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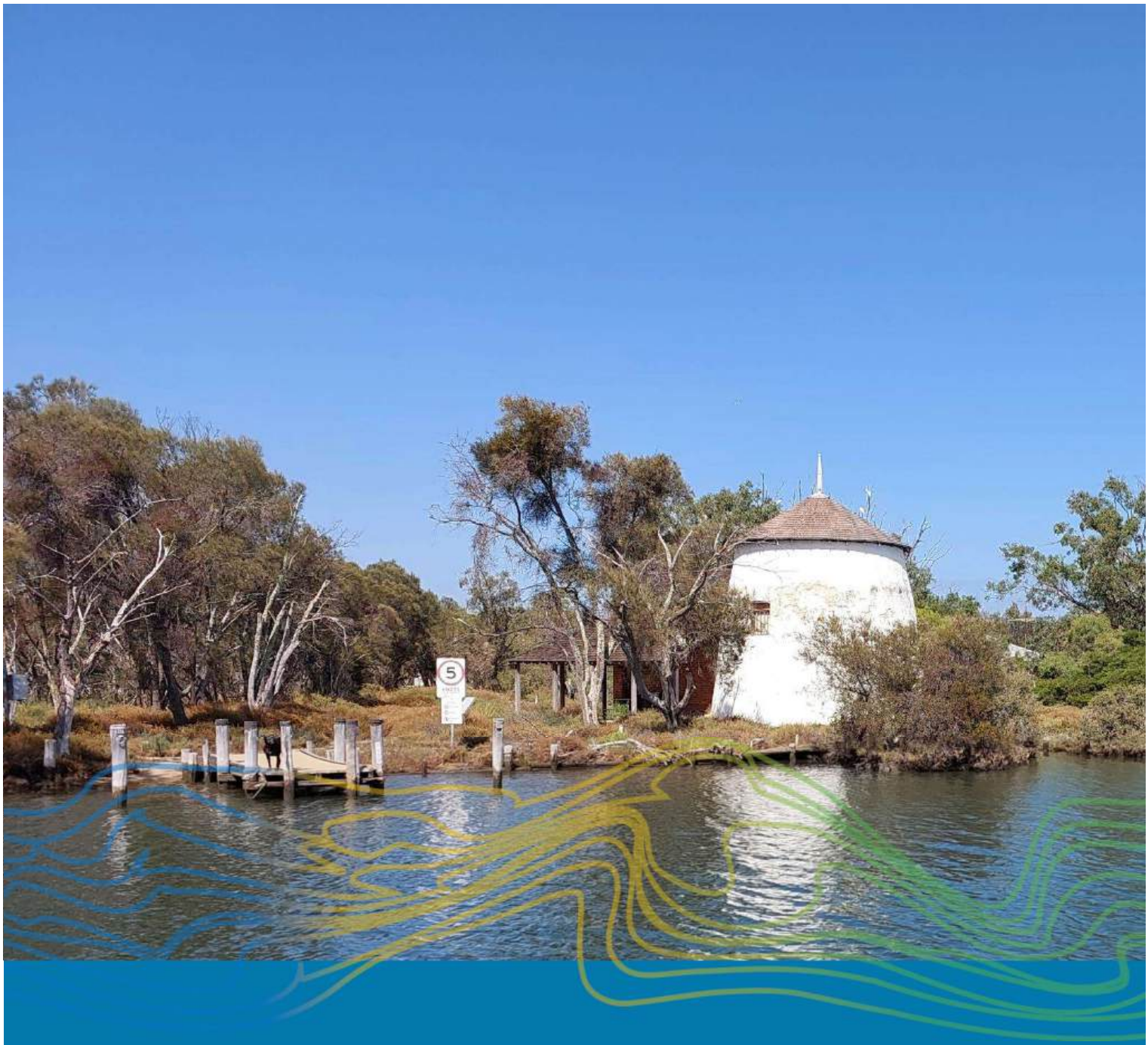

Report

Cooper's Mill Reserve 23015 Foreshore Management Plan

Shire of Murray

13 February 2026

Document Status

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Project Details

Project Name	Cooper's Mill Reserve 23015 Foreshore Management Plan
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ACKNOWLEDGEMENT OF COUNTRY

The Board and employees of Water Technology acknowledge and respect the Aboriginal and Torres Strait Islander Peoples as the Traditional Custodians of Country throughout Australia. We specifically acknowledge the Traditional Custodians of the land on which our offices reside and where we undertake our work.

We respect the knowledge, skills and lived experiences of Aboriginal and Torres Strait Islander Peoples, who we continue to learn from and collaborate with. We also extend our respect to all First Nations Peoples, their cultures and to their Elders, past and present.

Artwork by Maurice Goolagong 2023. This piece was commissioned by Water Technology and visualises the important connections we have to water, and the cultural significance of journeys taken by traditional custodians of our land to meeting places, where communities connect with each other around waterways.

The symbolism in the artwork includes:

- *Seven circles representing each of the States and Territories in Australia where we do our work*
- *Blue dots between each circle representing the waterways that connect us*
- *The animals that rely on healthy waterways for their home*
- *Black and white dots representing all the different communities that we visit in our work*
- *Hands that are for the people we help on our journey*

EXECUTIVE SUMMARY

The Shire of Murray (Shire) required the preparation of a Foreshore Management Plan (FMP) for Cooper's Mill Reserve 23015 as recommended in its Coastal Hazard Risk Management and Adaptation Plan (CHRMAP), (Baird, 2024). This FMP is consistent with WA's State Planning Policy Guidelines (including Coastal Planning SPP 2.6, focusing on adaptation) and undertaken considering The Heritage Council guidelines on Conservation Strategy.

Cooper's Mill is already subject to coastal inundation and projected to be impacted from coastal erosion hazard by 2030. Cooper's Mill is therefore rated as highly vulnerable in planning year 2030 and beyond. It is also listed on WA's State Register of Heritage Places and accordingly the Shire has commissioned this FMP to include heritage strategies to retain the value of this historic site. The physical description within the inHerit database for the heritage-listed Cooper's Mill (Place No. 01771) can be summarised as follows:

> *'Cooper's Mill is a cylindrical tower of limestone blocks constructed near a water's edge. The Mill has a 3m brick extension which is considered a significant overlay.'*

The FMP has been prepared in accordance with recommendations in the Shire's CHRMAP (Baird, 2024) and provides options to address erosion and inundation to help preserve Cooper's Mill into the future while maintaining a sense of place and appropriate aesthetic.

The project was delivered in two stages:

- Stage 1 – Community and Stakeholder Engagement Strategy (CSES), followed by
- Stage 2 – Foreshore Management Plan (FMP)

Upfront the project required the consultant team to undertake a background analysis to gather and gain understanding of the site's value(s) relevant to informing the CSES and the FMP. This included physical observations during a site inspection and reviews of relevant datasets, reports and studies carried out for the study area. Engagement was undertaken with community members and stakeholders through meetings and a workshop.

Water Technology has developed this consolidated FMP with a primary focus on management of Cooper's Mill. The plan identifies the areas at risk of coastal hazards, and sets out requirements for foreshore reserves, public access and facilities, and protection of nature landscape/Indigenous heritage and ecological systems.

The recommended implementation provided as part of the FMP details the timeline for the next ~10-20 years, including short, intermediate and medium-term actions.

The Mill and surrounds are currently at significant risk of inundation, which is projected to increase. The vulnerability to erosion also increases significantly over time but has not yet occurred as quickly as CHRMAP projections.

The CSES was prepared to identify relevant stakeholders and the structure and pathways for their engagement in accordance with the International Association of Public Participation (IAP2) Spectrum of Public Participation. A community workshop and targeted meetings were undertaken to understand the local community's values, and their perceptions of the key issues. The results of the workshop have informed the prioritisation of recommendations for the foreshore. The primary concerns from the community related to concerns about damage to the Mill and a desire for continued access to the foreshore facilities for decades to come, considering the coastal erosion and inundation vulnerability of the study area.

This Conservation Management Strategy (CMS) for Cooper's Mill has been prepared by Stephen Carricks Architecture and is provided in full at Appendix B. The CMS addresses the built heritage component of the FMP and is aimed at providing a guide to the appropriate conservation planning and maintenance of the place. A CMS is acknowledged as a best practice management document to provide a framework for the conservation of the place's significant values and building fabric. Section 4 of the Conservation Management Strategy sets out a detailed conservation and maintenance works schedule. This section outlines the required conservation works in order of priority.

- Immediate (0-1 year)
- Urgent Term (1-2 years)
- Medium Term (within 3 years)
- Long Term (safely deferred beyond 3 years)

A Building Condition Assessment Report is included as an Appendix to the CMS.

A summary of recommended management actions is provided for the rest of the study area. Indicative timeframes for implementing the actions are provided, along with suggested prioritisation (high, medium, low). Concept cost estimates for budgeting purposes are also provided for the key actions. The primary recommendation to address the vulnerability of the Mill to flooding and erosion is construction of a new seawall – with the concept depicted at Figure 1-1 and Figure 1-2 below.

Figure 1-1 PVC sheet pile wall concept design - Northern foreshore – plan view. The extent of the new wall is ~45m. The green arrow indicated the approximate position of a representative cross-section.

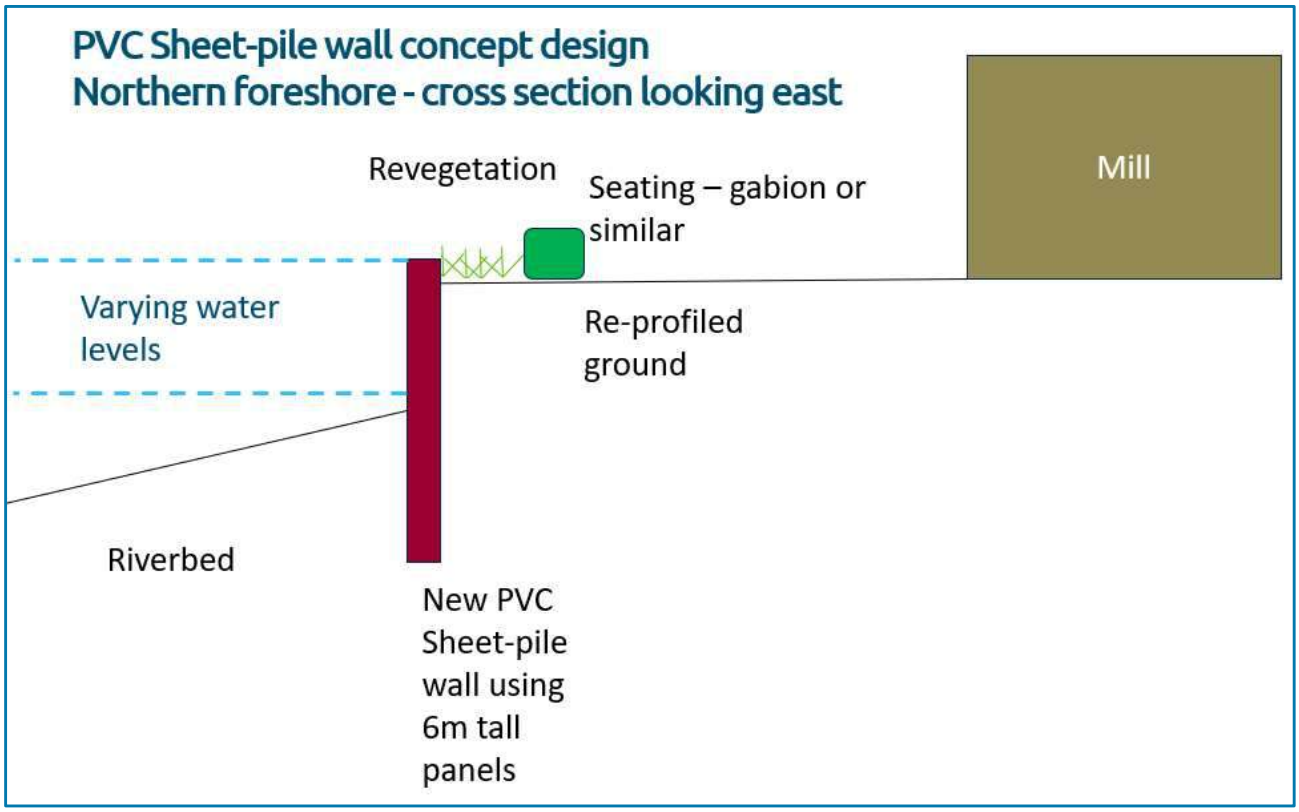

Figure 1-2 PVC sheet pile wall concept design - Northern foreshore – representative cross-section.

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1.1 Aims and Objectives

The objectives were established by the Shire and include:

- Desktop review of existing Coastal Hazard Risk Management and Adaptation Plan (Baird, 2024), and any other relevant documents, to identify the status of the area relevant to the FMP.
- Evaluate the success of the recommended coastal hazard mitigation pathways
- Develop and manage community and stakeholder engagement program
- Develop foreshore management plan

1.2 Background

Cooper's Mill is already subject to coastal inundation and projected to be impacted from coastal erosion hazard by 2030. Cooper's Mill is therefore rated as highly vulnerable in planning year 2030 and beyond. It is also listed on WA's State Register of Heritage Places and accordingly the Shire has commissioned this FMP to include heritage strategies to retain the value of this historic site. The physical description within the inHerit database for the heritage-listed Cooper's Mill (Place No. 01771) can be summarised as follows:

> *'Cooper's Mill is a cylindrical tower constructed of limestone blocks near a water's edge. The Mill has a 3m brick extension which is considered a significant overlay.'*

The FMP has been prepared in accordance with recommendations in the Shire's CHRMAP (Baird, 2024) and provides options to address erosion and inundation to help preserve Cooper's Mill into the future while maintaining a sense of place and appropriate aesthetic. The Shire's CHRMAP (Baird, 2024) recommends and details coastal hazard mitigation pathways for protecting Cooper's Mill Reserve. As short-term risk management and adaptation pathways, Monitoring (NR1), site specific inundation study (NR5), berm management, planting and nature-based 'soft protect' options to control erosion (PR1, PR2, PR3) are recommended. Monitoring (NR1), engineering edge treatments to protect against erosion and inundation (PR4) are recommended as medium- and long-term risk management and adaptation pathways. This FMP investigates these options and their suitability for implementation against the local context of the site in detail.

The project necessarily involved liaison and engagement under an agreed Community and Stakeholder Engagement Strategy (CSES) which included the project steering committee, local community representatives, the Shire, and government agencies during preparation of the FMP.

1.3 Study Area

The FMP covers the study area presented in Figure 1-1 comprising Cooper's Mill Reserve, R23015 on Cooleenup Island, South Yunderup, at the edge of the Murray River delta. The area is approximately 5 hectares (currently) including 1km of coastline / shoreline. The main built assets in the area are Cooper's Mill, a play area, two jetties, caretaker's cottage, public toilets, accessways and some foreshore treatments to address erosion. The Reserve's natural foreshore / coastline amenity is considered in the FMP too.

Figure 1-1 Study Area outlined in red

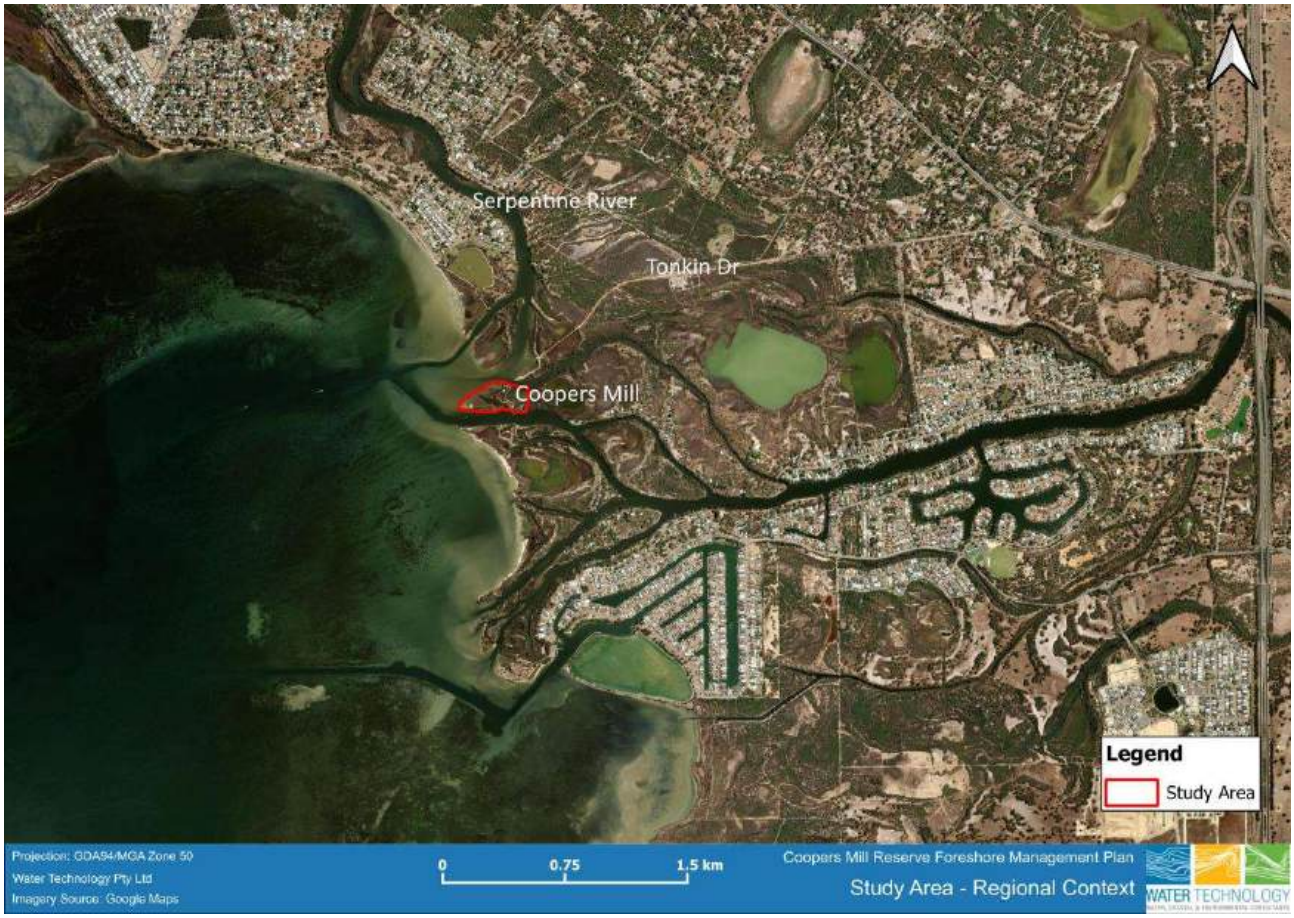


Figure 1-2 Regional context of Study Area

1.4 Methodology Overview

The project was delivered in two stages:

- Stage 1 – Community and Stakeholder Engagement Strategy (CSES), followed by
- Stage 2 – Foreshore Management Plan (FMP)

Upfront the project required the consultant team to undertake a background analysis to gather and gain understanding of the site's value(s) relevant to informing the CSES and the FMP. This included physical observations at the site, as well as reviews of relevant reports and studies undertaken at the site.

Water Technology developed a consolidated FMP with a primary focus on management of Cooper's Mill. The plan identifies the areas at risk of coastal hazards, and sets out requirements for foreshore reserves, public access and facilities, and protection of nature landscape/Indigenous heritage and ecological systems.

The recommended implementation provided as part of the FMP details the timeline for the next ~10-20 years, including short, intermediate and medium-term actions.

1.5 Project Inception

A project inception meeting was held with the Project steering committee on the 7th March 2025. This meeting provided an opportunity for the Committee members and consultant team to meet and refine the project's direction, scope, methodology and outcomes. The inception meeting included:

- Re-confirmation of the project timeframe and the nature of any outstanding information to be supplied by the Shire i.e. critical or not.
- Identification of key stakeholders to be included in the CSES.
- Gap analysis to identify actions required to fill any critical gaps of knowledge or technical requirements to fulfill the proposed work.
- Confirm some details for the engagement workshop.

2 DESKTOP REVIEW

A desktop review was undertaken to compile relevant information on planning and policy context; coastal processes and hazards; social, cultural, and environmental context; and past and present management activities for the study area.

2.1 Recent History

A summary of recent works history is provided from Shire records in Table 2-1 below.

Table 2-1 Summary of recent works history

Year	Note
2006	Interpretation Plan prepared by Mulloway Studio for Mill and surrounding area of the Island.
2011	Temporary repairs were made to foreshore walls on Cooper's Mill north side wall using filter cloth and wire after May 2011 storm damage caused sleepers and logs to shift.
2013	Approximately 66m of PVC sheet pile wall (SPW) installed on southern foreshore east of jetty. Backfilling was proposed but this does not appear to have been undertaken.
2016	John (caretaker) reported wooden-pole retaining wall next to southern Cooper's Mill dock coming apart – repair work was undertaken.
2017	Further damage and repairs to log wall and vertical SPW.
2022	Further damage to wooden-pole retaining wall.
2023	Log retaining wall at end of jetty shifting.

Figure 2-1 to Figure 2-5 below summarise the foreshore wall condition and characteristics and inundation processes in 2010 and 2011.

Figure 2-1 2010 winter water levels mark on Mill building. Supplied by Shire. Estimated water depth at ~0.5m above land surface assuming ~8cm per course of bricks.

Figure 2-2 Winter 2011 – Evidence of water flow leaving sand ripples inside Mill engine building. Supplied by Shire.

Figure 2-3 Winter 2011 – Northern revetment. Supplied by Shire.

Figure 2-4 Winter 2011 – Northern revetment. Overtopping evident. Supplied by Shire.

Figure 2-5 Winter 2011 – Northern revetment. New concrete capping installed. Supplied by Shire.

2.2 Planning and Policy Context

There are two key documents that guide coastal hazard assessment and coastal planning in Western Australia:

a. State Planning Policy No. 2.6, State Coastal Planning Policy (SPP2.6, WAPC 2013)

b. Coastal Hazard Risk Management and Adaptation Guidelines (CHRMAP Guidelines, WAPC 2019)

SPP2.6 informs and guides decision-making by the Western Australian Planning Commission (WAPC) and its Committees and aims to integrate and coordinate the activities of state agencies that influence the use and development of land in the coastal zone. SPP2.6 also guides local governments, state government agencies, the State Administrative Tribunal, and the State Government on aspects of state planning policy concerning the coastal zone that should be considered in decision-making. The policy provides a framework for coordinating those agencies' activities with those of the private sector to ensure a cohesive approach to coastal planning including for managing development and land use change, the establishment of foreshore reserves, and to protect, conserve and enhance coastal values. It is applicable for tidal waters.

SPP2.6 also contains guidance for the preparation of foreshore management plans (sections 5.9 and 5.10). Further information relating to foreshore management plans is presented in the SPP2.6 Guidelines (WAPC. 2013b) in Sections 7, 8, and 9. The SPP2.6 Guidelines also requires that landscape, seascape, and visual landscape elements of coastal planning reflect the advice within the Visual Landscape Planning manual (WAPC, 2007). The manual contains guidance for evaluation, assessment, siting, and design of coastal development. Advice on techniques for incorporating visual landscape planning into typical planning tasks is

provided along with guidance on the retention/restoration of natural landforms and vegetation and for the siting of foreshore infrastructure.

Schedule One of SPP 2.6 provides guidance on determining the necessary component of the coastal foreshore reserve to accommodate coastal processes. This component should be adequate to mitigate the impacts of coastal hazards, including erosion and inundation. An appropriate coastal foreshore reserve should incorporate a sufficient area for coastal processes and maintain an appropriate width to ensure that the reserve continues to fulfill its designated values, functions, and uses, even if the adverse effects of coastal processes are realised over the planning timeframe.

The CHRMAP Guidelines (WAPC, 2019) explain how decision-makers are to develop and implement effective coastal hazard risk management and adaptation plans. Existing planning controls applicable to land use and development within the Shire are detailed in the Shire's CHRMAP, (Baird, 2024). The CHRMAP provides guidance for ongoing management of foreshore reserves, monitoring of assets and the triggers for the managed retreat assets and infrastructure at risk of erosion.

The following are identified as relevant to the Foreshore Management Plan.

- State Planning Framework
  - Peel Region Scheme
    - The Peel Region Scheme (PRS) is the principal region scheme which applies to the study area; it zones and reserves land. The PRS reserves the majority of the coastal and river foreshore within the study area as 'Parks and Recreation' however there are some areas, such as the existing canal developments, which area zoned 'Urban'.
  - State Planning Policy 3.4: Natural Hazards and Disasters
    - State Planning Policy 3.4: Natural Hazards and Disasters (SPP3.4) was prepared to ensure that land use planning appropriately considers the risk of natural hazards and disasters. It addresses storm surge as well as a range of other hazards, including overland flooding.
    - With respect to overland flooding events, SPP3.4 requires that the 100-year average recurrence interval (ARI) overland flood event by used as the defined event in relation to the assessment of proposals.
    - With respect to storm surge, SPP3.4 further states with respect to cyclonic activity and storm surge:
      - Where storm surge studies have been undertaken and show inundation may occur, new permanent buildings should be constructed to take account of the effects of storm surge (including wind and wave set up)
      - In areas where storm surge studies have not been undertaken, but evidence is available to demonstrate vulnerability to inundation, any development proposals should be supported by studies that demonstrate inundation will not occur.
- Local Planning Framework
  - 2030 Shire of Murray Strategic Community Plan (SCP) is the overarching strategy which guides the future governance of the local government. The SCP establishes a range of strategies to address facets of community, the environment, the economy and governance, with the following strategies relevant to planning for coastal processes.
    - Connect the natural assets, waterways, parks and reserves to the community
    - Continually review and enhance public boating facilities and environmental sustainability within our waterways

- Shire of Murray Local Planning Scheme No. 4
  - The Shire's Local Planning Scheme No 4 (LPS4) is the principal statutory planning document which applies land use and development controls within the Shire at a local level.
  - A specific objective of LPS4 is to 'preserve the special environment associated with the lakes and waterways within the Scheme Area'.
  - Part XII of LPS4 establishes requirements for land located within river flood plains. Amongst these requirements are the following:
    - A plan of subdivision shall not be approved for land within a flood fringe in the Residential or Canal Development zones unless that part of the land behind the minimum setbacks from street and rear boundaries is not less than 300mm above the flood level.
    - A plan of subdivision shall not be approved for land within a flood fringe in the Special Rural zone unless part of the land in each lot has an area of not less than 2000sqm at or above the flood level and is suitable for the erection of a dwelling in accordance with the provisions of the Scheme.
    - Building levels within flood fringe land shall be a minimum of 150mm above the 1 in 100-year ARI flood level for all existing subdivisions, and for new subdivisions, 500mm above 1 in 100-year ARI flood level.
- Murray River Foreshore Masterplan
  - The Murray River Foreshore Masterplan seeks to create an attractive and sustainable foreshore precinct which is centred around the Murray River Square. The masterplan identifies a number of foreshore improvements including an upgraded path network, landscaping and informal amphitheatre, a formal town square and event space and upgrades to the existing Exchange Hotel.

2.3 Riverine Setting and Processes

The Serpentine and Murray Rivers empty into the north-eastern part of the Peel Inlet creating a complex fan delta formation, including a series of deltaic islands. These are formed from sediments carried by the rivers and deposited in the low energy environment of the Peel-Harvey Estuary. Over time, islands have formed as more and more sediments have accreted and vegetation has stabilised these formations. They are known as the Murray Delta Islands. Cooper's Mill is situated on Cooleenup Island, which is primarily bound by secondary channels of the Murray River, with the primary channels of the Serpentine and Murray Rivers emptying on either side of the 'spit' where Cooper's Mill is located.

95% of river flow entering the Peel-Harvey Estuary is highly seasonal, occurring during the high rainfall periods of the year (between May and October) (PHCC, 2019). Of these flows, the Murray River contributes 65% of the volume entering the estuary, travelling through the Murray Delta Islands. The Serpentine River contributes only 5% of flows with the remaining from the Harvey River (see Figure 2-6 below). Water quality variables such as salinity are greatly influenced by the seasonality of freshwater flows from these rivers.

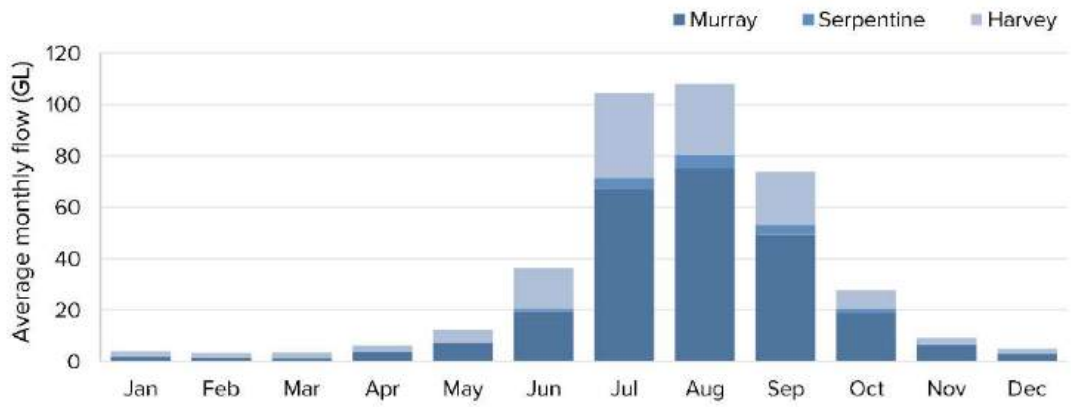


Figure 2-6 Average monthly flows on the Murray, Serpentine and Harvey Rivers. Sourced from PHCC (2019), with data from Department of Water and Environmental Regulation.

The Murray Delta Islands are subject to both riverine and estuarine processes and are considered to be at risk of both inundation and erosion (Baird, 2024). The flood risk assessment by Baird (2024) suggests that the lower lying areas of the Murray Delta Islands, including Cooleenup Island, are presently inundated during larger tide levels associated with winter storms. This is expected to increase in frequency and duration with projected sea level rise.

Baird (2024) have attributed bank and foreshore erosion occurring on the lower Murray and Serpentine Rivers to different active processes:

- Different vegetation conditions, influencing the rate and extent of erosion;
- Acute storm erosion, where strong winds generate relatively large waves while water levels are high;
- Higher tidal flows, as a result of rising sea levels; and
- Potentially 'channel switching', also known as thalweg shift, where the primary channel becomes blocked or infilled, pushing a larger proportion of river flow to a smaller, secondary channel, causing its bed and banks to adjust in response.

2.4 Coastal Setting and Processes

The study area, located in the Murray Delta, is characterised by an estuarine environment, influenced by the presence of low-lying land. A further complicating factor is the opening of the Dawesville Channel in 1994, which altered estuary water levels and, consequently, may have affected - or continue to be affecting - foreshore evolution.

The Peel-Harvey Estuarine System is a large water body that receives inflows from the Harvey, Murray, and Serpentine River systems. Any sediment supply in the region is primarily derived from riverine sources. As identified in the Shire of Murray CHRMAP, the study area is classified as being at risk of inundation under present-day conditions (below +1.44m AHD).

2.4.1 Coastal Monitoring

Coastal monitoring activities in the study area are focussed on the collection of field photographs. The Shire coordinates the collection to generate photographic data to monitor six key points and to improve understanding of coastal change impacts on the Murray Delta. The program uses photos taken by community members on smart phones from fixed marker points which determine their field of view and enables these to

be shared on social media to demonstrate the range of local coastal processes. One the monitoring points is located in the study area west of the Mill (Figure 2-7).

Figure 2-7 Example photos submitted by community members from the Cooper's Mill photo monitoring point.

2.4.2 Tides

The tide in the area is classified as micro-tidal, with a tidal range of approximately 0.3 metres between high and low water, occurring once per day. Tidal levels in the study area are influenced by the estuary's connection to the open ocean through the Mandurah and Dawesville Channels.

Within the estuary, tidal data measurements are available at Mandurah, Peel, and Harvey. For specific tidal levels at Peel, refer to Table 2-2, based on the Shire of Murray CHRMAP (Baird, 2024).

Table 2-2 Peel Tide Levels (Shire of Murray CHRMAP, Baird, 2024)

Tidal water Level	m Chart Datum	m AHD
Highest Astronomical Tide (HAT)	1.02	0.52
Mean Higher High Water (MHHW)	0.70	0.20
Mean Lower Low Water (MLLW)	0.68	0.18
Mean Sea Level (MSL)	0.55	0.01
Australian Height Datum (AHD)	0.54	0.00
Mean Higher Low Water (MHLL)	0.42	-0.08
Mean Lower Low Water (MLLW)	0.39	-0.11
Lowest Astronomical Tide (LAT)	0.08	-0.42

As mentioned in Shire of Murray CHRMAP (2024) tides in the study area are affected by a range of short term and longer-term influences, residual tide, surge; the key influences summarised as:

- Surges associated with low barometric pressure and storm events with westerly winds
- Minor, occasional surges associated with passage of continental shelf waves
- Inter-annual mean sea level variability, correlated with El Nino-Southern Oscillation, also correlated with Leeuwin current
- An 18.6-year cycle of tide, with annual variation of 20%
- Local wind set-up with presence of extreme events

2.4.3 Extreme Water Levels

Winter storms in the region can result in water levels exceeding the highest astronomical tide. As noted in the Shire of Murray CHRMAP, the highest water levels in the southwest of Western Australia are generally associated with rare south-tracking tropical cyclones. The most significant recorded event was Tropical Cyclone Alby in April 1978, which caused extensive flooding in the area.

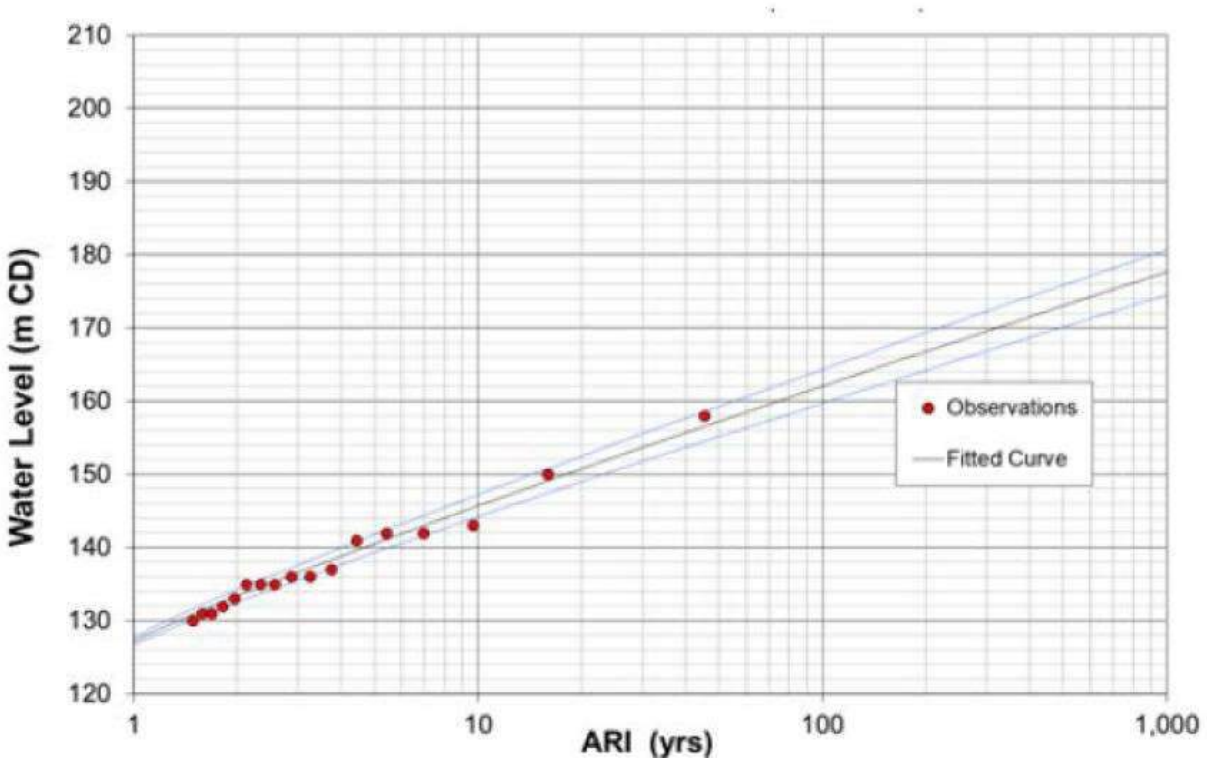


Figure 2-8 Peel Inlet Extreme Water Level, derived from 1994-2020 tide gauge data (Shire of Murray CHRMAP, Baird, 2024)

Table 2-3 Peel Inlet Extreme Water Level Best Fit from 2020 analysis (Shire of Murray CHRMAP, Baird 2024)

Event Recurrence	2yrARI	10yrARI	100yrARI	500yrARI
Water level (mCD)	1.3	1.4	1.6	1.9
Water level (mAHD)	0.8	0.9	1.1	1.4

2.4.4 Sea Level Rise

Sea Level Rise based on DoT's report "Sea Level Change in Western Australia, Application to Coastal Planning" (DoT, 2010), is +0.4m in the next 50 years and +0.9m over the next 100 years. Table 2-4 presents suitable sea level rise allowances for the study area.

Table 2-4 Sea level rise allowances (DoT, 2010)

Planning year	Present	+10yrs	+30yrs	+50yrs	+100yrs
Sea level rise	0m	+0.1m	+0.2m	+0.4m	+0.9m

2.4.5 Wind

Relevant to study area, wind measurements are available at Mandurah Park, and Mandurah, from 1965-present.

Table 2-5 Mandurah BoM measured Wind (Shire of Murray CHRMAP, 2024)

Station	Name	Location	Time	Notes
WS 9572	Mandurah Park	32.5031°S, 115.7664°E	Jan-1965 to Dec-1985	15m, 9am and 3pm
WS 9887	Mandurah	32.5211°S, 115.7500°E	Nov-1987 to Oct-2001	21m, 3-hr
WS 9977	Mandurah	32.5219°S, 115.7119°E	Oct-2001 to present	3m, 3-hr

Shire of Murray CHRMAP (2024) mentions the following conclusions, based on the recent wind measurements:

- Southerly sea breezes prevalent from October through to April
- Easterlies mainly occur in February and March
- Westerlies dominant between May and September
- Strong winds generally from west to northwest
- May to July northeast winds have a significant secondary occurrence
- Onshore winds from west through northwest directions are common, suggesting a tendency for alongshore transport

Refer Figure 2-9 for measured wind direction frequency plots and Figure 2-10 for recorded wind observations of a storm event.

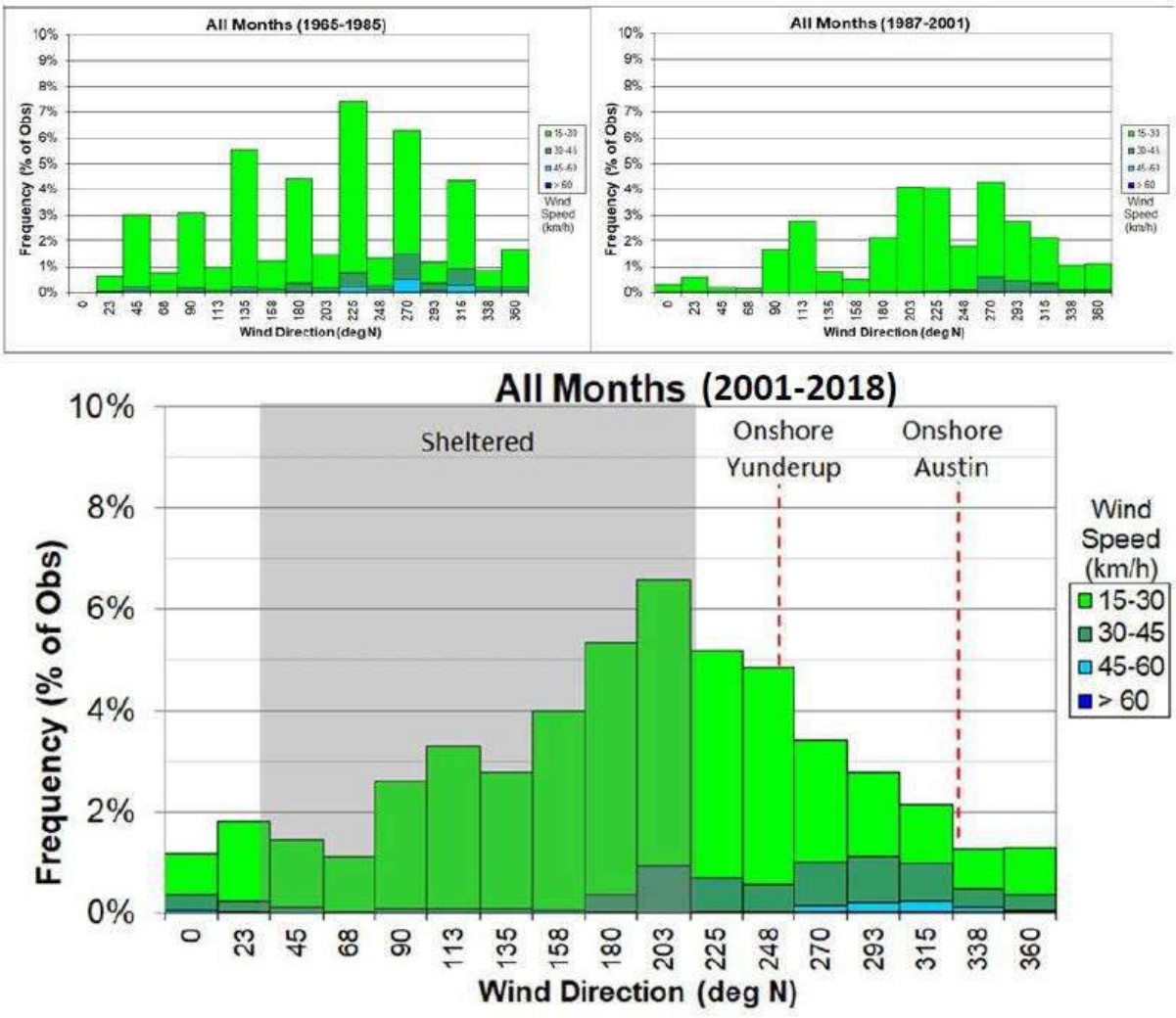


Figure 2-9 Mandurah speed and direction frequency plots (Shire of Murray CHRMAP, 2024)

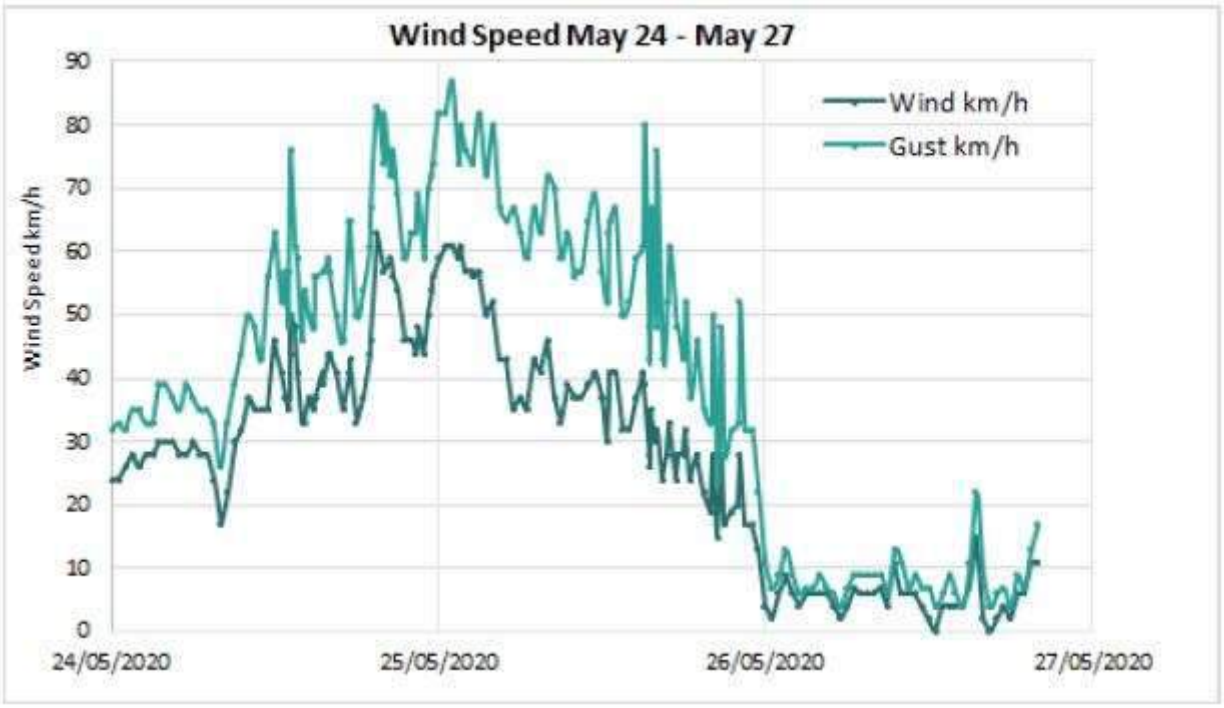


Figure 2-10 May 2020 Storm Wind record (Shire of Murray CHRMAP, Baird 2024)

2.4.6 Waves

There are no long-term wave measurements available for the study area. Given its location, the wave climate is expected to be dominated by locally produced wind-driven sea waves on the Peel estuary. Numerical modelling conducted as part of the CHRMAP (Baird, 2024) concluded that:

- Wave conditions within estuary are generally low energy
- Average wave heights of 0.2-0.3m, with annual maxima of 0.4-0.6m
- Greatest seasonal variation of wave height occurs where there are the largest north-westerly fetches, smaller seasonality is apparent where fetches are generally shorter, or there is a narrow direction over which waves could be generated.
- Seasonality of wave conditions is similar for each year, suggesting limited inter-annual variability.

2.4.6.1 Lower Murray River Boat Wake Study

Baird (2024) conducted a vessel wake study on the Murray River, focusing specifically on a downstream section adjacent to Ballee Island. Although the results may not precisely reflect the wake characteristics in the immediate study area at Cooper's Mill, they offer useful insights into vessel wake behaviour within the primary Murray River Channel and the broader regional context. The data serve as a valuable benchmark, contributing to an improved understanding of local river dynamics and supporting future assessments or regulatory considerations.

Figure 2-11 Field data collection location for the 2024 boat wake study by Baird (2024).

Instrumentation comprised submersible wave-measuring devices and a shoreline-mounted camera. The wave sensors recorded wave height and period, while the camera logged vessel activity, including transit counts, directions, estimated speeds, and approximate vessel lengths over the following data collection periods:

- 25 January – 1 February: captured peak weekend vessel traffic
- 17 – 20 April: represented a quieter phase outside of the summer season

The study aimed to characterise vessel usage on the river, specifically, vessel size, speed, and passage frequency, and to quantify the waves generated by vessel wakes.

Summary of findings:

- Vessel traffic was highest during the middle of the day, with significantly lower numbers observed in the early morning and around dusk
- The highest number of vessels recorded in a single day was 943, occurring on Australia Day (a public holiday)
- During the quieter April monitoring period, the average daily vessel count was approximately 50
- A total of 1,948 vessels were detected during the peak usage period. Of these, 25 vessels (approximately 1%) were estimated to be travelling faster than 5 knots. Notably, 20 of these occurred on January 25–26, representing just 2% of total vessel movements during those two days. The highest estimated speed was 7 knots

- Over the quiet period, 195 vessels were detected. Only two (1%) were estimated to exceed 5 knots, with the highest estimated speed being 5.5 knots
- The study concluded that most vessels complied with the 5-knot speed limit during both monitoring periods
- Most vessels observed were estimated to be 6 metres or shorter in length. The largest vessel detected fell within the 10 to 12-metre range. The most common vessel length category was between 4 and 6 metres
- The maximum wave height recorded was 0.22 m on January 27, followed by 0.19 m on January 26. Visual records indicated that in both cases, multiple vessels were passing at the same time, suggesting that the recorded wave heights were the result of combined wake effects rather than a single vessel

During peak river usage period, the percentile maximum wave heights were calculated and are summarised in Table 2-6.

Table 2-6 Maximum wave height percentiles, during peak usage period

Percentile	Maximum wave height (m)
80	0.07
90	0.09
95	0.11
99	0.15

Based on the collected measurements, a clear positive correlation was identified between wave height and vessel characteristics: higher waves were associated with increased vessel speeds, and greater wave heights were similarly linked to larger vessel lengths. These findings align with established hydrodynamic principles, which indicate that both vessel velocity, through its impact on Froude number, and vessel size, through its displacement and pressure distribution significantly influence wake generation.

Drawing on an analysis of measured wind data, Baird (2024) determined that wind-generated waves in the study area are minimal. Consequently, vessel wakes were identified as the primary contributor to shoreline erosion in that region. Based on comprehensive field measurements, Baird (2024) recommends targeted awareness-raising among boat operators regarding the heightened erosion impact that can result from navigating in close proximity, operating larger vessels, and exceeding prescribed speed limits (in line with the information provided in Figure 2-12). These recommendations are aimed at mitigating erosion risk by promoting responsible boating behaviour.

According to the Mandurah Marine Safety Boating Guide, (Boating Mandurah Guide) the recommended vessel speed limit of 5 knots applies at Coopers Mill, refer Figure 2-13.

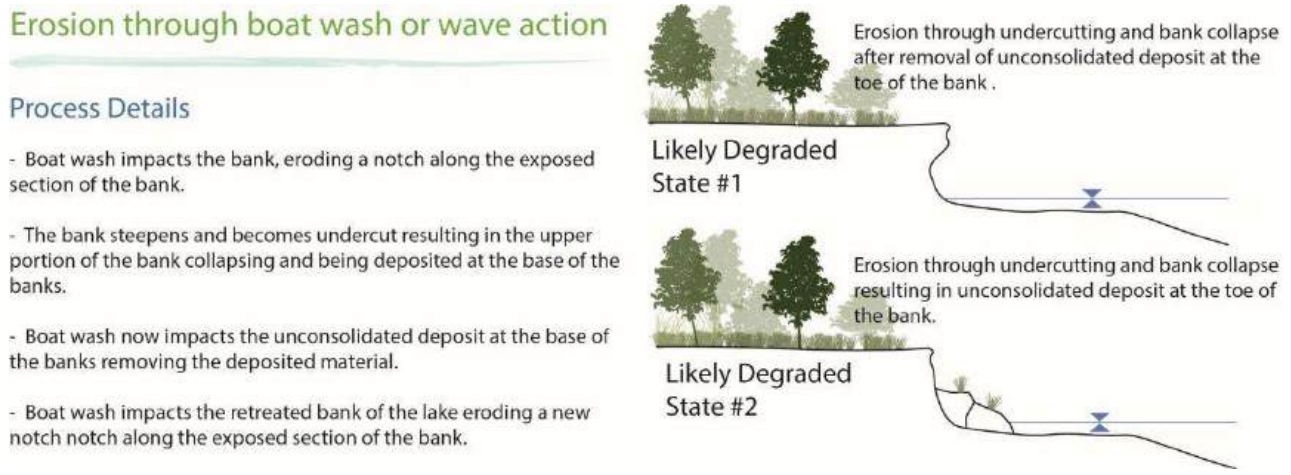


Figure 2-12 Diagram demonstrating how erosion from wave action and boat wash can affect banks.

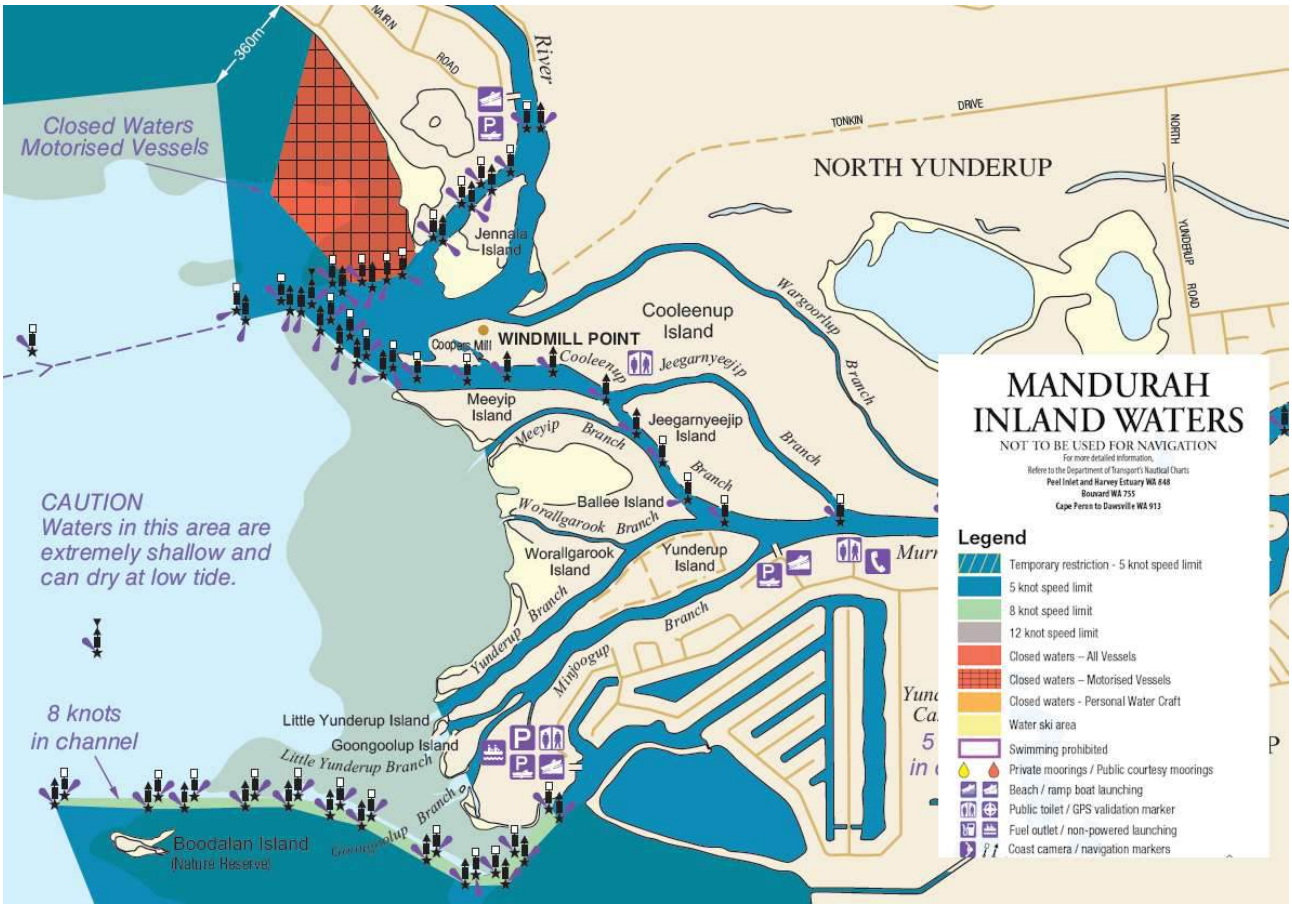


Figure 2-13 Recommended Boat Speed at Coopers Mill – extracted from Boating Guide Mandurah: Marine Safety (Mandurah Boating Guide)

2.5 Coastal Hazards

The results of the Shire's CHRMAP (Baird, 2024) hazard projections are summarised in Figure 2-14 for both erosion and inundation, along with the outputs of the Shire's asset database. A selection of land levels subject to inundation has been highlighted based off the CHRMAP information and are summarised in Table 2-7.

Table 2-7 Coastal inundation water levels for ~2030.

Scenario	Water Level (mAHD)	Notes
2030 Highest Astronomical Tide	0.7	A typical high-water level that would be observed every year. Includes 0.1m sea level rise from 2020 to 2030.
2030 10yr ARI	1.0	A high-water level that has a 10% chance of occurring every year. Includes 0.1m sea level rise from 2020 to 2030.
2030 100yr ARI	1.2	A high-water level that has a 1% chance of occurring every year. Includes 0.1m sea level rise from 2020 to 2030.
2030 500yr ARI	1.5	A high-water level that has a 0.2% chance of occurring every year. Includes 0.1m sea level rise from 2020 to 2030.
2120 500yr ARI	2.3	A high-water level that has a 0.2% chance of occurring every year at 2120. Includes 0.9m sea level rise from 2020 to 2120.

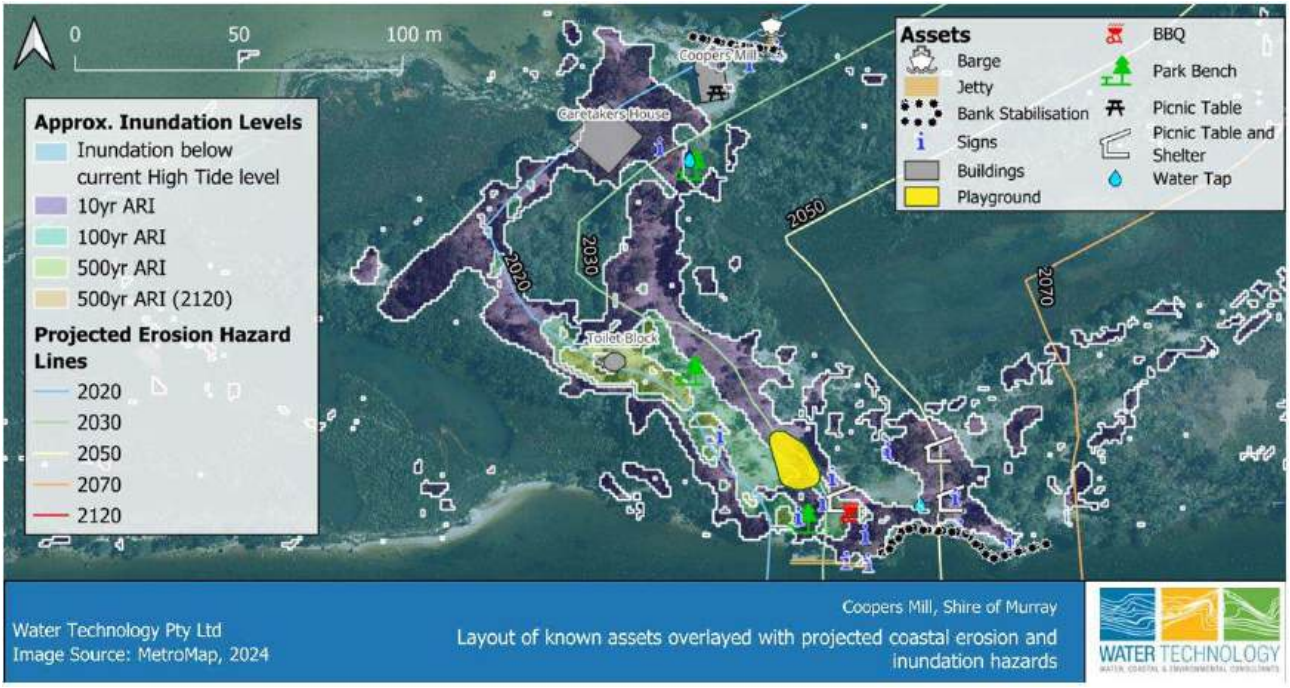


Figure 2-14 Layout of known assets overlayed with projected coastal erosion and inundation hazards.

For context, a field photo supplied by a community member taken on Monday 12/5/2025 is provided as Figure 2-15 below showing the parking area, and the northside barge jetty at the end of Tonkin Drive both submerged. The maximum recorded water level at the Peel tide gauge nearby for that day was 0.5mAHD – significantly less than the 2030 Highest Astronomical Tide level.

The study area already has significant vulnerability to coastal inundation, which will increase into the future. Coastal erosion projections are also significant but have not been observed so actively on the ground so far (Figure 2-16**).**

Figure 2-15 End of Tonkin Drive looking towards Cooper's Mill; Monday 12/5/2025 (Supplied by community member)

The Shire's CHRMAP (Baird, 2024) recommends and details coastal hazard mitigation pathways for protecting Cooper's Mill Reserve. As short-term risk management and adaptation pathways, Monitoring (NR1), site specific inundation study (NR5), berm management, planting and nature-based 'soft protect' options to control erosion (PR1, PR2, PR3) are recommended. Monitoring (NR1), engineering edge treatments to protect against erosion and inundation (PR4) are recommended as medium- and long-term risk management and adaptation pathways. This FMP investigates these options and their suitability for implementation against the local context of the site in detail.

Figure 2-16 Indicative coastal erosion between 2008 and 2024. The yellow outline shows where the foreshore was in 2008 in comparison with the satellite image taken in November 2024 (Metromap). This is indicative and water level comparisons and adjustments have not been made.

3 SITE VISIT

A site visit was undertaken by Water Technology and members of the steering committee on 7/3/2025 to gain a greater understanding of the coastal processes, and to identify any issues and other factors that may require consideration during the study.

During the visit a visual inspection was carried out and key items noted for reference including general foreshore features, berm formation, extent and condition of vegetation and any evidence of erosion/inundation. We also noted the general topography of the land, proximity to development, and the features and assets within the study area. The site visit included the collection of GPS-referenced photographs and associated notes for future reference.

The outcomes of site inspection are summarised in Table 3-1. Additional site visit notes include:

1. John L. is the full-time caretaker based on the island and has been there for approximately 20 years.
2. There was a major works program on the island in the 1980's including construction of the caretaker's house, and refurbishment of the Mill building. It is understood this was achieved by building a temporary causeway road near where barge now operates.
3. Power supply comes across under the river channel near the barge jetty; water supply is from the east end of the island; no other utilities or significant buried infrastructure are located within the study area (there are septic tanks at public toilets which also service the caretaker house as well, and reticulation at several spots).

Table 3-1 Site visit outcomes

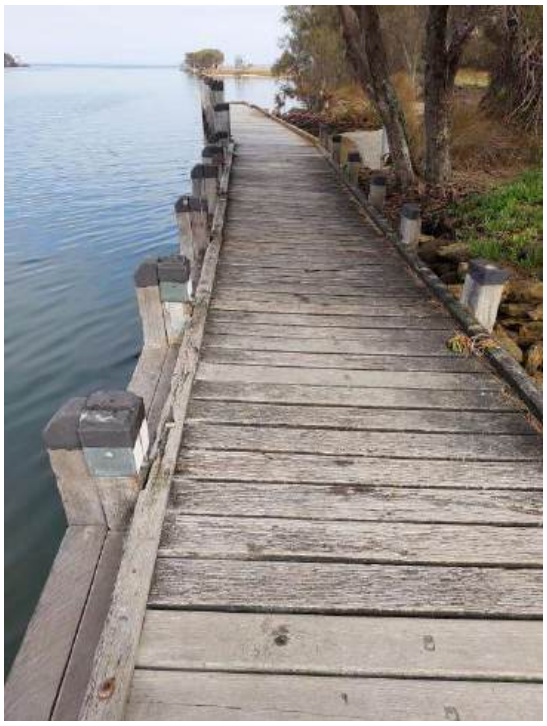
Location	Photos	Comments
Cooper's Mill	 	▪ Water from estuary comes inside Mill building often – approximately 5 to 10 times most winters (John L). Up to ~1.0m deep (2007 marked on bricks) and can linger days to a week or so. ▪ Need to remove seaweed / wrack and sand from Mill after flooding / overtopping events ▪ The round Mill engine room is approximately 6m back from the old timber wall – erosion management here is likely to be key. ▪ Overtopping at this location seems to be the primary pathway for estuary water and energy to reach and enter the Mill. Management of this area will be key to reducing flooding or energy of inundation reaching structure.

Location	Photos	Comments
Northern foreshore and seawall	 	▪ Approximately 5m long rock retaining wall east of barge jetty ▪ Approximately 10m long rock retaining wall west of barge jetty ▪ Approximately 25m long wooden wall west of the rock wall. ▪ All in poor or failed condition. Other than fallen trees and tree branches there is little vegetation connecting estuary and saltmarsh across wooden retaining wall. ▪ Some old, ragged geofabric cloth is present behind walls.
Caretaker's House		▪ Water laps at raised house pad (~0.3m) and slightly overtops retaining wall but hasn't got inside house in John's time.

Location	Photos	Comments
Western foreshore	  	▪ Largely a natural setting comprising tidal estuary samphire marsh backed by some woodland including tree species such as *Causarina obesa* and *Melaleuca rhaphiophylla*. ▪ Evidence of tree roots being undermined from gradual sediment erosion, resulting in trees falling into estuary.

Location	Photos	Comments
Foreshore amenities including bathrooms, playground, BBQ's pathway, picnic area and associated infrastructure	   	▪ Generally popular with family picknickers, boaters and people who want to visit Mill. ▪ Playground, picnic area and toilets provided with associated pathway and revegetation. ▪ No public bins (old ones vandalised by fire). ▪ Recurring nuisance behaviour in general – including theft and vandalism.

Location	Photos	Comments
Eastern vegetation and wetland	  Representative photo of samphire heath in wetland - image from Natural Area Holdings Veg Survey Report, 2018. Taken east of wetland in study area.	▪ Good saltmarsh vegetation (samphire, marine couch, Austral sea-blite and sea heath) except where there's been ground compaction from walking.

Location	Photos	Comments
Boating jetty on southern side	 	▪ Mandurah tour boat uses jetty. ▪ Also houseboats, can get quite busy at moorings.

Location	Photos	Comments
Mooring area on southern side	 	▪ Houseboats use moorings. ▪ Small craft such as houseboat tenders and kayaks / canoes use sandy beach access ramp.

Southern foreshore seawalls	   	▪ At east end there is ~35m PVC sheet pile wall (SPW - some damaged, not backfilled properly) crest height estimated at ~1.4mCD. This wall installed in last 20 years – other all built before ~2005. ▪ West of vertical SPW there is ~35m of largely failed wooden wall. ▪ West of, and in front of wooden wall, is a jetty – length doubled in last 20 years. Erosion evident around jetty structure, removal of sediment and soil from tree roots, undercutting banks. Likely affected by boat wash based on observations (video captured). ▪ Treated pine post wall immediately east of jetty has buried black plastic on land side – purpose and age unclear. Some additional treated pine work around one sheoak to try to protect from erosion. ▪ Geofabric cloth is present in poor condition - ripped, may have been pinned but now folded and ragged. ▪ Trees on foreshore are falling in with erosion in general – sediments entrained from around roots. ▪ Paperbarks on foreshore seem to grow well in the salty estuary water and dissipate wave energy – but falling in with erosion. Slow growing – will be hard to replace. Sheoaks also present and tolerating salty water well.

4 SOCIAL AND CULTURAL ENVIRONMENT

4.1 Land Management and Tenure

The land within the study area is reserved as Regional Open Space and managed by the Shire.

4.2 Existing Facilities

The existing facilities within the study area primarily centre around the Mill along with associated infrastructure and supporting foreshore amenities - with uses related to recreation and island / foreshore access including:

- Cooper's Mill and associated infrastructure:
  - Caretakers Facilities (house, barge, services)
- Foreshore Amenities:
  - Estuary and wetlands
  - Jetty and moorings
  - Picnic amenities (seating, BBQs, water taps, shade, playground)
  - Toilets
  - Car parking area at estuary end of Tonkin Drive

4.3 Existing Management Activities

Current foreshore management activities primarily include maintenance of existing Shire assets. A live-in caretaker provides ongoing surveillance and monitoring of the area and assets for the Shire. The Shire currently manages the study area and the assets within it by undertaking the following (via the caretaker and others):

- Management of the Mill
- Management of the Caretaker's house
- Management of the jetties and barge
- Management of the toilet block and foreshore amenities including maintenance and cleaning
- Ad-hoc coastal revegetation programs depending on sourcing grant funding and support form community groups and members such as local schools
- Coastal monitoring activities

4.4 Landscape, Seascape and Visual Landscape

The Visual Landscape Planning manual (WAPC, 2007) provides advice for evaluation, assessment, siting, and design of development for the protection of views and vistas and natural landscapes. It includes advice on techniques for incorporating visual landscape planning into typical planning tasks. Pages 73-80 provide advice for visual landscape planning specifically for coastal landscapes. Natural visual elements for the Shire's foreshore are the estuarine vegetation, shoreline, long unobstructed views from and to the water, and the high natural character value and Mill Heritage. Elements specific to development include siting and location, building design (colours, materials, height, reflectivity), parking areas, signage and entry statements, access and any vegetation clearing required. All of these shall be considered for any future coastal development within the foreshore reserve or adjacent coastal areas.

Landscape issues at the shoreline generally include degradation of natural landforms and vegetation, reduced visual access to the estuary (loss of views), visual dominance of built elements, the need for careful design and siting of foreshore infrastructure. The manual provides advice on how to minimise these impacts through appropriate design and scoping. The manual also provides guidance on the retention/restoration of natural landforms and vegetation and for the siting of foreshore infrastructure.

4.5 Social and Recreational Amenity

The results of the desktop review and site visit identified the following social and recreational priorities for the study area:

- Tourism (social, environmental, heritage).
- Recreation – social, island / shoreline focussed.
- Recreational Boating – power boating, paddle craft.
- Public and foreshore amenities.

Table 4-1 Values and assets identified from desktop review

Assets	Category	Values	Concerns
Cooper's Mill	Heritage	Point of interest of cultural and social value.	Inundation and erosion degrading the integrity of this asset.
Aboriginal Cultural Heritage sites and places	Heritage	Aboriginal cultural heritage - Murray River (Creation / Dreaming Narrative); Djilba (Creation / Dreaming Narrative)	Appropriate management and preservation
Estuary and wetlands	Environment	Supporting aquatic ecosystems including dolphins, crustaceans, fish and birds. Additionally, contributes to recreational values. Protected migratory shorebirds are also dependent on the estuary as feeding grounds.	Climate change, water quality impacts.
Estuary and River	Recreation	A selection of water sports is presently undertaken within the study area including swimming, boating, water skiing, kayaking, diving, and fishing / crabbing.	Water quality for people and for marine ecosystem – particularly edible fish and crabs.
Caretaker's Facilities (house, barge, services)	Public Infrastructure	Enabling caretaker on island, which supports and protects heritage and recreational values.	Inundation and erosion affecting facilities, and potential for safety of caretaker to be threatened by inundation and bushfire risk.
Jetty and moorings	Recreation	Supporting recreational and other social values by enabling greater accessibility to the island for visitors.	Erosion destabilising assets, threatening user safety. Boat wake contributing to erosion.

Assets	Category	Values	Concerns
Picnic amenities (seating, BBQs, water taps, shade, playground)	Recreation	Supporting social values by encouraging visitors to come to island and connect with the surrounds and each other.	Inundation and erosion affecting facilities, and potential for safety of visitors to be threatened by inundation and bushfire risk.
Vegetation	Environment	Supporting health of estuary and terrestrial ecosystems, providing habitat, foreshore stability, visual amenity, water quality. Additionally supports recreation. Includes the threatened ecological community - Subtropical and temperate coastal saltmarsh.	Inundation and erosion altering vegetation dynamics, trampling by visitors affecting plants and soil, bushfire risk.
Walking paths	Recreation	Supporting social values by encouraging exercise and connection to nature. Protects environmental values, e.g. vegetation and soil from being trampled. The existing paths are heavily used by community members and visitors alike and there is ongoing support for ensuring access for community members.	Not enough paths to support where people want to go, trampling and compaction occurring off the paths.
Toilets	Public Infrastructure	Supporting recreational and other social values. Protecting environmental values.	Inundation and erosion affecting toilets and ancillary components (pipes, tanks, etc.)

4.6 Future Land Use, Facilities and Visitor Behaviour

There are no plans for substantial future development within the study area. Future land use within the study area will need to meet several criteria, including:

- Form and scale of development appropriate for the zone – in accordance with the topography and visual landscape. Development of any public foreshore facilities shall sit appropriately within the foreshore, rather than standing out from it.
- Foreshore tenure and management – any development must be suitable for regional open space.
- Location, form, and land use within coastal nodes – any development should be appropriate for the foreshore zone – i.e., coastally dependant and/or low-value, or able to be removed when unacceptably vulnerable in the future.
- Stormwater and water sensitive urban design principles shall be utilised.
- Coastal hazard risk management and adaptation principles shall be considered in accordance with SPP2.6 and the coastal hazard risk areas identified in this plan.
- Financial responsibilities (capital and recurrent costs) for ongoing maintenance and management of foreshore areas – for development to be sustainable it must be able to be maintained within the Shire's operating budget.

Potential land use conflicts in the study area are low key and few, but antisocial behaviour by a minority of visitors is an ongoing concern to the caretaker and community-members. The foreshore has always been a

conflicted space with competing demands for different activities. This potential for safety issues and conflict will require ongoing management.

5 COMMUNITY AND STAKEHOLDER ENGAGEMENT

The project could not be completed without an understanding of the local knowledge and particular items of interest from within the community and other stakeholders. Engagement activities were undertaken to compile this knowledge and therefore set the scene in relation to options development in the FMP. Early, thorough and open engagement helped to provide a well-informed project.

5.1 Community and Stakeholder Engagement Strategy

A Community and Stakeholder Engagement Strategy (CSES: Water Technology, 2025) was prepared for review by the steering committee. Primary objectives of the CSES were:

- To identify the community and stakeholder key values for the Cooper's Mill Reserve foreshore, to ensure that the FMP outcomes are strongly aligned with the values of the community.
- Establish strong working relationships with community networks and stakeholders which are built on mutual trust and respect. This will be facilitated in part by providing details of all feedback and concerns regarding adaptation options in the final project report.
- To ensure all stakeholders have up to date information about the FMP, and the broader coastal management framework that supports the project.
- To provide the community and relevant stakeholders the opportunity to have direct input into the development and delivery of the FMP content.
- To understand community goals and aspirations for the study area and community views on values, assets, opportunities, and priorities.
- To highlight and explain the benefits and challenges of proposed implementation options, in terms of the meaning for community members and stakeholders.
- Discuss the potential management recommendations with the community and stakeholders to determine the preferred strategies and uncover any potential areas of concern prior to implementation.
- Increased community and stakeholder understanding of, and support for, actions and priorities in the FMP and CHRMAP (as it relates to the study area).

5.2 Engagement Activities

The following engagement activities were undertaken:

- Project inception, Internal engagement
- Coastal Assets, Values & adaptation preferences Workshop
- Targeted individual stakeholder engagement
- Internal (steering committee + relevant Shire staff) information session
- Presentation to Council of Revised Draft FMP for Public Comment

5.3 Coastal Assets, Values & Adaptation Preferences Workshop

A workshop to raise community awareness and participation in the FMP to ensure community opinions are factored properly was undertaken on Thursday 26/6/2025. This provided the community with an opportunity to discuss the project with the project team face to face, and to identify areas / assets of value and preferred adaptation approaches. Six community members and three councillors attended the workshop. The scope and context of the project was shared with the attendees, and they were invited to provide comments and information / feedback on:

- The community's priority values and assets for the study area, and
- Their preferences for management options for the study area.

5.3.1.1 Coastal Assets and Values

In groups, attendees used coloured stickers to label areas on aerial photo posters (which included information on assets, and projected inundation and erosion hazards similar to Figure 2-14) to highlight key areas which had assets/values important to them, grouped by the following colours and categories:

- Blue - Recreational
- Green - Environmental
- Yellow - Heritage (historical/cultural)
- Red - Public infrastructure (caretaker's facilities, paths, picnic facilities, toilets, playground)

In general, the results confirmed the desktop and site visit assessment (Figure 5-1 to Figure 5-3).

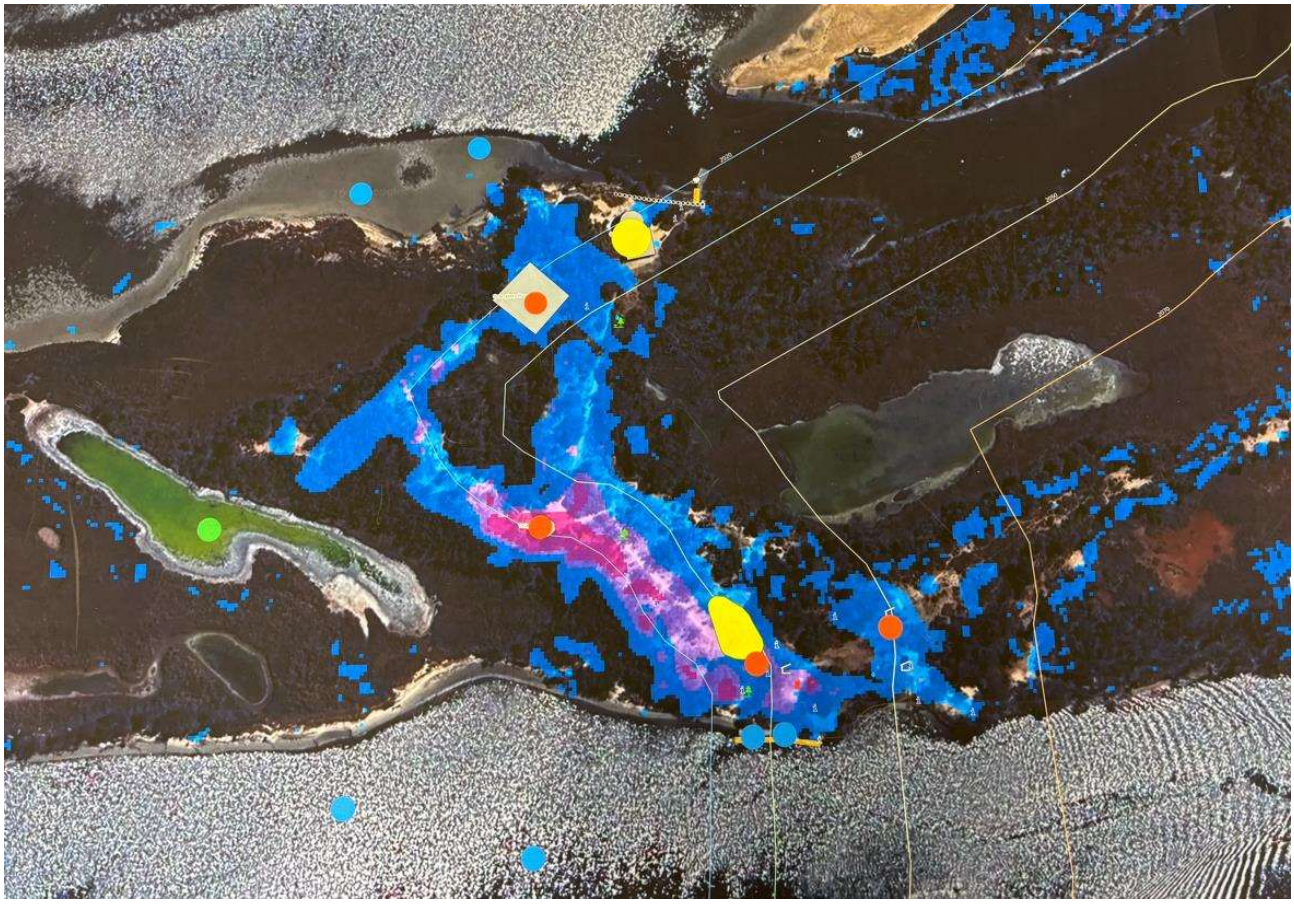


Figure 5-1 Values and assets identified by Group 1 – photo of engagement materials.

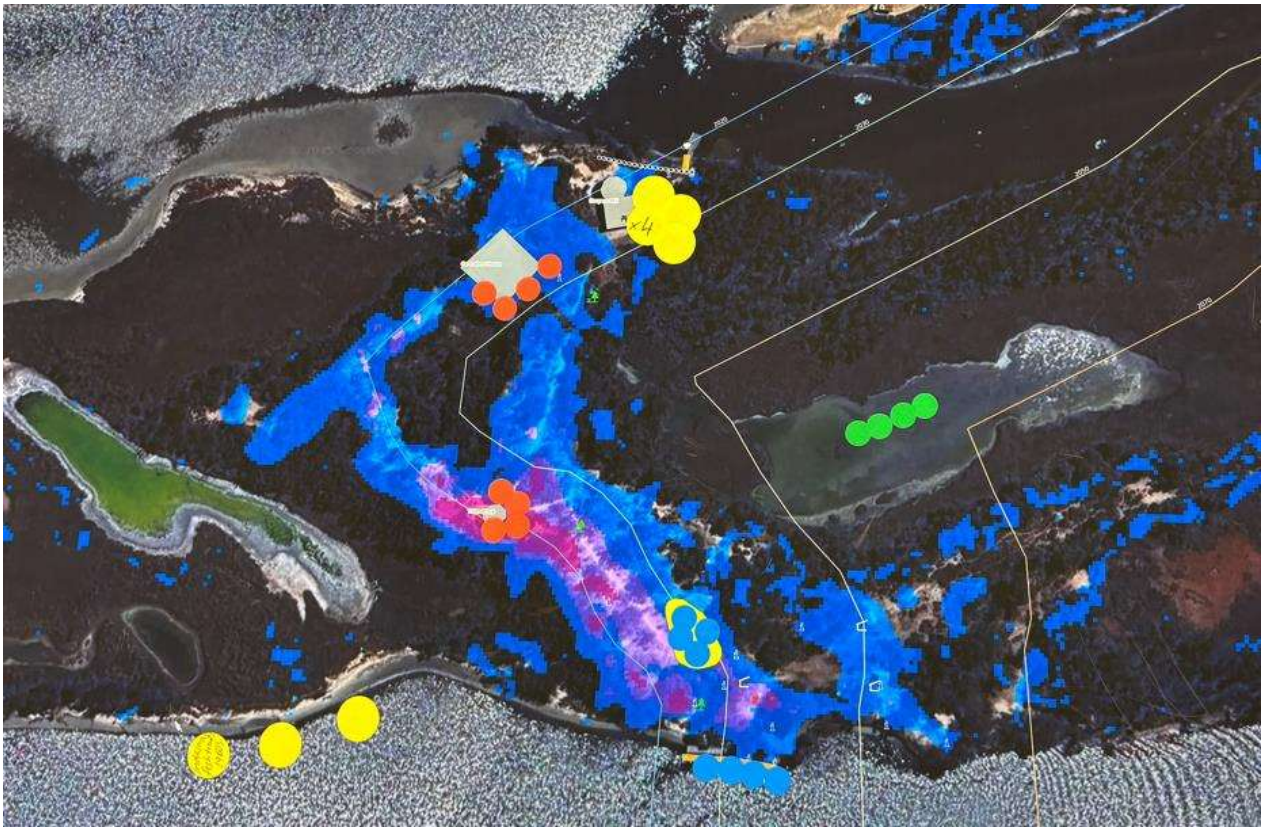


Figure 5-2 Values and assets identified by Group 2 – photo of engagement materials.

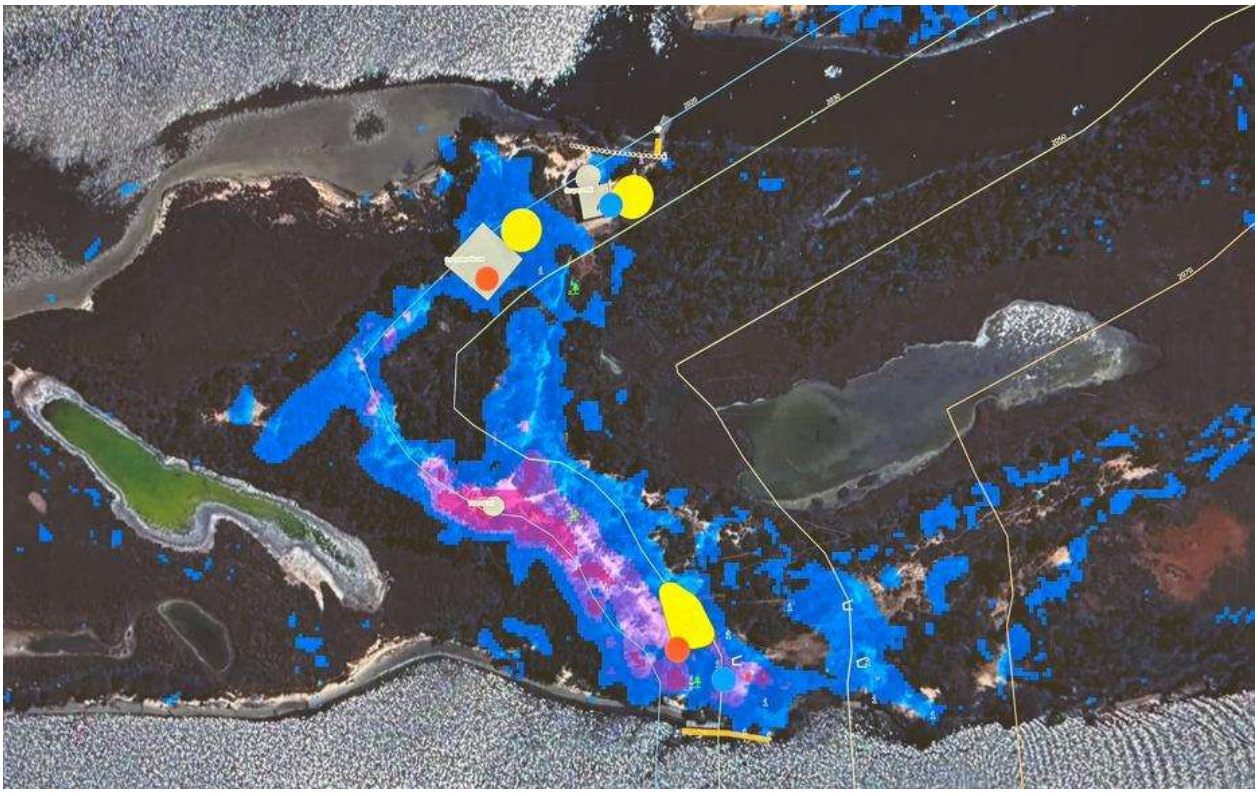


Figure 5-3 Values and assets identified by Group 3– photo of engagement materials.

The following additional notes and comments on assets and values were collected (underlining indicates a similar comment was made twice and **bolding** indicates it was made three or more times):

- **The Mill is the highest priority for protection given the heritage listing and immediate proximity to land loss to erosion on the western edge of the reserve.**
- Land-based and maritime infrastructure in general should be maintained and continue to be provided
- Aboriginal heritage is important and a value for the study area – including Fish Traps that are no longer visible/apparent but are remembered
- Heritage considerations for the Mill should also consider the need to confirm the location of other infrastructure associated with the original farm. The island's history includes Cooper's farm, which housed animals and had plans for a hotel at one point.
- The jetties, moorings and foreshore amenities on the south side of the island are heavily used by visitors and especially by houseboats who often stay overnight. The reserve attracts a mix of locals and numerous day-trippers, including house-boaters every weekend, due to its location between Ravenswood and Mandurah. Approximately 90% of visitors are day-trippers.
- Need to protect the lake in eastern half of study area from completely connecting to the river due to foreshore erosion.
- Local residents as well as visitors use the foreshore amenities – for example having community Christmas celebrations.
- Caretaker role and presence is very important – The Mill currently has a full-time resident caretaker, John L., who is integral to the heritage story and plays a crucial role in security and deterring vandalism. There could be options for revising the format in the future - including evaluating whether the caretaker role should remain full-time or part-time. Consider a rotation of personnel, like the system at Penguin Island, to protect the site.
- Access for non-boating people could be improved – in future the Shire could explore the possibility of providing an alternative access route, such as a footbridge, for visitors without boats.
- Preserving native flora and fauna species on the island and eradicating weeds and feral animals is very important.
- Assess and ensure this project will not have negative effects on other locations within the Murray Delta.
- Community members would still like to see the impact of Dawesville Cut and Mandurah Channels on the estuary investigated.

5.3.1.2 Coastal Adaptation Preferences

Attendees were introduced to potential treatment pathways to manage coastal erosion and inundations risks from the Lower Muray River Foreshore Stabilisation Guidelines (Syrinx, 2019):

- Revegetation / Managed Retreat
- Bioengineering
- Protection – soft, medium, hard
- Do nothing

These treatment options are presented in more detail in Section 9. Attendees were presented with a simplified map of the study area split into four zones based on their primary assets, values and use – Heritage, Infrastructure, Natural and Recreational (Figure 5-4) and asked to identify their preferred management pathways and any preferences for them (Table 5-1). The preferences and comments were quite varied but included a general preference to consider retreating / relocating some assets, revegetating and bioengineering

in preference to hard protection options at most of the study area except for the Mill. This information is utilised in the management options and identification in Section 9.

Figure 5-4 Simplified grouping of study area into four zones based on their primary assets, values and use – Heritage, Infrastructure, Natural and Recreational.

Table 5-1 Adaptation pathway preferences for the study area zones. Numbers in square brackets [#] show how many times the preference/comment was made.

Management Zone	Preferred Adaptation Pathway	Other management ideas including opportunities and constraints / issues
Heritage Zone	▪ Revegetation [2] ▪ Bioengineering [4] ▪ Hard protection [6]	▪ Manage power boating to reduce boat wake adjacent the Mill [2] ▪ Only protect areas / assets that cannot be moved. ▪ Work to reduce rising damp in Mill structure ▪ Berm to reduce water reaching Mill
Infrastructure Zone	▪ Managed Retreat ▪ Revegetation [3] ▪ Bioengineering [3] ▪ Hard protection [3]	▪ Relocate assets ▪ Harden access paths to reduce foot-traffic erosion ▪ Long-term maintenance program needed for all infrastructure ▪ More monitoring of water levels and asset condition needed

Management Zone	Preferred Adaptation Pathway	Other management ideas including opportunities and constraints / issues
Natural Zone	▪ Do nothing [2] ▪ Managed Retreat ▪ Revegetation ▪ Soft protection	▪ Caretaker management is important including for eradication of feral animals and weeds ▪ Increased salinity from opening Dawesville Cut has had a large effect ▪ Introduce more salt tolerant vegetation ▪ Boat wake considered a key cause of erosion ▪ Sand nourishment ▪ Manage power boating to reduce boat wake
Recreational Zone	▪ Do nothing ▪ Managed Retreat [2] ▪ Soft protection [2] ▪ Hard protection	▪ Relocate assets ▪ Caretaker management is important ▪ Need to complete the existing sheet pile wall ▪ Sand nourishment ▪ Dredging to provide sand for nourishment ▪ More monitoring of water levels and asset condition needed
Other (please describe)	▪ N/A	▪ Vandalism including environmental areas is a key concern ▪ Increase Ranger access and activity – enforce no camping and no fires ▪ Consistent aesthetic to be considered across delta islands ▪ Information / education information for Cultural and Historical aspects ▪ More monitoring of water levels - frequency, severity and their causes and impacts

6 HERITAGE

6.1 Aboriginal Heritage

The study area holds Aboriginal cultural significance. Water Technology conducted a review of the State Government's Aboriginal Heritage Inquiry System, available at Aboriginal Cultural Heritage Inquiry System, and identified four Registered Aboriginal Sites in the vicinity of the study area: Serpentine River, Djilba, Murray River and COODANUP CAMPS. Refer Table 6-1 through Table 6-4, and Figure 6-1 through Figure 6-7 for details. Further information about the history and significance of these sites and the surrounding area is provided in the appended Conservation Management Strategy for the Mill (refer Appendix B).

Table 6-1 Details of Aboriginal Cultural Heritage (ACH) Register Place 3582 Serpentine River, referencing State Government's Aboriginal Heritage Inquiry System available at: Aboriginal Cultural Heritage Inquiry System

Description	Details
ID	3582
Name	SERPENTINE RIVER
Place Type	Ritual / Ceremonial; Creation / Dreaming Narrative
Culturally Sensitive	Yes
Culturally Sensitive Nature	No Gender / Initiation Restrictions
Restricted Place	Yes

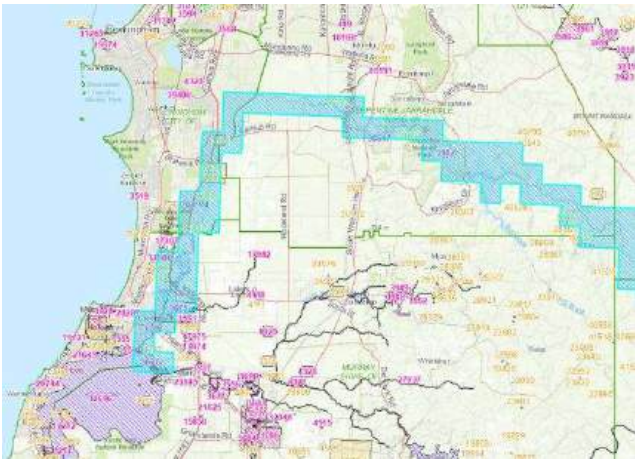


Figure 6-1 Area coverage of Aboriginal Cultural Heritage (ACH) Register Place 3582 SERPENTINE RIVER – Regional Context

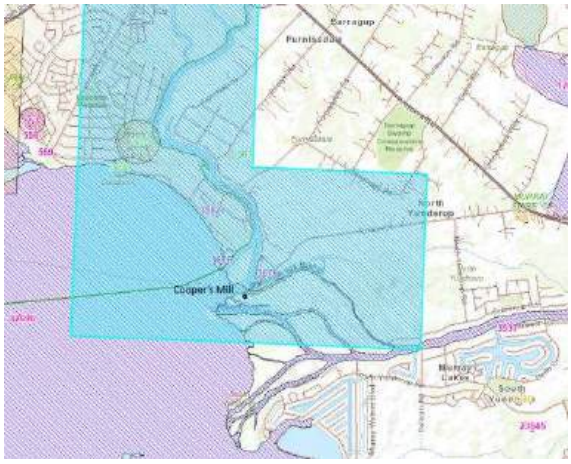


Figure 6-2 Area coverage of Aboriginal Cultural Heritage (ACH) Register Place 3582 SERPENTINE RIVER – Zoomed to Study Area

Table 6-2 Details of Aboriginal Cultural Heritage (ACH) Register Place 32696 Djilba, referencing State Government's Aboriginal Heritage Inquiry System available at: Aboriginal Cultural Heritage Inquiry System

Description	Details
ID	32696

Description	Details
Name	Djilba
Place Type	Creation / Dreaming Narrative
Culturally Sensitive	No
Culturally Sensitive Nature	No Gender / Initiation Restrictions
Restricted Place	No

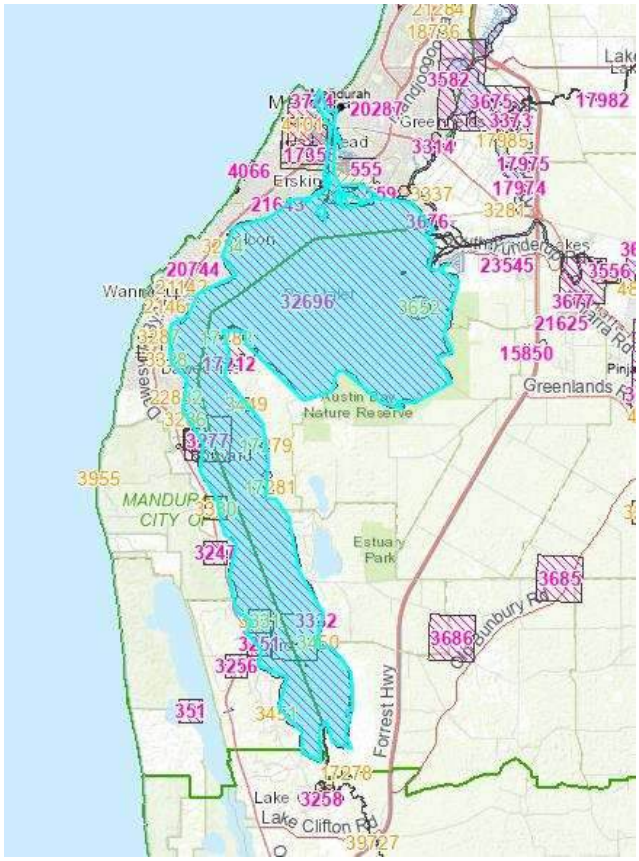


Figure 6-3 Area coverage of Aboriginal Cultural Heritage (ACH) Register Place 32696 Djilba – Regional Context

Figure 6-4 Area coverage of Aboriginal Cultural Heritage (ACH) Register Place 32696 Djilba – Zoomed to Study Area

Table 6-3 Details of Aboriginal Cultural Heritage (ACH) Register Place 3537 Murray River, referencing State Government's Aboriginal Heritage Inquiry System available at: Aboriginal Cultural Heritage Inquiry System

Description	Details
ID	3537
Name	Murray River
Place Type	Creation / Dreaming Narrative

Description	Details
Culturally Sensitive	No
Culturally Sensitive Nature	No Gender / Initiation Restrictions
Restricted Place	No

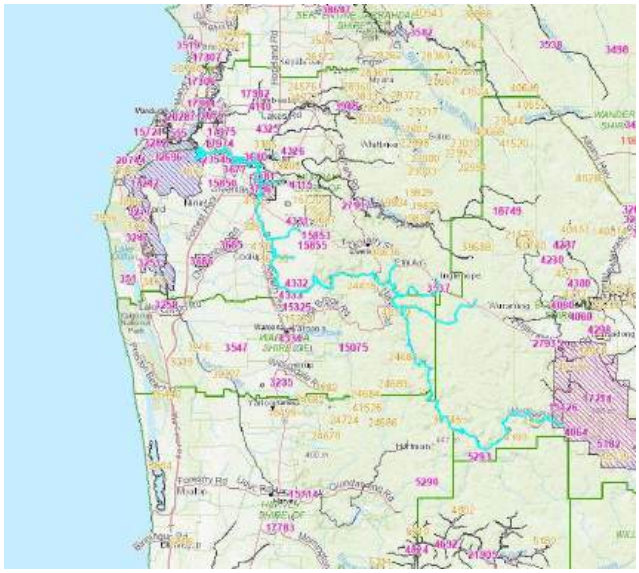


Figure 6-5 Area coverage of Aboriginal Cultural Heritage (ACH) Register Place 3537 Murray River – Regional Context

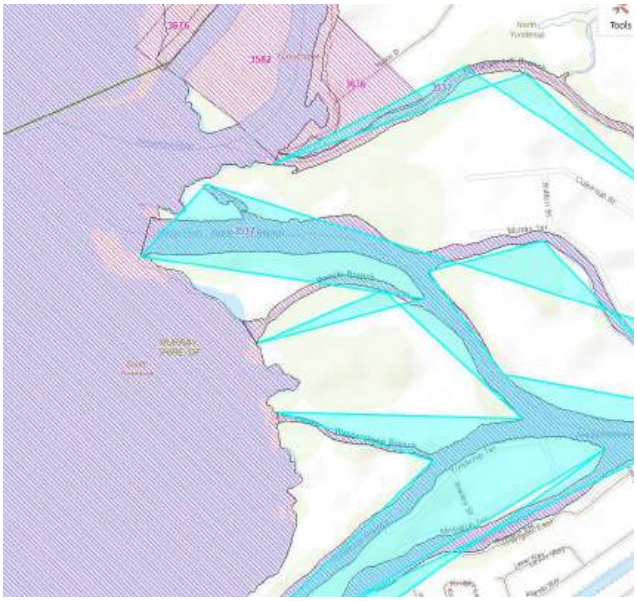


Figure 6-6 Area coverage of Aboriginal Cultural Heritage (ACH) Register Place 3537 Murray River – Zoomed to Study Area

Table 6-4 Details of Aboriginal Cultural Heritage (ACH) Register Place 3676 Coodanup Camps, referencing State Government's Aboriginal Heritage Inquiry System available at: Aboriginal Cultural Heritage Inquiry System

Description	Details
ID	3676
Name	COODANUP CAMPS
Place Type	Camp; Hunting Place
Culturally Sensitive	No
Culturally Sensitive Nature	No Gender / Initiation Restrictions
Restricted Place	No

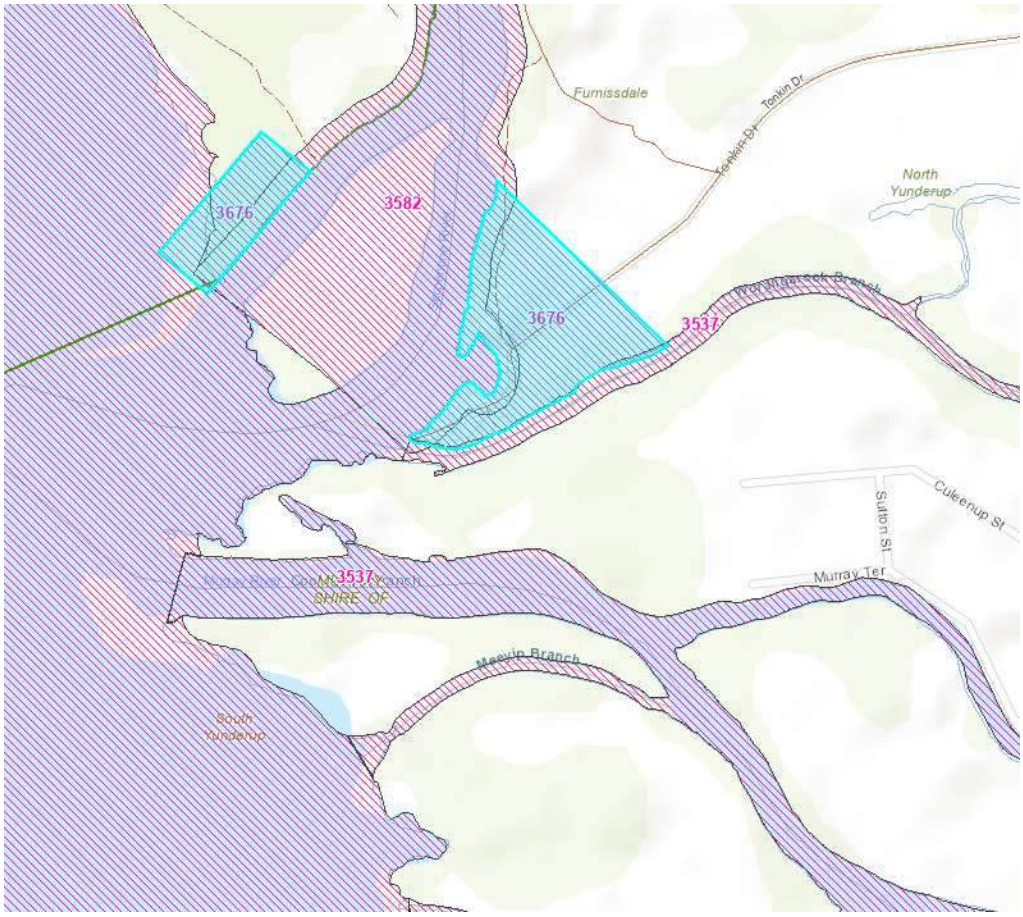


Figure 6-7 Area coverage of Aboriginal Cultural Heritage (ACH) Register Place 3676 COODANUP CAMPS

6.2 European Heritage

Water Technology undertook a search of the State Government's Heritage Register (available at https://inherit.dplh.wa.gov.au/) and one site was identified as being located within the study area, besides Cooper's Mill. The Peel Harvey Estuarine System is listed with the following information:

- Place Number 16113
- Heritage Listings and gradings – Municipal inventory Grade 1 adopted 27/5/2014 and Register of the National Estate adopted 15/5/1990.
- Physical Description – The system is the largest estuarine ecosystem of the Swan Coastal plain.
- Statement of Significance - Extremely important as bird habitat. The area provides the most important estuarine bird habitat in southwest Western Australia. Seventy species of bird have been recorded there including sixteen migratory species protected by international migratory bird treaties. The samphire flats and wetlands of the area support a considerable diversity of invertebrate fauna. There are thirty-seven species of fish that are supported by the estuary and are an important food source for birdlife but also have significant importance for commercial and recreational fishing. The vegetation along the banks is representative of types that were once more extensive on the coastal plain.
- History - The estuary has been a major source of food for both Aboriginal people and the early settlers. Aboriginal people gathered around the estuary tributaries at their mungahs for many years and during the

latter half of the nineteenth century a commercial fishing industry was established. The inlet was also highly valued as a place of recreation for both local residents and holidaymakers. Concern regarding eutrophication saw the Dawesville Channel being constructed between the ocean and the estuary in an attempt to flush out the estuary.

This designation is not considered likely to overly inhibit foreshore management decisions in the study area as the process actively considers the concerns raised in the designation and the priority is to address the vulnerability of the Mill.

6.3 Maritime Heritage

There are no known maritime heritage sites (such as shipwrecks) identified on the local nautical chart within the study area.

7 ENVIRONMENTAL CONTEXT

7.1 Environmental Context

Cooper's Mill Reserve is located on Cooleenup Island, one of eight riverine islands that make up the Murray River Delta Reserve in the township of South Yunderup. This reserve adjoins the Peel Inlet of the Peel-Harvey Estuary, part of the Peel-Yalgorup System that is recognised as a Wetland of International Importance under the Ramsar Convention.

The Peel-Harvey Estuary is the largest and most complex estuarine system in the South West of WA. It is made up of two shallow lagoons, namely, the Peel Inlet and the Harvey Estuary, into which three rivers empty – the Harvey, Murray and Serpentine Rivers. A channel connects the estuary to the sea at the northern end of the Peel Inlet at Mandurah, with another constructed channel at Dawesville further south.

The Dawesville Channel was constructed in 1994, after ongoing water quality issues within the Estuary resulted in severe eutrophication and algal blooms. The Channel was intended to promote flushing of the estuary with seawater, however the increase in exchange of seawater into the estuary has reduced the residence time of nutrient-rich waters from the catchment, and generally increased the salinity profile of the estuary (Department of Water and Environmental Regulation, 2025). This has in turn affected the ecological communities of the estuary, with notable deterioration of the benthic environment and changes in fish species composition (Rogers, Hall, & Valesini, 2010). Changes to fringing vegetation may also be occurring, though due to other changes in the catchment (including clearing for development), it is not clear whether this is solely a result of the channel construction.

The environmental values of the Peel-Harvey Estuary and the Murray River Delta Reserve are important to the local community and visitors to the region, and their protection and enhancement is supported. Understanding what these values are, the processes that support them, and the processes that threaten them, is key to generating effective environmental management actions.

7.1.1 Bioregion

The study area is in the western, low-lying coastal plain section of the Swan Coastal Plain IBRA bioregion (Mitchell, Williams, & Desmond, 2002). This bioregion is a 30 km wide coastal plain on the Indian Ocean coast directly west of the Darling Scarp uplands running from Cape Naturaliste in the south to north of Perth. The area generally consists of infertile sandy soil along with coastal sand dunes, river estuaries, and several wetlands kept back from the sea by the dunes. It is dominated by woodlands, including Banksia (*Banksia spp.*) or Tuart (*Eucalyptus gomphocephala*) on sandy soils, Swamp sheoak (*Casuarina obesa*) on outwash plains, and Paperbark (*Melaleuca spp.*) in swampy areas. The climate is Mediterranean, with the majority of the 600 to 1,000mm annual rainfall occurring in the winter months (Mitchell, Williams, & Desmond, 2002).

The Murray River Delta Islands consist of alluvial and estuarine deposits, largely clay and sand from the Murray and Serpentine Rivers. These soils are classified as belonging to the Vasse system, comprising of tidal flat soil, saline wet soil and pale deep sand (Keighery, et al., 2006). Much of these soils are occasionally or regularly inundated with salty water at high tide, with the exception of more elevated sandy ridges. Specific vegetation communities are adapted to these different soil environments.

7.1.2 Vegetation

A variety of vegetation types are present at Cooper's Mill Reserve. These include Samphire Heathland, Swamp Sheoak (*Casuarina obesa*) Woodland, and Mixed Woodland including Moitch (*Eucalyptus rudis*), Swamp paperbark (*Melaleuca rhaphiophylla*) and Swamp sheoak (*Casuarina obesa*) (Natural Area Holdings, 2018).

Samphire Heathland is a type of saltmarsh, a community of saline-tolerant plants that occupy areas at the interface between land and sea, particularly in estuaries and sheltered coastlines (Prof. A.J. McComb, 1995).

They are often subjected to periodic inundation from tidal movements, which generally dictates the saltmarsh distribution and composition. On Cooleenup Island it was observed that the lowest part of the saltmarsh that is frequently inundated is dominated by Samphire (*Sarcocornia quinqueflora*). As elevation increases, more diversity in species is observed, including Austral seablite (*Sueda australis*), Sea-heath (*Frankenia pauciflora*), Salt couch (*Sporobolus virginicus*) and Sea rush (*Juncus kraussii*). Higher up, larger shrubs and trees such as Swamp sheoak (*Casuarina obesa*) and Paperbarks (*Melaleuca spp.*) build a canopy and mark where the saltmarsh begins to transition into a woodland community. Figure 7-1 illustrates the relationship between topography (i.e. inundation frequency) and the vegetation dynamics of saltmarsh communities.

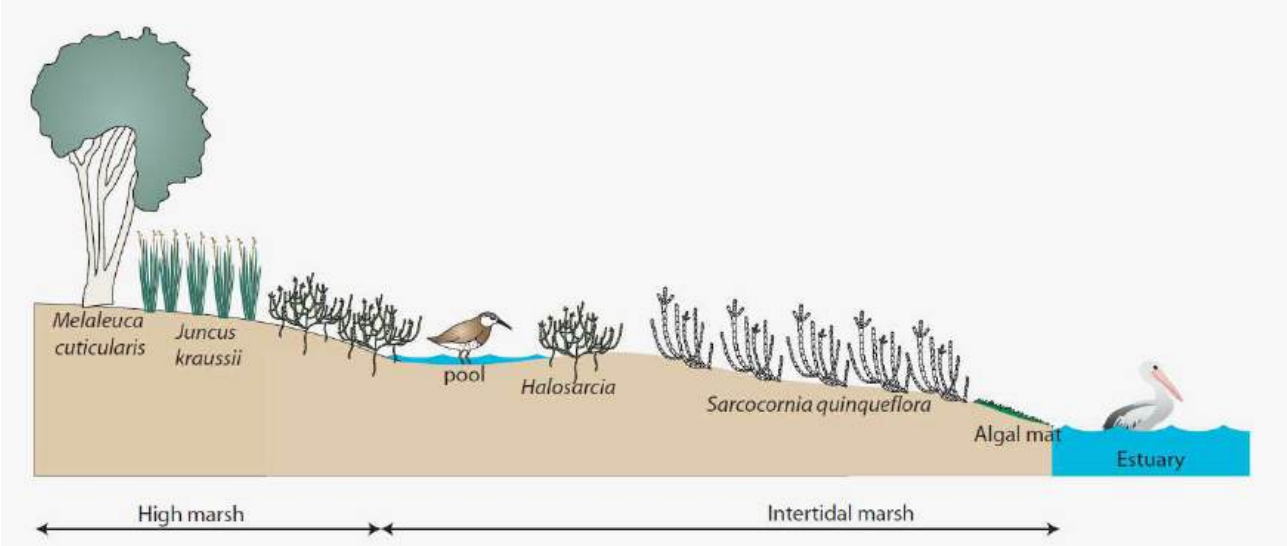


Figure 7-1 Cross-section of typical saltmarsh in the Peel-Harvey Estuary (sourced from Hale & Butcher, 2007)

Subtropical and Temperate Saltmarsh is considered a Threatened Ecological Community (TEC) currently listed as vulnerable under the Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (the EPBC Act). This TEC was confirmed as being present close to the site during the survey by Natural Area Holdings. While it cannot be confirmed that the saltmarsh vegetation observed during the site visit meets the characteristics of this TEC, it is recommended that any disturbance to its vegetation is avoided.

The EPBC Protected Matters Search Tool also indicated that the Critically Endangered Tuart (*Eucalyptus gomphocephala*) Woodlands and Forests community was likely to occur within the Study Area.

Using the Protected Matters Search Tool, the flora species shown in Table 7-1 were identified as being threatened under the EPBC Act and having species or species habitat known to or likely to occur within the Study Area. Of these, the Dwarf Bee-orchid (*Diuris micrantha*) is listed as Vulnerable and having species or habitat that is known to occur at the site and its immediate surrounds (Department of Climate Change, Energy, the Environment and Water, 2024). The endangered Glossy-leafed Hammer Orchid (*Drakaea elastica*) is indicated as having 'species or species habitat that may occur' but has been included due to recorded sightings in the Department of Biodiversity, Conservation and Attractions (2024) Dandjoo search.

Table 7-1 Flora species listed as threatened or otherwise protected under the EPBC Act (1999) and known to or likely to occur in the Study Area (EPBC Protected Matters Search Tool accessed 10/9/2025).

Scientific Name	Common Name	Threatened Category	Prescence Description (species or species habitat)
Diuris purdiei	Purdie's Donkey-orchid	Endangered	Likely to occur

Scientific Name	Common Name	Threatened Category	Prescence Description (species or species habitat)
Drakaea elastica	Glossy-leafed Hammer Orchid, Warty Hammer Orchid	Endangered	May occur
Diuris micrantha	Dwarf Bee-orchid	Vulnerable	Known to occur
Diuris drummondii	Tall Donkey Orchid	Vulnerable	Likely to occur

An understanding of the vegetation communities, their dynamics and whether they are protected is a key consideration for developing this FMP.

7.1.3 Fauna

7.1.3.1 Species Occurrences

Cooleenup Island and the surrounding environs of the Peel Harvey Estuary, Murray Delta Islands and lower reaches of the Serpentine and Murray Rivers host a variety of habitats and diverse fauna species. A desktop review of species occurrence data using the Western Australian Department of Biodiversity, Conservation and Attractions Danjoo search tool identified 65 fauna species recorded within the Study Area in the last 10 years. A full list of the recorded species is included in Appendix A, and included the following:

- 60 species of birds (class Aves)
- 3 species of mammals (class Mammalia)
- 1 species of reptile (class Reptilia)
- 1 species of arachnid (class Arachnida)

It is noted that occurrence records on platforms such as Danjoo are often incomplete and can be biased towards species groups that are commonly surveyed for. In this circumstance, it is likely that bird surveys are most common, due to the Study Area being located within a Ramsar site.

In addition to the findings of the desktop review, the following species were observed during the site visit:

Table 7-2 Species sighted during site visit.

Scientific Name	Common Name	Class
Tursiops adunctus	Bottlenose dolphin	Mammal
Portunus armatus	Blue swimmer crab	Malacostracans
Macropus fuliginosus	Western grey kangaroo	Mammal

Knowing these species are present, or likely to be present at the Study Site, will inform management actions to ensure the environmental values of the site are supported within this FMP.

7.1.3.2 Threatened Species

Using the Protected Matters Search Tool, threatened fauna species listed under the EPBC Act were determined for the Study Area. This search tool identifies species or their habitat that are known to occur, likely to occur or may occur at the site and/or its immediate surrounds. A summary of the search results is included in Table 7-3, and the complete species list is included in Appendix A.

Table 7-3: Summary of Fauna Species Listed as threatened or otherwise protected under the Commonwealth EPBC Act (EPBC Protected Matters Seach Tool, accessed 10-09-2025)

Threatened Category (EPBC Act)	Number of species with species or species habitat known to occur within area	Number of species with species or species habitat likely to occur within area	Number of species with species or species habitat may occur within area
Critically Endangered	2	1	1
Endangered	7	4	10
Vulnerable	9	8	5
Conservation Dependent	0	1	0
All Categories	**18**	**14**	**16**

In total, 48 fauna species were identified in the EPBC Protected Matters Search Tool. Of these, the following two species are critically endangered and known to occur in the study area:

- *Numenius madagascariensis* (Eastern Curlew, Far Eastern Curlew)
- *Calidris ferruginea* (Curlew Sandpiper)

Both the Eastern Curlew and Curlew Sandpiper are migratory birds that spend the non-breeding season in Australia, during which they rely on intertidal mudflats for feeding. Mud flat habitat provided in the Study Area is likely to be significant to these species, and minimising disturbance should be considered during the preparation of the FMP.

7.2 Threats to Environmental Values

There are several hazards and threats to environmental values within the study area. These include bushfire risk, feral animals, weeds, plant pathogens, bushfire, uncontrolled access, lack of awareness, climate change, acid sulphate soils and construction activities.

7.2.1 Bushfire Risk

Much of the Murray Delta Islands, including Cooleenup Island and Cooper's Mill, are designated as bushfire prone areas by the Department of Fire and Emergency Services. Consequently, any planning proposals or development at the site may trigger the application of State Planning Policy 3.7 Bushfire (SPP3.7) and associated Planning for Bushfire Guidelines (Guidelines) (DFES, 2025). This will occur if actions in the Foreshore Management Plan were to:

- Result in the intensification of development (or land use); or
- Result in an increase of visitors, residents or employees; or
- Adversely impact or increase the bushfire risk to the subject or surrounding site(s).

Consequently, the Foreshore Management Plan needs to consider bushfire risk at the site as a potential constraint. The Shire should confirm with DFES if the proposed recommendations are considered to be an "intensification of development" and if a Bushfire Management Plan should be prepared and maintained by the Shire to identify the potential bushfire risks and outline measures to reduce their potential impacts on the place.

7.2.2 Feral Animals

Feral animals are a key threat to biodiversity in Western Australia, causing a decline in native species populations due to changes to competition, predation, mortality, or habitat degradation. While Cooleenup

Island is not easily accessible for feral animals, it is still possible for them to be present. In the region nearby Cooleenup Island, feral animals likely to be present include (Keighery, et al., 2006):

- House Mouse (*Mus musculus)*
- Black Rat (*Rattus rattus)*
- Cat (*Felis catus*)
- Fox (*Vulpes vulpes*)
- European Rabbit (*Oryctolagus cuniculus*) – this has been observed on the island by Shire staff.

Populations of these species should be monitored to ensure they do not greatly impact on the native fauna and flora of Cooleenup Island and its surrounding area.

7.2.3 Weeds

Several introduced (weed) species have been identified in the study area, including Couch Grass (*Cynodon dactylon*) and Hottentot Fig (*Carpobrotus edulis*). Natural Area Holdings also identified Bridal Creeper (*Asparagus asparagoides*) as being present on Cooleenup Island, which is a declared weed of national significance. Shire staff have observed One-leaf Cape Tulip (*Moraea flaccida*) present on the island (declared under the Biosecurity and Agriculture Management Act 2007) and Watsonia (environmental weed especially *Watsonia meriana var. bulbillifera*) and are undertaking management of these species. Weeds often invade native vegetation and subsequently have negative impacts on the biodiversity of flora and fauna, fire management regimes, foreshore stability and erosion dynamics. Weeds often respond positively and rapidly to land or habitat disturbance, such as clearing, rubbish dumping, trampling and fire. Weeds create several issues for biodiversity within the study area including (Department of Biodiversity, Coservation and Attractions, 2025):

- Competition with native vegetation by inhibiting growth, seedling recruitment and displacing native species.
- Replacement of diverse native plant communities with more uniform weed communities.
- Changing the structure of vegetation communities, often by the removal of the shrub layer or native ground covers.
- Changing nutrient cycling of native communities.
- Altering soil acidity.
- Altering geomorphic processes, such as increased or decreased erosion.
- Altering fire regimes.
- Reducing resources available for fauna by altering the habitat.
- Some weeds are poisonous to native fauna.
- Providing habitat to non-native fauna.

The introduction and spread of weed species or diseases has the potential to occur through several means, particularly associated with the movement of vehicles and machinery. Key activities which may result in the introduction and spread of weeds and diseases include:

- Movement of vehicles, machinery and people along tracks, roads or through intact bushland.
- Importation of material containing weeds or diseases not previously present in the Study Area.

It should be noted that the extensive removal of weed species may contribute to the acceleration of erosion processes without careful management. Weed removal should be undertaken in conjunction with revegetation

using indigenous species to the area, in order to prevent recolonisation of weeds and potential acceleration of erosion.

7.2.4 Pathogens

Plant pathogens such as Phytophthora (*Phytophthora cinnamomic*) and Honey Fungus (*Armillaria luteobalbina*) have the potential to threaten the integrity of the native vegetation in the study area (Department of Biodiversity, Coservation and Attractions, 2025).

While there is no evidence of these pathogens in the study area, and the coastal soils are not particularly favourable for Phytophthora, steps should be taken to ensure that infection does not occur, particularly during development or rehabilitation activities. It is important to practice soil hygiene; for example, ensuring that any soil brought in during construction or landscaping is not from an infected area. Infected soil can be moved around on vehicles or bikes, footwear, animal movements, road construction and earth moving equipment.

7.2.5 Lack of Awareness

Knowledge and awareness of local biodiversity within the community is critical to improving behaviours and attitudes towards the natural environment and reducing damage from people's activities. The Shire has an important role in promoting environmental awareness: engaging and educating the community in biodiversity conservation.

7.2.6 Uncontrolled Access

Uncontrolled access to natural areas for recreational activities can be a threat to the native flora, fauna, and habitats in the study area. Whilst not currently a significant issue, uncontrolled pedestrian access on the island can lead to trampling of vegetation, spreading of pathogens, disturbance of soil surfaces leading to erosion and reduction in aesthetic values. Pedestrian access should continue to be controlled.

7.2.7 Climate Change

Climate change is a threat to biodiversity and environmental values within the study area. The southwest of Western Australia is becoming a hotter and drier climate with more frequent and severe bushfires and extreme weather events (Bureau of Meteorology, 2025). Drought months are predicted to increase, and seasonal rainfall decline will continue to intensify. The impacts of climate change on biodiversity include:

- Reduced water availability in wetlands and other groundwater dependant ecosystems, and deterioration of water quality causing negative ecological impacts.
- Increased risk of bushfire.
- Changes to wildlife migration patterns and to critical seasonal timing of reproduction
- Movement of species to areas of adequate rainfall causing a reduction in local biodiversity.
- Damage to natural areas causing hazards for wildlife.
- Erosion and inundation of sensitive ecosystems threatening biodiversity (including estuarine ecosystems).

7.2.8 Acid Sulphate Soils

Acid Sulphate Soils have been observed by DoT in dredged material from the estuary nearby to the study area and should be considered as likely to be present and not to be disturbed. Overtopping by riverine and estuary water inundating the Mill is not considered related to Acid Sulphate Soils, which are not considered to have a direct impact on the Mill. Any works in the study should avoid disturbing submerged Acid Sulphate Soils and exposing them to air.

7.2.9 Construction Activities

Habitat disturbance or removal during construction activities resulting from the implementation of the FMP is considered a potential threat to the environmental values of the Study Area. As such, it is recommended that options that mitigate or minimise habitat disturbance are considered during the Options Analysis, and actions to minimise site disturbance considered during Detailed Design and Construction of the recommended mitigation works. Accessing the foreshore and intertidal mudflats with machinery to enable construction works can threaten sensitive coastal habitats, remnant fringing vegetation and the species that rely on them.

7.3 Recommendations for Environmental Management

Based on the information collated within this section, it is evident that the Study Area is highly valuable from an environmental perspective. It is within an internationally recognised Ramsar wetland and supports many threatened flora and fauna species and communities. The intertidal mudflats and foreshore environment have recorded flora and fauna species that are sensitive to disturbance. Acid Sulphate Soils have been observed by DoT in dredged material from the estuary nearby to the study area and should be considered as likely to be present and not to be disturbed.

The protection of the species, communities and habitats should be considered during the options analysis stage of the FMP, and in detailed design and construction of mitigation actions. In addition to their intrinsic value, these environmental assets can be a drawcard for visitors and contribute to the social and cultural values of the site.

8 COOPERS MILL CONSERVATION MANAGEMENT STRATEGY

This Conservation Management Strategy (CMS) for Cooper's Mill has been prepared by Stephen Carricks Architecture and is provided in full at Appendix B.

The Shire of Murray recognises the cultural heritage significance of Cooper's Mill (fmr) and the environmental pressures associated with its island setting, including inundation and erosion. This has prompted the initiation of the FMP to provide coordinated strategies for the site's long-term management and conservation. The CMS addresses the built heritage component of the FMP and is aimed at providing a guide to the appropriate conservation planning and maintenance of the place.

A CMS is acknowledged as a best practice management document to provide a framework for the conservation of the place's significant values and building fabric. Cooper's Mill (fmr) is included on the Heritage Council of Western Australia's State Register of Heritage Places (P01771). The place comprises a group of buildings, amenities and the natural landscape. These include:

- Cooper's Mill Building:
  - The Stone Mill (1843) and Engine Room (1860)
- Other Built Elements:
  - The Caretaker's House (1986)
  - The Public Toilet Block (1984)
  - Visitor Facilities - timber framed shelters, children's playground and equipment, barbecues and seating, three timber jetties and signage (1984-1986)
  - Three timber Jetties and Time Capsule (1998)
- Natural landscape:
  - The Island setting
  - Native Landscape (vegetation)

It was agreed the CMS be prepared for the main Cooper's Mill building only - the Stone Mill (1843) and Engine Room (1860) with consideration for the immediate natural landscape surrounding the subject building. Other built elements and natural landscape in the broader site and reserve are not included within the CMS scope. For clarity and consistency, the title 'Cooper's Mill' will be used in the following sections of this CMS to refer to the main building only - the Stone Mill and Engine Room. This Conservation Management Strategy expands on the existing information provided in the Register of Heritage Places Assessment Document (1997), the 2013 Conservation Management Plan and Shire of Murray's Place Record Form (LHS No. 008) for Cooper's Mill (fmr).

8.1 Overview

Cooper's Mill is a cylindrical rendered stone tower with a conical timber shingle roof and a single-storey rectangular brick addition to the south. The building is located on the north-western end of Cooleenup Island, addressing the foreshore of the Serpentine and Murray River. Cooper's Mill was originally used as a wind-driven mill from 1843 to the 1850s. Following a bushfire that damaged the building, the mill was later converted to steam power with the Engine Room addition to the south in 1860. The mill was in operation until the place closed in 1865. As of 2025, the place is owned and maintained by the Shire of Murray as a public museum.

8.2 Locality

The locality of the place, as listed in the State Register of Heritage Places – 1997 Permanent Entry for Cooper's Mill (fmr), refers to 'Cooleenup Island, North Yunderup'. In 2025, planning data from both Landgate and the Shire of Murray Atlas Maps indicate that the place falls within the Locality of Coolenup Isalnd, South Yunderup. This CMS will refer to South Yunderup as the location of the place.

8.3 Heritage Listings

Cooper's Mill (fmr) has the following Heritage Listings:

- Shire of Murray - Local Heritage Survey (March 2020; Management Category A: Exceptional Significance)
- Shire of Murray - Heritage List
- State Register of Heritage Places - Permanent Entry for P01771, Cooper's Mill (fmr) (1997)
- Classified by the National Trust (1996)
- Register of National Estate (1984)

8.4 Conservation Strategy's Intentions

To provide guidance to the owners and occupants of the place, regarding the significance of the place as a whole and individual elements; and to provide recommendations for the conservation of the significant fabric and strategies for restoration, reconstruction, adaptation and maintenance of the significant elements.

8.5 Conservation Works Schedule

Section 4 of the Conservation Management Strategy sets out a detailed conservation and maintenance works schedule. This section outlines the required conservation works in order of priority.

- Immediate (0-1 year)
- Urgent Term (1-2 years)
- Medium Term (within 3 years)
- Long Term (safely deferred beyond 3 years)

A Building Condition Assessment Report is included as an Appendix to the CMS.

8.5.1 Immediate (0-1 year)

The building is considered to be in fair condition, acknowledging that it was constructed in the 1840s. There were no major issues that were identified during the site inspection that required immediate action. Some issues have been identified as requiring immediate or urgent action, these relate to rising and falling damp and roofing works.

8.5.1.1 Investigation Works

- Carefully remove exterior paint and render from a section of the external wall to the stone mill to investigate the condition of the masonry substrate underneath. Develop a repair and maintenance schedule to prevent further damage to the existing masonry.
- Inspect all roofs for water damage, structural defects and dislodged timber shingles to ascertain extent of conservation and maintenance work required.
- Consideration of an appropriate treatment for rising damp to be investigated and discussed.

8.5.1.2 Site and Drainage

- Regrade the surrounding natural ground levels to ensure water adequately falls away from the building
- Remove all vegetation within 0.5m of Cooper's Mill. Investigate an appropriate ground surface treatment to deter vegetation growth around the building line and immediate surroundings
- Consider installing drainage to the building to reduce impacts of water inundation
- Consider installing air vents to the structure and removing the plastic panels to the windows to improve natural ventilation to the internal
- Consider introducing low walls or barriers to stop and/or reduce water ingress in the case of flooding

8.5.2 Urgent Term (1-2 years)

8.5.2.1 Structural

- Engage a Structural Engineer, experienced with heritage structures, to prepare a structural condition report. Outcomes arising from this assessment should inform further Immediate and Urgent works.

8.5.2.2 Walls

- Investigate and treat areas of rising and falling damp and monitor accordingly. Inspect loose render to external and internal walls of the stone mill. Replace missing stone, repair and repoint underlying limestone, re-render with a lime-based mortar and repaint as required.
- Carefully remove render to the junctions between the stone mill and Engine Room. Assess the overall condition of the junctions to inform an appropriate methodology of repair. Treat junctions for rising damp, seal junctions as required to ensure water tightness, repair and repoint walls as required.
- Carefully remove render to the internal wall of the stone mill that faces the Engine Room to expose underlying masonry. Treat wall for rising damp, repair and repoint masonry using a lime-based mortar.

8.5.2.3 Timber Elements

- Lightly sand, patch and repair, and treat all exposed timbers with appropriate protective finish to ensure longevity.
- Replace and/or piece in timber to damaged structural timber roof elements to all roofs (including fascia and barge boards). Lightly sand, patch and repair, and treat all structural roof elements with appropriate protective finish.
- Replace missing or damaged timber shingles to all roofs (including verandah roof). Refix loose timber shingles and treat all roofs with an appropriate protective finish. Ensure watertight finish to all roofs. Instate a metal capping to the perimeter of the verandah roof to deter potential lifting of the timber shingles.
- Lightly sand, patch and repair, prime and repaint timber frames to all doors and windows using good external quality paint.

8.5.2.4 Flooring

- Remove sand and silt to the floor of the stone mill and Engine Room and investigate the condition of the stone flooring. Repair and replace stone and lime mortar as required.

8.5.2.5 Engine Room Roof

- Consider installing appropriate ventilated ridge capping to the Engine Room to improve roof ventilation to the internals. Capping to be simple in design and sympathetic to the existing timber shingle roof.

8.5.2.6 Security

- Remove sand and build-up to the base of all doors to ensure all doors are fully operable and can be adequately secured. Sand back and seal the base of all timber doors for appropriate clearances to ensure operability and ventilation to the internal while closed.
- Enclose and secure all external doors and windows. Ensure the building is lockable during conservation works period.

8.5.3 Medium Term (within 3 years)

8.5.3.1 Windows

- Remove plastic and metal panels to the two (2) high set windows to the stone mill. Treat steel bars for rust and paint with a rust guard paint suitable for marine environments.

8.5.3.2 Walls

- Carefully remove cement render and rake out cement mortar to the internal walls of the stone mill. Replace missing stone, repair and repoint and re-render using a lime-based render.
- Rake out existing mortar to the external and internal brick walls of the Engine Room and repoint using a lime-based mortar.
- Remove caulking and redundant conduits to the internal walls of the Engine Room. Patch and repair holes in the brick walls from former fixings.

8.5.3.3 Pest Activity

- Evidence of wasp nests throughout the building internally and externally. Carefully remove all wasp nests and treat periodically to prevent nesting.
- Regular inundation and exposure to moisture is conducive of potential termite activity. Evidence of former termite activity was identified and has been treated. Regularly monitor timber elements and treat for termite activity to prevent further damage.

8.5.3.4 Site

- Regularly clear and maintain a 3m buffer of shrubs or trees to reduce the potential risk of bushfire to the area and maintain sight lines to Cooper's Mill.

8.5.4 Long Term (beyond 3 years)

8.5.4.1 Verandah

- Piece in timber to damaged sections of the timber posts. Lightly sand, patch and repair and seal timber posts with an appropriate protective finish.
- Reseat existing timber posts by installing galvanised brackets to prevent further damage to the base of the timber posts.

8.5.4.2 Signage

- Clean and treat existing brass name plaque and stainless steel signage to south elevation.

8.5.4.3 Lighting

- Install external lighting for security as well as for highlighting the building.

8.5.4.4 Future Works

- Consider installing appropriate interpretation signage and/or installations to site.
- Consider installing appropriate seating to cater for proposed future use.
- Investigate proposals for adaptation to the place to suit a compatible future use.
- Remove existing timber finial to the conical roof of the stone mill and reinstate the former square based finial detail.

8.5.4.5 Roof

- Retain or remove skylights to Engine Room roof. If repairs are required to skylights, ensure new flashing is installed for water tightness to roof openings.

8.6 Recommended Maintenance Works Schedule

It is important that maintenance be carried out on a regular basis, and that any remedial action required be acted upon within an appropriate time frame. When implemented, the following schedule of maintenance works will ensure the upkeep of the place is programmed.

8.6.1 Three Monthly

- Ensure that all maintenance is recorded and referenced to the specific work undertaken, date of work and the specific location of the work. This should preferably be completed and stored electronically. Check security; repair door locks as required.
- Check for evidence of animal or pest activity and treat as required.
- Ensure that the interior remains relatively clean by having a regular cleaning program.
- The above is based on a visual inspection.

8.6.2 Annually

- Undertake termite and other pest treatment.
- Check condition of walls and roofs; repair as required.
- Check all drainage; repair as required.
- Check base of timbers for signs of deterioration or rot. Consider piecing in timber to remove damaged sections of the timber posts to the verandah and seating the timber posts in galvanised saddles.
- Monitor water marks on internal and external walls and undertake repairs as required.

8.6.3 Long Term

- Review this conservation management strategy every five to seven years or after a major program of works.
- Consider a full structural assessment every ten years if required.

Refer to the following publication to assist in documenting future maintenance works:

- Guide to Developing Heritage Places: An Owner's Guide to Conservation, Alterations and Compatible Development for Places entered on the State Register of Heritage Places; July 2024.

9 OPTIONS ANALYSIS

9.1 Identification of areas requiring management

Erosion and inundation are environmental processes - human intervention should only be considered when deemed essential. However, the need for intervention can arise due to alterations in the environment that affect the pace, direction and impacts of coastal hazards. In the study area the need for intervention has been triggered as the hazards are threatening priority infrastructure.

Following consideration of the projected coastal hazards and the community and stakeholder concerns, several areas have been prioritised for management – the numbered order matches Figure 9-1 below:

1. Cooper's Mill – this is addressed in the Conservation Management Plan - see Section 8.
2. The northern foreshore – this is addressed below.
3. The caretaker's house and toilet block – these are addressed with a series of recommendations in Section 10.
4. The southern foreshore – this is addressed below.
5. The remaining developed area of foreshore amenities – these are addressed with a series of recommendations in Section 10.

Figure 9-1 Simplified grouping of study area into four zones based on their primary assets, values and use – (Heritage, Infrastructure, Natural and Recreational) with priority areas for management numbered preferentially.

9.2 Identification of Management Approaches

Recommended hazard mitigation options for the study area, in the Shire's CHRMAP (Baird, 2024) included:

- Monitoring
- Berm management
- Planting and nature-based 'soft protect' options to control erosion
- Hard engineering edge treatments to protect against erosion and inundation

These and other options and/or sub-options were compiled into a preliminary long list with a focus on addressing the projected vulnerability to erosion and inundation of the prioritised area. The following documents were reviewed in considering feasible approaches:

- Lower Murray River Foreshore Stabilisation Guidelines (Syrinx, 2019)
- Best Management Practices for Foreshore Stabilisation (Swan River Trust, 2009)
- Best Management Practices for Foreshore Stabilisation – Brushwall (Syrinx, Seashore Engineering and Tranen, 2020)
- Best Management Practices for Foreshore Stabilisation (Swan River Trust, 2009)
- Guidelines for developing foreshore management plans in the Swan Canning Riverpark (Swan River Trust, 2012)

The identification of feasible approaches has specifically considered:

- The drivers of erosion and inundation.
- Assets and values at risk
- Management objectives
- Space available
- Time available
- Materials available
- Appropriate for land-use
- Likely impacts on existing assets/values acceptable
- Construction and maintenance feasibility
- Suitability of Nature-based Solutions (Appendix C)
- Swan River Trust Foreshore Stabilisation Decision Support Framework

Five primary stabilisation approaches have been considered:

- Revegetation
- Bioengineering aka Nature-based Solutions, i.e. using vegetation, wood and biodegradable products while vegetation establishes
- Renourishment: replacing sediment lost
- Walling / Revetments including rock walls, sheet pile walls and Gabion baskets
- Groynes / headlands: preventing alongshore sediment transport

Depending on the site conditions, erosion processes and constraints, either one or a combination of these management intervention techniques can be applied. The suitability of each technique will also be dependent upon factors such as budget, site objectives, public access and safety and stakeholder expectations.

9.2.1.1 Revegetation

The benefits of vegetation establishment include:

- The foreshore area is critical for protecting beaches and preserving the natural amenity of the coastline. It is a natural buffer zone that is adaptable to shoreline changes such as erosion during storm events and accretion during calmer conditions.
- Vegetation buffers reduce the amount of erosion compared to a non-vegetated foreshore. Vegetation significantly influences the size and stability of the foreshore area. It also facilitates foreshore growth by trapping sediments, organic debris, seeds and propagules and preventing it from escaping the system.
- The provision and management of vegetated buffer zones provide the most effective solution for preserving a natural foreshore with a high amenity factor that is adaptable to climate change.
- Improving ecological social and economic values of a foreshore area.

Importantly it must be acknowledged that vegetation alone will not completely arrest erosion, and it should be accepted that some erosion of the foreshore area is both inevitable and natural. Whilst it is unrealistic to expect that revegetation will completely stop erosion, it is expected that revegetation will impede and slow the rate of bank erosion and assist in accretion after an erosion event.

A 5m vegetation buffer can support foreshore bank resilience through the following:

- In the soil: roots holding sediments together, increasing its cohesiveness. For sandy soils, fibrous roots are generally best (Vannoppen et al, 2017).
- In the soil: as well as improving drainage, vegetation removes excess water from soil through evapotranspiration, reducing likelihood of slumping due to weight of saturated soil.
- Surfaces: Vegetation cover disperses water and reduces its ability to erode soil surface - the thicker, more complex the surface barrier, i.e. mix of plants, the better.
- Surfaces: Plants can prevent people accessing banks - this is a bit of a negative feedback loop, where plants are lost through trampling, then cannot re-establish where the soil has been compacted. These bare surfaces are then hotspots for erosion, which can lead to undermining of soil around them.
- Vegetation encourages deposition of sediment, providing new substrates for vegetation. The foreshore can recover and become stronger.

9.2.1.2 Bioengineering aka Nature-based Solutions

Varied approaches using combinations of vegetation, wood and biodegradable products to reduce surface erosion and provide toe protection while revegetation is established. Biodegradable engineering products are available and have been trialled internationally. These are essentially products engineered from biodegradable material such as potato starch and are used to increase stability on a riverbank while vegetation becomes established. Other similar products are designed to aid natural recruitment of vegetation, such as saltmarsh.

9.2.1.3 Renourishment

Placement of sand on the tidal foreshore to (re-)establish a sandy beach and provide a sediment supply. This option generally replaces sand lost through longshore drift or erosion.

9.2.1.4 Walling / Revetments

Vertical walls generally in the form of solid vertical structures installed to retain a higher elevation of foreshore by providing a barrier to the loss of material from the bank. Revetments are structures that provides a protective covering on an embankment of earth designed to maintain the slope or protect it from erosion. Construction of

walls is usually along a section of shoreline. Where a beach is to be retained, this risk treatment option should generally be accompanied with beach nourishment or replenishment.

Rock armouring (also known as rock revetment) involves the placement of quarried, angular rock against an embankment to prevent further erosion of the embankment. The rock is graded and placed to a design thickness to ensure that it forms an interlocking mass and is not easily spread along the foreshore. A foundation of rock is usually placed across or excavated into the bank toe to ensure that scour of the bed does not undermine the rock armouring.

9.2.1.5 Groynes / Headlands

Structures perpendicular to the shore (with renourishment) that reduce alongshore sediment transport, capturing sediment on the updrift side of the structure. Construction of groynes to stop or restrict the movement of sand around the end of the structure, to provide protection to assets on the foreshore reserve. They are primarily effective where there is longshore sand supply or when partnered with sand nourishment.

9.2.2 Innovative Options

Several more innovative options were identified and considered but they were found unlikely to be suitable for the project objectives at present. They are summarised below to allow for further monitoring and consideration in the future.

9.2.2.1 Oyster/Shellfish reefs

A structure like a rock breakwater only constructed from materials that encourage the recolonisation of shellfish. The structure then mimics a shellfish reef, promoting biodiversity and improving water quality. The units can be installed in the **shallow water** immediately out from the bank susceptible to erosion, and these breakwaters form a barrier to protect the bank from water energy, enable sediment build up, and enable recolonisation of estuarine plant species along the bank, as well as marine plants and invertebrates on the breakwater structure.

The Nature Conservancy, in collaboration with the Alcoa foundation and researchers from Murdoch University are trialling a project to promote the growth of Mussell reefs in the Peel Harvey Estuary for marine habitat restoration opportunities, improving fisheries, biodiversity and natural solutions to coastal defence. As these are only in a trial phase in southwest WA they have not been recommended for further analysis until results of the trial are available.

9.2.2.2 Rock fillets

Rock fillets are structures designed to dissipate energy from wave action before it impacts the bank. By creating an area of still water between the fillet and eroding bank, sediment is able to accumulate, providing opportunity for instream vegetation such as saltmarsh to be planted or recruit naturally at the bank toe and instream bench. Together with revegetation on the top of bank, this vegetation eventually becomes the primary form of bank stabilisation.

The structures are built to the mean high-water level in a “dog-leg” formation parallel to the eroding bank approximately 2-5m into the channel. Gaps in the structure allow for sediment accumulation, tidal flushing, fish access and seedling recruitment. They require a relatively wide intertidal bench to extend out from the bank to be applicable and have been found to be effective in estuaries.

Rock fillets can further enhance biodiversity values with the incorporation of woody habitat, artificial reefs and other fish habitat values. Over time, revegetation at the top of the eroding bank and the instream vegetation will merge forming a robust vegetation buffer, protecting the banks and negating the need for the rock structure. Consequently, dependent on the rate of colonisation maintenance will not be required indefinitely.

- Requires a wide intertidal bench to be applicable.
- Additional erosion control methods can be combined in the design, including bank toe protection, bank battering and log revetment.

Rock fillets have not been recommended for further analysis because a wide intertidal bench is not present and is unlikely to be cost effective to install; and the delivery of suitable rock to the study area is likely to be very expensive.

9.2.2.3 Suspended hardwood logs

Waterways with eroded beds and banks from wash and scouring can be restored through use of suspended logs along the banks. This can be achieved through vertical timber piles installed, with logs suspended horizontally between piles, parallel to the shore. This acts as a buffer to disperse wave energy and velocities. With this buffer in place, sediment can be built up behind the logs along the shore, and recruitment of riparian / estuarine seedlings such as saltmarsh can establish. In conjunction with targeted revegetation of the riparian zone, this solution can effectively stabilise banks from erosion. They have not been recommended for further analysis in this project as the primary hazard is coastal inundation.

9.3 Northern Foreshore

The northern foreshore encompasses the area adjacent to the caretaker's house and the Mill, along to the barge jetty. It is currently fronted by failed rock and wooden walling which we have assumed will be removed as part of any future option. The existing wall has reached the end of its functional life. This is evident through numerous failure mechanisms including:

- Gaps in the wall
- Undermining of the wall
- The wall is tilting forward
- Sinkholes forming behind the wall

On this basis, it is not considered feasible to repair the existing wall arrangement. The wall is beyond repair and removal of the wall is recommended.

9.3.1 First Pass Screening

In the first instance a wide range of available coastal management options were identified. A succinct first pass screening of the approaches, using a GO / STUDY / WAIT shortlisting method was undertaken to consider a range of rapid-assessment criteria.

9.3.2 Selection Criteria

Four selection criteria were selected to screen the most feasible options to manage the northern foreshore in the short- and medium-term. The shortlisting process helps identify options that can be removed or need further consideration. The selected criteria for this assessment are presented in Table 9-1 and summarised below:

1. **Coastal hazard performance** – the reduction of coastal erosion and inundation risks by stabilising the foreshore and protecting existing foreshore assets – primarily the Mill.
2. **Amenity and social** – the local community and visitors are key stakeholders, and the decision-making process requires community input and acceptance of the preferred option. Amenity and social impacts of options are typically considered in the context of impacts on safe and equitable public access to the foreshore and beach, as well as visual amenity.

3. **Whole of life costs** – implementation and maintenance costs are a significant consideration for the Shire and community. Feasibility of construction and maintenance (given the challenging island location) is considered as part of this criterion.
4. **Environmental sustainability** – environmental sustainability is an ongoing consideration. Maintaining the local natural habitat and character and minimising environmental impacts during construction are important objectives. The risk of impacts to the estuary has been considered as part of this criterion.

Table 9-1 Shortlist criteria summary

Score	Coastal hazard performance	Amenity and social	Whole of life costs	Environmental sustainability
GO	Reduces coastal hazard risk	Enhances community well-being and foreshore use	Low-cost pathway for council implementation	Positive environmental impact in short to long-term
STUDY	Uncertain impacts on coastal hazards	Uncertain or minimal impact on foreshore users	Medium-cost pathway – could be optimised	Minimal impact
WAIT	No reduction to coastal hazards	Negative social and amenity impacts	High-cost pathway	Negative environmental impact

9.3.3 Multi-Criteria Analysis

The options identified are presented in Table 9-2 along with the multi-criteria analysis of application of the selection criteria to determine feasible options.

Table 9-2 Multi-criteria analysis of options

Option	Description	Coastal hazard performance	Amenity and social	Whole of life costs	Environmental sustainability	Rating
Revegetation	Revegetating upper tidal zone and foreshore.	Minimal reduction.	Regular erosion scarps on beach and continued uninhibited inundation flows.	Costs are minimal.	No significant impact noted.	**WAIT**
Bioengineering aka Nature-based Solutions	Installation of nature-based solutions without traditional hard engineering structures.	May address some of the coastal hazard risk but not reliably.	Likely to be visually acceptable but may deteriorate if hazards damage the installed approach.	Costs are likely to be between revegetation and hard structure costs. They could escalate if performance isn't acceptable and increased maintenance is required.	Can be designed with minimal long-term impact, but during construction there may be local impacts.	**WAIT**
Renourishment	Import suitable sand and build a sacrificial beach to absorb erosion and reduce inundation flows.	May address coastal hazard risk – but restrictions of accessible sand and the potential rate of erosion may mean this option is not reliable.	Likely to be visually acceptable but may deteriorate if hazards damage the installed approach.	Sand sourcing likely to be expensive because of island construction constraints.	Given the existing sandy foreshore, can be designed with minimal impact. We contacted DoT regarding the potential re-use of dredged material from the nearby navigation channel but due to potential acid sulphate soils it needs to be placed in water beneath the tidal zone.	**WAIT**
Walling / Revetment	Construct new wall/revetment approximately 45m long. There are several options for construction materials.	Provides protection of all foreshore assets from erosion. Can be designed to increase height of adjacent foreshore to reduce the energy of inundation flows impacting the Mill.	Protects vulnerable assets very well. Improves visual amenity.	Construction cost is significant but not markedly more than other structural options. Reduced maintenance costs required compared to beach nourishment.	Given the existing eroded beach and failed revetment, can be designed with minimal net impact as it is a replacement.	**GO**
Groynes / Headlands with nourishment.	Construction of 2 or 3 short beach groynes approximately 10 to 15m long, approximately 20m apart. Could be built with Geosynthetic Sand Containers or other materials.	Can provide increased foreshore buffer width to Mill. May reduce longshore transport of sand but it is not clear this is cause of the erosion.	Protects vulnerable assets. Structures will be present on beach, but also sections of dry sandy beach. May not be supported due to extensions into waterway.	Construction cost is significant and more than wall/revetment options as more mass involved to be transported to island. Reduced maintenance requirements and costs required compared to beach nourishment.	Extension into waterway may be required. Increased approvals compared to wall replacement	**WAIT**

9.3.4 Identification of Preferred Approach

The purpose of this screening was to determine the preferred approach to proceed through to design development. The only approach achieving a 'GO' assessment is the walling / revetment approach.

While the other approaches may reduce the risk in some instances, they would have significant trade-offs to a point where much of the area's amenity and/or heritage and environmental value could be lost, or they don't address the hazard issues to the desired level as a standalone option, or not for an appropriate whole-of-life cost. Therefore, these pathways have not progressed to the feasibility level in this project.

Application of the Swan River Trust's Foreshore Stabilisation Decision Support Framework identified the following walling / revetment options as suitable for further investigation:

- Gabions
- Rock revetment
- Vertical concrete or limestone block wall
- Piled log wall
- Sheet pile wall

Due to the island nature of the study area options utilising large quantities of heavy materials have been considered as unlikely to be feasible because of the significant construction costs involved in transporting and installing materials. We have considered rock revetments, concrete and limestone walls as unfeasible. The remaining three options are assessed below.

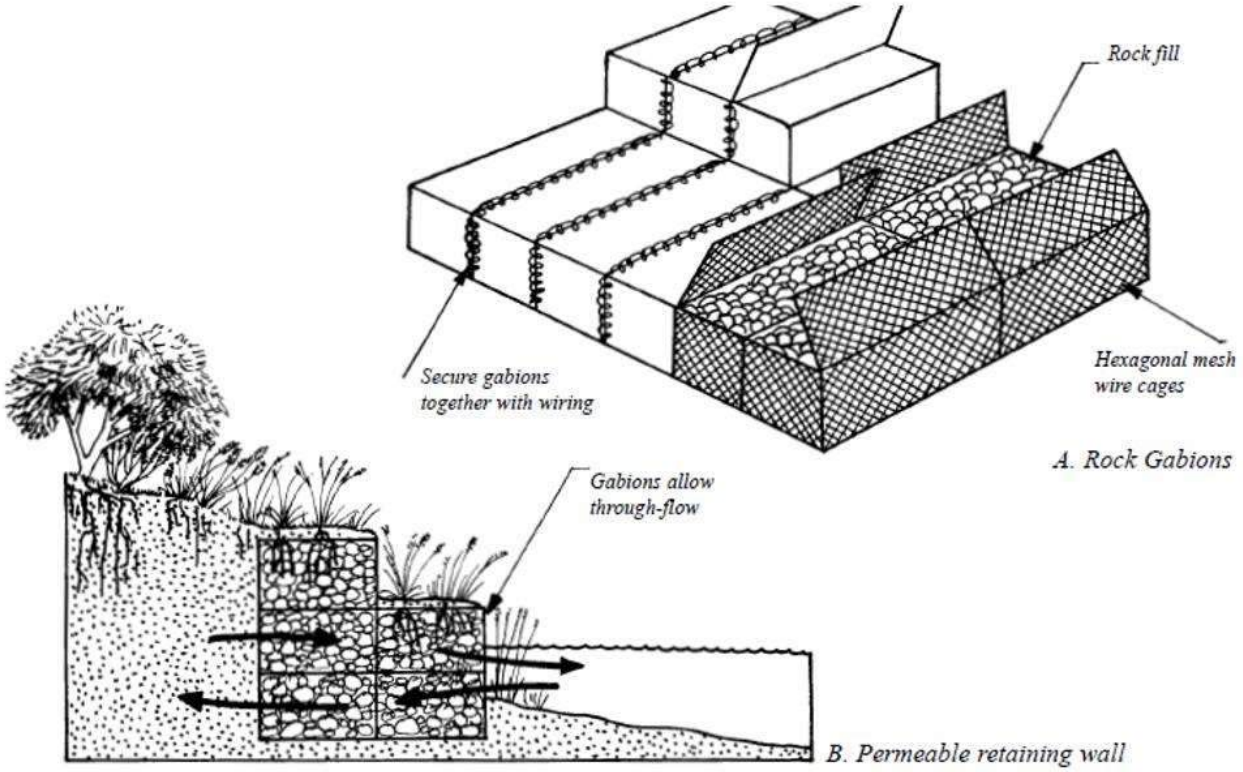


Figure 9-2 Gabion wall (Water and Rivers Commission, 2000)

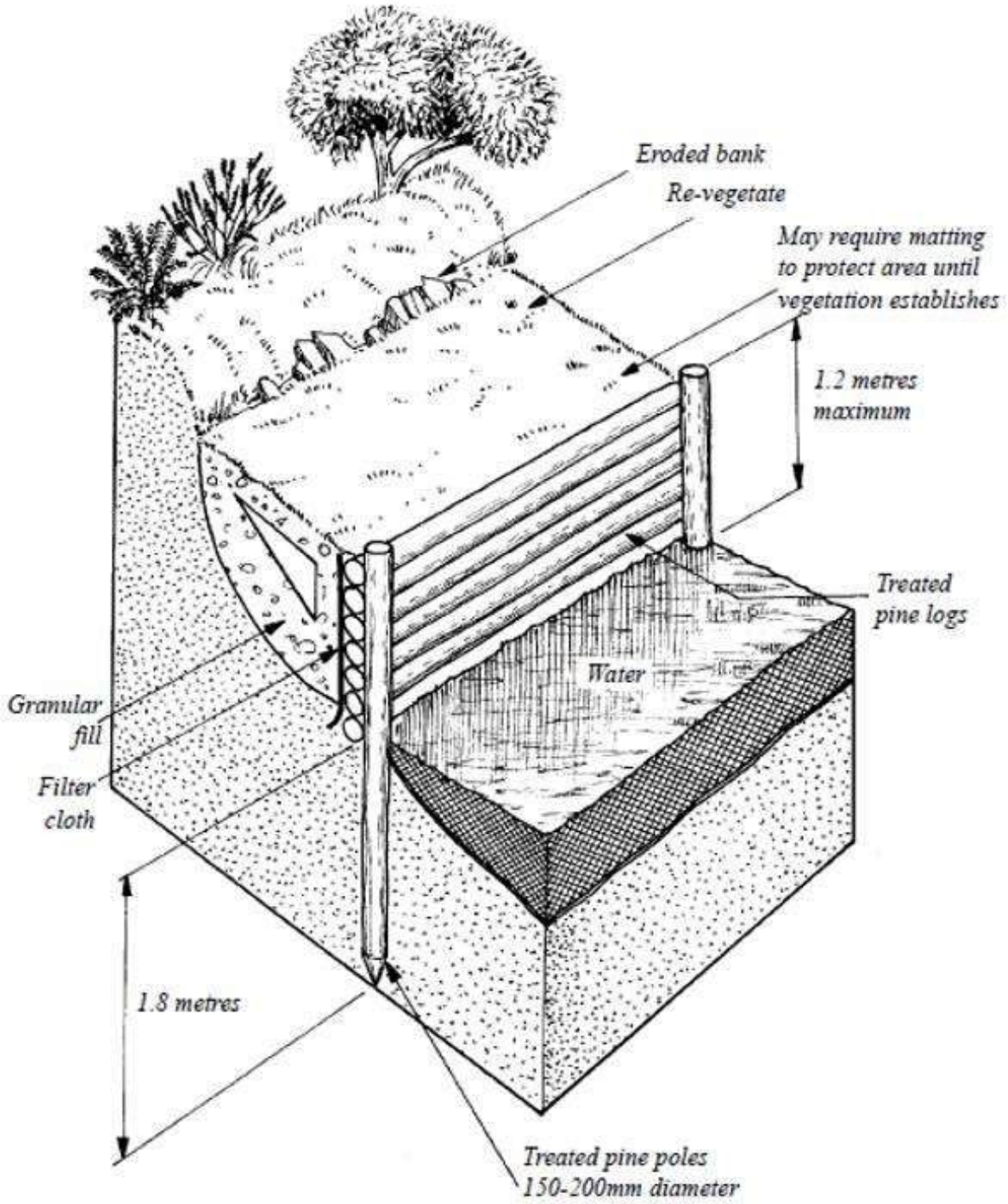


Figure 9-3 Piled log wall (Water and Rivers Commission, 2000)

Figure 9-4 PVC sheet piled wall in place on the southern foreshore of the study area since ~2013.

9.3.5 Option Assessment & Recommendation(s):

Each option was further assessed across a range of criteria, summarised in Table 9-3. Following this assessment, we recommend the Shire pursue the replacement of the failed walls at the northern foreshore with PVC sheet pile walling.

Table 9-3 Option assessment

Criteria	Gabions	Piled Log Wall	Sheet pile wall
Engineering ▪ Description ▪ Engineering performance & hazard protection ▪ Design life ▪ Constructability ▪ Maintenance requirements	▪ Gabion baskets typically comprise of rectangular wire mesh baskets filled with small rock (approximately 100-250mm in diameter in size). The gabion baskets are often placed on top of one another in the form of a vertical or terraced retaining wall to prevent further erosion of the embankment. ▪ Gabion baskets can utilise smaller rock material that would otherwise be unsuitable to prevent erosion. ▪ Typically utilise less material compared to rock armouring. ▪ Gabion baskets can be placed on a steeper finished bank angle compared to rock armouring. ▪ In waterway and coastal environments gabion baskets tend to fail or be damaged due to: – Water and sediment abrasion against the wire mesh. – Stretching and corrosion of the wire mesh. – Erosion at the interface of the gabion baskets and the in-situ bed and bank material. – Failure or damage of the gabion baskets is most common across the lower bank profile. Consequently, structural maintenance often requires the disassembly of the entire structure. – Settlement and displacement in soft marine sediments	▪ Timber revetment involves the placement of suitable timber logs / sleepers on an embankment with the objective of preventing erosion over the short to medium term. ▪ The revetment typically extends into the toe of the embankment to deal with scour of the toe and is held against the embankment with timber piles. ▪ A gravel filter layer or filter fabric can be placed under the revetment to prevent water permeating through and causing erosion behind the timber. Revegetation is often undertaken to complement revetment (where appropriate). Timber revetment has a design life of approximately 10 – 15 years in the marine environment, in which time revegetation should be established on and surrounding the revetment. Hence, as the revetment fails the vegetation will colonise the area to provide some ongoing bank stability. ▪ Provides moderate protection against wave induced bank erosion. ▪ Mimics elements of the natural morphology and provides improved near bank and in-stream habitat. ▪ Likely to contribute to improved vegetation establishment outcomes through trapping of fine sediment and formation of niches for vegetation establishment. ▪ The timber blends into the surrounds, offering improved visual amenity compared to other seawall options. ▪ The success of this option strongly relates to being able to source and supply suitable timber material. ▪ Erosion may continue behind the timber revetment if any voids exist amongst the timber or if the timber revetment wall is overtopped.	▪ Sheet pile provides a physical barrier between the in-situ soil and the water which will prevent erosion. It is proposed that PVC sheet pile would be used rather than steel. ▪ The PVC sheet piling is durable and highly resistant to corrosion in marine environments. ▪ PVC sheet piling is a cost-effective option that is also quick and easy to install. ▪ The finished level of the sheet pile is to extend beyond the level of HAT ▪ The sheet pile can be capped to make the finished sheet pile safe and to improve aesthetics.
Economic ▪ Capital costs ▪ Maintenance costs	▪ Capital costs are considered likely to be the highest of the three options given the need for initial excavation and the labour-intensive process of placing and filling gabions. ▪ Maintenance costs are potentially high if the gabions suffer corrosion.	▪ Capital costs are considered likely to be in the middle of the three options given the need for labour to place geofabric and the logs. ▪ Maintenance costs are likely to be low.	▪ Capital costs are considered likely to be the lowest of the three options given the construction is focussed on the use of machinery. ▪ Maintenance costs are likely to be low.
Environmental ▪ Impact on local coastal processes ▪ Coastal and estuarine ecology ▪ Carbon footprint	▪ Porous nature of the structure may reduce overtopping in some instances but given how inundation-prone the foreshore land is this benefit may not be realised. ▪ Increased footprint width compared to other two options. ▪ Likely to disturb existing trees by the construction activities on site.	▪ Long term site resilience would be improved by vegetation establishment behind the wall. ▪ Narrow footprint. ▪ If possible, the preference would be not to disturb existing trees by the activities on site.	▪ Long term site resilience would be improved by vegetation establishment behind the wall. ▪ Narrow footprint. ▪ If possible, the preference would be not to disturb existing trees by the activities on site.
Social & Recreational ▪ Recreational amenity and provision of safe foreshore access ▪ Visual amenity / aesthetic	▪ Improves visual amenity compared to erosion but may not be preferred by community due to appearance of gabions.	▪ Mimics elements of the natural morphology ▪ Provides improved near bank and in-stream habitat, contributes to improved vegetation establishment outcomes ▪ Improve aesthetic ▪ May be more acceptable because familiar with existing wall of similar nature	▪ Improves visual amenity compared to erosion but may not be preferred by community due to appearance of sheet pile.
Governance and Approvals	▪ Similar across options.		

9.3.6 Concept design

As there is only a small erosion buffer from the failed log wall to the Mill (of approximately 6m) it is recommended:

- To replace the existing wall with a structural solution rather than a soft engineering solution.
- Construct the replacement wall using PVC sheet pile walling.
- Construct the replacement wall on a different alignment, further into the waterway to increase the distance to the Mill.
- To increase the land height between the new wall and the Mill to reduce the energy associated with inundation events impacting the Mill.
- Landscape design and revegetation is undertaken to increase environmental and community amenity at this part of the study area. Landscaping could include education/information signage about the study area, the Mill and its history and seating / lookout for an estuary view.

Walls typically provide an effective and robust approach to reduce erosion rates landward of the structure. However, their structural integrity can be impacted by overtopping which is common in low lying areas and in areas vulnerable to sea level rise associated with climate change. Walls are typically applied at locations where public and/or private assets and infrastructure are at immediate risk, such as the already impacted Mill.

Properly designed and constructed walls can be very effective in protecting foreshore assets by stopping any further recession. However, they can interfere with natural beach processes by separating the active beach from sand reserves stored behind the structure. In other words, they can protect infrastructure located landward of the wall, but they do not prevent in any way the erosion processes continuing in front of them. Typically, the effect of foreshore wall construction on actively eroding shores is for the level of the beach in front of it to become steadily lower - until the beach reaches a new equilibrium profile. As the northern foreshore of the study area already has a wall in place it is anticipated that the impacts will be minimal.

This lowering is primarily caused by wave action washing against the wall causing a high degree of turbulence in front of the structure - which scours sediment material. Wave energy reflected from the wall can also contribute to these scour processes. Scouring in front of walls can also present problems for the overall stability of the structure. Unless appropriate foundation and toe arrangements are constructed, the wall can fail by undermining. Even if only damaged, it is extremely difficult and very expensive to repair walls that have been damaged by undermining. Indeed, frequently the most cost-effective solution is to demolish the structure and rebuild it with deeper and more robust foundations.

Another typical impact of seawalls is that the original erosion problem that they aim to solve is relocated further along the shore. Natural beach processes can no longer access the sand reserves in the upper part of the active beach that are behind the seawall. Consequently, this sand cannot be moved downdrift by longshore sand transport processes to replenish the sand that these same processes are moving along the shoreline beyond the end of the seawall. The deficit in sand supply to these downdrift sections initiates erosion, thereby shifting the erosion risk to a location immediately downdrift of the seawall.

Despite their disadvantages, walls are probably one of the most commonly used methods for protecting foreshore assets against the threat of erosion. This can probably be attributed to their versatility.

The location and extents / general arrangement of a new PVC sheet-pile will at the northern foreshore area have been estimated and are presented in Figure 9-5.

Figure 9-5 **PVC sheet pile wall concept design - Northern foreshore – plan view. The extent of the new wall is ~45m. The green arrow indicated the approximate position of a representative cross-section.**

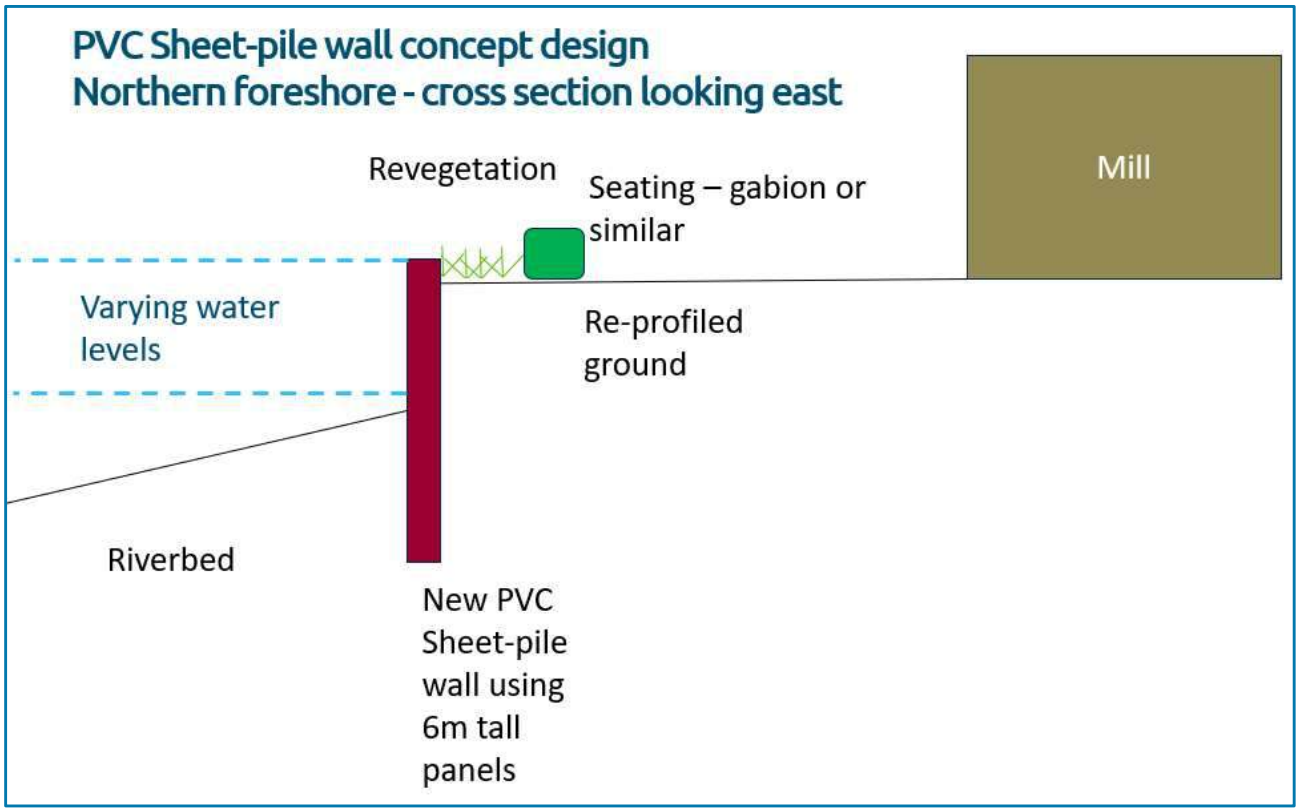


Figure 9-6 Representative cross-section for the PVC sheet pile wall concept design for the Northern foreshore. Areas for revegetation and simple seating are depicted. The seating could provide additional resistance to water flows in high water level events to reduce impacts to the Mill. The area between the seating and the Mill could be used for landscaping and education signage.

9.4 Southern Foreshore

The southern foreshore encompasses the area from the public jetty and the shoreline approximately 70m to the east. It is currently fronted by the jetty and existing walls:

- At the east end there is ~35m PVC sheet pile wall, likely installed around 2013. The wall was never backfilled and has some damaged sections. The crest height is estimated at ~1.4mCD.
- West of the PVC sheet pile wall there is ~35m of piled log wall built before ~2005. The wall is in poor condition.
- West of, and in front of the piled log wall, is the public jetty.

Given the exposed nature of the southern foreshore area to erosion from boat wake, and the existing value of the foreshore recreational area, together with the boating access provided by the public jetty, it is recommended to continue the use of hard walling to stabilise this section of foreshore. The eastern end of this section should switch to a managed retreat approach in line with the natural western end of the study area.

The existing piled log wall may have reached the end of its functional life. This is evident through numerous failure mechanisms including:

- Gaps in the wall.
- Undermining of the wall.
- Loss of some elements.
- Erosion from overtopping of the structure.

On this basis, it is unclear if it is feasible to repair the existing wall arrangement. Given there are no crucial assets behind these walls a staged approach to their refurbishment is proposed:

1. Repair damage to PVC sheet pile wall and backfill. The foreshore area should be revegetated appropriately.
2. Existing foreshore amenities should be maintained until the end of their functional life and then replaced as necessary – in general they should be moved further landward and designed to tolerate occasional inundation by salty water.
3. This work should be undertaken at the same time as the northern foreshore wall replacement.
4. Undertake detailed inspections of the piled log wall to determine if it can be refurbished or needs to be removed.
5. Refurbish the piled log wall if feasible or remove and replace it with PVC sheet pile wall in the future.

9.5 Cost Estimates

Due to the high-level nature of this assessment, cost estimates have been prepared for feasibility and budgeting purposes. Unit rates have been developed based on Water Technology's engineering design and construction experience and other financial data.

Water Technology has developed initial estimates of the required materials and quantities for each task. Based on this, preliminary cost estimates have been prepared. The island location of the study area significantly limits access for construction equipment. Water Technology understand that a locally available barge can transport materials and equipment of up to approximately 2.0 to 2.5 tonnes.

A cost estimate for the construction works at the northern and southern foreshore area is presented in Table 9-4 and Table 9-5 below. Reasonable economic assumptions have been used to determine unit costs for construction and maintenance works. The cost estimates have been provided to a level of confidence of approximately ±50%.

The following methodology has been used:

1. Scoping and designing the options to concept design level.
2. Estimating quantities of materials required based on standard geometry and typical materials.
3. Pricing the implementation of the options based on unit rates.
4. Presenting a summary of the capital cost estimates.

The structure cost elements have been determined using the following steps:

1. Calculate quantity of materials required.
2. Use assumed costs to calculate initial costs of material purchase and installation.
3. Cost allowances have been made for mobilisation and demobilisation, Indirect, Risk and Contingency costs (15% for each of these three) for uncertainties in cost estimating.
4. Assume cost to supply and install PVC sheet pile wall. This has been estimated based on Water Technology's engineering experience on similar projects nationally, as well as factoring for inflation and the island location of the study area.
5. Calculate the initial nourishment cost to supply, transport and place sand fill. Assume there is a suitable land-based sand source in the sub-region that can supply adequate quality, particle size and volume of sand over the project timeframe.

The cost estimates presented have been based on several assumptions and estimates. No contractor quotations have been sourced specifically to inform these estimates. Base costs for historical works are assumed to be representative of future markets. Costs are based on Water Technology's experience with similar coastal projects and represent an opinion of potential cost. Costs for detailed design and approvals have not been included.

Table 9-4 Cost estimate for the recommended works at the northern foreshore area.

Item	Unit	Quantity	Rate	Sub total
Mobilisation, site establishment and demobilisation and contractor overheads	item	1	$20,000	$20,000
Removal of wall	item	1	$8,000	$8,000
Supply and delivery of PVC sheet pile	m	45	$1,200	$54,000
Prepare work area and install PVC sheet pile	m	45	$500	$22,500
Supply sand fill to site (estimated volume)	m3	145	$100	$14,500
Place sand fill (estimated volume)	m3	145	$60	$8,700
Planting area preparation and cultivation (allow 150mm depth across 30m by 2m)	m2	60	$40	$2,400
Supply and place topsoil (250mm depth)	m3	15	$160	$2,400
Supply and place vegetation	m2	60	$60	$3,600
Landscaping and foreshore amenities (seating, signage, fencing)	item	1	$25,000	$25,000
Subtotal	-	-	-	$161,100
Contingency (Indirect costs, risk costs, other contingency)	-	45%	-	$72,495
TOTAL (excl. GST)	**-**	**-**	**-**	**$233,595**

Table 9-5 Cost estimate for the recommended works at the southern foreshore area.

Item	Unit	Quantity	Rate	Sub total
Mobilisation, site establishment and demobilisation and contractor overheads	item	1	$20,000	$20,000
Supply sand fill to site (estimated volume)	m3	75	$100	$7,500
Place sand fill (estimated volume)	m3	75	$60	$4,500
Repairs to damaged PVC sheet pile wall	item	1	$2,000	$2,000
Planting area preparation and cultivation (allow 150mm depth across 40m by 2m)	m2	80	$40	$3,200
Supply and place topsoil (250mm depth)	m3	20	$160	$3,200
Supply and place jute matting	m2	80	$15	$1,200
Supply and place coir log	m	50	$40	$2,000
Supply and place vegetation:	m2	80	$60	$4,800
Fencing	m	50	$100	$5,000
Landscaping and foreshore amenities (seating, signage)	item	1	$10,000	$10,000
Subtotal	-	-	-	$63,400
Contingency (Indirect costs, risk costs, other contingency)	-	45%	-	$28,530
TOTAL (excl. GST)	**-**	**-**	**-**	**$91,930**

10 FORESHORE MANAGEMENT PLAN

10.1 Management Action Summary

A summary of recommended management actions for the next ~15 years is provided for the study area in Table 10-1 below. Indicative timeframes for implementing the actions are provided, along with suggested prioritisation (high, medium, low). The primary recommendation to address the vulnerability of the Mill to flooding and erosion is construction of a new seawall – with the concept depicted at Figure 10-1.

10.2 Monitoring and Review of Foreshore Management Plan

The management actions should be planned to be implemented by 2040. As such, monitoring and reporting by Shire staff to Council should occur approximately once per year to provide updates on the status of the actions to ensure they remain current, and resourced. This FMP should be reviewed and updated by 2035 or earlier, if necessary, should any of the following triggers occur:

- Significant coastal erosion or inundation in line with a 100-year ARI event or similar.
- Overarching planning documents are amended with changes that directly affect the foreshore zone.
- Coastal Monitoring Data indicates changes occurring to the study area which are substantially different to the coastal hazard risk processes and areas summarised in this report.

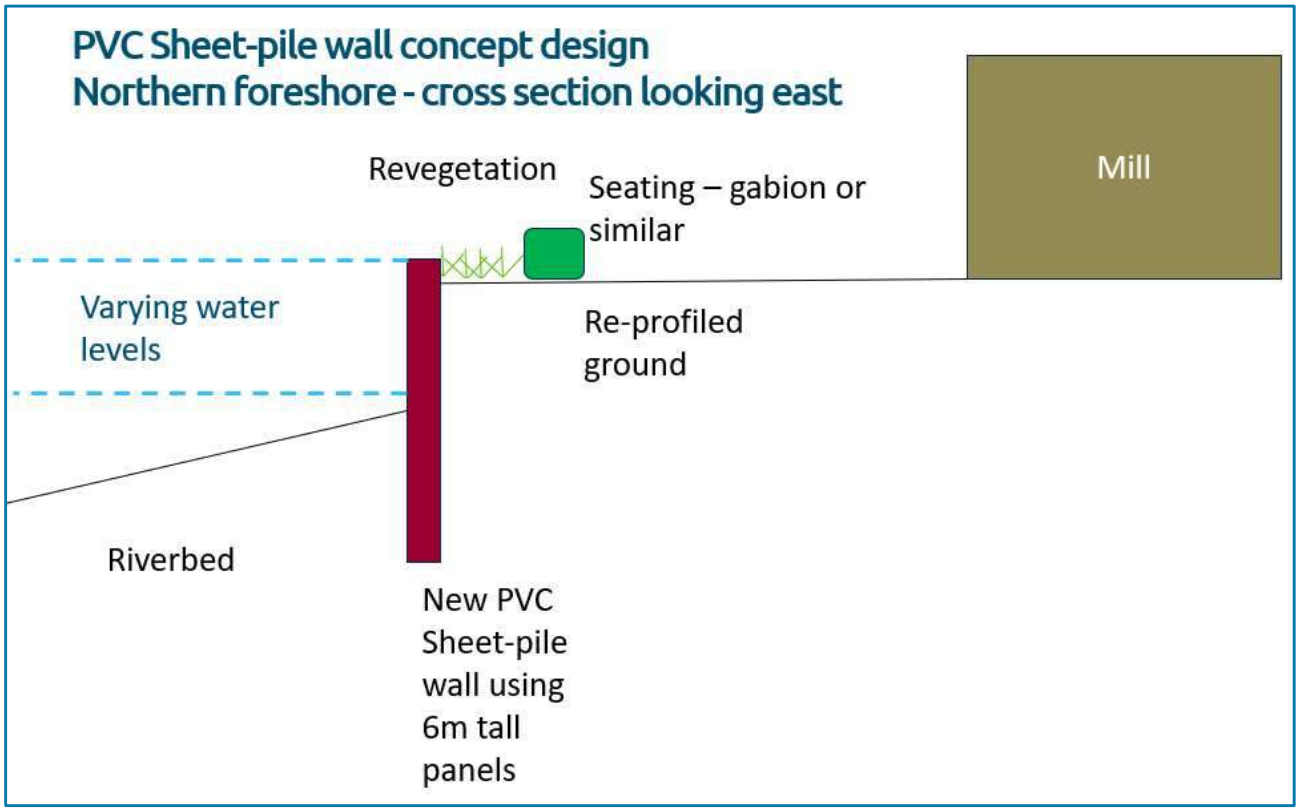


Figure 10-1 Representative cross-section for the PVC sheet pile wall concept design for the Northern foreshore. Areas for revegetation and simple seating are depicted. The seating could provide additional resistance to water flows in high water level events to reduce impacts to the Mill. The area between the seating and the Mill could be used for landscaping and education signage.

Table 10-1 Recommended Foreshore Management Actions

#	Management Action	Timeframe & Priority
1	Protect and enhance vegetation. Continue to restrict access to the foreshore area. Current policies of education, monitoring by caretaker and Shire staff, demarcation of access tracks and pedestrian paths should continue to ensure informal access into the vegetated foreshore is minimised as much as possible to protect the condition of the foredunes and vegetation. The intertidal mudflats and foreshore environment have recorded flora and fauna species that are sensitive to disturbance. The protection of these species, communities and habitats should be considered during the detailed design and construction of mitigation actions.	Continuous High
2	Continue coastal monitoring photography to characterise the behaviour of the coastline in the study area. In addition, undertake the following: ▪ Collect detailed topographic and feature survey of all land and infrastructure in the developed zones of the study area. ▪ Collect water level data at northern foreshore jetty (and southern foreshore jetty if budget available) to link local changes to Peel tide gauge and river conditions. ▪ Monitor inundation at the Mill building – establish a surveyed monitoring point and use photos/records to identify when the structure and surrounding area floods and by what depth. ▪ Monitor environmental threats - their potential to impact the identified flora and fauna communities and any actual impacts from feral animals, weeds, pathogens, pedestrians. ▪ Consider flood risk to caretaker's house and if any remedial works are currently required to make the building more resilient to flood events.	Continuous High
3	**Coopers Mill** Implement the Conservation Works Schedule outlined in the CMS for the Mill in order of priority. Based on project experience, investigative works with chemical analysis and reporting is between $15,000 ex GST to $20,000 ex GST	Continuous High

#	Management Action	Timeframe & Priority
4	**Northern Foreshore** The primary recommendation to address the vulnerability of the Mill to flooding and erosion is construction of a new seawall: ▪ To replace the existing wall with a structural solution rather than a soft engineering solution. ▪ Construct the replacement wall using PVC sheet pile walling. ▪ Construct the replacement wall on a different alignment, further into the waterway to increase the distance to the Mill. ▪ To increase the land height between the new wall and the Mill to reduce the energy associated with inundation events impacting the Mill. ▪ Hard Landscape and revegetation design is undertaken to reduce the energy associated with inundation events impacting the Mill and increase environmental and community amenity at this part of the study area. Hard Landscaping to limit the speed and extent of inundation events could incorporate seating and / or a lookout for an estuary view. ▪ Install education / information signage about the study area, the environmental priorities, the Mill and its history. ▪ To avoid damaging vegetation, consider the possibility of constructing from a barge on the water. Accessing the foreshore and intertidal mudflats with machinery to enable construction works can threaten sensitive coastal habitats, remnant fringing vegetation and the species that rely on them. ▪ Aim to minimise and/or mitigate the disturbance of soil, mud, Acid Sulphate Soils, vegetation and habitat during the detailed design process and onsite during construction. The estimated capital cost is ~$235,000 (excl. GST)	0-2 years High

#	Management Action	Timeframe & Priority
5	**Southern Foreshore** Maintain the existing PVC sheet pile walling until it reaches the end of its design life. The eastern end of this section should switch to a managed retreat approach in line with the natural western end of the study area. A staged approach to refurbishment is proposed: ▪ Repair damage to PVC sheet pile wall and backfill. ▪ Revegetate the foreshore area appropriately. ▪ This work should be undertaken at the same time as the northern foreshore wall replacement. The estimated capital cost is ~$92,000 (excl. GST) The existing foreshore amenities should be maintained until the end of their functional life and then replaced as necessary – in general they should be moved further landward and designed to tolerate occasional inundation by salty water. Undertake detailed inspections of the piled log wall sections to determine if they can be refurbished or need to be removed.	0-2 years High
6	Continue to undertake and support programs for the eradication of weeds and the rehabilitation and revegetation within the foreshore reserves. Appropriate local species should be used. ▪ Works near the jetties could be enhanced by descriptive signage to provide education and tell the story of the natural flora and fauna for the various locations. ▪ Input from DBCA, Peel Harvey Catchment Council and the Peel Harvey Biosecurity Group should be sought for vegetation condition inspection, the eradication of weeds, and rehabilitation and revegetation activities. ▪ The extensive removal of weed species may contribute to the acceleration of erosion processes without careful management. Weed removal should be undertaken in conjunction with revegetation using indigenous species to the area, in order to prevent recolonisation of weeds and potential acceleration of erosion. ▪ It is important to practice soil hygiene; for example, ensuring that any soil brought in during construction or landscaping is not from an infected area. Infected soil can be moved around on vehicles or bikes, footwear, animal movements, road construction and earth moving equipment.	Continuous Medium
7	The Shire should confirm with DFES if the proposed recommendations are considered to be an “intensification of development” and if a Bushfire Management Plan should be prepared and maintained by the Shire to identify the potential bushfire risks and outline measures to reduce their potential impacts on the place.	0-2 years Medium

#	Management Action	Timeframe & Priority
8	Implement the Maintenance Works Schedule outlined in the CMS for the Mill. It is important that maintenance be carried out on a regular basis, and that any remedial action required be acted upon within an appropriate time frame.	Continuous Medium
9	Consider a suitable method to record visitor numbers to the island and Mill to establish the volume and nature of people utilising the study area to guide future decision making.	Continuous Medium
10	Pursue grant funding opportunities from state and federal government to assist with the implementation of these recommendations.	Continuous Medium
11	Consider refurbishment options for the ablution block and foreshore amenities. Potential upgrades for the ablution block should address current maintenance and upkeep issues.	2-5 years Medium
12	Undertake condition inspections of the three jetties to identify maintenance requirements early.	2-5 years Medium
13	Update the assets database with additional information for the foreshore stabilisation structures and jetties including: ▪ Construction year. ▪ Division of separate structures on southern foreshore – separate PVC sheet pile from log wall. ▪ Estimated remaining life with routine maintenance.	2-5 years Medium
14	Review the signage provided in the study area and at the car park at end of Tonkin Drive. Remove/replace outdated signage and install new signage as required. Focus should be on education of visitors with regard to the local natural environment, and heritage of the Mill and its protection. The combined effect of the signs should be to enhance the experience of the users and the condition of the foreshore environment, without detracting significantly from the visual landscape. Information about management of the Mill and a summary of the coastal hazards could be provided on new information boards	2-5 years Medium
15	Review feral animal management in conjunction with input from DBCA and Peel Harvey Biosecurity Group.	2-5 years Low
16	Monitor and review innovative erosion management practices for estuaries including the shellfish reef trials in Peel Harvey estuary.	2-5 years Low

#	Management Action	Timeframe & Priority
17	The foreshore amenities are generally of a reasonable standard. To maintain or improve this standard through to 2040 however, it will be important to undertake maintenance and refurbishment of the facilities as required every few years. Government grant funding for upgrades and additions should be sought.	5-10 years Low

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APPENDIX A
FAUNA PRESENCE IN STUDY AREA

Table 11-1 Species occurrence records for the Study Area sourced from the WA Department of Biodiversity, Conservation and Attractions (Danjoo search, accessed 10-9-25) and listed threatened species from the EBPC Protected Matters Search Tool (accessed 10-9-25).

Scientific Name	Class	Listed Threatened Species (EBPC Protected Matters Search Tool)			Species Occurrence Records (Dandjoo Search)	
		Listed Species?(Y/N)	Simple Presence	Threatened Category	Species recorded? (Y/N)	Conservation Code
Acanthiza apicalis	Bird	N			Y	-
Actitis hypoleucos	Bird	N			Y	MI
Anarhynchus leschenaultii	Bird	N			Y	VU
Anas gracilis	Bird	N			Y	-
Anas platyrhynchos	Bird	N			Y	-
Anas superciliosa	Bird	N			Y	-
Anhinga novaehollandiae	Bird	N			Y	-
Anthochaera carunculata	Bird	N			Y	-
Ardea alba Linnaeus	Bird	N			Y	MI
Arenaria interpres	Bird	Y	Known	V	Y	-
Barnardius zonarius	Bird	N			Y	MI
Calidris acuminata	Bird	Y	Known	V	Y	-
Calidris alba	Bird	N			Y	MI
Calidris canutus	Bird	Y	Known	V	Y	EN
Calidris ferruginea	Bird	Y	Known	CE	Y	CR
Calidris ruficollis	Bird	N			Y	MI
Calidris subminuta	Bird	N			Y	MI

Scientific Name	Class	Listed Threatened Species (EBPC Protected Matters Search Tool)			Species Occurrence Records (Dandjoo Search)	
		Listed Species?(Y/N)	Simple Presence	Threatened Category	Species recorded? (Y/N)	Conservation Code
Calidris tenuirostris	Bird	Y	Known	V	Y	CR
Calyptorhynchus banksii naso	Bird	Y	Likely	V	Y	VU
Caretta caretta	Reptile	Y	Known	E	Y	EN
Charadrius leschenaultii	Bird	Y	Known	V	N	
Charadrius mongolus	Bird	Y	Known	E	N	
Chelonia mydas	Reptile	Y	Known	V	N	
Chenonetta jubata	Bird	N			Y	-
Cladorhynchus leucocephalus	Bird	N			Y	-
Coracina novaehollandiae	Bird	N			Y	-
Corvus coronoides	Bird	N			Y	-
Dasyurus geoffroii	Mammal	Y	Likely	V	N	
Dermochelys coriacea	Reptile	Y	Known	E	N	
Diomedea exulans	Bird	Y	Likely	V	N	
Eolophus roseicapilla	Bird	N			Y	-
Falco peregrinus	Bird	N			Y	OS
Gerygone fusca	Bird	N			Y	-
Grallina cyanoleuca	Bird	N			Y	-
Gymnorhina tibicen	Bird	N			Y	-

Scientific Name	Class	Listed Threatened Species (EBPC Protected Matters Search Tool)			Species Occurrence Records (Dandjoo Search)	
		Listed Species?(Y/N)	Simple Presence	Threatened Category	Species recorded? (Y/N)	Conservation Code
Haematopus longirostris	Bird	N			Y	-
Haliastur sphenurus	Bird	N			Y	-
Hirundo neoxena	Bird	N			Y	-
Hydroprogne caspia	Bird	N			Y	MI
Idiosoma sigillatum	Arachnid	N			Y	P3
Isoodon fusciventer	Mammal	N			Y	P4
Leipoa ocellata	Bird	Y	Likely	V	N	
Lichmera indistincta	Bird	N			Y	-
Limosa lapponica menzbieri	Bird	Y	Known	E	Y	MI
Limosa limosa	Bird	Y	Known	E	Y	MI
Macronectes halli	Bird	Y	Likely	V	N	
Malurus splendens	Bird	N			Y	-
Natator depressus	Reptile	Y	Known	V	N	
Numenius madagascariensis	Bird	Y	Known	CE	Y	CR
Numenius phaeopus	Bird	N			Y	MI
Nycticorax caledonicus	Bird	N			Y	-
Oxyura australis	Bird	N			Y	P4
Pachyptila turtur subantarctica	Bird	Y	Likely	V	N	

Scientific Name	Class	Listed Threatened Species (EBPC Protected Matters Search Tool)			Species Occurrence Records (Dandjoo Search)	
		Listed Species?(Y/N)	Simple Presence	Threatened Category	Species recorded? (Y/N)	Conservation Code
Pandion haliaetus	Bird	N			Y	MI
Pelecanus conspicillatus	Bird	N			Y	-
Phalacrocorax sulcirostris	Bird	N			Y	-
Phalacrocorax varius	Bird	N			Y	-
Platalea flavipes	Bird	N			Y	-
Pluvialis fulva	Bird	N			Y	MI
Pluvialis squatarola	Bird	N			Y	MI
Poodytes gramineus	Bird	N			Y	-
Pseudocheirus occidentalis	Mammal	Y	Likely	CE	Y	CR
Rhipidura albiscapa	Bird	N			Y	-
Rostratula australis	Bird	Y	Likely	E	N	
Sphyrna lewini	Shark	Y	Likely	Conservation Dependent	N	
Sterna hirundo	Bird	N			Y	MI
Sternula nereis nereis	Bird	Y	Known	V	Y	VU
Thalassarche cauta	Bird	Y	Likely	E	N	
Thalassarche melanophris	Bird	Y	Likely	V	N	
Thalasseus bergii	Bird	N			Y	MI
Tringa brevipes	Bird	N			Y	MI, P4

Scientific Name	Class	Listed Threatened Species (EBPC Protected Matters Search Tool)			Species Occurrence Records (Dandjoo Search)	
		Listed Species?(Y/N)	Simple Presence	Threatened Category	Species recorded? (Y/N)	Conservation Code
Tringa glareola	Bird	N			Y	MI
Tringa nebularia	Bird	Y	Known	E	Y	MI
Tringa stagnatilis	Bird	N			Y	MI
Tursiops aduncus	Mammal	N			Y	MI
Xenus cinereus	Bird	N			Y	MI
Zanda baudinii	Bird	Y	Likely	E	Y	EN
Zanda latirostris	Bird	Y	Known	E	Y	EN

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APPENDIX B
CONSERVATION MANAGEMENT STRATEGY – STEPHEN CARRICKS AND ASSOCIATES

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APPENDIX C
APPLICATIONS AND CONSTRAINTS OF NATURE-BASED SOLUTIONS

Table A3-11-2 Applications and constraints of Nature-Based Solutions (all engineered structures are assumed to have associated revegetation)

Nature Based Solution	Geomorphic process potentially addressed		Complementary Benefits of Implementation						Solution likely to be constrained by:							
	Fluvial Erosion	Boat wash	Recreational access	Supports biodiversity	Improves water quality	Visual amenity	Shades waterway	Flood Mitigation	Available space	Time for delivery	Specific materials needed	Land use	Impacts on values	Feasibility of construction	Feasibility of maintenance	Feasibility of cost
Vegetation establishment	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				✓	✓	
Weed management				✓	✓	✓										
Shellfish Reefs	✓	✓		✓	✓	✓		✓	✓		✓		✓	✓		
Biodegradable Engineering Products	✓	✓									✓			✓	✓	
Timber brushing	✓	✓	✓	✓	✓			✓	✓		✓			✓		✓
Log revetment	✓	✓	✓	✓	✓			✓	✓		✓			✓		✓
Pile fields	✓			✓	✓			✓	✓		✓			✓	✓	✓
Suspended logs	✓	✓		✓					✓	✓	✓			✓		✓
Sand nourishment						✓			✓		✓			✓		✓
Rock fillets	✓	✓		✓					✓	✓			✓	✓	✓	✓
Bank battering	✓					✓		✓	✓			✓		✓		
Living seawalls	✓	✓	✓	✓	✓			✓	✓		✓		✓	✓	✓	✓
Fencing / Setbacks	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓			✓
Rock Armouring	✓	✓	✓						✓		✓			✓	✓	✓
Retaining Walls	✓	✓	✓			✓					✓		✓	✓	✓	✓
Formalise access	✓	✓	✓	✓	✓	✓	✓		✓			✓	✓			✓

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