Review of coastal hazards and adaptation options for:

FOUL BAY,
YORKE PENINSULA

Prepared for:
Yorke Peninsula Council

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Front cover photographs:

Aerial photograph, P. Hesp, Flinders University July 2022,
Flood photograph, R. Bushell, Foul Bay, July 2021.

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Background and methodology

Yorke Peninsula Council has engaged Integrated Coasts to undertake a review of the coastal hazards at Foul Bay and to produce an adaptation strategy to manage these coastal hazards.

REPORTING LAYOUT

This project is divided into two sections. Section 1 is the Coastal Hazard Assessment which identifies the historical circumstances of the settlement, geomorphology, and vulnerability to coastal hazards both in this current era and taking into account sea level rise.

Section 2 is the Coastal Adaptation Strategy which draws on Section 1 but also can be read as a standalone document and therefore functions like an executive summary. Included in Section 2 are summary tables with actions which are prioritised according to time.

BACKGROUND TO THE PROJECT

Foul Bay is located on the southern coastline of Yorke Peninsula. In 2018, inundation mapping was carried out by Integrated Coasts for settlements in Foul Bay, concluding that Mud Alley had a very high inundation risk. Erosion risk was also identified as a key concern for Mud Alley, with the report concluding that Foul Bay may be vulnerable to both erosion and inundation in the next major storm event. Additional background to the project includes the impact of the storms of 29 September 2016 and 14 July 2021 and observations of rapid erosion in the southern portion of Mud Alley.

The initial area of interest was confined to the Mud Alley portion of Foul Bay. However, preliminary investigation showed that erosion and accretion trends were acting upon all the residential sections of Foul Bay. Therefore, the area of interest was expanded to include all settlements within Foul Bay.

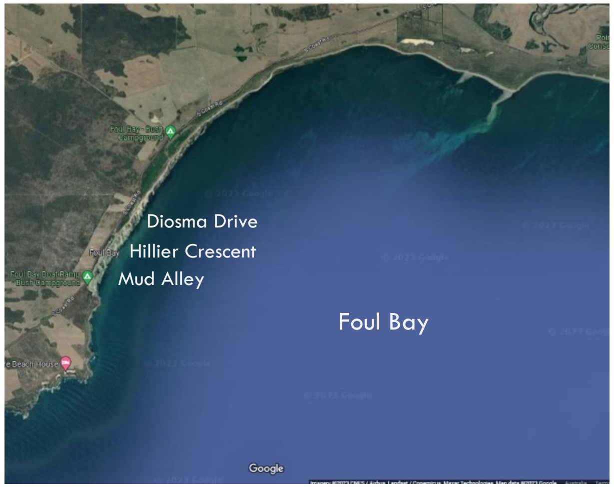

Figure a: Area of Interest (Google Maps, 2023)

METHODOLOGY

This project adopts a simple and intuitive assessment framework. Adopting a conceptual framework ensures that the study is accessible to all stakeholders and that projects are completed in a systematic manner. Coastal hazards experienced along a section of a coastline can be generally framed in terms of the nature of the 'fabric' (the nature of the geology and form) in the context of the nature of the 'exposure' (the impact of wind, tides, waves) (Figure b).

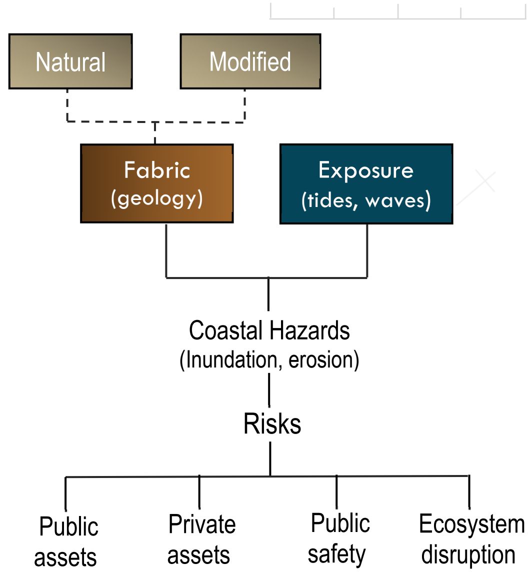

Figure b: Conceptual Assessment Framework (Integrated Coasts, 2017)

Background and methodology

METHODOLOGY (CONT)

Coastal Hazards

South Australian Coast Protection Board considers three main coastal hazards: inundation, erosion, and sand drift[1]. Due to the nature of the Foul Bay coastline, only the first two are under consideration in this project. Inundation and erosion hazards experienced along a section of a coastline can be assessed by considering two main coastal features: ***coastal fabric*** and ***coastal exposure***.

Coastal fabric

Geological setting

Intuitively we understand that if we are standing on an elevated coastline of granite that the coast is not easily erodible. Conversely, we understand if we are standing on a low sandy dune that erosion may indeed be a factor. It is the geology of the coast upon which our settlements are situated that determines one side of the hazard assessment in terms of elevation (height above sea level), and the nature of the fabric of the coasts (how resistant it is to erosion). We assess coastal geology in four categories of erodibility:

- Low erodibility
- Moderate erodibility
- High erodibility
- Very high erodibility

The following aspects are analysed:

- Geology (landforms),
- Bathymetry and Benthic (forms of the seafloor),
- Geomorphology (how the coast was formed and changes over time),
- Historical shoreline analysis (erosion trends).

Coastal modifiers (human intervention)

In some locations there are additional factors that modify this core relationship between fabric and exposure. For example, an earthen levee has been installed at Coobowie. A seawall has been installed at Port Vincent. Esplanade roads can act as 'hold points' that prevent dune systems from receding. These installations can modify the fabric of the coast in elevation (i.e. increasing height above sea level), or modify the nature of the fabric, for example, from sand to 'rock'. However, such installations sometimes alter the natural processes of the coast. For example, new erosion problems may emerge either side of the installation or sand levels may decline on the beach. In this study we identify how the coast has been modified and the implications (if any). Furthermore, we review the history of the Foul Bay settlement to ascertain how humans have interacted with this part of the coast over time.

Coastal exposure (actions of the sea)

If we find ourselves on the shore of a protected bay, or in the upper reaches of a gulf, we intuitively 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.

[1] The concept of sand drift as a hazard relates to sand movements that would threaten human settlement.

Background and methodology

METHODOLOGY (CONT)

This assessment categorises coastal exposure in four main ways:

- Very sheltered
- Moderately sheltered
- Moderately exposed
- Very exposed

The following aspects are analysed:

- Exposure ratings from Nature Maps (SA),
- Historical flood events,
- Sea flood mapping for 1 in 100-year ARI events set by Coast Protection Board.

Hazard risk assessments

Inherent risk assessment

The coast is then assessed to determine how inherently at risk it is to the coastal hazards of inundation or erosion. For example, areas of land that are elevated are not at inherently at risk from inundation, whereas low lying land is more inherently vulnerable to inundation. Landforms that are highly erodible are assigned as higher risk because they are inherently more vulnerable to erosion, and the converse applies.

Changes in the relationship

In a coastal adaptation study, we are also interested to know how this relationship between fabric and exposure may change over time, and what this may mean in the context of the coastal settlement. Our sea levels have been quite stable for several thousand years (after falling 1-2 metres about 5-6,000 years ago). In the last century sea level rose on average at ~1.7mm per year and larger rates of rises have occurred since 1990 (2.5-3.5 mm in our region)[2]. The general consensus of the scientific community is that the rate of sea level rise will continue to escalate towards the end of this century, but the exact rate is uncertain. What is certain is that if seas rise as projected then the relationship between fabric and exposure will change significantly in some coastal locations.

In this study, we will model the event of 14 July 2021, the current 1 in 100-year storm surge events, and sea level rise projections for 2050 and 2100[3].

Specific risk assessment

Considering all of the above, impacts of erosion and inundation hazards are then considered within four receiving environments:

- Public infrastructure
- Private assets
- Public safety
- Ecosystem disruption

Using Yorke Peninsula Council's risk assessment framework, we analyse current risk (2020) and future risk (2100). The latter time frame is utilised because human infrastructure such as housing and roads normally have long life spans.

Coastal Cells

In summary, the aim of this project is to evaluate the relationship between the fabric of the coast and its current exposure to actions of the sea and how this relationship may change with rising sea levels. We conduct this evaluation within the secondary coastal cell ***Yorke Peninsula - South Coast***[4] and within tertiary cell, ***Yorke Peninsula YP-49*** (Nature Maps SA).

[2] www.sealevelrise.info, mean sea level rise since 1990 for Port Giles (2.58mm), Victor Harbor (2.48) and Outer Harbor (3.60mm).

[3] These risk levels are set by SA Coast Protection Board.

[4] www.coastadapt.com

Stage 1

Coastal Hazard Assessment

1. Introduction

Regional Setting

Cell YP-49

Secondary Cell:

Yorke Peninsula (South Coast)

Australian regional setting
Foul Bay is situated within the Yorke Peninsula South Coast secondary cell.

Geomorphology of the cell:
Most of the south facing coast is exposed to swell waves. This coast is characterised by rocky headlands, shore platforms and cliffs with crenulated coastline.

Sediment supply has accumulated through the Pleistocene and Holocene but is predicted to decline. Sediment generally moves west to east with accumulation, such as at Sultana Point which is located at the eastern end of this compartment. There are massive sand deposits of the Troubridge shoals and sand cay.

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The dominant regional processes influencing coastal geomorphology in this region are the Mediterranean to humid cool-temperate climate, micro-tides, high energy south-westerly swells, westerly seas, carbonate sediments with interrupted swell driven longshore transport, and the Southern Annular Mode (driving dominant south-westerly swells and storms). Regional hazards or processes driving large scale rapid coastal changes include: mid-latitude cyclones (depressions), storm surges and shelf waves.
Source: https://coastadapt.com.au/sites/default/files/docs/sediment_compartments/SA02.01.07.pdf

1. Introduction

Regional Setting

Cell YP-49

Tertiary Cell:

Foul Bay

Relative Exposure

Moderate

Wave energy

Low

Shoreline class

Reflective and sand flats

Substrate

Nature Maps ascribes 'coarse sand'. However, low profile limestone reef is present in the south of the bay.

Form

Low to moderate (3-10 degrees)

Other

Seagrass grows almost to the shore.

Source: Nature Maps (SA)

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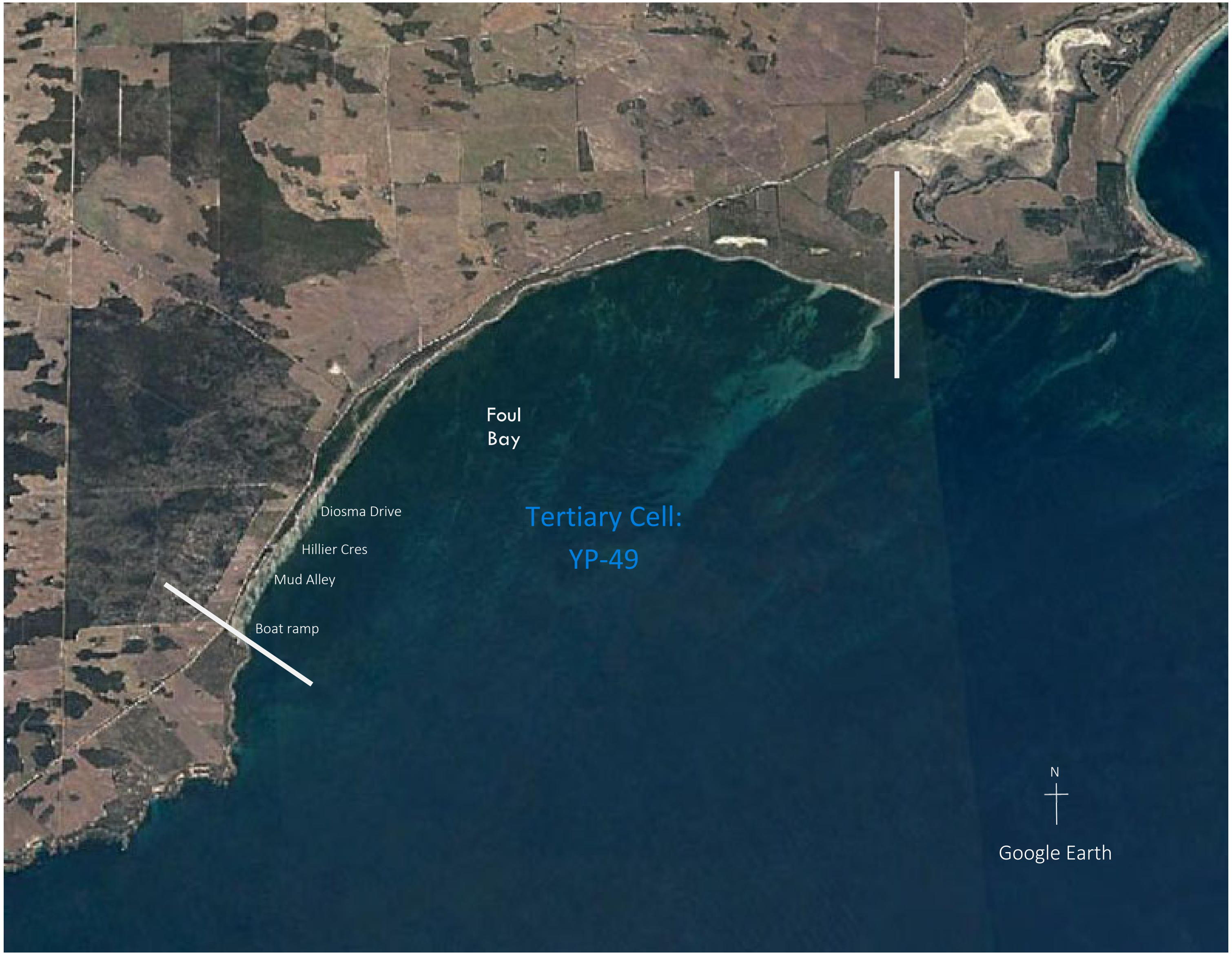

2. SETTLEMENT HISTORY

A historical review ensures that the circumstances in which the settlement was founded are understood, identifies how actions of the sea have interacted with the settlement, and builds appropriately on previous study. In this section we:

- Give a brief history of the settlement
- Review archives at Coastal Management Branch
- Identify key coastal studies
- Identify implementation of key coastal structures

2. Settlement history

The first purpose of this section is to identify the key factors of settlement history in the context of the coastal environment. The second purpose is to identify key studies and plans so that we bring all previous work into one place of reference. Sources for this section of work include archival review of Department of Environment and Water (DEW) and general internet searches.

BRIEF HISTORY

Early history

For thousands of years before European settlement, the Narungga people (traditionally spelled, 'Nharangga') also known as Adjahdura, moved among their many campsites across Yorke Peninsula while hunting, fishing, and gathering food. More recently the area of Foul Bay has been used as farming land. Foul Bay is probably named after the decaying seagrass that is usually found on the beach and perhaps due to the shallow water and reefs[5].

Shack site

In 1954, the Sarah family built the first coastal house on Section 169 (Shack 100) on the southern extremity of Foul Bay. They also constructed a boat ramp in the early 1960s on public land and the ramp is therefore also used by the public. The area just to the north has been utilised as a campground from the 1960s until current time. The boat ramp area and campground are currently accessed by Boat Ramp Road. These southern areas of Foul Bay are outside the scope of this project.

Archival search at Department of Environment and Water (DEW) revealed that 'about 50 shack sites'[6] were established in the 1960s by District Council of Warooka, which along with other district Councils, was merged into what is now known as Yorke Peninsula Council.

These allotments were positioned upon State Crown Land and were therefore leasehold. In the 1990s, the State Government undertook studies of leasehold sites along the coast and River Murray to ascertain their suitability for conversion to freehold status[7]. Yorke Peninsula Council informs that only 3 properties remain as leasehold tenure, and all of these are situated on Diosma Drive (email, 17 August 2022).

Foul Bay settlement

Foul Bay was formally established in May 1999 as a township or settlement[8]. There are currently 66 coastal allotments and 51 houses[9]:

- Mud Alley – 35 allotments, 24 houses.
- Hillier Crescent – 6 allotments, 6 houses.
- Diosma Drive – 25 allotments, 21 houses.

The aerial photograph of 1976 depicts a very similar number of houses at 50. However, many of the older shacks have been replaced with more substantial dwellings in size and construction.

DEW informs that the number of development applications has increased in recent years. The trend to demolish shacks and rebuild, or to develop vacant allotments, is expected to continue.

Narungga interests

Under the Indigenous Land Use Agreement (ILUA) the land within 5km of the coastline is considered significant and the interests of the Narungga people are considered relevant in coastal management.

[5] https://beachsafe.org.au/beach/sa/yorke-peninsula/foul-bay/foul-bay-east

[6] Archive: 19880801, 550:21:03.

[7] Department of Environment and Natural Resources, 1994, Shack Coastal Hazard Study, A report for the shack site freeholding committee.

[8] https://mapcarta.com/35443110

[9] South Australian Property and Planning Atlas, and site survey of 25/07/2022.

2. Settlement history

COASTAL STRUCTURES

Public infrastructure

The coastal structures in the area are limited to the boat ramp and public roads. Aerial photographs from 1976 show that Mud Alley and Hillier Crescent have always been in their current position. Diosma Drive was formed and sealed circa 2002 which eliminated the various 'bush tracks' from South Coast Road. Mud Alley is the only road positioned between private assets and the dune escarpment. Overhead electrical infrastructure is positioned on the landward side of Mud Alley and seaward side of Diosma Drive. There is no sewer or mains water infrastructure in Foul Bay.

Protection items

Temporary sandbags have been installed on the western end of mud alley as an interim measure to control the erosion in this location.

The Shack Coastal Hazard Study (1994) noted that the owner of Allotment 175 (Likely no. 12 Diosma Drive) had installed a small seawall of grouted rocks with evidence of erosion either side[10]. Archives exist concerning the installation of informal protection on the eastern end of Diosma Drive by means of stones to fill up depressions in the dunes (Lands Department, 1985), branches deposited in the dunes to increase sand deposition (20050127, 20050302) and the dumping of rocks in front of vicinity of 50 Diosma Drive (anecdote from resident). However, due to accretion of the coast in front of Diosma Drive, these would no longer function as protection items.

[10] Department of Environment and Natural Resources, 1994, Shack Coastal Hazard Study, A report for the shack site freeholding committee.

COASTAL STUDIES

There are no formal studies focussed specifically on Foul Bay. Two studies exist that were created in the shack freeholding process that occurred during the 1980s and 1990s in South Australia. The purpose within this project is not to critique the process or findings of these studies in relation to freeholding, but rather to use the studies to gain insight to the nature of the coast 30-40 years ago.

Review of shack sites at 20 locations on the coast, S.A. Department of Lands, 1985[11].

This report contains several parts, of which only Part B was available in the archives of DEW. Unfortunately, the original photographs and diagrams are not available in this report. For reasons that are not apparent, the report only reviewed sites on Diosma Drive, Hillier Drive and Shack 100 which is Section 169 at the boat ramp. The shack sites were not reviewed on Mud Alley.

[11] The DEW archives mention a report by Fargher Maunsell which was also completed in 1985. It is likely that this work was reported in the S.A. Department of Lands report (1985).

Coastal assessment

<u>Sieve analysis</u>

The median grain size was assessed as 0.42mm and consisted of a fine mixed mineral sand with some calcareous material and shells. The analysis suggested that the beach was subject to incident waves of high energy, but this finding was deemed unlikely as the beach is covered with seaweed which could significantly alter the behaviour of the profile. The site was deemed to be sheltered from high energy wave activity by reefs and a rock platform which extend to the low water mark.

2. Settlement history

S.A. Department of Lands, 1985 (continued).

Aerial photographs

In the era before Geographical Information Systems (GIS) comparative analysis was not possible at this location. The study identified the longshore drift from West to East which is generated by the south-westerly swell. It was also noted that dune faces of the western end showed recent signs of erosion and this sediment was being transported along the littoral zone and deposited in some areas, possibly due to the presence of rock outcrops. Despite this trend, some erosion was observed in front of shacks 185 (no. 30) and 186 (no. 32) Diosma Drive.

Site observations

Boat Ramp Road was experiencing erosion about 200m east of the boat ramp and some hard materials had been deposited to slow erosion.

Shacks 198 to 203 (no. 2- 12) Hillier Crescent are underlain by limestone, at least at the High-Water-Level and possibly higher. The beach profile (sand levels) could be depleted because of this hard surface, but the shacks are not at risk from erosion of the dune.

Shacks 170 to 195 (no. 2-50) Diosma Drive are low lying and clearing of dune vegetation has occurred. Evidence was observed high up on the dune from old seagrass which was utilised as the basis of the sea levels in this location.

Profiles were taken but not included in this report. Profiles A-C, which are likely to have been for Hillier and Mud Alley, were considered to be underlain by limestone and therefore would be 'marginally secure from undermining by erosion'. Profile D (i.e. shacks on Diosma Drive) would face an 'unacceptable risk of undermining by erosion'.

Consultation

Interviews and questionnaires were utilized to obtain the views of residents. Shack owner 176 (no. 14) Diosma Drive recalled a storm in 1981 that eroded about 10m of the dune in front of the shack but the dune had since rebuilt by 6m[12].

Shack owner 195 (no. 50) Diosma Drive recalled that the swash from the storm in 1981 had reached Shacks 170-172 (no. 2-6) and an earlier storm (about ten years prior) had come over the dune near Shacks 182-183 (no. 26,28).

This shack owner was attempting to improve the accretion of sand by burning the grass and filling small depressions in the dune with rocks about 50mm in size.

Conclusions

Shack 100 (at the boat ramp) and Shacks 198-203 (2-12) Hillier Crescent were considered secure from coastal erosion and inundation impacts.

Shacks 170-195 (2-50) Diosma Drive would be subject to occasional erosion from storm activity which would subsequently be 'repaired' by the supply of sediment from the longshore drift and onshore accretion in summer. In the long term, possibly towards the end of the planning period, the supply of sediment from the western end of the beach may be reduced, either due to man's interference or due to the presence of limestone instead of dune sand. In this case the erosion zone would move eastward and was concluded that in the long term there is a risk that undermining of these shacks by coastal erosion could occur. It was also noted that the elevation of the land would be subject to flooding from the design maximum sea level (1 in 100 AR).

[12] The third and fifth largest events on record at Outer Harbor occurred in June and July of 1981.

2. Settlement history

Shack Coastal Hazard Study, A report for the shack site freeholding committee, 1994[13].

This report was created to inform the process of converting leasehold shack sites to freehold tenure. Each shack site was assessed against established criteria, but this criterion was not available for this current project. The report only relates to the shacks on Diosma Drive (25 shacks) and does not review the shacks on Hillier Crescent and Mud Alley. It is unknown why the shacks on Mud Alley were not reviewed, but these may have already obtained freehold tenure (not confirmed).

Compliance with criteria

The summary conclusion was that none of the shacks on Diosma Drive complied with the criteria set for 'tide and wave inundation' or 'susceptibility to shore erosion'. The following 'notes' accompanied these determinations:

- The coast at this bay is showing considerable natural instability and an allowance of 20-30m is recommended for natural coastline fluctuations.
- A description of the form of the beach and the nature of the shacks was provided[14].
- The report described a storm that occurred in 'early winter' in 1994 noting that 'all sites are very low compared to where the 1994 storm tides reached', in other words, the height of the water on the dune faces[15].
- It was recommended that Coast and Marine Branch set a minimum site and floor level of AHD 2.80m and 3.05m respectively based on a 100-year ARI tide of 1.80, 0.30m allowance for sea level rise, and 0.70m total wave effects.
- A comparison with the findings of the 1985 report (see above) showed that a similar result was obtained to that study.

Protection options

Protection was not recommended because of the beach loss and erosion that would result. Further, protection was deemed to be costly in the long term when seawalls need to be upgraded and the coast recedes, and the water depths increase. It was noted that the land would need to be raised by 1m to meet the inundation criteria.

Previous evaluations

The report cites a 1991 study by PPK Consultants (not reviewed) which took a more positive view than the 1985 report (see above). PPK Consultants considered that the sites conformed on grounds of tidal inundation now but possibly not in the future. It was noted that unusual storm events could cause minor inundation. With the exception of the 5 shacks closest to the sea (174, 175, 183-185) (check to see if these have been replaced) structures were not considered to be threatened by natural recession of the foreshore. Other shacks were recommended for longer tenure subject to recession being monitored over a significant period.

Key Points

- Foul Bay settlement began as a shack site in 1960s and currently contains 66 allotments and 51 houses (only three are now leasehold).
- There are no formal protection items at Foul Bay (apart from recent installation of temporary sandbags).
- Two studies provide insight into coastal history: Department of Lands, 1985, and Department of Environment and Natural Resources (now DEW), 1994.

13 Prepared by Department of Environment and Natural Resources (now known as Department of Environment and Water).

14 The description not repeated here, refer to aerial photograph of 1992 to review the nature of the beach.

15 Two storms were measured at Outer Harbor for May and June which were 13th and 14th highest on record.

3. GEOMORPHOLOGY

The study of coastal geomorphology analyses how the coast was formed and how the coast has changed over time. The study provides the 'bigger picture' for understanding how sea level rise may interrelate with the coastline in the future.

The inputs for this section are provided by Professor Patrick Hesp, Flinders University.

3. Geomorphological context

GEOMORPHOLOGICAL SETTING

Introduction

In simple terms, the geomorphology of coasts is assessed in three main parallel zones: the subtidal, intertidal and backshore. The intertidal zone consists of the area between low and high-water marks. The backshore is typically characterised as up to 300m inland of the intertidal zone. In this study we divide the backshore into the immediate backshore above the high-water mark (Backshore 1) and the characteristics of the backshore up to 500m inland (Backshore 2). At Foul Bay backshores are described as:

- Backshore 1: sandy beach backed by low height dunes.
- Backshore 2: sedimentary plain (<8m AHD elevation at 500m inland).

Sediment balance

Coasts should also be assessed in relation to their position within their 'alongshore' geological position. These sections of beach are known as coastal cells and are utilised to assess the nature of sediment supply. If a coastal location has a natural tendency for sand to be moved alongshore but there is limited supply of sand coming into the cell, then the coastline will tend to recede. In this study we adopt Secondary Cell, Yorke Peninsula (South-coast) and Coastal Conservation Cell, Yorke Peninsula 49 from Nature Maps[16]. At Foul Bay sediment accumulated through the Pleistocene and Holocene periods but is likely significantly less than in the past, and it is further likely we are seeing now is readjustments within cells rather than any new sediment delivery into the system. Sediment in Foul Bay tends to move west to east due to the action of swell waves moving up Investigator Strait and swinging around the headland at the boat ramp (Figure b).

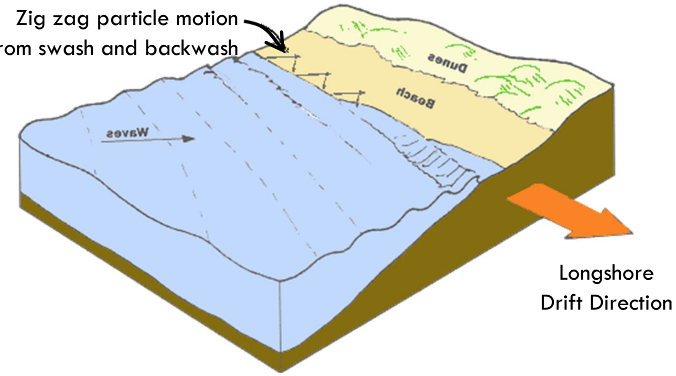

Figure a. Diagram illustrating littoral drift of sand alongshore. Contextualised to Foul Bay, the boat ramp headland area is to the left of the diagram and Mud Alley, Hillier Crescent and Diosma Drive are settlements situated behind the dunes.

Figure b. Note the oblique way in which the waves (in this photo, very small) interact with the Foul Bay coastline in this location which tend to move sediment eastward (P. Hesp, 2022)

[16] https://data.environment.sa.gov.au/NatureMaps/Pages/default.aspx

3. Geomorphological context

Sea levels

Sea levels have cycled between 2m above present sea level during the Last Interglacial Maximum (the last time the earth was free of ice, 132-118ka) to 125m below present sea level during the Last Glacial Maximum (the maximum ice extent, 21 ka). These major cyclic fluctuations in sea level meant that the present area of Gulf St Vincent was periodically exposed as dry land, and some higher sea level events such as the Last Interglacial experienced even larger areas of sea coverage. Furthermore, the climate at that time was warmer and wetter than today, with the Leeuwin Current bringing warmer ocean surface waters from Indonesia and the north-eastern Indian Ocean.

More recently, ~3000-6000 years ago seas were approximately 1m higher than present and subsided to their current level a few thousand years ago. The implication of this history is that the sandy beaches and the 'benches' upon which the settlements now sit were formed very recently as sea levels lowered.

Structure of the coastline

Foul Bay extends eastwards from the headlands of Point Mole, in a shallow arc to the western margin of Point Davenport.

The oldest basement rocks are on the Yorke Peninsula are 2,000 to 1,800 m. years old. They occasionally crop out at the coast (e.g. Point Riley; Port Victoria, Meteor Bay) and are primarily gneisses, granites and other intrusive rocks[17].

Gonwandaland (the name of a single large continent which joined Antarctica to South America, Africa, India and Australia) was glaciated in the Permian (~270 million years ago), and by the Cretaceous a long period of erosion removed glacial deposits from areas of higher elevation. The Permian glacial till, clays, and granite erratics may be seen at Port Vincent.

Australia and Antarctica broke up in the Tertiary era around 10 million years ago producing the depositional basins of the Nullabor, The Murray Basin and the St Vincent basin. The faulting produced Spencer and St Vincent Gulfs. Tertiary rocks occur on the eastern coast of the Yorke Peninsula.

The headland at the western end of the embayment comprises a 2,500 to 1,600 million years age Palaeoproterozoic Gneiss, layered biotite-hornblende microadamellite; interlayered and concordant with the Gleesons Landing Granite (emplaced 1850 Ma)[18]. This gneiss and granite basement rocks underlie the western portion of the embayment and inland. To the east of this (roughly extending north of Hillier Crescent) lies the granite intrusive rocks of the Kimban orogeny[19].

The Pleistocene Bridgewater Formation overlies basement and other rocks and extends across the study site. This comprises aeolian calcareous sand, with a calcrete surface. This likely extends offshore and forms the reefs adjacent to Foul Bay.

[17] Field Geology Club of SA, 1976, A Field Guide to the Geology of Yorke Peninsula. Publication No. 1. 1976. Printed by Kerton Bros (S.A.) Pty Ltd, Edwardstown, S.A.

[18] Reid, A., Hand, M., Jagodzinski, E., Kelsey, D., & Pearson, N. (2008). Paleoproterozoic orogenesis in the southeastern Gawler craton, South Australia. *Australian Journal of Earth Sciences*, *55*(4), 449-471.

[19] South Australian Resources Information Gateway (SARIG); https://map.sarig.sa.gov.au/

3. Geomorphological context

Immediately to the East of Diosma Drive where it 'dog-legs' to join South Coast Road is the Gantheaume Sand Member of the St.Kilda formation. South Australian Resources Information Gateway (SARIG) state that these sediments comprise unconsolidated aeolian sand sheets (and elsewhere cliff top dunes) of Holocene age, and are derived from reworking of the Bridgewater Formation. However, in the Foul Bay area, they are likely mapped incorrectly as they also comprise foredune ridges, spits and salients extending to Point Davenport and beyond.

The modern beach and foredune comprises the Semaphore Sand Member which is unconsolidated white bioclastic quartz-carbonate sand. The beach is backed by a low foredune, except at the western end of Mud Alley where it has been completely eroded away (Figure a). It is very eroded in the western section but characterised by a low prograded terrace in the eastern portion. Figure b. clearly shows the prograding section where the bluish-green pioneer vegetation zone widens to the east. Bourman et al (2016) note that at the western end of Foul Bay, near the boat ramp, the shore is backed by a former sea cliff. A relict cobble beach is present at the base of the cliff and is assumed to be Last Interglacial age (~120,000 years BP).

Key Points

1. The shape of the bay has been formed and dictated by the waves that swing around the rocky headland in the south (adjacent the boat ramp).

2. Sand transport is to the east (away from the headland), and if no new sand enters into the bay, the coastline will tend to erode.

2. The sandy 'terraces' upon which the settlements are situated are 'young' and were formed as seas receded in height 6,000 to 3000 years ago.

Figure a: The dune system on the western end has been eroded away (P. Hesp, 2022)

Figure b: The dune system on the eastern end has been prograding (building) (P. Hesp, 2022).

4. COASTAL FABRIC

In this section we evaluate coastal fabric with:

- Overview of the current coastal fabric
- Changes to the shoreline position (erosion and accretion trends)
- The impact of human intervention

Viewing instruction:

View the coastal fabric section utilising full screen mode within your PDF software (Control L). Then use arrow keys to navigate.

4.1 Coastal fabric – overview

Introduction

It is the geology of the coast upon which our settlements are situated that determines one side of the hazard assessment in terms of elevation (height above sea level), and the nature of the fabric (how resistant to erosion).

In some locations, humans have intervened and changed the nature of the coastal fabric. For example, a construction of a seawall changes the fabric from sand to rock. The construction of an esplanade road or car park too close to the shoreline can install a rigidity in the backshore, which was once flexible and able to naturally adapt to cycles of erosion and accretion. Some interventions change the way in which the beach operates, and new erosion problems are created.

Why evaluate shoreline change?

Beaches undergo normal cycles of accretion and erosion which may span time measured in decades. These changes can be observed in two main ways. The position of the shoreline changes, and the levels of sand change on the beach. In times of erosion, the shoreline tends to recede, and sand levels become lower. In times of accretion, the opposite is true. If sea levels rise as projected, then shorelines are likely to go into longer term recession (Caton 2007).

The purpose of evaluating the historical changes to the shoreline is to formulate a baseline understanding of past trends of accretion or erosion. In the context of rising sea levels, identifying future shoreline recession trends will assist us to identify when the beach begins to operate outside its normal historical range.

What is the shoreline?

The shoreline is the position of the land-water interface at one instant in time. The shoreline position changes continually through time because of the dynamic nature of water levels at the coastal boundary. The best indicator of shoreline position is the location of the vegetation line above normal wave swash. In other circumstances the shoreline may be the base of a cliff, an earthen bank at the toe of a slope, or a seawall (Figure a).

How will we analyze the shoreline?

The analysis includes:

- Comparisons of aerial photography from 1981 to current day using georeferenced photography.
- Evaluation as to how humans may have intervened in the coastal fabric and how this intervention may have changed the natural operation of the coast.

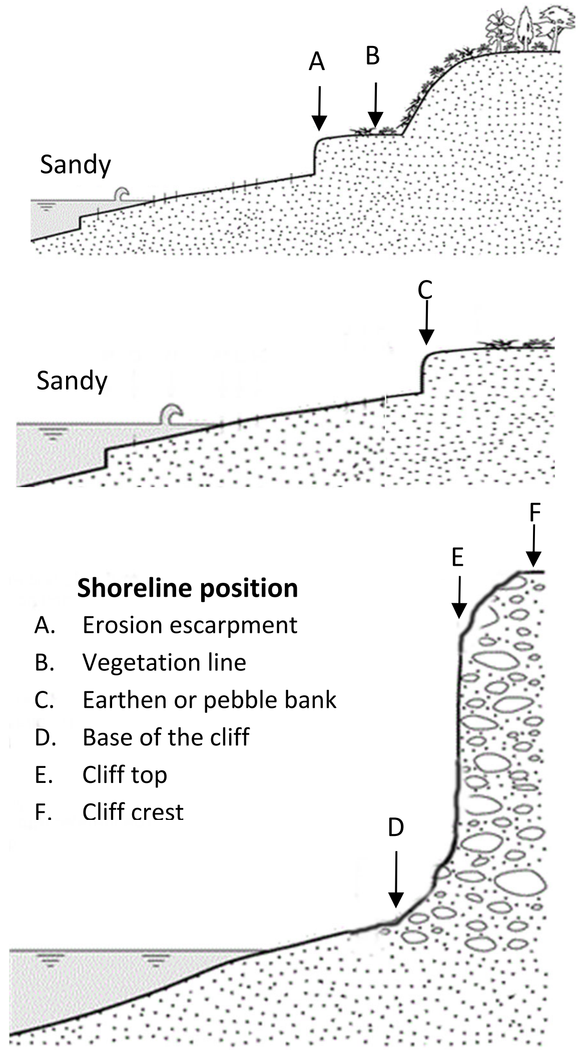

Figure a. Adapted from Boak and Turner (2005), Shoreline definition and detection.

4.1 Coastal fabric – overview

Overview

Foul Bay
Yorke Peninsula
Cell YP47
Form

Beach
Fine grain sand beach, median grain size was assessed as 0.42mm and consisted of fine mixed mineral sand with some calcareous material and shells.

Backshores
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

Bathymetry
Overall slope of ocean floor:
-5m ~600m from beach (overall slope ratio 1:120). Bathymetry based on jetski survey conducted in July, 2022.

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4.1 Coastal fabric – overview

Overview

Foul Bay
Yorke Peninsula
Cell YP47
Geology

Geology

Beach and backshore 1
St Kilda Formation (sand), intertidal flat and nearshore.
Age: Holocene: less than 6ka before present (B.P.).

Backshore 2 (up to 500m inland)
Dune plain: Holocene aeolian sediments (blown into place by wind) Age: Holocene. ~10k B.P. and younger.

Beach shape has been formed by the swells and currents flowing around the older (2.5-1.6m B.P.) and more resistant rock on the southern headland (located on left hand side of this map).

Map adapted from www.sarig.gov.au

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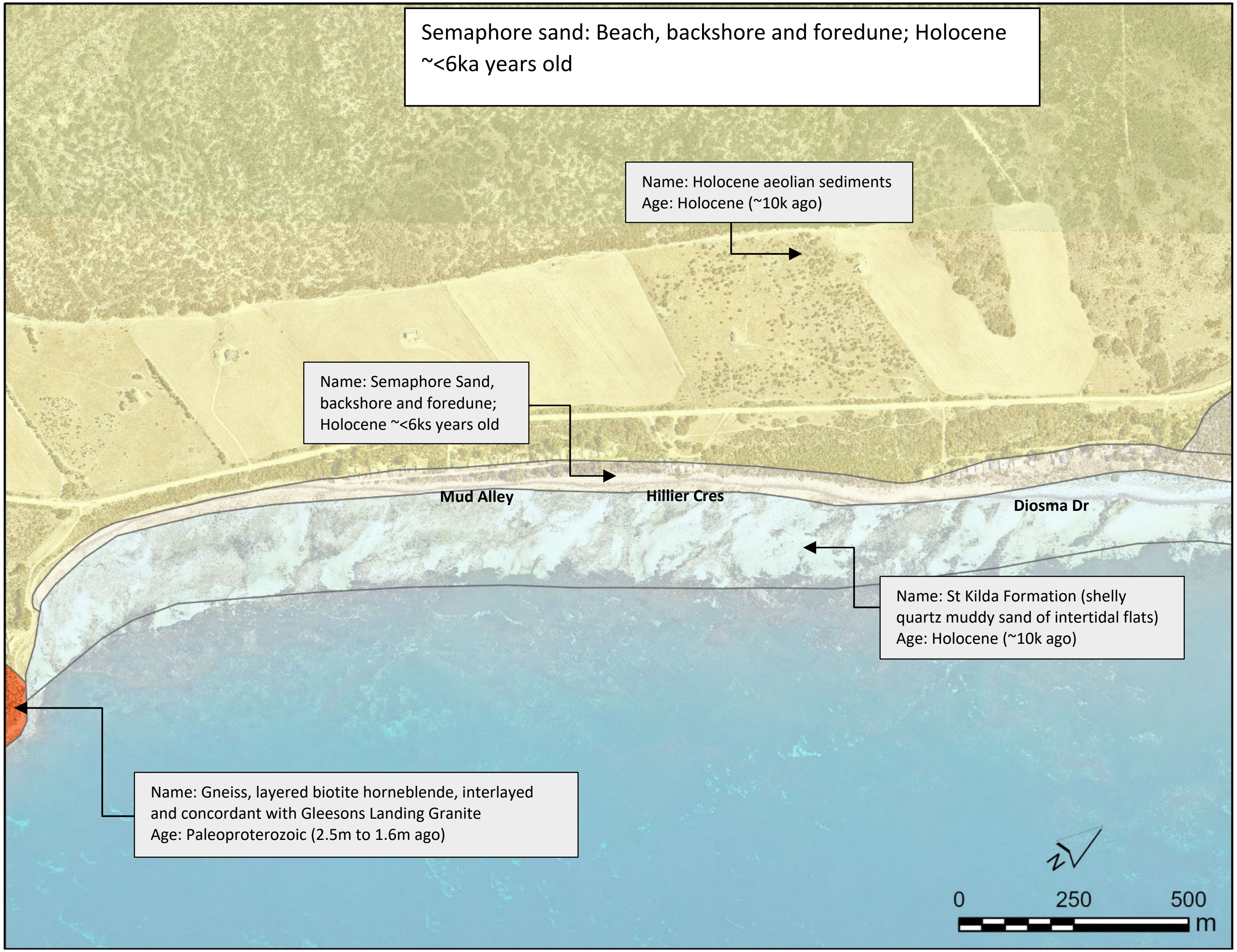

4.1 Coastal fabric – overview

Overview

Foul Bay
Yorke Peninsula
Cell YP47
Benthic

Benthic

Nearshore dominated by low profile limestone reef interspersed with sand beds.

Offshore dominated by dense seagrass beds.

Notes: Study of 1985 by Department of Lands observed that the reef was diminished in width / density in the vicinity of Diosma Drive. Anecdotes by residents suggest that the reef diminishes towards the eastern end of Diosma Drive and that boats can be launched on bare sand. However, this may just mean that sand covers the reef at this point, but conversely, the former shape of the beach may support this claim. See historical shoreline analysis below.

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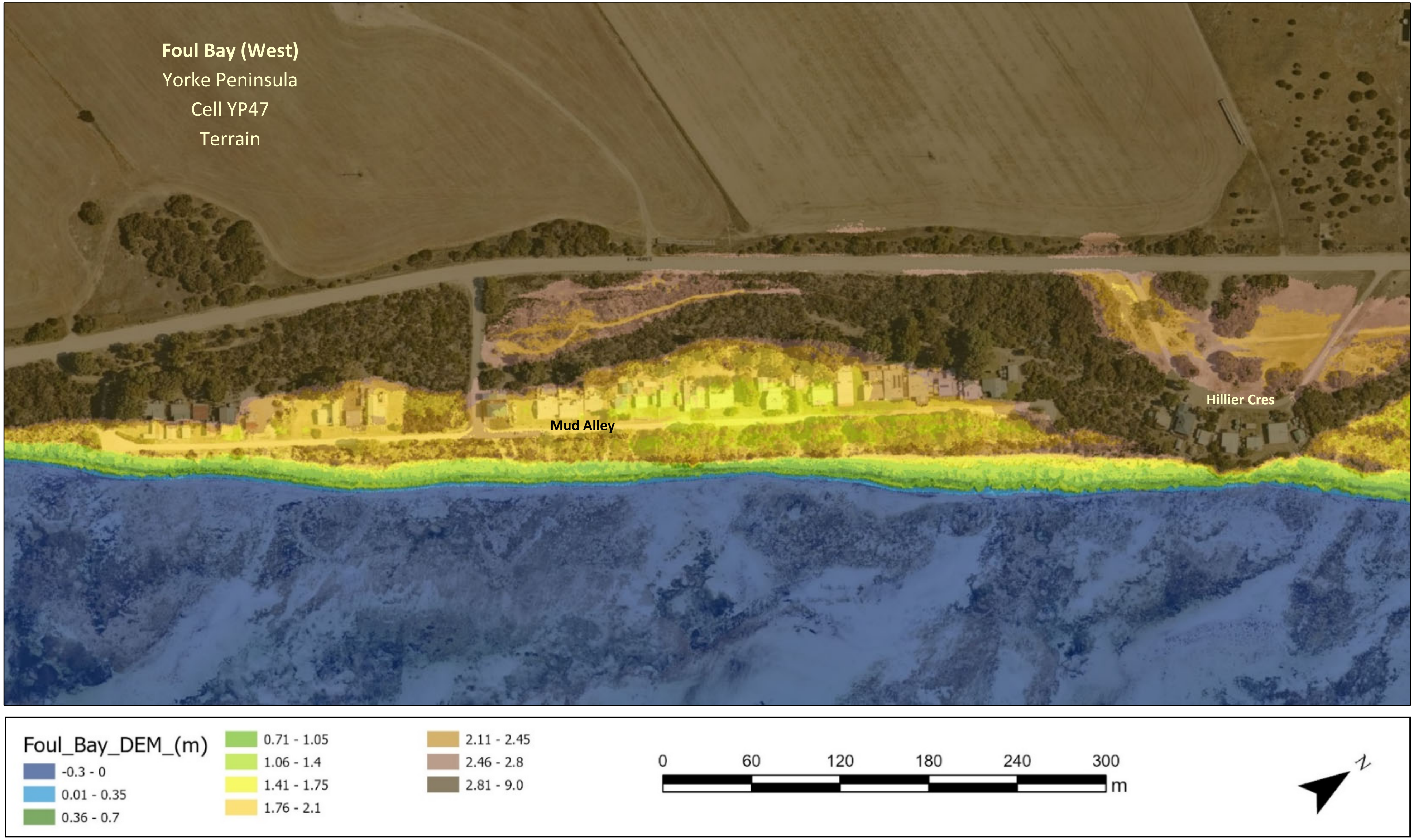
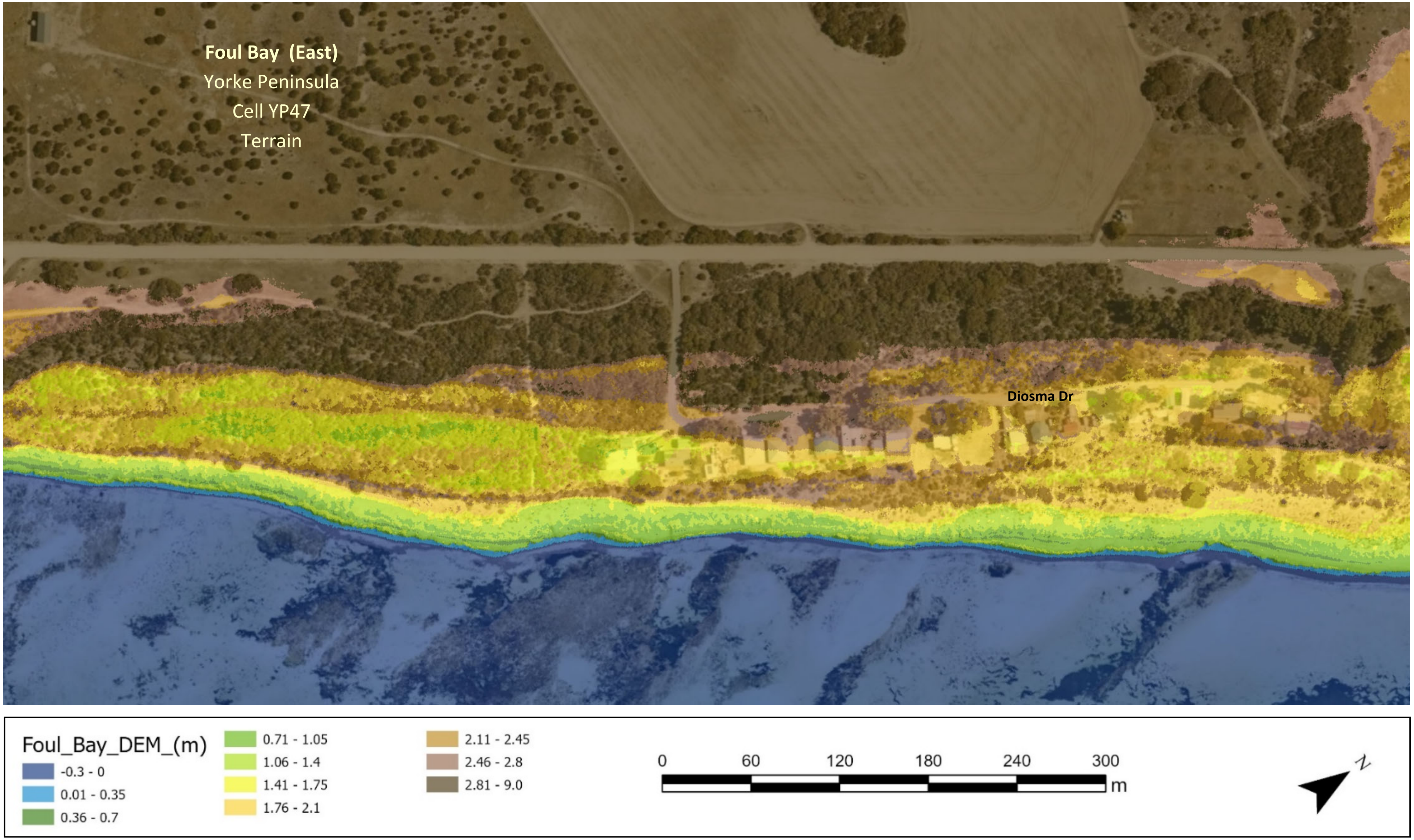
4.1 Coastal fabric – overview



4.1 Coastal fabric – overview



4.2 Coastal fabric – shoreline changes (west)

Medium Term

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

Foul Bay (west)
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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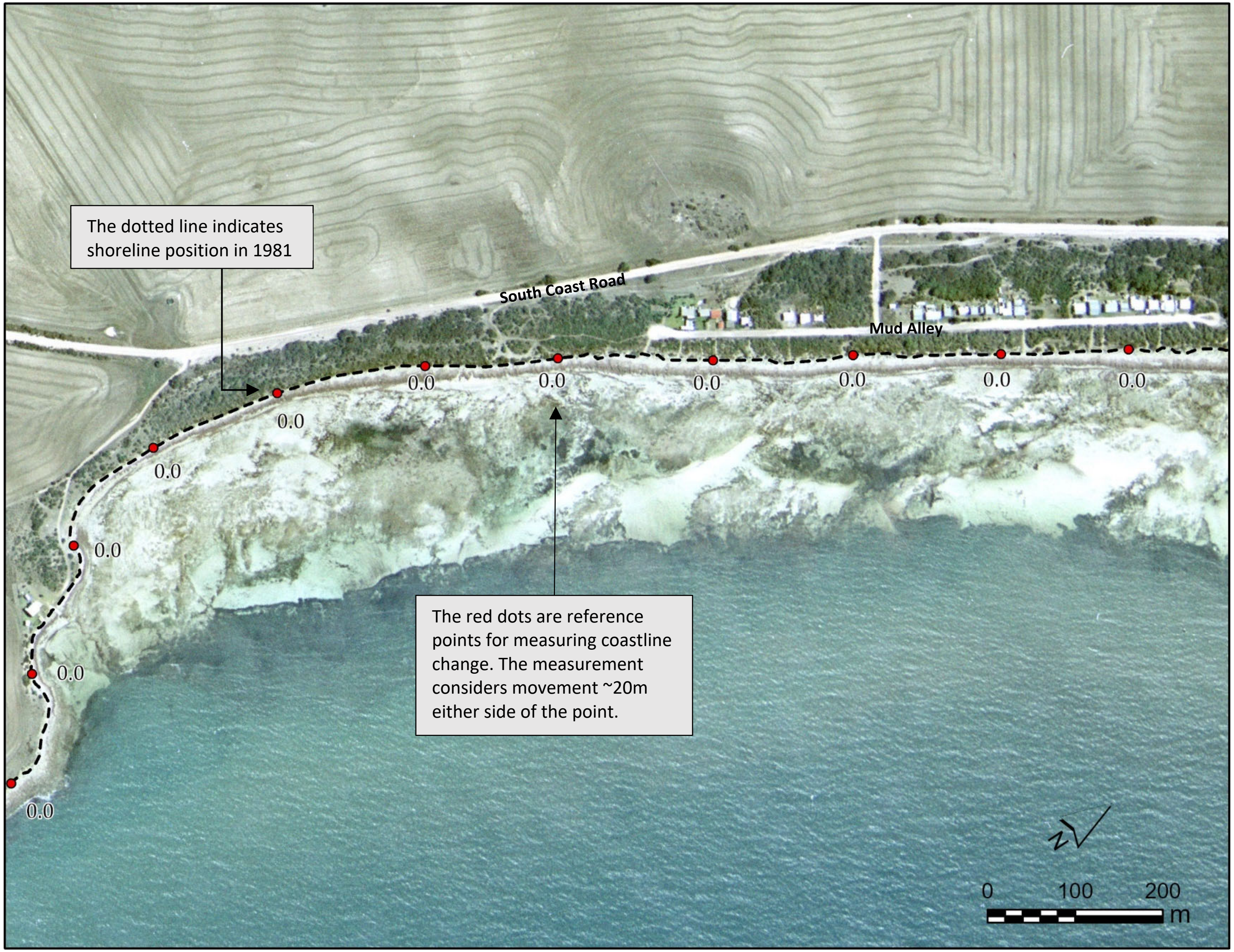

4.2 Coastal fabric – shoreline changes (west)

Medium Term

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

Foul Bay (West)
Year: 1992

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

The erosion from 1981 to 1992 (ten years) occurred on the western end of Foul Bay at net change of ~-3m to -8m.

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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: 2001

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

The erosion from 1992 to 2001 (~ 10 years) appears to have stabilized nearer to Mud Alley but increased towards the boat ramp. However, the interpretation is limited by the truncated photograph.

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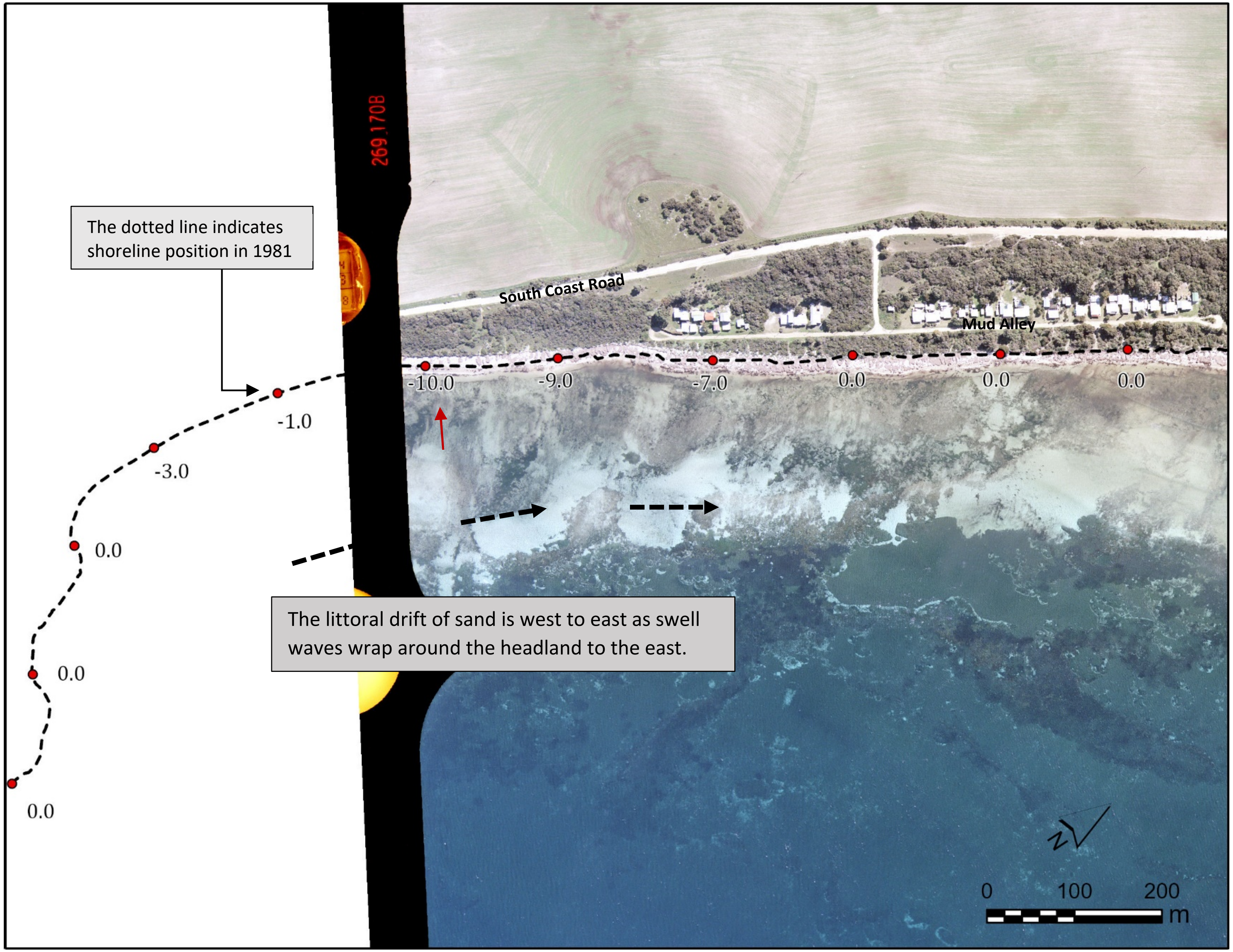

4.2 Coastal fabric – shoreline changes (west)

Medium Term

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

Foul Bay (West)
Year: 2008

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

The erosion from 2001 to 2008 appears to have accelerated west of Mud Alley with recession of up to 10m in a seven-year period.

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. At this point, the coast in line with the Mud Alley access road (T-Junction) has not begun to erode.

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