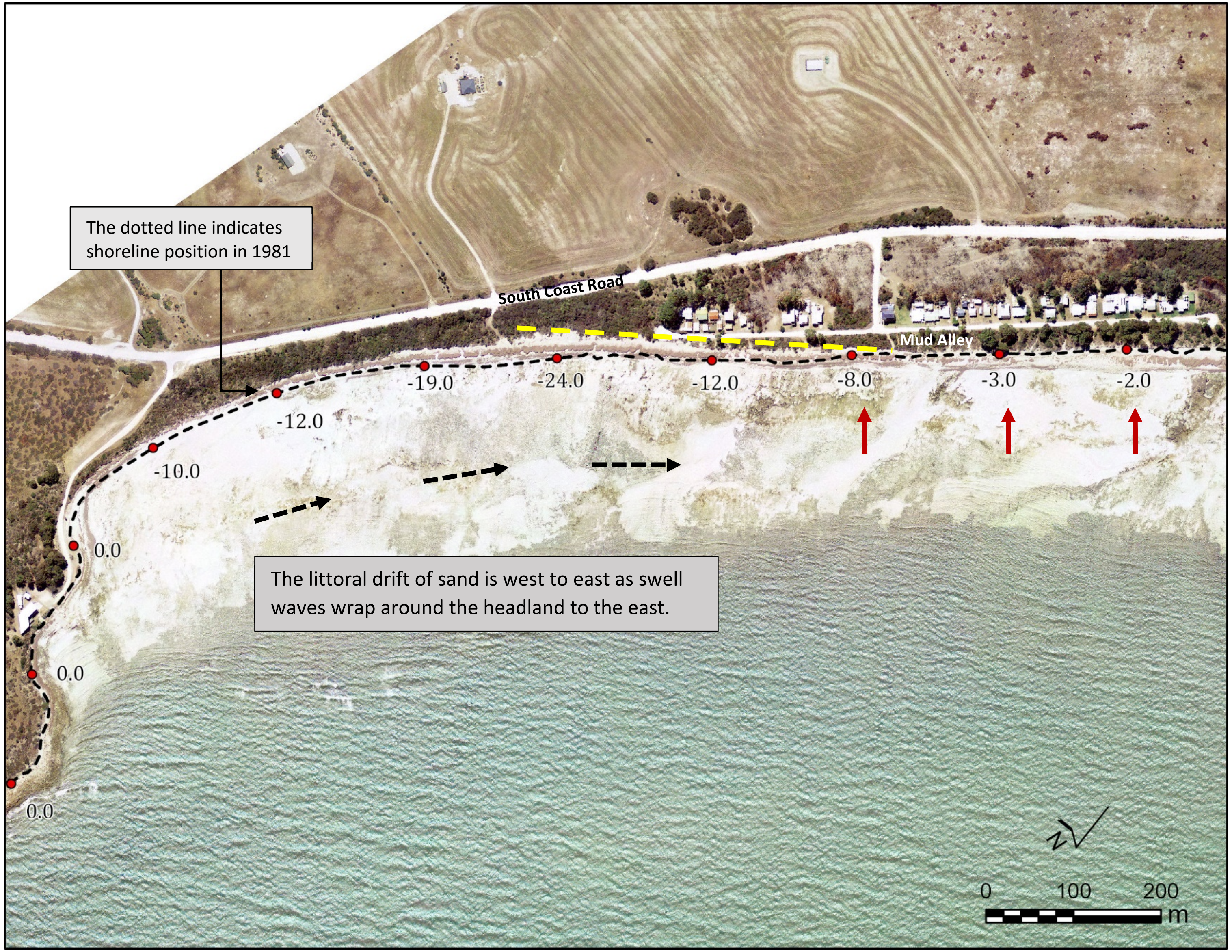

4.2 Coastal fabric – shoreline changes (west)

Medium Term

Foul Bay
Yorke Peninsula (South Coast)
Cell YP49.1
Shoreline changes

Foul Bay (West)
Year: 2018

The dotted line indicates the position of the shoreline in 1981.

The erosion from 2015 to 2018 (three years) is significant. This time period includes the storm events of 9 May 2016 and 29 September 2016. Historical accounts exist of flooding for the September event, but not the May event. However, erosion is likely to have been significant.

One resident indicated that the 29 September event is likely to have been the first event that flooded Mud Alley road.

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4.2 Coastal fabric – shoreline changes (west)

Medium term

Foul Bay
Yorke Peninsula (South Coast)
Cell YP49.1
Shoreline changes

Foul Bay (West)
Year: 2020

40 years of change
The greatest recession occurred in in the curve from boat ramp road to Mud Alley entrance road, with 30m recession in the middle of the curve. As a result of this erosion, the shoreline has realigned (rotated) resulting in increased erosion along Mud Alley.

Summary
Shoreline movement reflects the predictions of the 1985 Lands Department report which identified that littoral drift to the east, and with possible limited sediment supply from the west, would result in erosion of this section of the bay.

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4.2 Coastal fabric – shoreline changes (east)

Medium term

Foul Bay
Yorke Peninsula (South Coast)
Cell YP49.2
Shoreline changes

Foul Bay (east)
Introduction

Aerial photograph from 1981 provides the basis for comparison of coastal change over the last 40 years. Comparisons are made with aerial photography from:

- 1981
- 1992
- 2001
- 2008
- 2015
- 2018
- 2020

In this location the shoreline position is the vegetation line or dune escarpment in 1981.

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4.2 Coastal fabric – shoreline changes (east)

Medium term

Foul Bay

Yorke Peninsula (South Coast)

Cell YP49.2

Shoreline changes

Foul Bay (east)
1992

The dotted line indicates the position of the shoreline in 1981.

In this ten-year period a dune formed 10-30m forward of the 1981 shoreline position on the eastern end of Diosma Drive.

Minor erosion in between Diosma Drive and Hillier Crescent.

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4.2 Coastal fabric – shoreline changes (east)

Medium term

Foul Bay
Yorke Peninsula (South Coast)
Cell YP49.2
Shoreline changes

Foul Bay (east)
Year: 2001

The dotted line indicates the position of the shoreline in 1981.

In this ten-year period the dune consolidated and expanded in length along Diosma Drive.

Minor erosion between Diosma Drive and Hillier Crescent.

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4.2 Coastal fabric – shoreline changes (east)

Short term

Foul Bay
Yorke Peninsula (South Coast)
Cell YP49.2
Shoreline changes

Foul Bay (east)
Year: 2008

The dotted line indicates the position of the shoreline in 1981.

In this seven-year period the dune consolidated and expanded in length along Diosma Drive.

The minor erosion evident in previous aerial photographs between Diosma Drive and Hillier Drive reversed and accreted back to 1981 position.

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4.2 Coastal fabric – shoreline changes (east)

Short term

Foul Bay
Yorke Peninsula (South Coast)
Cell YP49.2
Shoreline changes

Foul Bay (east)
Year: 2015

The dotted line indicates the position of the shoreline in 1981.

In this seven-year period the dune continued to accrete and consolidate on the eastern end of Diosma Drive.

The coastline between Diosma and Hillier was largely stable with minor erosion and accretion evident.

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4.2 Coastal fabric – shoreline changes (east)

Short term

Foul Bay
Yorke Peninsula (South Coast)
Cell YP49.2
Shoreline changes

Foul Bay (east)
Year: 2018

The dotted line indicates the position of the shoreline in 1981.

This three-year period was characterized by significant accretion on the eastern end of Diosma Drive (~14-20m).

The coastline between Diosma and Hillier was largely stable with minor erosion and accretion evident.

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4.2 Coastal fabric – shoreline changes (east)

Short term

Foul Bay
Yorke Peninsula (South Coast)
Cell YP49.2
Shoreline changes

Foul Bay (east)
Year: 2020

The dotted line indicates the position of the shoreline in 1981.

This two-year period was characterized by significant accretion on the eastern end of Diosma Drive (~8-14m).

The coastline between Diosma and Hillier was largely stable with minor erosion and accretion evident, but the point just west of Diosma Drive also accreted substantially.

See also summary next page.

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4.2 Coastal fabric – shoreline changes (east)

Short term

Foul Bay
Yorke Peninsula (South Coast)
Cell YP49.2
Shoreline changes

Foul Bay (East)
Summary

40 years
Overall, the eastern end of this section in the vicinity of Diosma Drive has accreted 30-50m.
The area in the vicinity of Hillier Crescent underwent periods of erosion and accretion but was more stable.

Summary
Generally, the area of Mud Alley has eroded while Diosma Drive has accreted. The area between Hillier Crescent and Diosma Drive represents the midpoint around which the coastline has rotated.

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4-4 Coastal fabric – human intervention (Mud Alley)

MODIFIED COASTS

Urban settlements placed too close to shorelines impose rigidity in the backshores, which were formerly flexible and more able to cope with the natural cycles of accretion and erosion. If sea levels rise as projected, then beach shorelines will recede. Those beaches that have room to recede will tend to maintain their existing profile and sand levels. Those that cannot recede will suffer erosion at the human-coastline interface and tend to lose sand levels from their beaches. Furthermore, protection items that may be installed into backshores may change the operation of the beach and increase erosion in adjacent locations.

Archival review

Studies conducted in 1985 and 1994 (see above) concluded that:

- the coast showed considerable natural instability and an allowance of 20-30m is recommended for natural coastline fluctuations.
- Protection was not recommended because of the beach loss and erosion that would result.
- In the longer term, sand supply may decrease from the west leaving exposed limestone reef and erosion may move eastward.

Historical aerial review

The historical aerial review demonstrated that since 1981 the beach has eroded up to 30m in the Mud Alley region and accreted up to 45m in the Diosma Drive region which tends to support the earlier findings. These issues are analysed further below.

4-4 Coastal fabric – human intervention (Diosma Drive)

MODIFIED COASTS

Urban settlements placed too close to shorelines impose rigidity in the backshores, which were formerly flexible and more able to cope with the natural cycles of accretion and erosion. If sea levels rise as projected, then beach shorelines will recede. Those beaches that have room to recede will tend to maintain their existing profile and sand levels. Those that cannot recede will suffer erosion at the human-coastline interface and tend to lose sand levels from their beaches. Furthermore, protection items that may be installed into backshores may change the operation of the beach and increase erosion in adjacent locations.

Informal protection items

Records at Department of Environment and Water and some recent anecdotes recount the installation of informal protection measures in the Diosma Drive region, especially on the eastern end:

- Infilling dune depressions with rocks (1985).
- Small rock / concrete wall (1994).
- Dumping of rock in front of a house on eastern end (date unknown).
- Stacking branches in the dunes to increase sand retention (2005).

Key points

These archival references inform us that erosion was a problem in the vicinity of Diosma Drive in the 1980s and 1990s. Conversely, there are no references in the archives about erosion in the west at Mud Alley. Note also that the limestone reef appears to diminish towards the east.

4-4 Coastal fabric – human intervention (Foul Bay)

LAND USE ZONING

Human intervention is generally controlled in South Australia by the *Planning, Development and Infrastructure Act, 2016*. The purpose here is not to provide a legal interpretation of the planning system, but to provide an understanding of the framework that guides development and how coastal hazards are managed[1]. Further investigation may be required when considering adaptation options.

Land Use (Zoning):

Conservation Zone

Areas outside the immediate residential area are zoned *Coastal Conservation.* This zoning restricts most forms of development.

Rural Shack Settlement Zone

The 'desired outcome' is for 'limited development within an environment where natural processes such as flooding, sea-level rise, and erosion occur. The natural environment is protected from inappropriate development and existing development is upgraded to incorporate environmental improvements'.

Performance outcomes include (2 only):

- Predominantly low-density residential development with complementary non-residential uses compatible with a low-density residential character and natural environment. Detached dwellings only.
- Provision of small-scale tourist and visitor facilities such as public amenities and barbeque and picnic infrastructure.

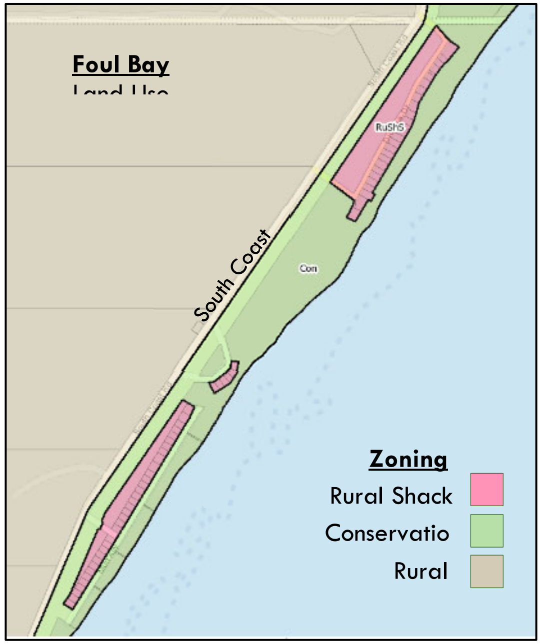
Land division is classified as 'restricted', but this may be under review (Email, Coast and Marine Branch, 18 August 2022).

Overlays (Coastal)

Hazard controls are managed within the planning system by overlays. The land seaward of South Coast Road is subject to a *Coastal Areas* overlay (Figure X) which provides the context from which to evaluate coastal hazard risks of inundation, erosion, sand drift, or coastal acid sulfate soils. Of these four risks, only inundation and erosion are under consideration in Foul Bay.

Inundation Hazard Controls

- Development, including associated roads and parking areas, is protected from the *standard sea flood risk level* and 0.3m of sea level rise (indicatively by 2050) but there must be practical means to protect from 1.0m sea level rise (indicatively by 2100).



[1] Refer to https://sappa.plan.sa.gov.au for comprehensive review.

4-4 Coastal fabric – human intervention (Foul Bay)

HAZARDS CONTROLS

Inundation Hazard Controls (cont.)

- Buildings sited over tidal water or that are not capable of being raised or protected by flood protection measures in the future are protected against the *standard sea flood risk level* and 1m of sea level rise. Therefore, building floor levels to be 1.25m above the *standard sea flood risk level*.
- Specifically in Foul Bay, minimum finished ground level in Foul Bay is 2.90m AHD and minimum finished floor level is 3.15m AHD.

Erosion Hazard Controls

Development will not create or aggravate coastal erosion or require coast protection works that cause or aggravate coastal erosion. Development is set back a sufficient distance from the coast to provide an erosion buffer in addition to a public reserve that will allow for at least 100 years of coastal retreat for single buildings or small-scale developments unless:

- the development incorporates appropriate private coastal protection measures to protect it from anticipated erosion or
- There are formal commitments to protect development from future coastal erosion.

Coast Protection Works

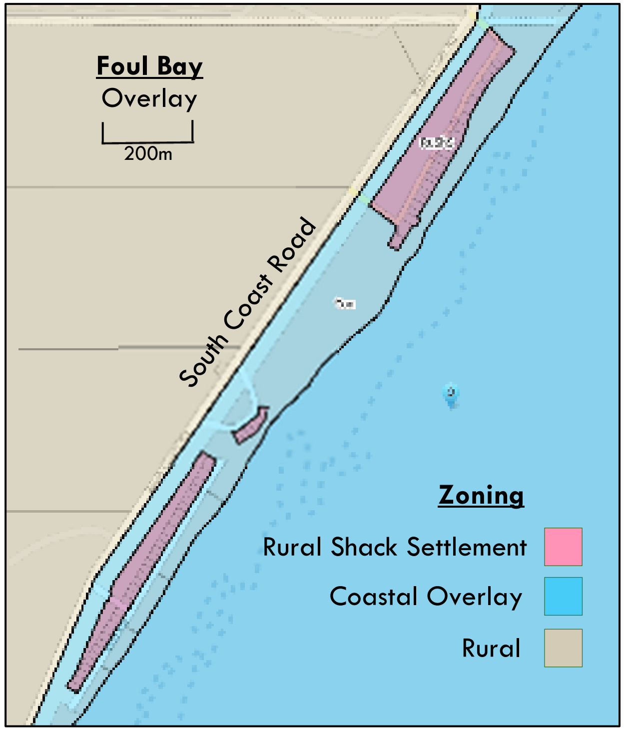
Development avoids the need for coast protection works through measures such as setbacks to protect development from coastal erosion, sea or stormwater flooding, sand drift or other coastal processes.

Unavoidable coast protection works are the subject of binding agreements to cover the cost of future construction, operation, maintenance and management measures and will not:

1. have an adverse effect on coastal ecology, processes, conservation, access and amenity.
2. require commitment of public resources including land.
3. present an unacceptable risk of failure relative to potential hazard resulting from failure.

Standard sea flood risk level

Means the 1% AEP sea flood level (tide, stormwater, and wave effects combined). Using previous tide and storm data this is the height of the storm that is predicted to occur once every 100 years or looking at this another way, there is a 1% chance of this event occurring in any given year. This is a rare event, but it is used as a means to establish safe heights for buildings and roads.



Key Points

Foul Bay residential areas are zoned in a manner that confines development to single dwellings and restricts further subdivision.

A coastal overlay controls and guides how coastal hazards are managed. Sea-flood hazards are managed by site levels and floor levels, and erosion hazards are managed by sufficient setbacks.

4. Coastal fabric – summary table

Foul Bay		Coastal context - natural				Modified	Coastal changes		
Cell	Location	Bathymetry	Benthic	Beach	Backshore	Human	40 years	7 years	**Erodibility**
47.1	Boat ramp to Hillier Crescent	Slope 1:120 (-5m at 600m offshore).	Nearshore dominated by low profile limestone reef interspersed with sand beds. Offshore dominated by dense seagrass beds.	Sheltered. Fine sand beach. Median grain size was assessed as 0.42mm (continued below)	Sandy shore back by low height dunes and sand flat sloping up to South Coast Road at 3-4m AHD. At 500m inland from the shoreline, elevation is ~10m AHD	Interim sandbags have been installed on western end of Mud Alley. Mud Alley imposes a 'hold point' for future erosion (if this occurs).	Significant shoreline ***recession*** west of Mud Alley, and consequent recession in front of Mud Alley as the shoreline realigned.	Significant ***erosion*** since 2015, in particular in the region of Mud Alley (west of the access road).	High Erodibility (low backshore, Holocene sediments). Limestone reef provides some stability.
47.2	Hillier Crescent to Diosma Drive	Slope 1:120 (-5m at 600m offshore).	Same as above, but the reef may diminish in size toward the eastern end of Diosma Drive.	Sand consisted of fine mixed mineral sand with some calcareous material and shells.	Same as above.	Minor informal protection items now made obsolete by significant shoreline accretion.	Significant shoreline **accretion** on the eastern end of Diosma Drive. The coastline has realigned (rotated)	Significant ***accretion*** since 2015, in particular on the eastern end of Diosma Drive.	High Erodibility (low backshore, Holocene sediments). Limestone reef diminishes to the east.

Erodibility Rating: High (3) But not very high (4) due to sheltered position and presence of limestone reef.

Foul Bay: key points

The assessment of Lands Department 1985 noted that Foul Bay was an unstable beach subject to littoral sand drift to the east. The prediction was that if sediment supply declined from the west, that Foul Bay coastline would erode in the west and that this erosion could continue towards the east. The historical analysis shows that significant shoreline recession has occurred in the Mud Alley region (up to 30m) and significant accretion has occurred on the eastern end of Diosma (up 45m). In effect the coastline has realigned or rotated clockwise. The coastline has been recently modified with the installation of sandbags as a temporary measure on the west end of Mud Alley.

5. COASTAL EXPOSURE

To evaluate how actions of the sea currently impact the coastal fabric and how actions of the sea are projected to impact in the future in this section:

- Review impact of storms (if any),
- Analyse routine high-water impact,
- Apply current 1 in 100 sea-flood risk scenarios,
- Analyse these scenarios in time frames: 2020, 2050, 2100,

Viewing instruction:
View sea-flood modelling using full screen mode within your PDF software (Control L). Then use arrow keys to navigate.

5. Coastal exposure – overview

The concept of coastal exposure is something we tend to understand intuitively. For example, if we find ourselves on the shore of a protected bay, we know that the impact from the ocean is likely to be limited. On the other hand, if we are standing on a beach on the Southern Ocean and listening to the roar of the waves, we understand that we are far more exposed.

The residential settlements in Foul Bay are afforded protection due to their location in the bay, and additional protection due to their proximity to the headland of resistant rock to the south-west. Furthermore, the orientation of the shoreline means that the winds that generate storm conditions blow offshore, apart from a wind from the southwest which would blow in line with the coastline. Taking these factors into consideration, Nature Maps (SA) has assigned the exposure rating for Foul Bay as 'moderate' and the wave energy as 'low'[1].

Storm surges

Despite this protection, when a number of meteorological conditions combine, storm surges can produce water levels up to 0.6m higher than the predicted astronomical tide at Port Giles which is the nearest tide gauge to Foul Bay. To manage the risk of these events upon human infrastructure, SA Coast Protection Board has set storm surge policy risk levels for the 1 in 100-year event. In terms of probability, this event is predicted to occur once every hundred years.

However, 'nature' does not read our probability charts and there is no reason why these large events could not occur closer together, albeit unlikely.

The event of 9 May 2016 was the highest event recorded at the Port Giles tide gauge since records began in 1994 (3.38m CD[2] or 1.84 AHD[3]). This event was also the highest on record at Outer Harbor since 1945 and came close to the 100-year event set by South Australian Coast Protection Board. However, there were no reports of flooding for this event at Foul Bay. In contrast, the event of 29 September 2016 (2.79 CD, 1.25m AHD) did impact Foul Bay and one resident believed that this was the first known event to flood Mud Alley[4].

South Australian Coast Protection Board has set the 1 in 100-year storm surge event at Foul Bay at 1.80m AHD and an allowance for wave setup of 0.20m and wave runup of 0.70m. These concepts are illustrated below (Figure a).

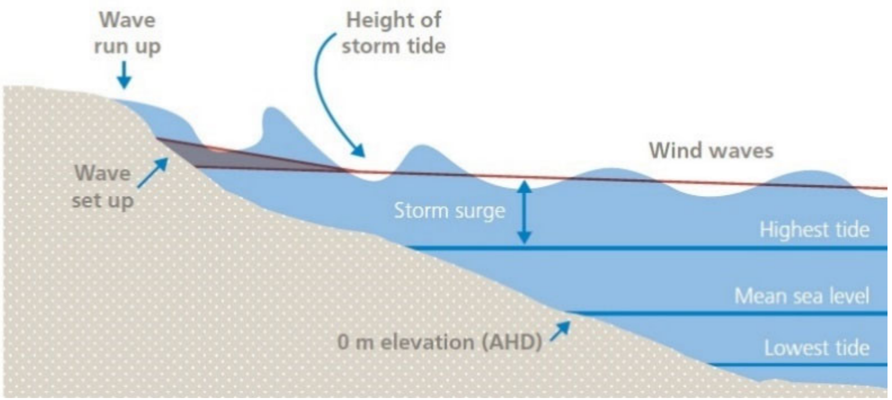


Figure a: Illustration of storm surge, wave setup, and wave runup (CoastAdapt).

[1] https://data.environment.sa.gov.au/NatureMaps

[2] CD stands for Chart Datum and relates to tide heights recorded in the local tide charts.

[3] AHD stands for Australian Height Datum and this is the same measurement system that a surveyor would utilise.

[4] Owner, 65 Mud Alley.

5. Coastal exposure – overview

Routine high water

While storm surges can have a significant impact on the coast, these are rare events. Beaches can recover and any damage can be repaired. Routine tidal action is likely to have a greater impact on the erosion of the backshore over time, especially in the later part of this century if seas rise as projected. In this study we seek to identify a tidal event that is likely to occur once or twice a month within the months of the year that are known to have higher storm action (April to September). To identify this event, we analysed:

- A comparison of monthly high tides between the tide gauges a Port Giles[5] and Outer Harbor from 1994 to 2020.
- The average high tide level in months April to September at Port Giles from 1994 to 2020.
- A three-hour tidal study on 26 August 2022 at the boat ramp of Foul Bay and compared with data from Port Giles tide gauge.
- The highest tidal event of 2021 at Outer Harbor and Port Giles that occurred on 24 July, including wave runup data from overtopping at Mud Alley (see page 54).

The routine event identified for Foul Bay, that is likely to occur once or twice a month for April to September is:

Tide height at Foul Bay[6]	0.80m AHD
Wave setup (from CPB)	0.20m
Wave runup (based on events)	0.50m
Routine tide event for modelling	1.50m AHD

[5] The Port Giles tide gauge is situated within Gulf St Vincent and is positioned approximately midway (as the crow flies) between Foul Bay and Outer Harbor.

Tide gauge analysis:

Port Giles tide gauge has operated from September 1994 and is positioned within Gulf St Vincent about 55kms from Foul Bay. A comparison of the top 50 events within months April to September at Port Giles reveal the following relationship with Outer Harbor:

- Outer Harbor gauge was 350 to 500mm higher than Port Giles (40x).
- Outer Harbor gauge was 500mm to 600mm higher than Port Giles (9x). Generally, these events were grouped in the top ten events.
- 38 of the top 50 events in Port Giles occurred in months May to July.
- The average of monthly high tide calculated at Port Giles from 1994 to 2000 in months April to September was 1.58 (CD) or **1.04 (AHD).**

The events of 9 May 2016 (Highest at Outer Harbor) and July 1995 (Sixth highest at Outer Harbor) were congruent with the Port Giles data.

Tidal study – 26 August 2022

Survey equipment was utilised to record the level of the tide (AHD) at 15-minute intervals at the boat ramp of Foul Bay from 1350 to 1650 hours. Ten-minute data is immediately available online for Port Giles, but this data is subject to potential peaks and troughs that can be further evaluated and averaged (when 1 minute data is available). The initial findings of the tide study:

- There was very strong congruence in the data if Foul Bay data was positioned 1 hour later than the Port Giles data.
- The difference between the two tide heights was between 290mm and 316mm Therefore, for modelling purposes we can tentatively adopt 300mm lower at Foul Bay than Pt Giles.

[6] Average tide height is 1.04 AHD at Port Giles. Less 0.30m adjustment (based on tidal study), say 0.80m AHD at Foul Bay.

5. Coastal exposure – overview

SEA LEVEL RISE

Long term variability of sea levels

Climate change occurs over long timescales in response to solar variations, changes in the Earth's orbit around the Sun, volcanic eruptions, movement of the continents and natural variability[7]. Sea levels reflect the state of the climate system. During ice ages a large volume of water is stored on land in the form of ice sheets and glaciers, leading to lower sea levels, while during warm interglacial periods, glaciers and ice sheets are reduced and more water is stored in the oceans[8]. Over the last few thousand years sea levels have stabilised and this has coincided with the time that urban settlements have been established in close proximity to the coast all over the world.

Global mean sea levels

Tide gauge records show that seas began to rise in the mid-19th century and this trend has continued throughout the 20th century at on average rate of 1.7mm per year. The average level of the ocean is known as global mean sea level (GMSL). While the average rate of rise was 1.7mm/yr over the last century, this rate of rise was not constant. Rates of sea level rise were higher in the period 1920s to1940s[9] (in the context of higher global temperatures and melting of the Greenland ice sheets[10]). From the 1990s, rates of sea level rise have also been observed at a higher rate than 1.7mm/yr. It is likely that the current rate of rise is not unusual in the context of natural variability and the data record from last century[9].

[7] Coast Adapt (2017).

[8] CSRIO (2020) Sea level, waves and coastal extremes.

[9] IPCC, WG1AR5, Sea level change, 2014, Watson, P, 2020, Updated mean sea-level analysis.

Regional sea levels

Regional changes occur in sea level, but these do not change the overall mass of the ocean. For example, regional sea levels change with the climate variability associated with El Nino and La Nina cycles. During El Nino years sea level rises in the eastern Pacific and falls in the western Pacific, whereas in La Nina years the opposite is true. Longer term changes are also associated with changes in the Trade Winds which bring increases in sea levels in the Western Tropical Pacific region[7]. Sea levels can also change in relationship to the vertical movement of land. If an area of land is falling, then in relative terms, sea levels will rise, and vice versa.

Since 1990, satellites have been tracking global mean sea level rise at 3-4mm per year in our region[11]. This data correlates well with basic calculations of sea level rise from 1990 from tide gauges at Victor Harbor (2.48mm), Port Giles (2.58mm), and Port Lincoln (2.14mm)[12]. A recent study by P. Watson (2020) demonstrated similar rates of rise at Outer Harbor[11].

Projected sea level rise.

Projections of future climate change are carried out using climate models that use various greenhouse gas emissions scenarios. These models are computer-based simulations of the earth-ocean-atmosphere system that identify plausible futures as to how the climate will respond over the coming century. Sea level rise projections are based upon these various scenarios.

[10] Curry, J., Sea level and climate change, 2019.

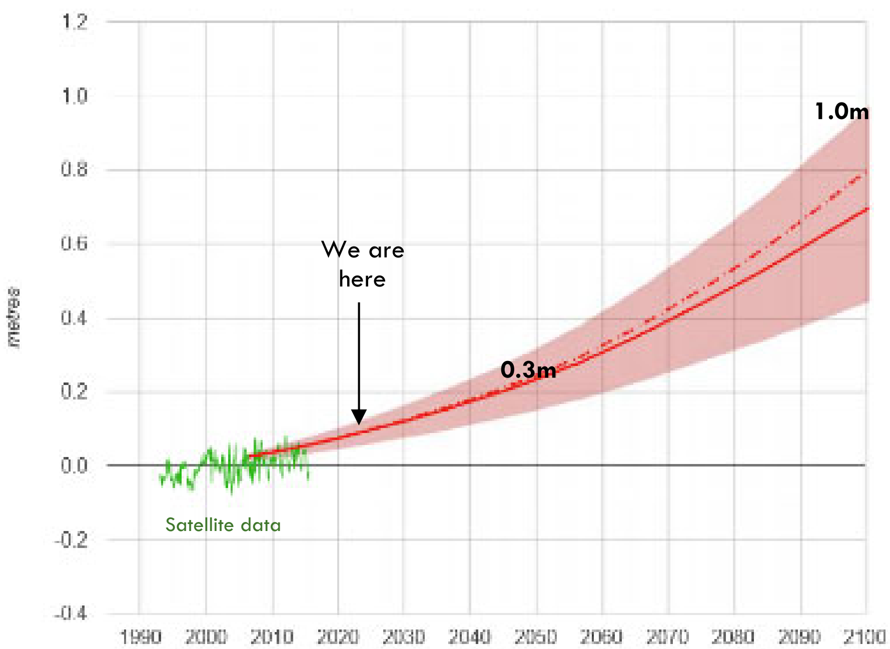
[11] Watson, P. 2020, Updated mean sea-level analysis.

[12] Calculations from sealevel.info

5. Coastal exposure – overview

Projected sea level rise (cont).

The Intergovernmental Panel on Climate Change (2014) developed four sea level rises scenarios based on various greenhouse gas emission scenarios from 'very low' to 'very high'. In 1993, South Australian Coast Protection Board (CPB) adopted sea level rise allowances into planning policy of 0.3m rise by 2050 and 1.0m rise by 2100. These sea level rise projections are similar to the high emissions scenario shown in the figure below (Figure a). Therefore, it is acknowledged that the future sea-flood scenarios shown in this section of the report represent the most pessimistic outlook of the sea level rise scenarios rates of sea level rise. On the other hand, we need to remember that current rates of sea level rise remain relatively low.



The events modelled in this section.

Historical events:

29 September 2016.

Tide height	0.95m AHD
Wave setup	0.20m
Wave runup	0.70m
Total	1.85m AHD

21 July 2021 had similar wave effects total height as 29 September 2016 on the western end of Mud Alley, but at a different ration of the inputs.

Routine high-water event:

Established with tide gauge and tidal monitoring at Foul Bay.

Tide height	0.80m AHD
Wave setup	0.20m
Waver runup	0.50m
Total	1.50m AHD (Current)

Add 0.30m for 2050 scenario and 1.0m for 2100 scenario.

Storm surge events:

Based on Coast Protection Board 1 in 100-year sea-flood and sea level rise risk policy levels of 0.30 and 1.00m.

Storm surge	1.80m AHD
Wave setup	0.20m
Wave runup	0.70m
Total	2.70m AHD

Add 0.30m for 2050 scenario and 1.0m for 2100 scenario.

Figure a: Sea level rise high emissions scenario (RCP 8.5) and including SA Coast Protection Board sea level rise policy projections (Adapted from CoastAdapt, 2017).

5. Coastal exposure – overview

Overview

Foul Bay

Yorke Peninsula

Coastal Exposure

Overview

SA Classification

Nature Maps (SA)

Relative Exposure:
Sheltered

Wave energy:
Low

Shoreline class
Rock Platform

Sand rating
Coarse Sand

Form:
Overall slope of ocean floor: -5m ~700 to 1000m from beach (overall slope ratio ~1:150).

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Key points. The prevailing winds are from the north-west to south-west. North-west and westerly winds blow offshore from Foul Bay. A southwest wind (which is associated with the most elevated waters in Gulf St Vincent) blows along shore. South to south easterly blow onshore but these winds are not associated with strong storm events, but rather occur after a storm system has passed. It is likely that storm conditions that impact Foul Bay are elevated swell waves that sweep around the southern point (near boat ramp).

5. Coastal exposure – storm impact (29 September 2016)

29 SEPTEMBER 2016

<u>Key points:</u>

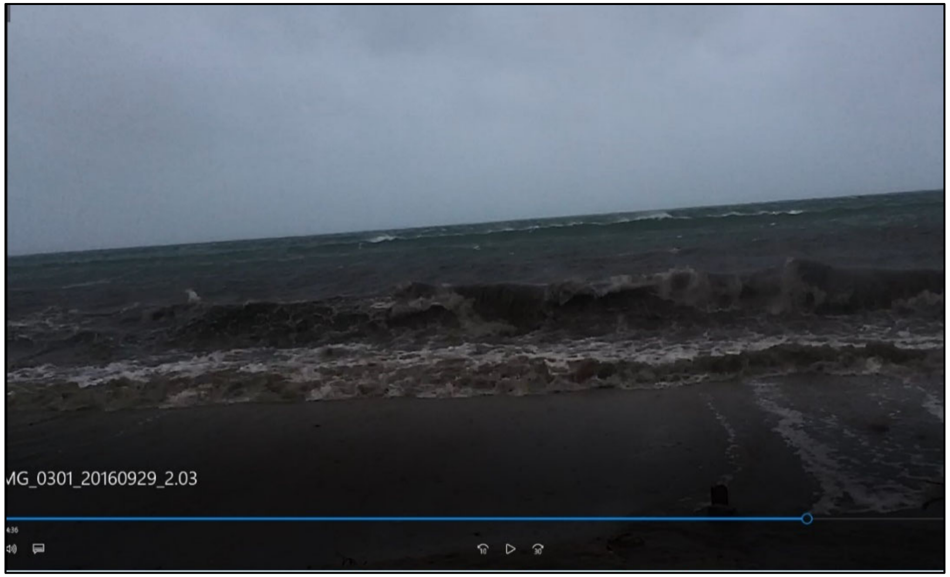
- This may be the first event that overtopped Mud Alley on the southern end (resident's recollection).
- This event was the day after the storm event for 28 September which blew over transmission lines and caused the South Australian blackout.
- It was not an event felt severely within Gulf St Vincent but was felt in Spencer Gulf. Foul Bay's position on the southern coast of Yorke Peninsula may leave it open to weather events that impact either or both Gulfs, but this has not been established.
- Photographs and videos were taken by Tony Pelgrave at around 2pm. Analysis of the tide gauge at Port Giles demonstrated that the tide remained at a similar height between 2pm and 3pm at 1.25m AHD.
- The height of the wave effects was established by using video footage of the event to identify locations that would be suitable to survey. Two locations were surveyed on 26/08/22 at 1.87m and 1.86m AHD.
- Therefore, this storm was assigned:

Storm Surge (AHD)*	0.95m
Wave setup (CPB)	0.20m
Wave run-up	<u>0.70m</u>
Total risk (AHD)	1.85m

*Based on Port Giles 1.25m AHD, less 0.30m for adjustment to Foul Bay (based on tidal study, 22 August, 22).

5. Coastal exposure – storm impact (29 September 2016)

29 SEPTEMBER 2016



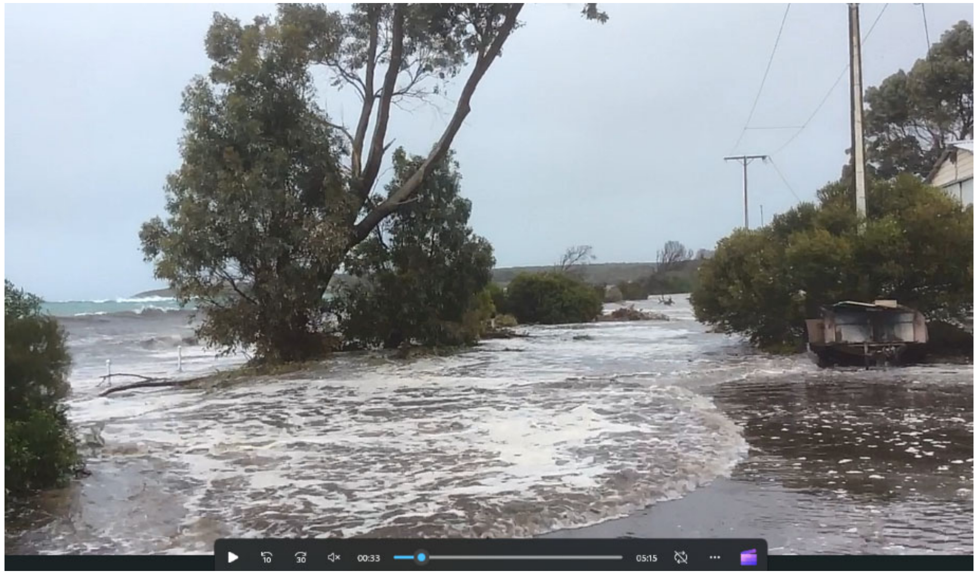


Figure a (top left): Wave height ~1m. Spray is along-shore indicating a SW wind (Source: Tony Pelgrave).

Figure b (top right): Note the proximity of breaking waves to the shore (Source: Tony Pelgrave).

Figure c (bottom left): Waves overtopping frontal dune on the eastern end of Mud Alley (Source: Tony Pelgrave).

Figure d (bottom right): Small flows of seawater to Mud Alley (eastern end of Mud Alley. This event is likely to be the only event where seawater has flowed to Mud Alley (Source: Tony Pelgrave).

5. Coastal exposure – storm impact (29 September 2016)

Storm event

Foul Bay (West)
Yorke Peninsula
Cell YP49.1
Event 29 September 2016

Mud Alley

The event modelled:

Storm Surge (AHD)*	0.95m
Wave setup (CPB)	0.20m
Wave run-up	0.70m
Total risk (AHD)	1.85m

*Calculated as 1.25m AHD at Port Giles. Tidal study on 27 August indicated Foul Bay may be 0.30m lower than Port Giles (and one hour behind).

Note…there is very strong congruence with the survey at 1.85 and the calculation above which is a positive outcome, but it shouldn't be over interpreted in the context of one tidal study.

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5. Coastal exposure – storm impact (29 September 2016)

Storm event

Foul Bay (East)

Yorke Peninsula

Cell YP49.2

Event 29 September 2016

Diosma Drive

The event modelled:

Storm Surge (AHD)*	0.95m
Wave setup (CPB)	0.20m
Wave run-up	0.70m
Total risk (AHD)	1.85m

*Calculated as 1.25m AHD at Port Giles. Tidal study on 27 August indicated Foul Bay may be 0.30m lower than Port Giles (and one hour behind).

Note…there is very strong congruence with the survey at 1.85 and the calculation above which is a positive outcome, but it shouldn't be over interpreted in the context of one tidal study.

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5. Coastal exposure – storm impact (24 July 2021)

24 JULY 2021

Key points:

- This event was the highest for 2021 at the Outer Harbor tide gauge but was outside the top fifty events for the Port Giles gauge (20 years).
- The tide height at Port Giles was 0.30m HIGHER than the storm event of 29 September 2016. This may indicate that we do not fully understand the relationship of Foul Bay to the Port Giles tide gauge.
- The event was not accompanied by high waves, but ironically the wave effects were surveyed at the same as 29 September 2016, but and in similar locations.
- The loss of dune since the 2016 is likely to have increased the impact of the event which was less intense than 29 September 2016.
- Therefore, this storm was assigned:

Storm Surge (AHD)*	1.25m
Wave setup**	0.10m
Wave run-up**	0.50m
Total risk (AHD)	1.85m

*Storm surge at Port Giles was 1.54 AHD less 0.30 adjustment for Foul Bay is 1.24 (say 1.25m AHD).

** The total wave effects were surveyed at average of 1.87m AHD, say 1.85m AHD. The wave effects are divided into 0.10m wave setup (based on observation of wave height) and the residual of 0.50m to wave runup.

Figure a (top): The photograph was utilised as a basis for survey on 26 August 22, at range 1.84 to 1.94m AHD (average 1.89m AHD).

Figure b (bottom): Surveying the location of the seaweed strand on 26 August 22, 1.86m AHD.

5. Coastal exposure – storm impact (24 July 2021)

Storm event

Foul Bay (West)

Yorke Peninsula

Cell YP49.1

Event 24 July 2021

Mud Alley

The event modelled:

Storm Surge (AHD)*	1.25m
Wave setup**	0.10m
Wave run-up**	0.50m
Total risk (AHD)	1.85m

*Calculated as 1.54m AHD at Port Giles. Tidal study on 27 August indicated Foul Bay may be 0.30m lower than Port Giles (and one hour behind).

**Wave setup assigned based on observations of low wave height and the residual assigned to wave run-up.

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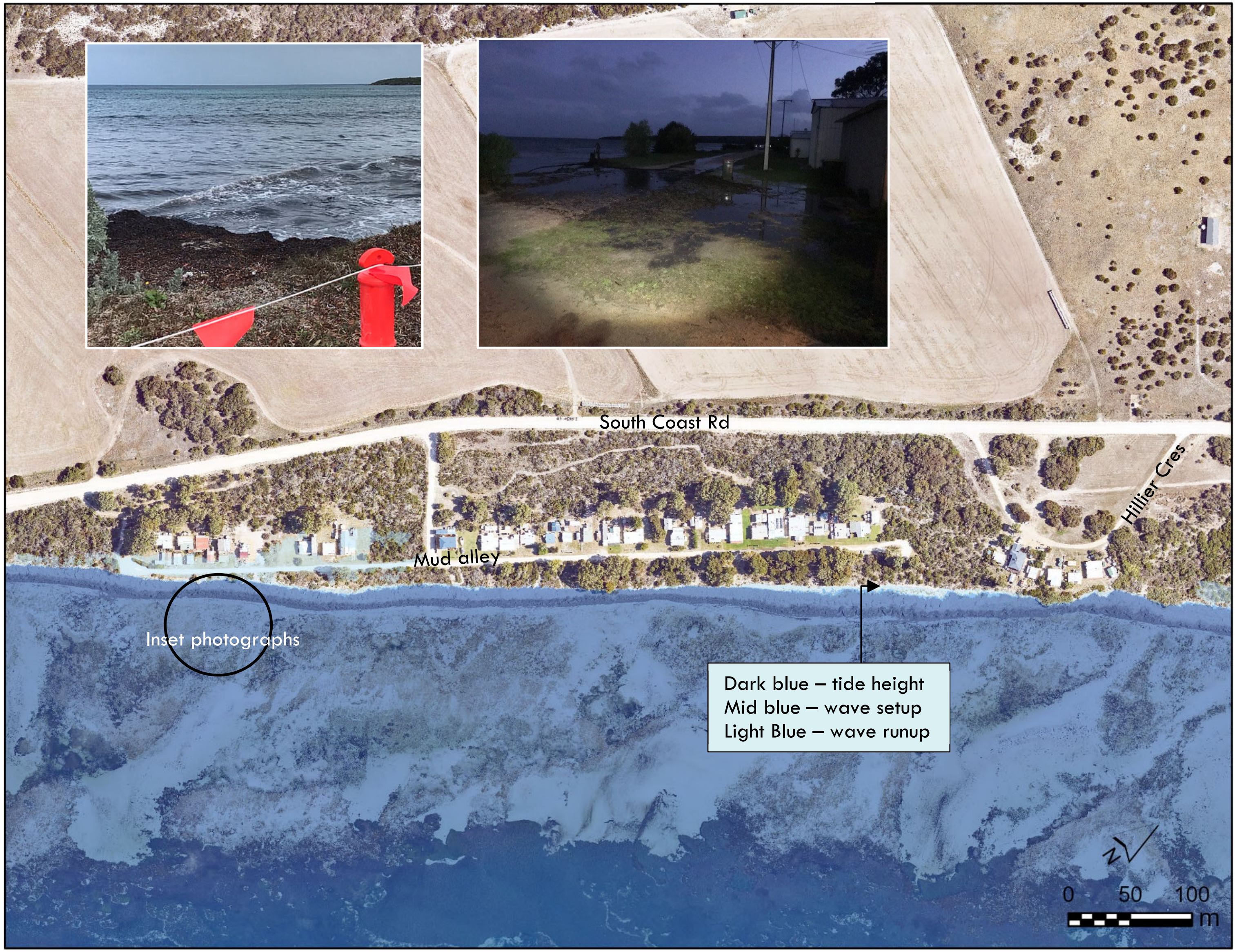

5. Coastal exposure – storm impact (24 July 2021)

Storm event

Foul Bay (East)

Yorke Peninsula

Cell YP49.2

Event 24 July 2021

Diosma Drive

The event modelled:

Storm Surge (AHD)*	1.25m
Wave setup**	0.10m
Wave run-up**	0.50m
Total risk (AHD)	1.85m

*Calculated as 1.54m AHD at Port Giles. Tidal study on 27 August indicated Foul Bay may be 0.30m lower than Port Giles (and one hour behind).

**Wave setup assigned based on observations of low wave height and the residual assigned to wave run-up.

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5. Coastal exposure – storm impact (hypothetical 1)

Storm event

Foul Bay (West)

Yorke Peninsula
Cell YP49.1
Event: hybrid

Mud Alley

If the wave effects for 29 September 2016 occurred on the tidal event for 21 July 2021 the event modelled would be as follows:

Storm Surge (AHD)*	1.25m
Wave setup**	0.20m
Wave run-up	0.70m
Total risk (AHD)	2.15m

*Calculated as 1.54m AHD at Port Giles. Tidal study on 27 August indicated Foul Bay may be 0.30m lower than Port Giles (and one hour behind).
**Wave setup assigned based on 1 in 100-year ARI event. Note, the event of 21 July was NOT in the top 50 events since records began in 1994.

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5. Coastal exposure – storm impact (hypothetical 1)

Storm event

Foul Bay (East)

Yorke Peninsula

Cell YP49.2

Event: hybrid

Diosma Drive

If the wave effects for 29 September 2016 occurred on the tidal event for 21 July 2021 the event modelled would be as follows:

Storm Surge (AHD)*	1.25m
Wave setup**	0.20m
Wave run-up	0.70m
Total risk (AHD)	2.15m

*Calculated as 1.54m AHD at Port Giles. Tidal study on 27 August indicated Foul Bay may be 0.30m lower than Port Giles (and one hour behind).

**Wave setup assigned based on 1 in 100-year ARI event. Note, the event of 21 July was NOT in the top 50 events since records began in 1994.

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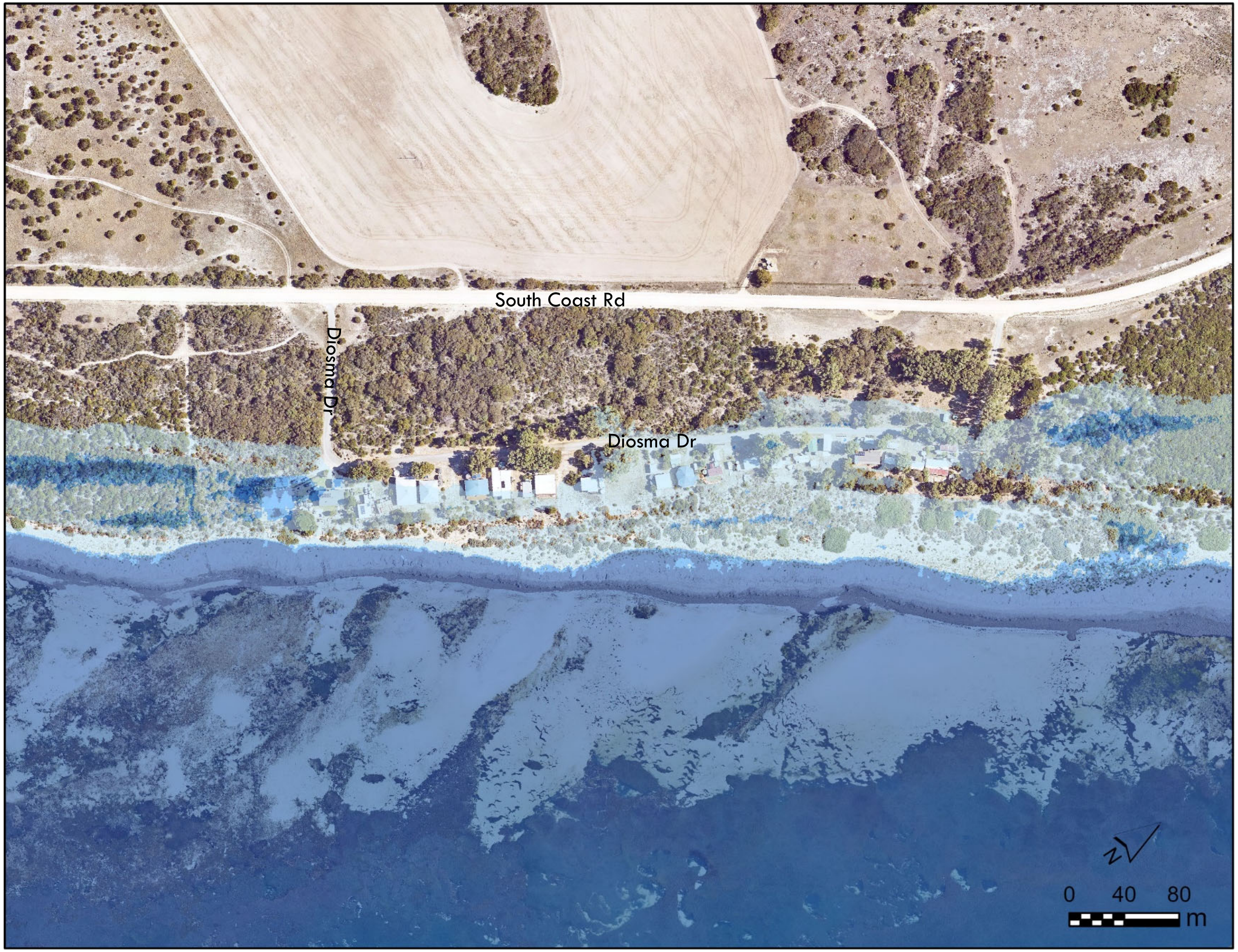

5. Coastal exposure – storm impact (hypothetical 2)

Storm event

Foul Bay (West)

Yorke Peninsula

Cell YP49.1

Event: without dunes

Mud Alley

The dune ridge is relatively low and of narrow width. If these dunes continue to erode, then seawater will directly impact Mud Alley on a more routine basis.

Modelling the event from 24 July 2021 (which has similar wave effects as 29 September 2016) without taking into account flow paths demonstrates the likely flood pattern.

Note, this event was not in top 50 events for Port Giles since records began in 1994 and therefore could be expected to occur once or twice a year.

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5. Coastal exposure – storm impact (hypothetical 2)

Storm event

Foul Bay (East)

Yorke Peninsula

Cell YP49.2

Event: Without dunes

Diosma Drive

The dune ridge is relatively low but there is reasonable width of dunes in this location (20m to 45m). It is important to remember that thirty years ago there were no dunes in this location. If the Lands Department study of 1985 is correct then the sand could continue to move eastward, and if limited sand supply is coming from the west then these dunes could also begin to erode again.

Modelling the event from 24 July 2021 (which has similar wave effects as 29 September 2016) without considering flow paths

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5. Coastal exposure – scenario modelling (Mud Alley)

Location

Foul Bay (West)

Yorke Peninsula

Cell YP49.1

Mud Alley

Location Map

The scenarios modelled are:

Routine tide: is likely to have greater impact on the backshore over time. Routine high-water events are expected to occur a few times per month from April to September.

1 in 100-year ARI storm event (CPB) The timing of the scenarios:

- Current
- 2050
- 2100

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