DEPARTMENT OF TRANSPORT

WA Coastal Erosion Hotspots

Review of Coastal Management History - 12 Sites

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Synopsis

The scope of this report has focused on 12 diverse hotspots selected throughout Western Australia. The objective of this study was to compile a history of past coastal management measures, and review the performance and effectiveness of hard and soft coastal protection measures used at each of the identified sites.

Disclaimer

PROJECT 311012-02081-CS-REP-001: WA Coastal Erosion Hotspots - Review of Coastal Management History - 12 Sites

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Table of acronyms and abbreviations

Acronym/abbreviation	Definition
DoT	Department of Transport
DPI	Department of Planning and Infrastructure
LAT	Lowest astronomical tide
LGA	Local Government Area
Lidar	Light detection and ranging
RTK-GPS	Real-time kinematic global positioning system
USACE	United States Army Corps of Engineers
WA	Western Australia

1. Introduction

1.1 Background

In 2019, the State Government commissioned a study to evaluate the scale and extent of coastal erosion in Western Australia (WA): Assessment of Coastal Erosion Hotspots in Western Australia (Seashore Engineering, 2019). From this study, 55 locations were identified where coastal erosion is, or is expected to be, a threat to coastal values and assets and require management and adaptation within 25 years. These locations are termed 'hotspots'.

Many coastal erosion hotspots have long and varied management histories. In some instances, the coastal protection measures have been only partially effective, and improvements to coastal management practices are needed. Before they can be improved, past coastal management measures and their effectiveness needed to be reviewed.

1.2 Scope and objectives (this report)

The scope of this report has focused on 12 diverse hotspots selected throughout WA (refer to Figure 1-1). The objective of this study was to compile a history of past coastal management measures and review the performance and effectiveness of hard and soft coastal protection measures used at each of the 12 hotspots.

Department of Transport (DoT) will use the data and findings from this study to support the CoastWA program, and local coastal managers will use it as they plan to maintain, upgrade, refurbish or replace coastal management measures.

Note: The performance assessment component of the scope focuses on the protection pathway of the Coastal Hazard Risk Management and Adaptation Planning (CHRMAP) hierarchy. Worley recognises that other coastal management measures – such as Avoid, Planned/Managed Retreat, and Accommodate – were also implemented in the past. The historical performance of these alternative pathways and measures was not assessed in this scope.

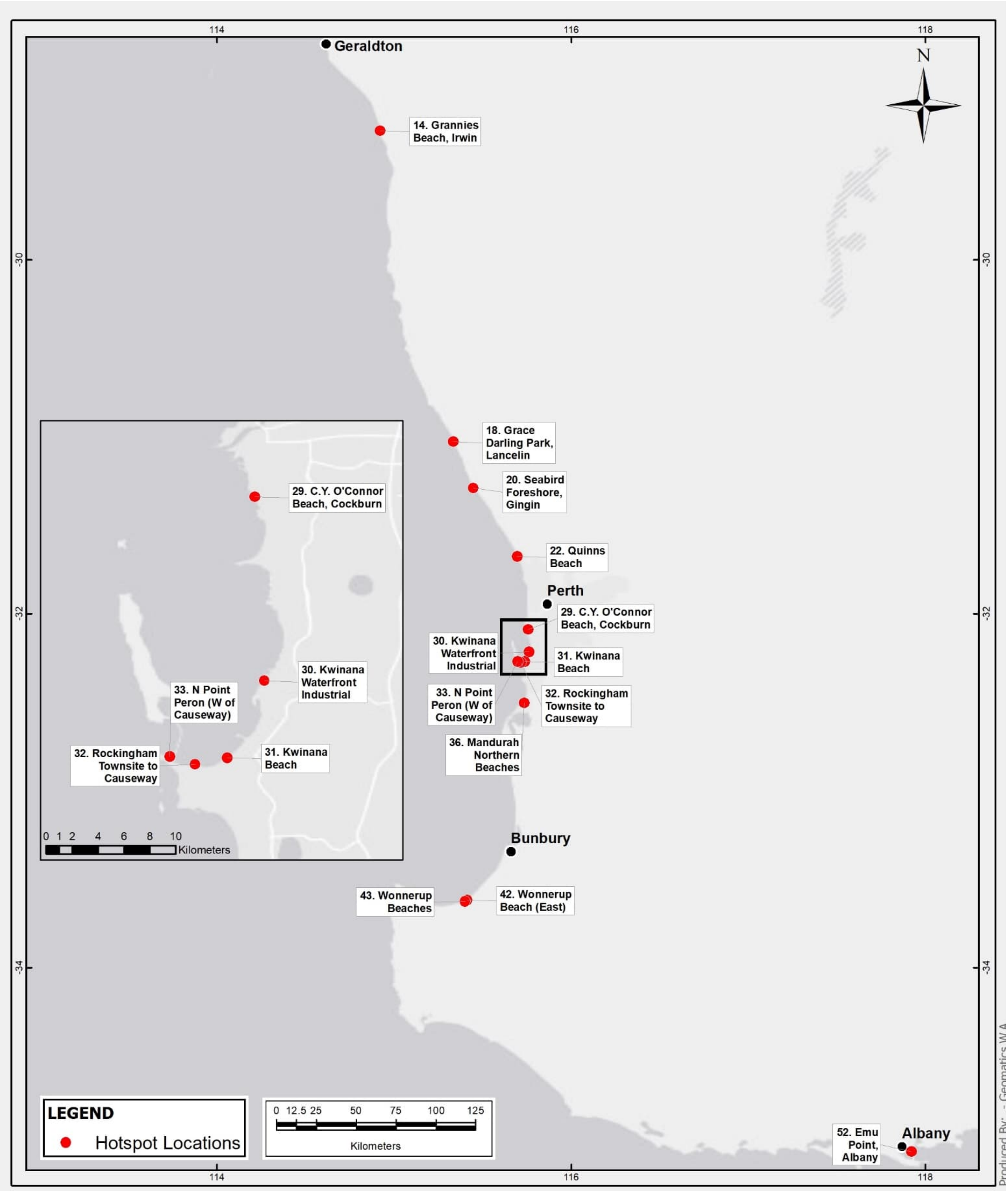

Figure 1-1: Map of the 12 hotspots selected for review in this study

1.3 Assessment methodology

These activities formed the framework for assessing each site:

1. Collate relevant site information in an easy-to-follow chronological database, documenting significant coastal management measures and other works that impact erosion at the hotspots, not limited to:
   a. sand nourishment and bypassing works
   b. construction of groynes, headlands, seawalls and artificial reefs
   c. dredging disposal that is impacting the coastal system.
2. Visit the site and meet with the coastal managers responsible for works at each of the hotspots. Inspect the general condition of the structures.
3. Capture mid- (eight to ten years) and short-term (four to five years) vegetation lines (2-dimensional) along hotspot chainages to understand recent shoreline changes. Give preference to consistent short- and mid-term volumetric surveys of sub-aerial beach, where available, to better quantify changes.
4. Illustrate the current structures in place, as well as coastal management measures taken at the hotspot, in a site overview figure.
5. Capture lessons learned and recommendations for future coastal management measures at each site.

2. Hotspot investigation

Individual site summary tables are presented within Appendix A. A general overview of the coastal management measures used at each hotspot is shown in Table 2-1.

Table 2-1: General coastal management measures implemented at each hotspot

ID	Groynes	Seawall / Revetment	Nourishment	Revegetation	Other	CHRMAP
14. Grannies		✓	✓ (Historical)	✓	Concrete stabilisation	2016
18. Grace Darling (Lancelin)			✓			2023
20. Seabird		✓	✓ (Historical)	✓		2023
22. Quinns Beach	✓	✓	✓			2018
23. C.Y. O'Connor Beach	✓	✓	✓	✓	Submerged reef	2015
30. Kwinana Industrial	✓	✓		✓	Artificial headlands	2016
31. Kwinana Beach		✓	✓	✓	Artificial headlands	2016
32. Rockingham	✓	✓	✓			2019
33. North Point Peron	✓	✓	✓			2019
36. Mandurah Northern Beaches	✓	✓	✓	✓		2022
42,43. Wonnerup	✓	✓	✓			2022
52. Emu Point	✓	✓	✓		Artificial headland	2019

2.1 Coastal management

2.1.1 Nourishment

Sand nourishment is a technique that was used historically at 11 out of the 12 hotspots, but is now only actively used at nine of the hotspots.

Different hotspots appear to have alternate management drivers for when and what quantity of sand is used annually for nourishment. These key drivers appear to dictate how nourishment campaigns are executed across WA:

- Source-constrained – sites that are nourished with a variable quantity of sand, typically sourced from within the system, and quantified based on what is sustainable to remove from the system.
- Budget-constrained – sites that are nourished using an annual budget allocated by Local Government Area (LGA)/DoT. In many cases, this is based on historical nourishment volumes (for equilibrium) or analysis to determine the volume needed to sustain the littoral transport. For some sites that use this management method, sand is sourced from outside the sediment cell.

- Destination-constrained – where a distinct beach profile and extent is intended, and only the volume of sand required to meet the profile is delivered.

Nourishment sand is currently sourced within six of the nine actively nourished sites. Should sand be available from within the system, nourishment is most likely to be driven by source availability.

In most instances, the management preference should be to source nourishment sand from within the system, keeping within 'working with nature' principles and making sure the source material is compatible with the native sand at the placement area. Backpassing and bypassing are successful examples of this, as long as beaches down-drift are not being starved of sediment that would otherwise be relied on to maintain beaches. Where sand is sourced from outside the sediment cell, it should be assessed for compatibility with the native sand at the placement area.

At the C.Y. O'Connor hotspot, nourishment material is periodically sourced from the northern end of the beach and back-passed to the southern end. This practice can create down-drift impacts to South Beach (City of Fremantle), as sand is prevented from migrating to beaches further north. This is a practice that should be carefully monitored to make sure erosional pressures aren't transferred to this neighbouring beach. This represents an exception to the recommendation that nourishment sand is sourced from within the system.

From discussion with City of Albany, Emu Point is currently managed with campaign volumes estimated from site survey, but also restricted to a works duration (and budget). The timeframe of works is typically communicated to the local community (most recently, one week) and limits the volume of material that can be carted and placed.

Table 2-2: Hotspots with current sand nourishment, typical methods

Site Name	Current Frequency	Management Driver	Source	Design
18. Grace Darling (Lancelin)	Annually	Budget	Internal (jetty dredging) and external (dune sand)	Informal
22. Quinns Beach	Annually	Budget	External (private quarry)	Informal
29. C.Y. O'Connor Beach	1 to 2 yearly	Source	Internal (backpassing)	Informal
31. Kwinana Beach	Varied (3 to 9 yearly)	Source	External (Point Peron sand trap)	Informal
32. Rockingham	Annually	Source and destination	External (Point Peron sand trap)	Yes
33. North Point Peron	10 yearly	Source	Internal (backpassing)	Informal
36. Mandurah Northern Beaches	Annually	Source	Internal (bypassing)	None
42,43. Wonnerup	Annually	Source and budget	Internal and external (Bunbury sand trap/quarries)	Informal
52. Emu Point	Biannually	Source and budget	Internal (backpassing)	Yes

At both the Mandurah Northern Beaches and Wonnerup hotspots, sand bypassing activities are undertaken updrift of the sites. Campaign volumes are typically determined by the volume of sand accumulating within each sand trap.

At Mandurah, the Doddi's Beach sand trap saturation is visually assessed annually; DoT and City of Mandurah subsequently decide bypassing volume and campaign start dates.

At Port Geographe (Wonnerup), the availability of shore-accessed sand has decreased since the sand trap and western groyne were reconfigured (2014). This has likely contributed to the significant reduction of bypassing practices at this site, with wide-spread accretion no longer 'easy' to win from a localised area (refer to Figure 2-1). Although natural bypassing of sand has likely improved at the site (since reconfiguration), investigation of the Wonnerup hotspots indicates not enough sand was transported to Wonnerup eastern beaches to prevent erosion. Additionally, the impact that bypassing has on wrack accretion updrift of Port Geographe is a key consideration that has limited bypassing since reconfiguration.

Most sites do not follow a clear design process at both borrow and nourishment locations, and subsequently do not have a defined design life. For those that have undergone formal design, typical profiles with desired beach gradients are drawn, as is the impacted footprint, in a plan view format. Set-back distances from key infrastructure are typically included as well as indicative crest widths and heights. In addition, volumes are typically provided per campaign.

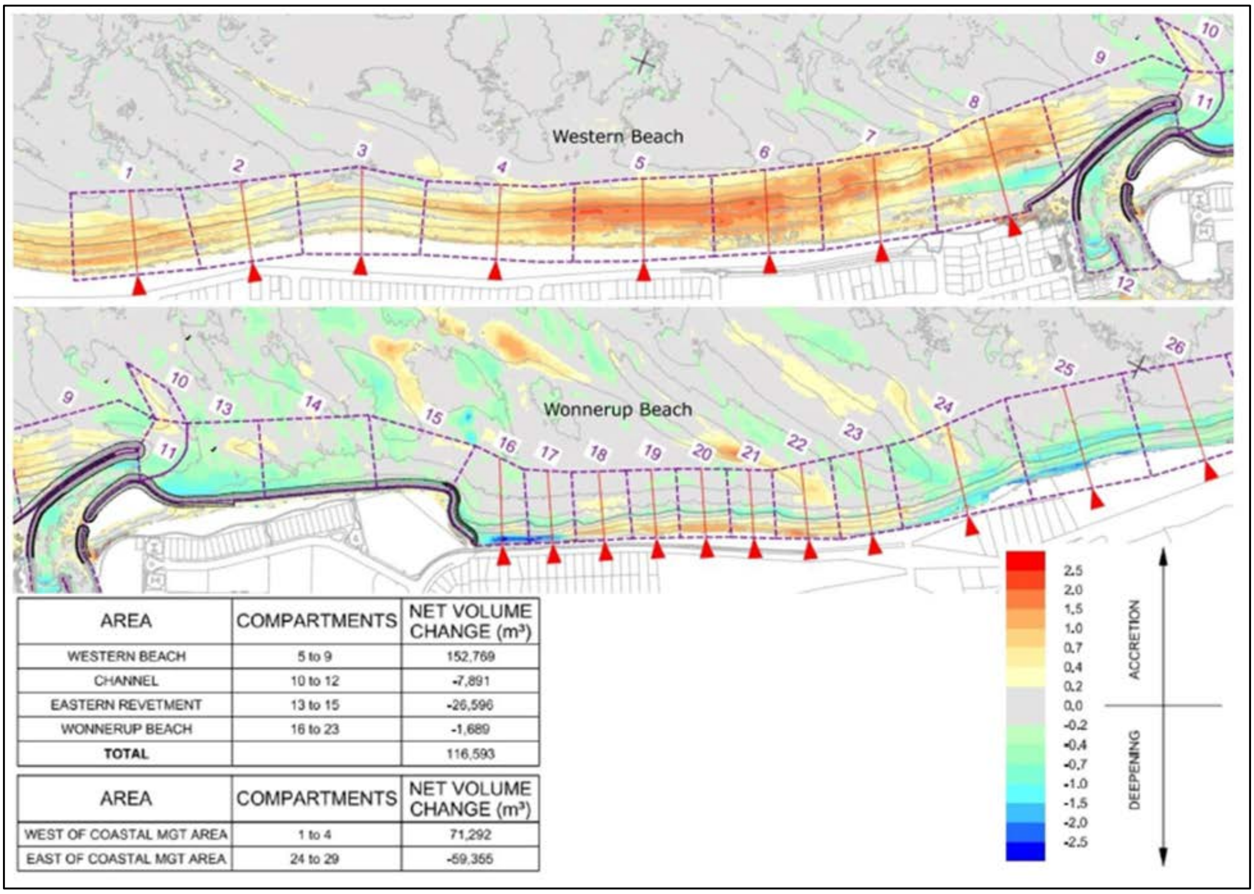

Figure 2-1: Survey changes along the Western and Wonnerup beaches since reconfiguration of the Port Geographe Marina (Department of Transport, 2020); changes from Nov 2014 to Dec 2019

2.1.2 Groyne fields

Eight of the 12 hotspots feature groyne(s) to support wider beach formation and increase the erosion buffer. Groynes throughout the hotspots are typically isolated structures, using the accretion updrift side, and supporting isolated beach growth close to the groyne. While groynes provide accretion on the updrift side, they do not defend against cross-shore erosion from storms. Their application needs to be tailored accordingly. In most cases, the groynes have reached saturation, allowing littoral sand movement to bypass the structures and support accretion on beaches down-drift.

Across eight of the hotspots that use groynes, most are rubble-mound types, with timber retaining structures present along the Rockingham coastline. Their construction material has depended on the local availability of rock, with most made of limestone or laterite materials. Many of the newer groynes were constructed with geotextile sand containers filled with locally sourced sands.

Low-crested groynes, at Wonnerup, Emu Point and Point Peron, are a variation of the traditional groyne design outlined within USACE (2008). Such structures have a lower crest (0.5 to 3.0 m LAT) than traditional design – typical groyne head crest height across WA sites is 4.25 to 6.00m LAT – and do not extend as far offshore. Low-crested groynes are typically overtopped in design events, are unable to retain as much sand as traditional groyne structures (making them unsafe for pedestrian access in storm events), and naturally bypass faster than traditional groynes. This lessens the down-drift impact on the coastline, while retaining more sand than a ‘no groyne’ approach. They require less resources to construct due to their smaller volume profile, and are therefore cheaper to construct than larger structures. Such structures may require more frequent maintenance throughout their design life.

Within WA’s southwestern climate, local winds acting predominantly south-southwest, combined with smaller swell conditions, create steady accretion and northward littoral transport along many of the west-facing coastlines. In winter, storm conditions drive a reversal in sand movement trends, with variability in the storminess of the season driving the overall transport effects.

The Quinns Beach and Mandurah Northern Beaches hotspots appear to be impacted by reversing of littoral transport associated with seasonal metocean climates. Many of the hotspots feature changing seasonal littoral transport directions; some even change across multi-year temporal scales. Changing sediment transport patterns create the need for beaches to have additional buffer and in some of the cases identified, tighter spacing for groynes may be required, especially where infrastructure is being threatened.

Groynes have progressively been extended at many of the hotspots, including Quinns Beach, C.Y. O’Connor Beach, North Point Peron and Emu Point. This coastal management measure was used to minimise bypassing of sediment out of the groyne compartment, to encourage retention updrift of the structure.

Analysis of groyne spacing to length ratios, at relevant hotspots where a series of closely spaced groynes were deployed, is provided in Table 2-3.

Table 2-3: Typical groyne spacing at individual sites

Hotspot	Number of Groynes	Spacing / Length Ratio
22. Quinns Beach	4	4.5-8
29. C.Y. O'Connor Beach	1	5-6

33. North Point Peron	2	4-5.5
36. Mandurah Northern Beaches	5	4-40
42,43. Wonnerup	10	2-4
52. Emu Point	2	1.5

2.1.3 Beach scraping

Beach scraping (also referred to as Nature-Assisted Beach Enhancement, or NABE) is a technique used for accelerating beach recovery after erosion, by periodically changing the slope of a beach so the energy of the sea can bring more sand onshore (Figure 2-2). This is achieved by removing a small amount of sand from the beach berm at low tide, then adding the sand to the dune system. This process serves to assist nature in beach enhancement by systematically speeding up the natural dune recovery process. This is best undertaken in periods of natural beach accretion.

Beach scraping was trialled by City of Wanneroo at the Quinns Beach hotspot and by City of Busselton at Wonnerup. At both these locations, down-drift impacts to the beach and dune system are being monitored closely, a sign of proactive management by the LGAs.

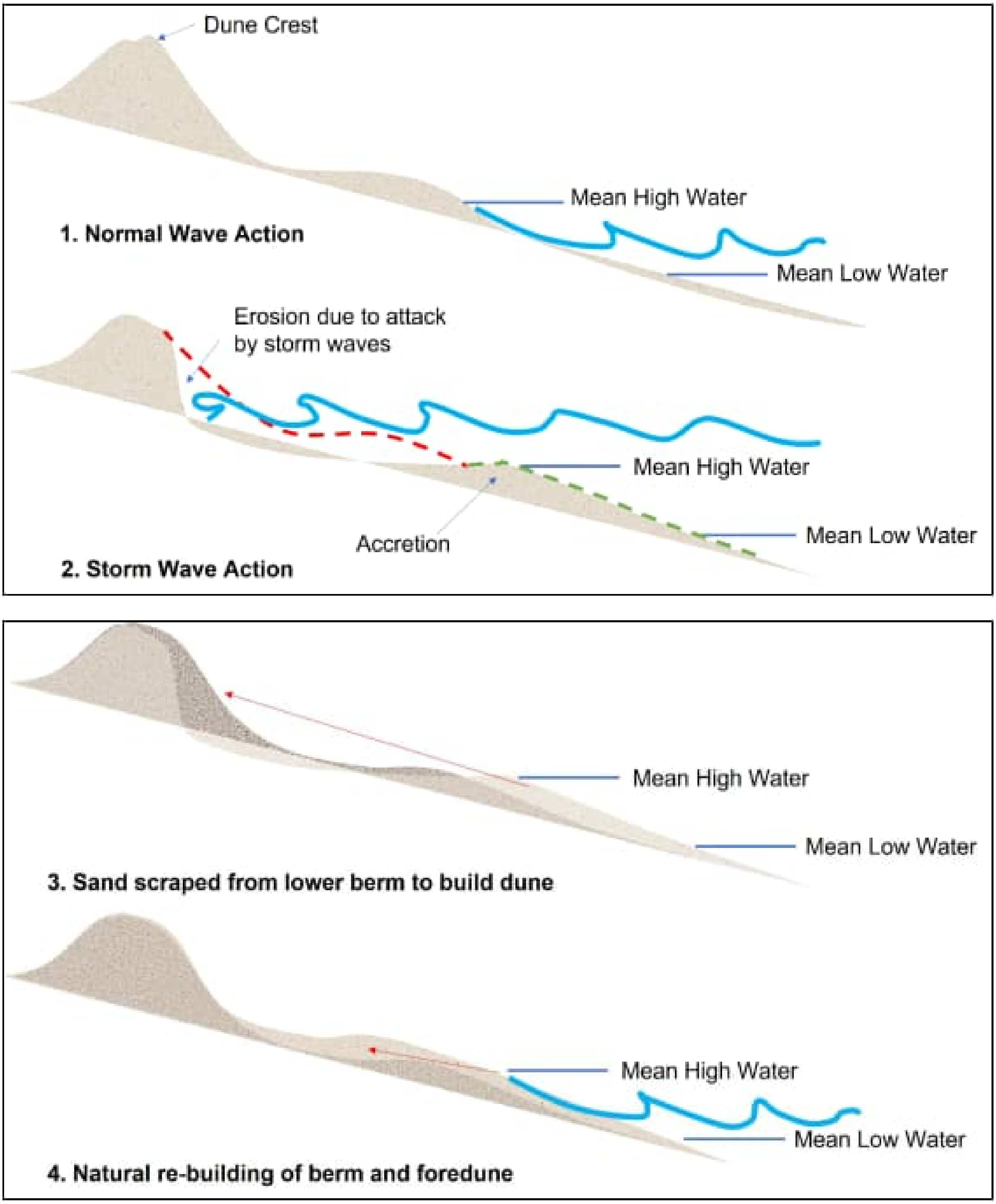

Figure 2-2: Concept of Beach Scraping

2.1.4 Seawalls and revetments

Seawalls and revetments are coastal protection structures used at nearly all sites within this investigation, Grace Darling being the only exception. These structures act as a last line of coastal defence (erosion and inundation), but in most cases, if sand supply is not maintained naturally or artificially, they typically result in a loss of usable beach next to it. Across the 11 hotspots, these are rubble mound types, typically made of locally sourced rock materials (limestone, laterite, basalt). Many of the newer seawalls are constructed with geotextile sand containers filled with locally sourced sands.

Seawalls were implemented ad hoc where protection of infrastructure has warranted the spend. In some cases, a lack of formal design was possibly seen as a cost- or time-saving measure. Some constructed seawalls lack formal design or planning, with armour rock placed or ‘draped’ with limited effectiveness in protecting the land and infrastructure behind (refer Figure 2-3). Some of the ad hoc designs lack one or more of:

- geotextile filtering, to limit loss of fines (Quinns, Kwinana Beach, and Rockingham Town Beaches)
- filtering of underlayers (Quinns, Kwinana Beach, and Rockingham Town Beaches)
- sufficient geotechnical foundations and/or stability against geotechnical slip failure
- scour protection/insufficient toe depth to prevent undermining by scour
- insufficient crest height to prevent wave overtopping (Kwinana Industrial, Emu Point, Mandurah)
- undersized armour and inadequate interlocking (Kwinana Beach)

Figure 2-3: (left) Wells Park headland/revetment (Kwinana Beach) with poor interlocking of armour material (right) Informal seawall at Hymus St. (Rockingham Town Beach) with erosion from overtopping and omission of lack of filter layer and geotextile

Formal designs of seawalls typically assume minimal sand is available as a buffer at the toe of such structures, resulting in waves and deep water during a design storm event. When the structure is exposed to a storm event, scour will occur in front of the structure and will be subject to depth-limited breaking waves. Should sufficient sand nourishment volume be available to provide a buffer against storm erosion demand, and maintenance is readily available, the structure would act as a last line of defence against erosion. Under these conditions, the structure will offer some degree of protection, even if there is a lack of formal design to address all the criteria listed above. Formal design of seawalls does, however, offer coastal managers lesser maintenance requirements longer term.

2.1.5 Other techniques

Artificial headlands are being used effectively to encourage salient tombolo growth and beach width in environments with relatively calm wave action, at Kwinana Industrial, Kwinana Beach and Emu Point. In most cases, when spaced correctly, used in the correct environments, and periodically nourished, these can offer an effective coastal management measure. Despite this, these structures have amenity concerns, which are key when considering their application.

Artificial fringing reef structures – also known as a submerged reefs – were constructed at C.Y. O'Connor Beach, with the plan to reduce the wave energy behind and minimise associated erosion impacts. It is too soon to fully realise the impact this structure has had on the coastline. Long-term monitoring of this structure will be crucial to help analyse this application.

Revegetation is a technique used at many of the sites – Kwinana Industrial, Kwinana Beach, Mandurah Northern Beaches, C.Y. O'Connor Beach – typically in combination with nourishment and sand retention strategies. Revegetation is best used when dune systems are sufficiently nourished after an erosion event, and vegetation is given enough time and favourable biological conditions to re-establish itself. Vegetation planting, when carefully planned, can create a more complex and lower wind environment to encourage vegetation species diversity, and create a wind trap for sand to fall into during onshore winds, thereby encouraging natural dune accretion (Figure 2-4). Dune stabilisation works should be done as soon as possible after nourishment or scraping, to reduce the potential of landward transport of windblown sand and smothering of landside infrastructure. More robust revegetation can be planted at the back of the dune if the beach is in an accretionary phase, to aid natural onshore wind-driven dune buildup. Wind velocity is generally reduced by plant cover, encouraging deposition, and trapping of wind-borne sand.

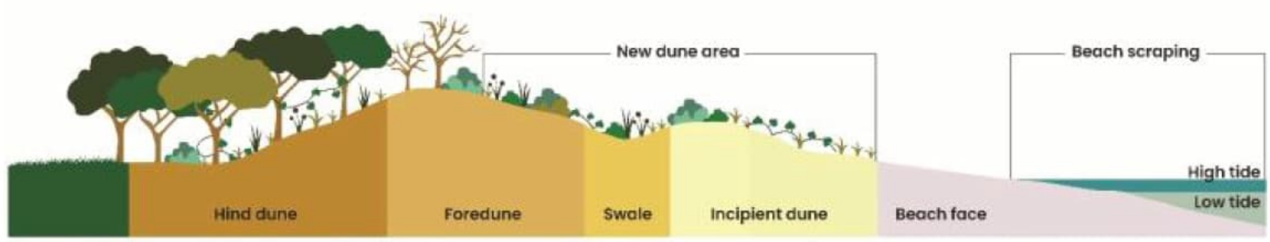

Figure 2-4: Generic example of zonation of dune vegetation to encourage dune building through beach scraping (Byron Shire Council, 2023)

Concrete stabilisation is a technique used at Grannies Beach, where sand was mixed with cement to create a hard 'cap' beach berm profile. Sand stabilisation works and dune revegetation have so far shown promising signs from an amenity perspective, and the local community seems to indicate satisfaction with the chosen management response. The design life of this informal solution is uncertain. Damage in the short-term may be difficult to repair from an access perspective, creating amenity concerns going forward. This solution is expected to last five to 10 years. Should this occur, it may be costly when compared to other options, based on the life of the works. For this reason, it is recommended this solution be carefully monitored before being considered at other sites.

2.2 Coastal monitoring

LGAs perform various types of coastal monitoring, including:

- remote photography
- topographic survey of beaches (profiles and drone surveys)
- structure condition inspection (visual and topographic survey)
- coastal transect surveys
- 'Coast Snap' and Northern Agricultural Catchment Council citizen-led photography
- metocean analysis (wave, current and water level).

DoT has also performed topographic laser scans at the 12 hotspots reviewed in this study, on a variable frequency.

Monitoring and coastal analysis appears to be more prevalent for LGAs who have more income from rate payments. LGAs with consistent periodic surveys, like City of Wanneroo at Quinns Beach and City of Albany at Emu Point, can refine the timing and quantity of sand nourishment needed for seasonal works and the associated budgets. Some LGAs with enough resources, specifically City of Albany at Emu Point and City of Mandurah at Mandurah Northern Beaches, are even doing their own surveys by using innovative survey methods, such as Lidar-equipped drones.

Monitoring is particularly important where coastal managers are trialling newer coastal management measures; for example, the beach stabilisation at Grannies Beach and the fringing reef at C.Y. O'Connor Beach.

2.3 Coastal investigation

The typical investigations suggested within this study are specific to each site (refer Appendix A). An exception to this is the suggested investigation of larger-scale nourishment campaigns at both Quinns Beach and C.Y. O'Connor (and other hotspots not covered within this study).

2.3.1 Offshore sand supply

The LGAs for both the Quinns Beach and C.Y. O'Connor Beach hotspots have flagged the need to investigate the viability of using new sand sources outside of their sediment cells for nourishment. They have also expressed interest in nourishing from offshore sources and using dredging vessels capable of larger campaign production, rather than typical trucking methods.

Given the close proximity of sites within the metropolitan area, if dredged material can be reused beneficially and becomes available, significant opportunity exists to support sediment cells by placing material in the nearshore zone (within the secondary cells), and providing a steady feed of sand onshore over multiple years. Alternatively, a dedicated offshore-sourced nourishment campaign could be developed with the primary aim of supporting sand supply for multiple hotspots.

Adjacent LGAs have historically partnered to spread financial costs of consultancy and monitoring. For example, Northern Beaches Alliance, for the LGAs of Wanneroo, Joondalup, Stirling, Cambridge, Nedlands and Gingin, and Cockburn Sound Coastal Alliance, for the LGAs of Kwinana, Cockburn, Fremantle and Rockingham. Such groupings could be beneficial by spreading the financial impact of offshore sand sourcing studies and the execution of such works, as individual councils would be unlikely to finance such campaigns alone.

The 'Westport' development in Cockburn Sound has communicated the need for a large dredging scope. Such a project could support coastal hotspots in the region, if dredged sand is deemed to be suitable for beach nourishment.

3. Recommendations and lessons learned

The general recommendations and lessons learned from coastal management measures in Western Australia are summarised below.

3.1.1 Nourishment

3.1.1.1 Lessons learned

Beach nourishment projects are often undertaken with limited design, due to source, budget or destination-related constraints. This has led to mixed outcomes in general from amenity and coastal protection perspectives. The success of a beach nourishment project depends on careful design, one that considers the compatibility of the sand source with the native sand at the nourishment site, community education and engagement, and a good understanding of the local coastal processes at each site.

Also, sites where bypassing is used could benefit with more detailed assessment of the required quantity of individual campaigns at North Point Peron and Mandurah Northern Beach locations. These locations have typically targeted annual volumes and could benefit from more dynamic management.

3.1.1.2 Recommendations

Coastal Monitoring: Coastal monitoring, including pre-and post-storm dune survey, mapping of vegetation lines and mapping of sediment erosion/accretion, should continue at the hotspots to understand the broad-scale coastal processes, sediment pathways and sediment budget at the site before planning a beach nourishment campaign.

Sediment Compatibility: Successful beach nourishment campaigns require knowledge of the compatibility of the source and native sand to confirm their suitability. Where possible, sand should be sourced from within the same littoral system, to ensure compatibility.

Nourishment frequency and volume: To compensate for interruptions to littoral drift due to the presence of structures such as breakwaters or trained harbour entrances, beach nourishment should be performed regularly to reduce downstream impacts, with an understanding of the required bypassing or backpassing volumes so nourishment volumes can best match net transport volumes. This has worked best at those locations with sand sourced from formalised sand traps at updrift locations, or formalised sand bypassing systems across harbour entrances, using buried pipeline infrastructure.

Community/Stakeholder Engagement: Beach nourishment programs will generally be more successful if the community is engaged, to manage their expectations around construction impacts and benefits to recreational amenity.

3.1.2 Groynes

3.1.2.1 Lessons learned

Design standards with respect to the materials, length, height, spacing and number of groynes have varied across many of these sites, and some groyne fields are nearing the end of their design life, despite still retaining compartment sand. Some groyne fields have led to unacceptable impacts downdrift; others were constructed with spacings that are too wide, with infrastructure threatened within the updrift side of a groyne compartment.

Many groynes along the WA coastline were also built ad hoc sometimes without formal design, only built when infrastructure is at risk or after damage. Emu Point and Wonnerup are examples. These projects were resource-constrained, therefore only building what was necessary at the time, which is a common approach by LGAs. This can typically explain some of the variance in groyne design across WA.

In general, the bypassing efficiency of a groyne varies with groyne length, median sediment diameter and wave climate (obliquity, wave height, period). Where median sediment diameter is finer, greater groyne bypassing can be expected. Similarly, larger waves lead to higher bypassing rates, and longer groynes lead to lower bypassing. Advisian (2017) undertook 3D sediment transport modelling of groyne bypassing to assess the influence of grain size, incident wave height and groyne length, for typical swell waves approaching the groyne at an angle of 10° and typical median sediment sizes varying from 0.2 mm to 0.4 mm, with these conditions typical of beaches with groyne fields along the south-west WA coastline. The results of this modelling are shown in Figure 3-1, and can be used as a general guide to designing groyne length for varying situations. As most sediment transport occurs in the surfzone, low-crested groynes will be effective at trapping sand updrift where wave climate is low, and transport occurs mainly as bedload. Conversely, higher crested groynes would be required for effective sand retention where wave climate is higher and the sediment transport occurs mainly as suspended load (Advisian, 2017).

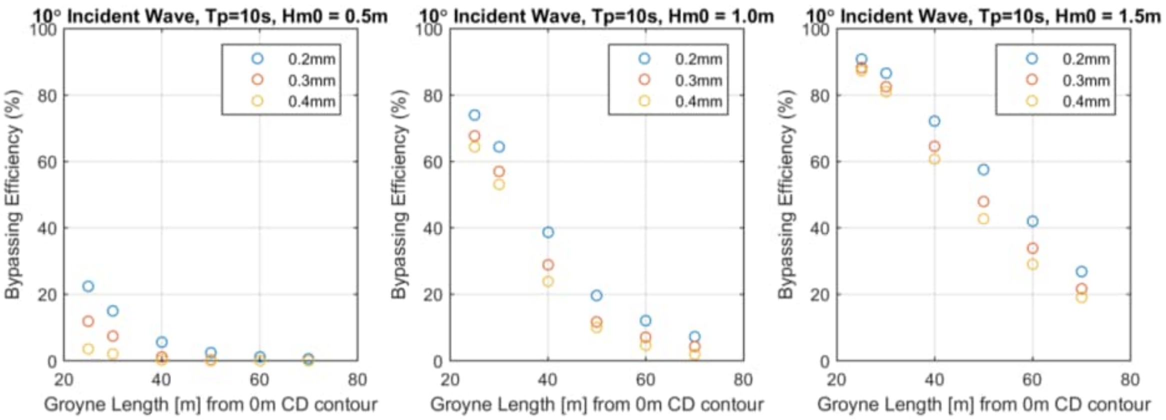

Figure 3-1: Variation in bypassing efficiency with groyne length, sediment diameter and incident wave height (Advisian, 2017)

3.1.2.2 Recommendations

Groyne Length and Spacing: USACE (1984) recommended groyne spacing (two to three times the groyne length) as a starting point for groyne design. However, site-specific factors should be considered and groyne configurations tailored accordingly. Groyne length and spacing at each site is a balance between net longshore sediment transport, natural bypassing, and erosion protection for the beaches within the groyne compartment.

Groynes can also be permeable to sediment transport, which was achieved at Wonnerup by employing low-crested groyne structures that allow littoral sand transport to bypass over the top of the groyne.

Additional groynes may be beneficial at the Quinns Beach and Mandurah Northern Beaches hotspots. At these locations, the groyne compartments have a spacing-length ratio of 4.5-8 and 4-40, respectively, which is be larger than recommended by the United States Army Corps of Engineers (USACE, 1984). Here, infrastructure is threatened by erosional processes at the southern end of each groyne compartment, indicating the groynes may be more far apart than is optimal.

USACE suggests the space between groynes should be two to three times the groyne length, so the groyne compartments act as a system rather than individual compartments. USACE's recommended spacing is a starting point for groyne design, but site-specific factors should be considered and groyne configurations tailored accordingly (for example Quinns Beach[1] has undertaken studies more specific than such industry suggestions, and hence should not rely on USACE's guidelines alone).

Accompanying Nourishment: For any new groynes planned, it is recommended that capital nourishment should accompany the construction on the updrift side, to encourage natural bypassing as soon as possible and reduce downdrift impact. This was done at all hotspots with groynes.

Site Specific Design: Groyne design should consider local coastal processes, as informed by coastal monitoring. Groyne length, height and materials used should all be carefully considered as part of any groyne project. The results of 3D modelling as shown in Figure 3-1 (Advisian, 2017) are applicable to the south-west WA coastline, and may be used as a general guide to designing groynes for the beaches in the study area. For example, geotextile groynes will have a limited design life and aren't appropriate for sites exposed to high wave energy, where rock may be more appropriate. Low-crested groynes will not be as effective in areas with high wave energy, where sediment transport occurs mainly as suspended load.

The use of geotextile sand containers can also be effective beyond initial design life estimates, if coastal managers actively maintain and inspect the bags frequently for early signs of wear or

[1] Note: Although Quinns Beach management has been informed by modelling of sediment transport processes (using site specific information), some groyne compartments continue to be threatened by seasonal erosion. This is being managed by dedicated nourishment campaigns. For more information refer to the site summary within Appendix A

damage. Vandalism and damage from four-wheel-drive contact was common where these are used at Wonnerup and Point Peron.

Groyne Spacing: Groyne spacing should be designed so the beach head is not exposed to wave action at any point within a groyne compartment under the design conditions (CIRIA, 1996). Where a groyne field has resulted in severe erosion impacts downdrift, a series of shorter 'transition' groynes on the downdrift side could be considered to reduce the downdrift impacts (USACE, 2009).

Many sites feature changing seasonal littoral transport directions. Some even change across multi-year temporal scales. Changing sediment transport patterns create the need for beaches to have more buffer, and in some of the cases identified, tighter spacing for groynes may be needed, especially where infrastructure is being threatened.

3.1.3 Seawalls and Revetments

3.1.3.1 Lessons learned

Several of the hotspots have erosion protection structures such as seawalls and revetments of varying design, materials and condition. At some of these sites, the erosion protection structures have reached the end of their design life, and at others, end effects are having detrimental impacts on the beaches downdrift. Some of these structures weren't formally designed or maintained.

Geotextile container structures have a limited design life, generally five to 10 years, and at some hotspots, the containers have ruptured, reducing their effective design life. These materials are only appropriate for temporary or trial structures, or in areas not exposed to a high wave climate.

Seawall construction has typically resulted in loss of usable beach directly adjacent to such structures, such as Grannies Beach and Seabird. In some cases, this isn't the coastal strategy the local community prefers, and local support is critical when assessing the best strategy for implementation. In some instances these structures only benefit a small group of public/private landowners and typically transfer erosive forces downdrift. Therefore, balancing the loss of amenity with the protection of infrastructure is key for coastal managers.

Sites where a seawall buffer is maintained with consistent nourishment/bypassing tend to be more accepted by the public, but this carries costs that smaller LGAs are unlikely to justify.

3.1.3.2 Recommendations

Monitoring: It is recommended that existing erosion protection structures continue to be monitored for structural integrity and downdrift impacts. Monitoring/inspections of structures should be undertaken on a regular basis (and especially after storm events), in accordance with the recommendations of the Ports Australia Wharf Structures Condition Assessment Manual (WSCAM), as a guide to assessing the structure condition and effectiveness.

Design Details: Where structures are recommended for upgrade or replacement, the coastal processes need to be assessed and engineering design done to make sure the structure would be appropriate for the local conditions – such as, slope, crest level, toe level, geotechnical stability and armour sizing – and not cause detrimental impacts due to edge effects. Structures should be designed for depth-limited breaking waves and be founded to withstand a scour level appropriate to the site.

Removal of redundant/ineffective structures: Erosion protection structures should be seen as a 'last line of defence' – where some of these structures have reached the end of their design life and are a threat to public safety, such as exposed sections of the unstable limestone block seawall at Kwinana Beach, recommended for removal. At some areas, there is an opportunity to move public infrastructure landward to avoid the risk of erosion instead of building erosion protection structures, particularly where these assets are due for replacement (for example, paths, picnic shelters and carparks).

Accompanying Nourishment: For any new seawalls or revetments, it is recommended that their construction be accompanied by sand nourishment where available, to offset the impact of the structure on the local coastal processes.

3.1.4 Coastal monitoring

3.1.4.1 Lessons learned

At all the hotspot sites, coastal monitoring has proven to be a valuable tool to help coastal managers understand the local coastal processes and plan for future coastal protection works or nourishment campaigns. DoT performs periodic bathymetric surveys at all of the hotspots reviewed in this study, which are valuable in understanding the sediment transport pathways. Some LGAs perform regular topographic or Lidar surveys. Some perform remote photograph monitoring and others do not perform any regular monitoring. As a result, many of the hotspots have limited or outdated information available to assess coastal processes and effectively plan coastal management measures.

Vegetation line mapping (2-dimensional) is typically accurate to ±3 m, and the use of vegetation as a proxy for shoreline movement can be limited in some areas. Regular inspection and photo monitoring should be used to supplement vegetation line mapping as a monitoring technique, particularly after storm events.

3.1.4.2 Recommendations

It is recommend DoT continues its regular bathymetric survey program, as this provides valuable information for coastal managers. Specific monitoring recommendations are provided within the individual site summaries (refer Appendix A). Some general recommendations on coastal monitoring include:

- Citizen-science photo monitoring stations, such as CoastSnap and Northern Agricultural Catchment Council monitoring, can be established at select locations. It is a low-cost monitoring initiative that acts as both a valuable coastal monitoring tool, and a means to encourage community engagement and participation. CoastSnap (Harley & Kinsela, 2022) is a citizen science program where the public can take images of a beach by placing their smartphone on a specially designed cradle, allowing the images to be analysed to assess changes in beach morphology over time.

- Low-cost survey techniques, such as real-time kinematic global positioning system (RTK-GPS) survey, can be used by coastal managers for monitoring before and after storms. The RTK-GPS is a simple and cost-effective method to assess pre- and post-storm dune profiles, and to assess volumes of coastal erosion and volumes of material moved during a particular beach scraping or nourishment exercise. The data should ideally be collected soon after a storm, and before a storm if one is forecast, to allow post-processing to assess coastal hazard parameters such as wave runup elevation and storm erosion demand.

  Other examples of post-storm surveying effort that can be easily collected using the RTK-GPS survey equipment include debris lines along the back beach areas, delineating limits of wave runup. Data should be collected along pre-determined profiles that extend at least as far landward as the landward side of the dune crest, and down to the water line, ideally at low tide, and delineating important features such as the dune vegetation line, top and toe of erosion escarpment. At least three profiles at each beach location would allow the data to be post-processed as a 3D surface in geographic information system software for analysis.
- Coastal managers can set up a photographic database linked to a geographic information system, with the photos geo-tagged and uploaded to the database. The database could include fields for entering comments about the photograph, which can be entered in real-time by Council employees using a tablet. This provides a valuable record of coastal processes, erosion and beach management works that can be referred to by coastal managers in the future.
- Uncrewed aerial vehicles, like drones, equipped with Lidar scanning capabilities, are becoming more accessible to coastal managers. LGAs with this capability include City of Mandurah and City of Albany. Such monitoring can be used for both periodic surveys and after storms, where significant response is required. Uncrewed aerial vehicle surveys provide a larger spatial coverage and resolution than the RTK-GPS method.

3.1.5 General coastal management recommendations

In addition to the above recommendations regarding nourishment, groynes, coastal protection structures and monitoring, our general recommendations about coastal management in WA are:

- Successful coastal management projects need the support and understanding of local communities; all coastal management projects should be accompanied by a community engagement and education program that is tailored to the needs of the local community.
- Four-wheel-drive access to the beaches can impact coastal vegetation and needs to be managed at some sites (Kwinana Beach, Grace Darling, Wonnerup)

- Local dredging projects can impact coastal processes, including nearshore wave direction and sediment transport patterns. These need to be understood through local area studies and data collection. They also provide an opportunity to beneficially reuse sand for beach nourishment to mitigate coastal hazards.
- LGAs should maintain and build on the coastal management records developed within this study. Such records could form a blueprint for key inputs into future Coastal Adaptation and Protection grant applications, for consistency across submissions, as well as help future coastal managers maintain a comprehensive history of the coastal management at each site.
- Follow-up investigations of the hotspots should be performed approximately every 10 years, to compare management progress against the baselines assessed in this study.

4. Summary

The investigation of the 12 hotspots highlighted the diversity of coastal management measures and processes across the geographical region.

The income LGAs receive from rates has considerable impact on the types and extent of management being implemented.

It is recommended that this study is expanded to support the remaining hotspots, to improve on the collective coastal management learnings across WA. It is also recommended that the historical coastal management records that were developed within this study be continually updated to make sure concise records are available for all the DoT-managed hotspots.

Follow-up investigation of the sites covered within this document is suggested on a 10-year basis, to compare management progress against the baselines assessed in this study.

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Appendix A. Individual Site Summaries and Assessment

DEPARTMENT OF TRANSPORT

WA Coastal Erosion Hotspots

Individual Site Summaries – 12 Sites

Document no. Rev 0: 311012-02081-CS-REP-001 Appendix A

9 June 2025

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Table of acronyms and abbreviations

AFR	Artificial fringing reef
AHD	Australian Height Datum
ARI	Annual Recurrence Interval
CAP	Coastal adaptation and protection
CHRMAP	Coastal hazard risk management and adaptation plan
CIS	Coastal inundation study
CMPAP	Coastal Management Plan Assistance Program
CMS	Coastal management Strategy
CoA	City of Albany
CoB	City of Busselton
CoC	City of Cockburn
CoK	City of Kwinana
CoM	City of Mandurah
CoR	City of Rockingham
CoW	City of Wanneroo
CSCA	Cockburn Sound Coastal Alliance
DBCA	Department of Biodiversity Conservation and Attractions
DOT	Department of Transport
DPI	Department of Planning and Infrastructure
DPLH	Department of Planning Lands and Heritage
DWER	Department of Water and Environmental Regulation
EMMP	Environmental Monitoring and Management Plan
GSC	Geosynthetic Container
KBJ	Kwinana Bulk Jetty
KBT	Kwinana Bulk Terminal
LGA	Local government area
MCA	Multi-criteria analysis
MCDA	Multi-criteria decision analysis
NACC	Northern Agricultural Catchments Council

PFAS	Per- and polyfluoroalkyl Substances
PGCMU	Port Geographe Coastal Management Unit
RTK	Real-time kinematic
SoG	Shire of Gingin
SoI	Shire of Irwin
SPP	State planning policy
WA	Western Australia

1. Grannies Beach

ID	Category	Content	
1.	**Site name / Date review complete**	Grannies Beach	May 2024
2.	**Key details**	LGA: Shire of Irwin (SoI) Townsite: Dongara: Hotspot ID: #14	
3.	**Summary of erosion issue**	This hotspot extends north of Port Denison northern breakwater, incorporating both Grannies, and Surf Beaches. Grannies Beach was originally located in the central part of a half heart shaped embayment, at Leander Point, within the vicinity of the Irwin River Mouth (approximately 67 km southeast of Geraldton). This site has been facing erosion issues in response to the construction of the Port Denison Marina in 1979 (Seashore, 2019). Beach erosion investigations undertaken in 2001 determined a 400 m long section of beach extending 50 m to 450 m north of the boat harbour, in front of the Caravan Park, was undergoing erosion (M J Paul and Associated Pty Ltd, 2001). Despite intermittent nourishment programs there has been continued erosion at this site over winter. Historically, key storm events have resulted in significant damage to beach/infrastructure including the following: • 2021, winter storms lead to cracking of limestone retaining wall, from overtopping of the structure at Grannies beach. • 2020, winter storms, eroding the beach and dune scarp north of seawall, along Surf beach. From (Seashore, 2019), eight publicly owned assets may be at risk of erosion damage in the area, with four assets at risk of damage in the short-term, including shade umbrellas, beach access points, the path and reconstructed car park. In the longer term, Ocean Drive, Marine heights, the leasehold caravan park, and associated services (critical pipeline, phone and power) would be at risk of damage. Six private properties are high-value assets at risk.	
4.	**Overview of key coastal processes**	Dongara and Port Denison are located on the North-Central Shire of Irwin coast, and are morphologically complex, due to the presence of the Irwin River (Seashore Engineering, 2020). Patches of offshore reef modify the nearshore wave climate, with sheltering leading to sand salient or tombola in the lee of. Historically, it is understood that this site relies on sediment sources as follows: • Sediment supply from the south. • Bio production from offshore reefs shoreward. • Sediment discharged from the Irwin River during flood events. Studies undertaken in 2001, (M J Paul and Associated Pty Ltd, 2001)) indicated that since 1977, 16,100 – 22,100 m^3 of sand has eroded from the aerial beach extending from 50 m north of Port Denison for 450 m. This corresponded with an annual net loss of 690 to 920 m^3/ yr of sediment. More recently an indicative sediment budget developed by Seashore (Seashore Engineering, 2020) based on data from 1993 to 2010 indicated net longshore transport to the north, increasing from approximately 200 m^3/yr at Grannies Beach to approximately 2,000 m^3/yr at Surf beach. It is understood that a loss of sediment storage following the construction of the Port Denison Boat Harbour, has been a key contributor to progressive erosion at this site.	

ID	Category	Content
5.	**Overview of historical coastal management actions**	The following key actions have been taken at this site (not including emergency repairs/measures: • 2020-2023, poured concrete/beach face stabilisation including re-vegetation, undertaken in three phases north of seawall. • 2010-2014, rock seawall, built in three phases with final seawall approximately 240m. • 2011, sand nourishment (totalling 5,800 m^3) across three occasions, at Grannies and Surf beach. • 2009, Geosynthetic Containers placed in front of Seawall in attempt to protect the limestone block wall during storms. • 2009, in June overtopping resulted in failure of limestone retaining wall requiring emergency repair of the wall and stairs. • 2009-2010, sand nourishment (13,500 m^3) at Grannies and Surf Beach • Prior to 2001, recent Shire construction of a limestone rubble mound seawall. • 1999, sand nourishment (20,000 m^3) in front of the Caravan Park

6.	**Management issues and challenges**	• Small limestone retaining wall (Grannies Beach) has been reported to be overtopped on multiple occasions (SoI,2024) and is not adequately designed to withstand the wave or water level conditions in the area. From discussion with SoI (Jones, 2024) a replacement structure including beach access has been distributed for public consultation.
		• Significant pushback was received following the last sand nourishment undertaken at the site (2011), residents believed the works were wasteful as the sand 'disappeared' following placement and the number of trucks transiting the area generated numerous complaints (Jones, 2024)
		• The Beach Stabilisation works have been met by the community and Shire positively, and hence the decision was made to undertake all three subphases of the works. Despite the amenity of this solution, the longevity of this novel solution is untested. Two possible modes of failure are:
		    • Run-up of storm event waves may overtop this structure and may cause the concrete face to break apart requiring repeated repairs to the structure. The maintenance requirements and cost for the Beach Stabilisation works is unknown.
		    • The initial sand placed over the structure was immediately washed off the main face (refer Figure 1-3: Photo taken of Surf Beach dune/beach profile, post storm event, scarp and exposed concrete face apparent 11 April 2021) leaving a steeper repose at the transition into the vegetation zone. Consecutive storms may cause the matting to slump into the erosion zone.

7.	**Current management focus**	• SoI plan to upgrade the retaining wall and access to Grannies beach. • SoI plan to upgrade the foreshore area at Grannies Beach, between the Caravan Park and Boat Harbour. • SoI plan to manage the stabilisation and any repairs/revegetation on an ad hoc basis.
8.	**Performance / Effectiveness of coastal management measure/s**	Short and mid-term shoreline mapping has been undertaken using satellite imagery, and beach changes in 50 m increments are presented in Figure 1-6. **Grannies Beach** The retaining wall is being considered for upgrade by SoI and is understood to be in the concept phase of planning. The existing structure is reportedly overtopped frequently and is therefore at risk of failure. Despite this risk of failure, the structure is acting as a last line of defence and is performing it's intended function adequately. **Seawall Coastline** The seawall adjacent to the caravan park is serving the structure's intended purpose as a last line of erosion defence. Despite this there are safety concerns with children playing on the structure, and the beach adjacent is inaccessible to the public.

ID	Category	Content
		Surf Beach Vegetation line mapping has confirmed that the coastline 600 m north of the seawall, has eroded up to 10 m from 2010 to 2020, and up to 5 m between 2016 to 2020. Annually the coastline has been receding at similar rates across both periods, up to 1.0 m per year. It is expected that stabilisation works will indicate favourable results during future analysis due to the revegetation and jute matting directly impacting the coastal vegetation mapped from satellite imagery. Because of this direct impact, future vegetation analysis should be interpreted with caution when assessing the beach stabilisation impact on the coastline.
9.	**Recommendations & lessons learnt**	**Coastal monitoring** • Recommend photo monitoring station establishment to recommence monitoring of impacts of beach stabilisation such as a 'CoastSnap' station (last records available online from 2018). • Repeat LIDAR survey(s) to quantify shore sand quantities overlying the stabilisation section of beach. Alternatively, cross sectional profiles spaced every 50 m and undertaken at 6 monthly intervals will provide useful dataset to understand sand changes. **Coastal management actions** • Sand stabilisation works and dune revegetation have so far shown promising signs from an amenity perspective and the local community seems to indicate satisfaction with the chosen management response. The design life of this informal solution is uncertain. Damage in the short-term may be difficult to repair from an access perspective creating amenity concerns going forward. This solution is expected to last 5-10 years. Should this occur, it may be costly when compared to other options based on the life of the works. • Previous studies (Seashore Engineering, 2020) (Cardno, 2018) have recommended a groyne field combined with capital and maintenance nourishment to increase sand retention and buffer adjacent to Ocean Drive and carpark immediately north of the Caravan Park. Selection and implementation of a long-term coastal management pathway following on from the stabilisation works and in alignment with the CHRMAP should be considered for this site. **Coastal adaptation design** • It is recommended that the retaining wall behind Grannies beach is rebuilt based on a renewed design that is suited to existing site conditions. It is likely that the crest level is higher than the existing to minimise impact of overtopping. **Community engagement/education** • Nourishment combined with groyne field construction is the recommended management solution in recent studies (Cardno, 2018) (Seashore Engineering, 2020). Should this be reconsidered, engagement of the community including education of sand nourishment practices should be considered.

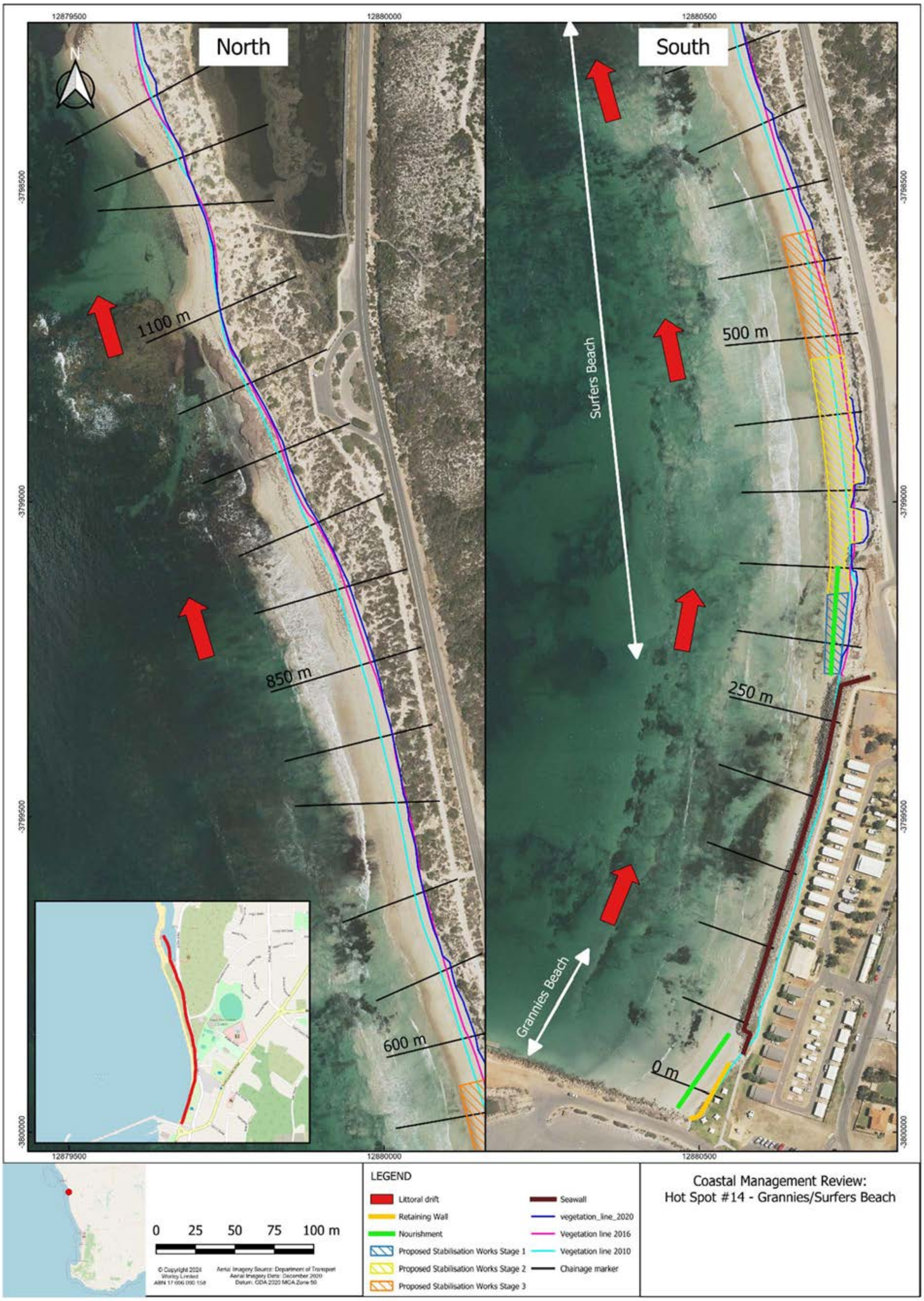

Figure 1-1: Grannies Beach – coastal management schematic

Figure 1-2: Photo taken of Surf beach dune/beach profile, post stage 2 stabilisation works, 10 March 2021

Figure 1-3: Photo taken of Surf Beach dune/beach profile, post storm event, scarp and exposed concrete face apparent 11 April 2021

Figure 1-4: Photo taken of Surf beach dune/beach profile during site visit 29 January 2024

Figure 1-5: Ad hoc repairs/cracking of poured concrete supporting retaining wall at Grannies beach (taken during site visit 29 January 2024)

Figure 1-6: Ad hoc repairs of limestone stair access/retaining wall at Grannies beach (taken during site visit 29 January 2024)

Figure 1-7: Seawall looking southwest (taken during site visit 29 January 2024)

Figure 1-8: Seawall and retaining wall looking north (taken during site visit 29 January 2024)

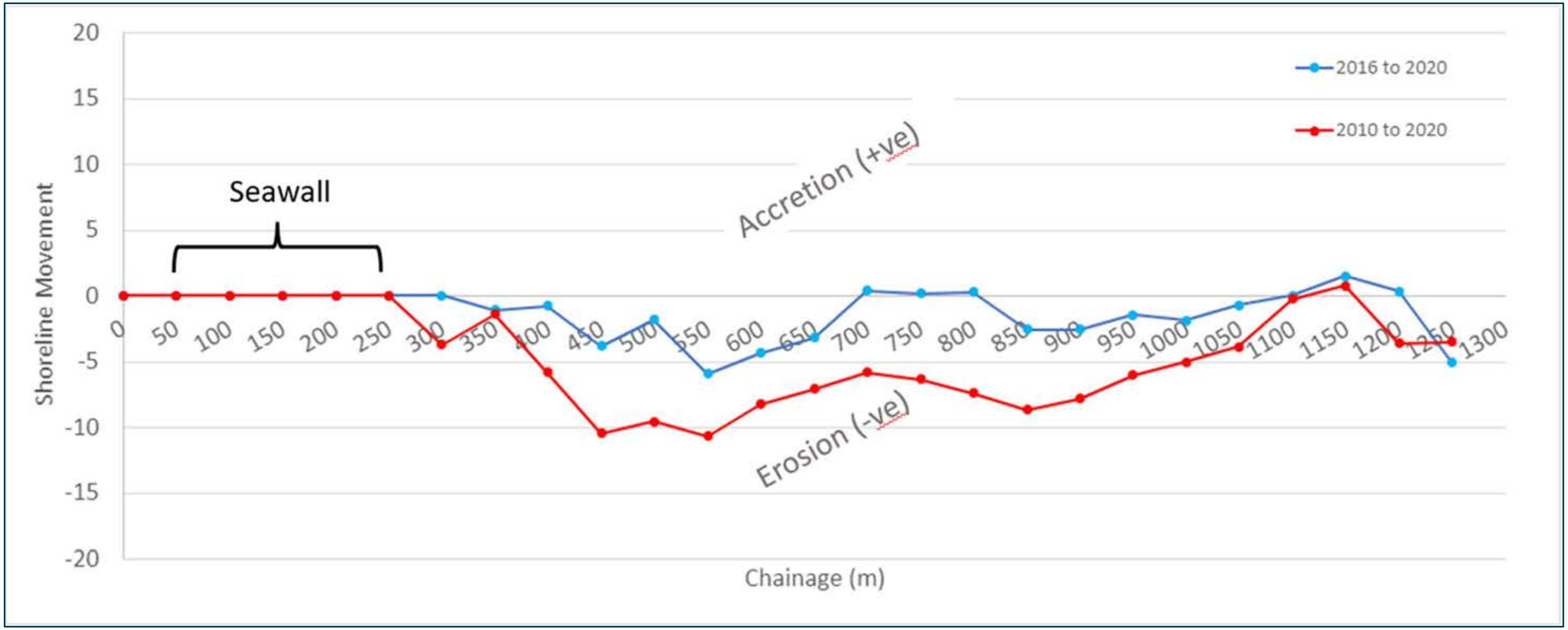

Figure 1-9: *Shoreline changes, calculated from vegetation line mapping (chainages refer to coastal management schematic)*

2. Grace Darling (Lancelin)

ID	Category	Content	
1.	**Site name / Date review complete**	Grace Darling	August 2024
2.	**Key details**	LGA: Shire of Gingin (SoG) Townsite: Lancelin Hotspot ID: #18	
3.	**Summary of erosion issue**	Grace Darling Park is located on the northern side of a sandy cuspate foreland in the lee of Edward Island. From Seashore (2019) the shoreline has faced significant variability with up to 75m of change in the last 70 years. The variability in foreshore position is due to variation in weather, wave regimes and sediment availability. Shore parallel reef systems flanking the Lancelin townsite create a complex system of refraction and diffraction wave patterns within the lagoon system (Sanderson & Eliot, 1995). Some of the infrastructure at threat includes car parking bays, the Volunteer Sea Rescue building, a toilet block, and various buried services (M P Rogers, 2018). These facilities were added to the park during a period of accretion, at a maximum in 1994. The park has experienced rapid erosion from winter storms since 2012 (Seashore 2019). Historically, key storm events have resulted in significant damage to beach/infrastructure including the following: • 2021, winter storm led to erosion at carpark beach access, damage to signage, and waves overtopping carpark (Friends of Lancelin Coast, 2018) • 2020, autumn storm (ex-tropical cyclone Mangga) leading to erosion adjacent to sea rescue building, tree, and carpark damage at Grace Darling Park (Baird, 2020) • Frequent scarping of the grassed area adjacent to the park, creating a hazard to the community following annual storm events (Friends of Lancelin Coast, 2018).	
4.	**Overview of key coastal processes**	As reported in Stul et al. (2014) Grace Darling Beach is located within a secondary sediment cell stretching from Ledge Point in the south to North Break Reef in the north (approximately five kilometres north of the Grace Darling hotspot). Edward Island lies on the boundary separating the tertiary cells 2b and 2c. This boundary at Edwards Island is reported as ambulatory, with sediment transfer likely occurring across the boundary based on seasonal trends. The Lancelin region is flanked by a line of reef and islands running parallel to the shoreline. These reefs provide wave sheltering or exposure that controls the development of cuspate foreland, tombolos, and embayments (Sanderson & Eliot, 1995).	
5.	**Overview of historical coastal management actions**	The Shire of Gingin is currently adopting nourishment on an annual basis, budgeting up to $100,000 per year (Cook, 2024) Based on recent cost information, this budget equates to 3,000 m^3 per year. Maintenance dredging at Lancelin Jetty, approximately one kilometre north of Grace Darling Park is typically undertaken by DoT every three to five years (BMT Oceanica, 2016). Within the last two campaigns (2017 and 2020) a portion of the disposed dredged material was used to nourish the beach adjacent to Grace Darling Park. The following key actions have been taken at this site not including emergency repairs/measures: • annual sand nourishment, sourced from Lancelin sand dunes • 2020, Grace Darling beach nourished with 8,000 m^3 of dredged sand, 1,500 m^3 stockpiled on the Edward Island cuspate foreland • 2017, Grace Darling beach nourished with 4,500 m^3 of dredged sand	

ID	Category	Content
		• seasonal closure of four-wheel-drive access south of Grace Darling Beach, typically enforced in winter months • removal of beach shelters (Seashore, 2019). An erosion protection study was undertaken by M P Rogers (2018) outlining the concept options recommended for the site including costs estimated for each. Key design proposed for the site featured a seawall constructed with geosynthetic containers (GSC) protecting both the Volunteer Marine Sea Rescue building and the Grace Darling Park and infrastructure. To support coastal management at this site DoT undertook a detailed geotechnical survey in 2023 (GBG Group). Findings indicated that top of rock substrate along the beach ranged from -9 m AHD to -2.5m AHD averaging -4.5 m AHD (exposed beach typically overlain by four to seven metres of variably compacted sediment). This finding indicates that substantial erosion can occur before rock is exposed and able to naturally protect assets leeward.
6.	**Management issues and challenges**	The initial CHRMAP study undertaken (Cardno, 2019) was adopted by the SoG in 2019, with conditions on a full public consultation required during the future review to be conducted in 2022. Coastal erosion at Grace Darling Park has been managed by interim sand nourishment while the revised CHRMAP and Coastal Management Plan is awaiting adoption by SoG. Ongoing use of interim management and the delayed endorsement of such a program has created uncertainty regarding the future of Grace Darling Park. The Shire of Gingin is a small local government without dedicated coastal engineering or coastal planning officers. It also has a small rate base. As a result, the Shire has historically had limited financial and technical coastal management capacity to manage the challenging coastal management issues along its coast. Sand nourishment as a coastal management measure has divided support amongst the local community due to the short-term interim nature of the strategy. Community sentiment is understood to be divided between those favouring sustainable coastal management, and those prioritising recreation. An example of this is divergent community attitude to four-wheel-driving. Some people would like to see beach access controlled, whilst others would prefer it to be maintained (Shape Urban, 2023).
7.	**Current management focus**	Shape Urban recently released an integrated CHRMAP study (2023) and Coastal Management Strategy (CMS) combining the recommendations from the Coastal Inundation Study (Baird, 2020) and the CHRMAP undertaken for Lancelin previously (Cardno, 2019). The integrated study, indicated that both the Grace Darling hotspot, and the wider Lancelin region, is facing high vulnerability of erosion and inundation in the short term (2040) prediction. Due to the combined risks, the study recommended that the retreat pathway is adopted for Lancelin. The summarised short-term management measures that have been recommended for Grace Darling and adjacent coastline include (Shape Urban, 2023): • revegetation and bolstering of the sand dunes, specifically at Hopkins Street • reduction in four-wheel -driving access north and south of Grace Darling • reduction in pathways along the primary dune system (along entire length of the Grace Darling hotspot) • modifying the caravan park for light camping (fewer permanent dwellings). Protection in the form of seawall, offshore breakwater, or groyne network along Grace Darling Beach was not supported by this study, due to their collective inability to mitigate the inundation risk to the site. In addition, the removal/relocation of the Sea Rescue building and toilet block are to be addressed as per the management triggers, which include when damage is sustained, or utility supply are removed.

ID	Category	Content
		Currently the integrated CHRMAP and CMS are under review.
8.	**Performance / Effectiveness of coastal management measure/s**	Short and mid-term shoreline mapping has been undertaken using satellite imagery, and beach changes in 50 m increments are presented in Figure 1-6. **South of Edward Island cuspate foreland** Negligible changes were observed south of Edward Island cuspate foreland between 2011 to 2023, and intermediate timeframes in-between, indicating that the shoreline has been relatively stable in the medium and short-term. **Edward Island cuspate foreland**[1] Mapping shows significant erosion up to 50 m between 2011 and 2023, annually this equates to four metres per year. Shorter term analysis indicates minor slowing of the erosion, up to three metres per year. **Grace Darling Beach** Mapping shows erosion along Grace Darling Beach has been more pronounced at the southern end of the beach, (ranging between 45 m in the south to 15 m in the north) from 2011 to 2023. Annually this equates to one to four metres per year during this period. The erosion variability across the Grace Darling foreshore is due to the cuspate foreland joining at the southern end of the park. Erosion is more uniform across the length of Grace Darling Beach between 2016 to 2023 averaging one to two metres per year. **North of Grace Darling Beach** Vegetation line mapping has confirmed that the coastline north of Grace Darling Beach has accreted (up to 12 m) from 2011 to 2023. On an annualised basis the coastline has been accreting one metre per year. Across the shorter term, this coastline has undertaken a mixture of accretion and erosion from 2016 to 2023, annually less than one metre per year.
9.	**Recommendations & lessons learnt**	**Coastal monitoring and investigation** • Limited information is available on the morphology and seasonal changes of the Edward Island cuspate foreland in response to annual and inter-annual metocean conditions. This information would be beneficial as understanding the evolution of the spit, will allow coastal managers to forecast when erosion events are most likely to occur, and allow them to best plan nourishment campaigns. • Undertake asset monitoring to determine when sufficient damage has been sustained to justify removal of assets, e.g., Sea Rescue building, toilet blocks (as per damage trigger in (Shape Urban, 2023) **Coastal management actions** • Sand nourishment has shown promising signs at being able to influence the amount of erosion experienced at Grace Darling Park (based off the shorter-term analysis). Continuing the current annual nourishment strategy is recommended as the most suitable interim protection strategy. • Should nourishment sand be sourced from the onshore dune systems it is recommended that overfill ratios are considered in the event a smaller grain size is available from dunes in the region (compared to typical grains found onsite at Grace Darling). • Vegetation line mapping has indicated that accretion in the short and medium term is being experienced north and south of the Grace Darling Park. Sediment transport is likely transporting historical nourishment material northwards, resulting in accretion. Beaches south of Edward Island face more complex sediment pathways associated with the morphological changes at the foreland.

[1] *The cuspate foreland in the lee of Edward Island is extremely dynamic, with significant changes seasonally and annually preventing the establishment of vegetation and limiting the accuracy of vegetation line mapping in this area. Any findings at this location should be interpreted with caution.*

ID	Category	Content
		• Four-wheel-drive access to the south of Grace Darling is impacting the coastal vegetation, and their ability to stabilise the sand dune bordering the cuspate foreland. Restricting access here year-round will assist the dune to establish itself. • Stockpiling disposed dredge material at the cuspate spit should be continued during future maintenance dredging campaigns (in addition to nourishing Grace Darling during the same campaigns). Keeping reserve of sand within the system will assist the sand dunes rebuild here but will also give the SoG access to sand to use for nourishment at their discretion. **Community engagement/education** • Lancelin is likely to face some strong opposition regarding the proposed action, and findings from the integrated CHRMAP study. To execute the proposed path forward, public support and education is required, to inform the community of the implications if action is not taken.

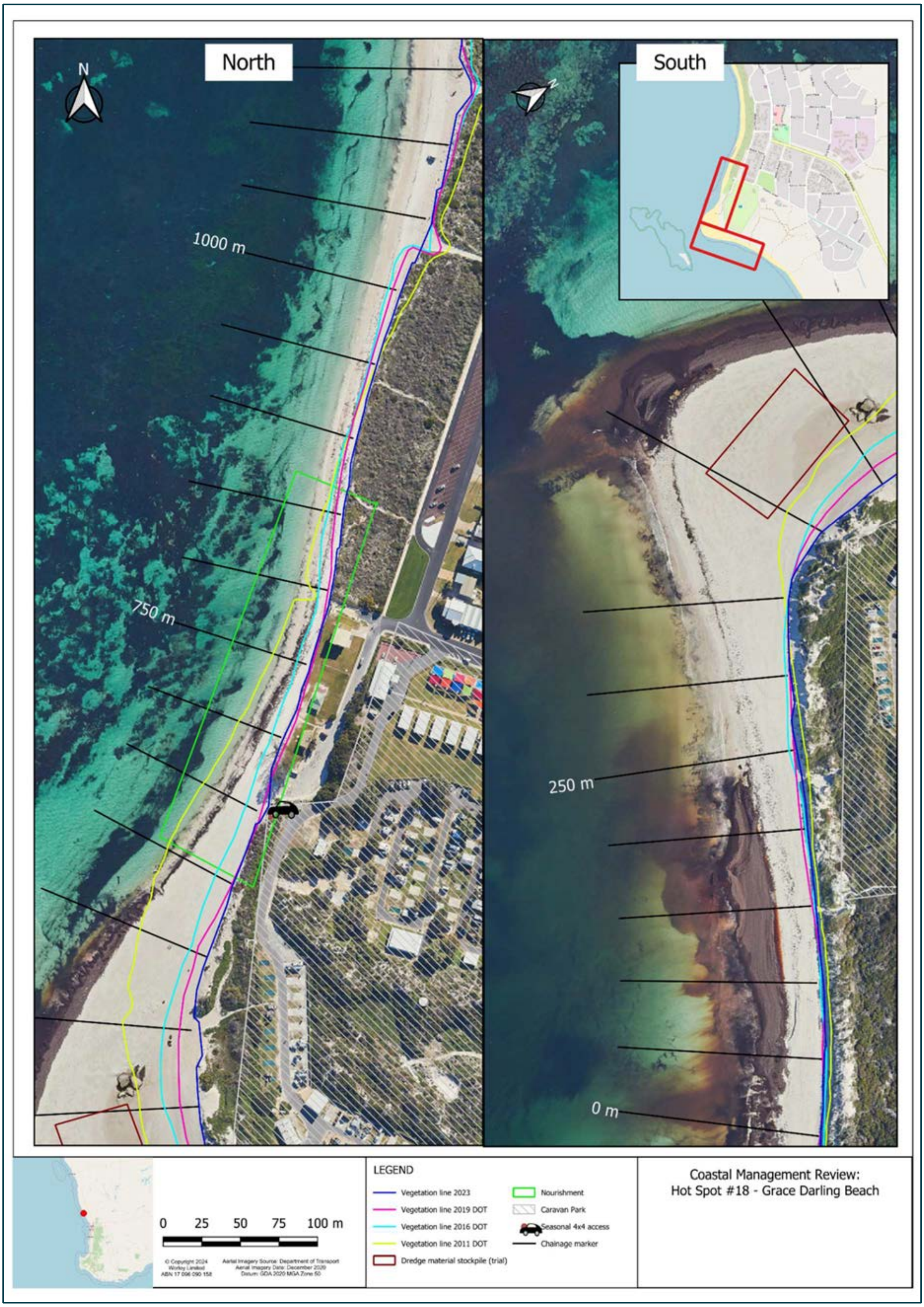

Figure 2-1: Grace Darling hotspot - coastal management schematic.

Figure 2-2: Photo taken of Grace Darling Park, looking south, adjacent to car park. Taken during site visit 20/05/2024 (5 months after latest nourishment campaign).

Figure 2-3: Photo taken of Grace Darling Park, looking south, adjacent to Volunteer Marine Sea Rescue building. Taken during site visit 20/05/2024 (5 months after latest nourishment campaign).

Figure 2-4: Dune adjacent to Edward Island cuspate foreland, showing vehicle proximity to foot of dune system. Taken during site visit 20/05/2024.

Figure 2-5: Photo taken of Edward Island four-wheel-drive access south of Grace Darling car park. Taken during site visit 20 May 2024.

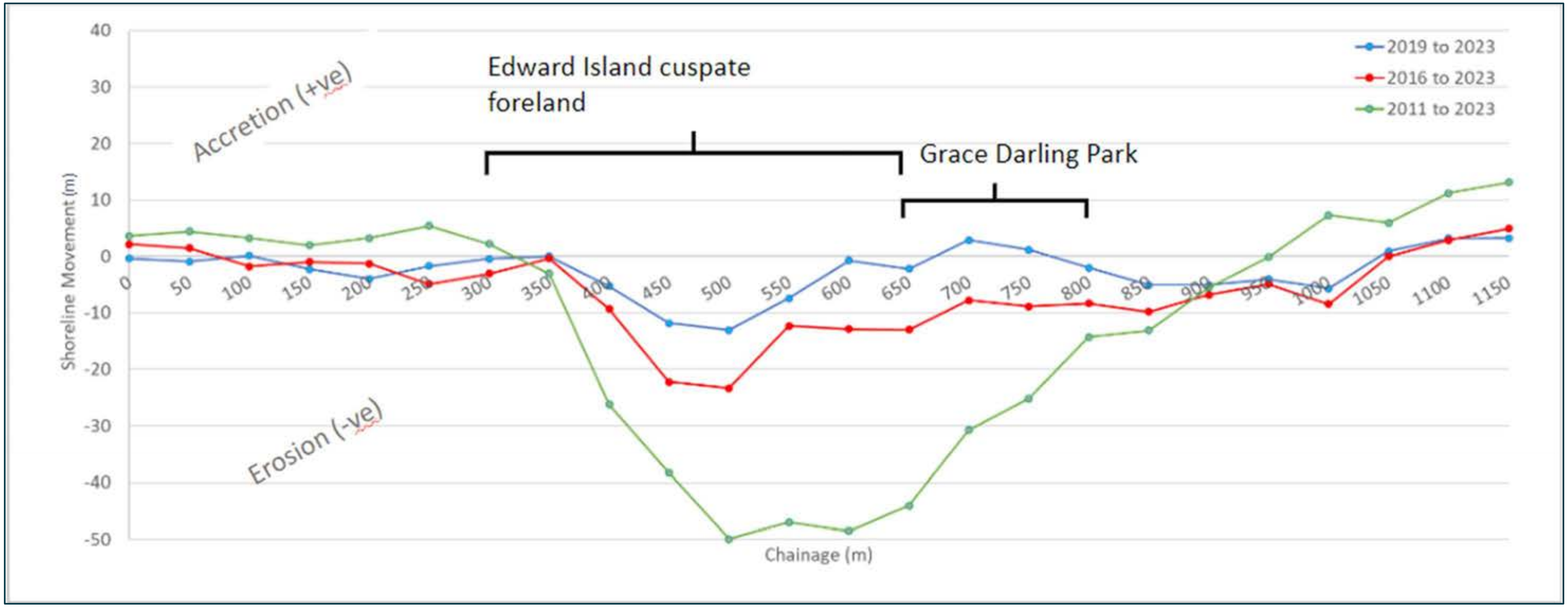

Figure 2-6: Results of Grace Darling Park - beach shoreline changes, showing short (4 year) and mid-term (7, 12 year) changes, for chainage reference refer to Figure 2-1:.

3. Seabird

ID	Category	Content	
1.	**Site name / Date review complete**	Seabird	January 2025
2.	**Key details**	LGA: Shire of Gingin (SoG) Townsite: Seabird: Hotspot ID: #20	
3.	**Summary of erosion issue**	Seabird has experienced ongoing coastal erosion, causing the loss of the town's primary coastal dunes and a coastal road (Turner Street). Erosion was initially reported in 1988 (Worley, 2002), and led to partial removal of Turner Street in 2002 following storm erosion damage. Emergency protection in 2015 using flex-mats was followed by construction of a seawall in 2016. As described in Seashore (2019) Seabird is located on an unstable salient with infrastructure located too close to the coast, including private properties. Several of the locations experiencing high levels of vulnerability include residential properties on Turner and McCormick Street, beaches, coastal and dune vegetation, car parks and roads. Erosion protection funding has remained an issue, as private residences are directly impacted by erosion instead of public assets. Erosion threat at Seabird Foreshore has continued since the construction and subsequent extension of the seawall. Erosion to the north has likely been exacerbated by the effect of the seawall on local coastal processes. In the winter of 2021, storm erosion has threatened beach access stairs and the beach access ramp fronting the caravan park. Continuing to armour additional sections of the foreshore will create permanent loss of beach and continued downdrift erosion north of any new seawalls. Such erosion can be expected to continue along the foreshore to the north for up to three times the length of the revetment (Seashore, 2019).	
4.	**Overview of key coastal processes**	As reported in Stul et al. (2014) Seabird is located within a secondary sediment cell stretching from Moore River in the south to Ledge in the north (approximately 20 km north of the Seabird hotspot). Seabird lies on the boundary separating the tertiary cells 1a and 1b. This boundary at Seabird is reported as ambulatory, with sediment transfer likely occurring across the boundary based on seasonal trends. This site lacks the significant reefs or offshore islands which are present off some townships further to the north such as Lancelin. From Worley (2004) there is a high degree of variability in the direction and magnitude of sediment movement from year to year at the site. Gross seasonal sediment transport at the site has been estimated at 50,000 m3 to 100,000 m3 (north and south) by M P Rogers (2015) with typical net annual estimated at 20,000 m3 / year in a northerly direction (refer Figure 3-1). Geotechnical investigation (GBG Group, 2023) has indicated that sections of coastal limestone are present within five metres of the ground surface adjacent to the Seabird Tavern and the southern end of the Caravan Park. Such rock is visible at the surface of the dune system (refer Figure 3-3).	
5.	**Overview of historical coastal management actions**	The following key actions have been taken at this site, including emergency repairs/measures: • 2016, construction of a 700 m limestone revetment and associated dune revegetation, including removal of flex-mats previously installed • 2015, emergency protection using a combination of sand nourishment (3,500 m^3) and concrete flex-mats • 2015 sand nourishment (3,500 m^3) (M P Rogers & Associates, 2015) • 2014 sand nourishment (1,800 m^3)	

ID	Category	Content
		• 2002, emergency sand nourishment/dune rebuilding (2,000 m^3) and partial road removal following storm damage to Turner St. • Sand scraping has been undertaken by the Seabird Private Caravan Park approximately 50 m north/south of their beach access stairs/ramp (Cook, 2024).
6.	**Management issues and challenges**	• Seabird is a small town, with a small rate base. Given the erosion risk is primarily faced by few private asset owners, allocation of public funding to implement and maintain costly protection strategies remains a challenge. • Within the integrated Coastal Hazard Risk Management Adaptation Plan (CHRMAP) (Shape Urban, 2023) it was reported that the primary beneficiaries of any protect measure at Seabird will be private property owners (more than 81% of the benefit). • Downdrift erosion has occurred either side of the seawall, to the North of the seawall this has undermined beach access including beach staircases. • Vulnerability risk northwards of the seawall is limited to a few private owners (both caravan parks and tavern). Extending the seawall north is possible, however not without significant investment, therefore has not been recommended in 2023 CHRMAP study. • Local residences have lost a useable beach for the central coastline because of the seawall. This has led to requests to the Shire for nourishment and/or groyne fields to restore beach amenity in front of the seawall. • The initial construction and annual seawall maintenance has remained a contentious issue, with maintenance currently being funded by SoG estimated between \$25,000 - \$50,000 per year. It is understood that the seawall was constructed with a shortened design life as a 'interim' measure to protect the coastline whilst planning was arranged for retreat of properties at risk.
7.	**Current management focus**	In 2023, Shape Urban released an integrated CHRMAP study (Shape Urban, 2023) and Coastal Management Strategy (CMS) combining the recommendations from the Coastal Inundation Study (Baird, 2020) and the CHRMAP undertaken previously (Cardno, 2019). The integrated CHRMAP summary recommended a retreat pathway is adopted for Seabird but recognised that some opportunities exist for private entities to work together and agree on alternative protect pathways if they could generate sufficient funding. Short and immediate-term coastal management actions that have been recommended to SoG include: • revegetation of the dunes to allow natural vegetation • rationalise and revegetate beach access points and provide directional/wayfinding signage • relocate the public four-wheel-drive and boat launching to another site further north • reduce the number of pathways along the primary dune, allowing vegetation growth. It is understood SoG will commence investigations for longer-term retreat of properties impacted by erosion in the short-term. The protect strategy remains in place for the 700 m of coastline where the structure spans, with end-of-life expected 2036 (estimated based on 20-year initial life expectancy). Currently the integrated CHRMAP and CMS are under review.
8.	**Performance / Effectiveness of coastal management measure/s**	Mid and short-term shoreline mapping has been undertaken using satellite imagery, and beach changes in 50 m increments are presented in Figure 3-10. No changes were observed along the revetment stretch of coastline. The 2013 vegetation line was omitted from the revetment stretch of coastline due to the seawall construction impacting the data.

ID	Category	Content
		North of revetment Mid-term shoreline mapping indicates that the coastline, up to 500 m north of the seawall, has been undergoing erosion (up to 11 m) between 2016 and 2023. The most significant erosion occurs within the first 100 m immediately north of the revetment. This is equivalent to one metre per year. In addition, topographic survey results (DoT, 2020) have indicated that between 2016 and 2019, the dunes eroded more aggressively, up to 12 m (four metres per year) immediately north of the revetment. Short-term shoreline mapping between 2019 and 2023, indicates that the erosion trend has stabilised, with accretion 100 m north of the seawall (up to five metres) transitioning to minor erosion (up to five metres) for the next 300 m. This is equivalent of one metre of accretion and erosion respectively, per year. **South of revetment** Mid-term shoreline mapping indicates that the coastline has been eroding the 300m immediately south of the seawall (up to eight metres) between 2016 and 2023. This is most pronounced immediately south of the seawall at an annualised rate of one metre per year. In addition, topographic survey results (DoT, 2020) have indicated that between 2016 and 2019, the dunes eroded at a similar rate, up to five metres immediately north of the revetment. Short-term shoreline mapping between 2019 and 2023, indicates a similar rate of erosion (one metre per year) along the 300 m immediately south of the seawall. **Revetment** From site inspection conducted 20 May 2024, the revetment appears to be in good condition, with no signs of exposed core, and well interlocked armour units that individually appear in good condition. There is a clear slope transition, where it steepens prior to the toe. There was no evidence to show that the slope has collapsed, therefore it most likely constructed with a benched profile (refer Figure 3-8). It is understood that annual maintenance may have been undertaken recently (prior to site visit) hence the good condition observed of the structure.
9.	**Recommendations & lessons learnt**	**Coastal monitoring** • Photo monitoring station/website renewal to recommence monitoring of beach erosion north and south of seawall such as a 'CoastSnap' or Northern Agricultural Catchments Council (NACC) station (last NACC records available online from 2016). • It is recommended that shoreline mapping is continued in future years to confirm the slowing of erosion trend, north of the seawall. • It is unclear the design that was followed for the 'interim' seawall construction. Despite significant annual maintenance costs (structural repairs), no detailed condition inspection has been carried out to confirm estimates of remaining design life. It is recommended that recent laser/LIDAR survey of the existing seawall is used (December 2024 acquisition) as baseline to compare future surveys using comparable methods. **Coastal management actions** • Following geotechnical investigation (GBG Group, 2023), the presence of coastal limestone indicates future resilience to coastal erosion for parts of the private lots north of the seawall (Private Caravan Park and Tavern). It is recommended that this information is used to inform coastal retreat adjacent to the hotspot location. It is also recommended that further geotechnical investigation is carried out with additional transects to support more detailed planning of the retreat necessary. • Should private entities consider self-funding protection pathways for their assets, it is recommended that concept designs are carried out to determine the approximate costs of a groyne field and continual beach nourishment. Effects of such management on neighbouring coastline should also be investigated.

ID	Category	Content
		• Four-wheel-drive access to the beach should be transferred to an alternate location north of the existing Edwards Street carpark. The existing location faces multiple erosional pressures including the downdrift impacts associated with the Seawall. It is recommended that the carpark is modified to minimise the encroachment into the coastal dune system.

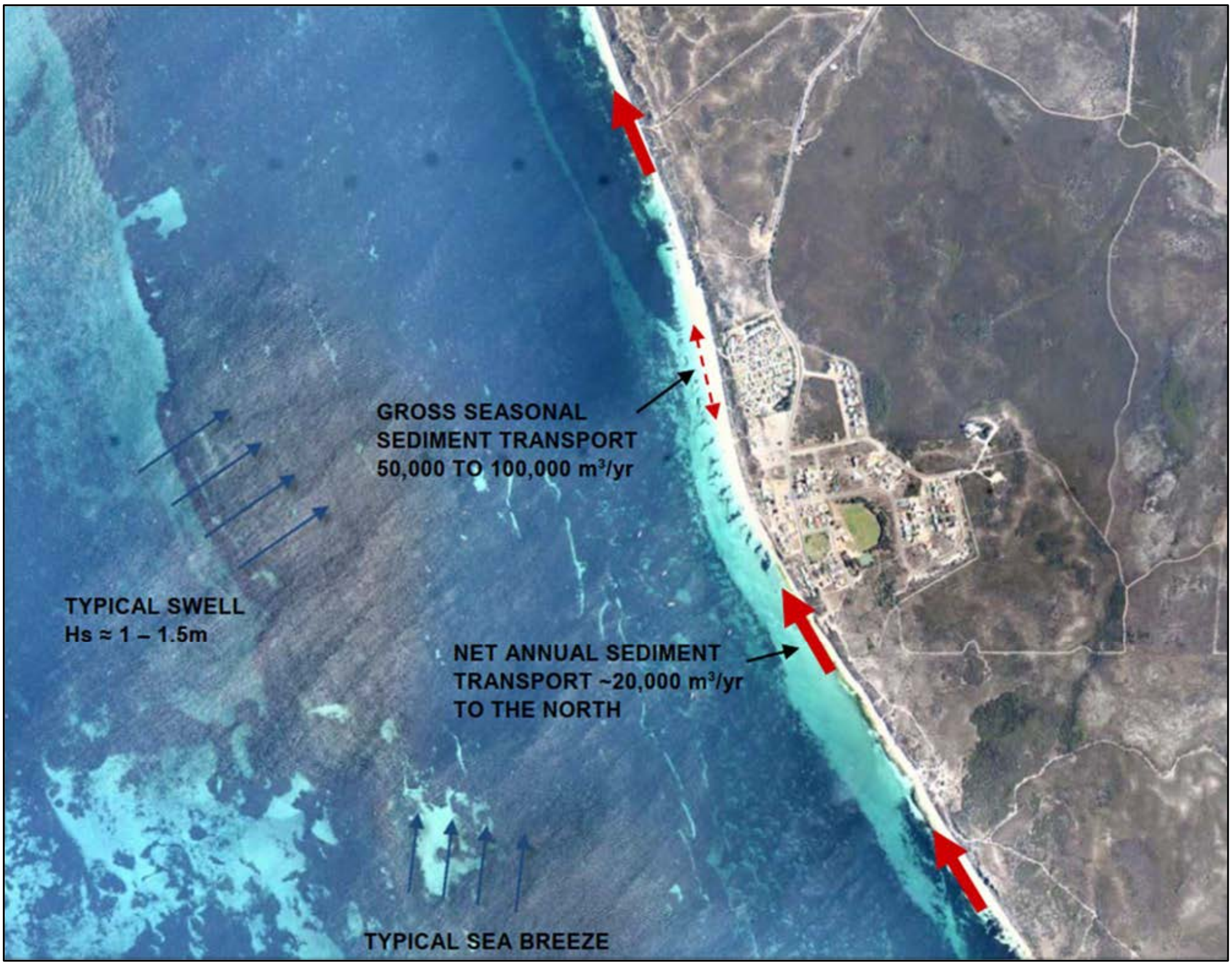

Figure 3-1: (MP Rogers & Associates, 2012)

Figure 3-2: Photo taken of 4x4 access onto beach, immediately north of Seabird rock revetment, facing south during site visit 20 May 2024

Figure 3-3: Photo taken of coastal rock protruding from dune surface (facing east) adjacent to Seabird Tavern, during site visit 20 May 2024.

Figure 3-4: Private pedestrian access down from Seabird Tavern onto beach. Erosion apparent at base of access path. Taken facing east during site visit 20 May 2024.

Figure 3-5: Pedestrian boardwalk/lookout at the Edwards St beach access ramp. northern terminus of the rock revetment. Concrete foundations exposed indicating likely erosion since initial construction. Photo taken facing south-east during site visit 20 May 2024.

Figure 3-6: Seabird Private Caravan Park, private access vehicle ramp. Light retaining structure and wind fencing in place to protect road access. Facing east, taken during site visit 20 May 2024.

Figure 3-7: Seabird Private Caravan Park, pedestrian access stairs. Facing northeast, taken during site visit 20 May 2024.

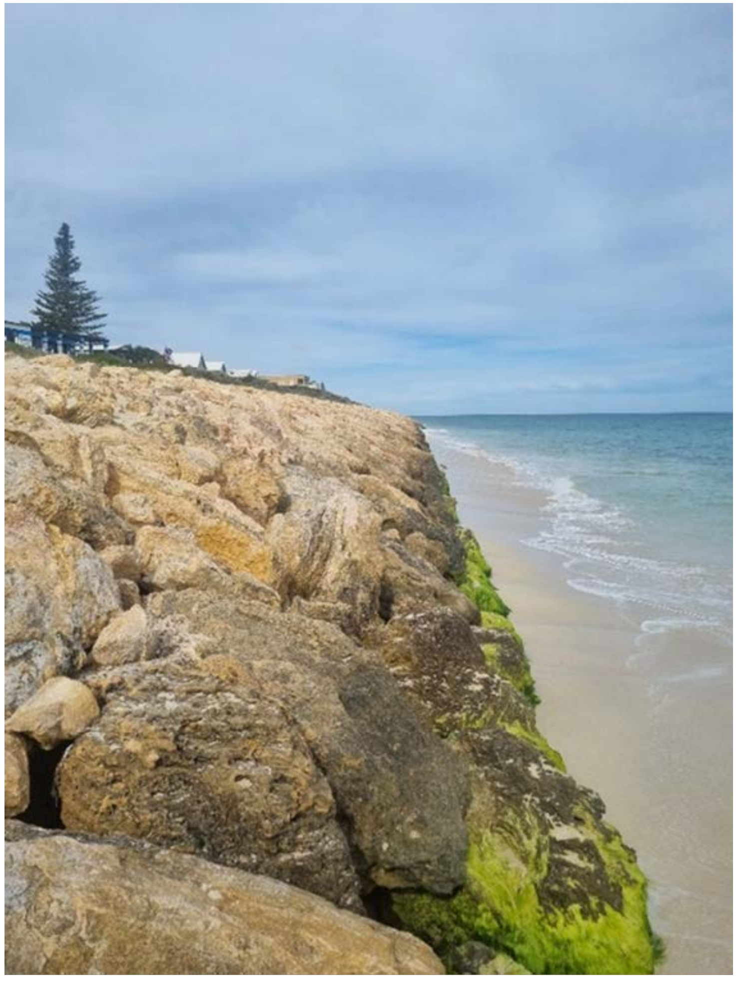

Figure 3-8: Seawall photo taken facing south, at chainage ~+1000m

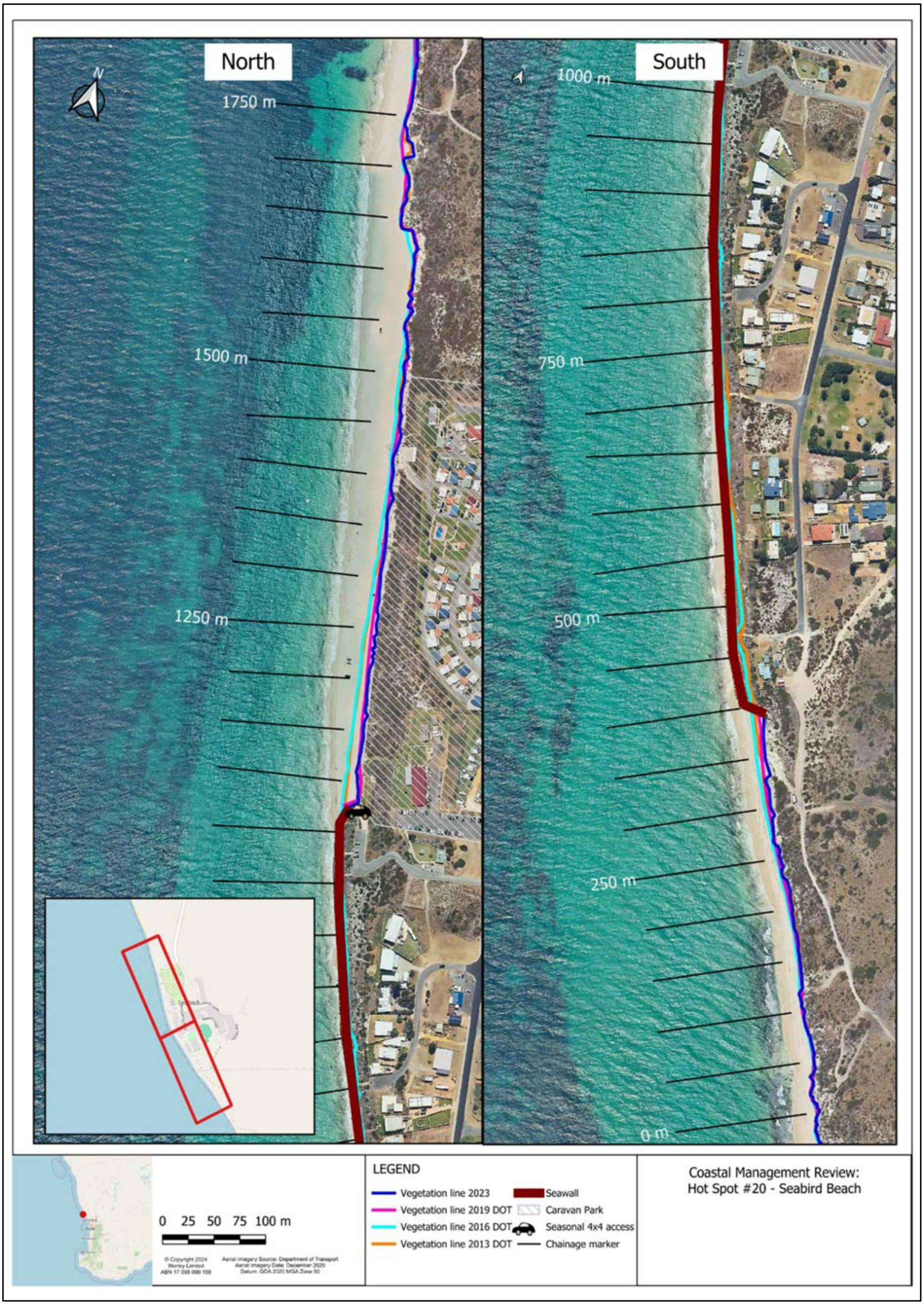

Figure 3-9: Seabird hotspot - coastal management schematic

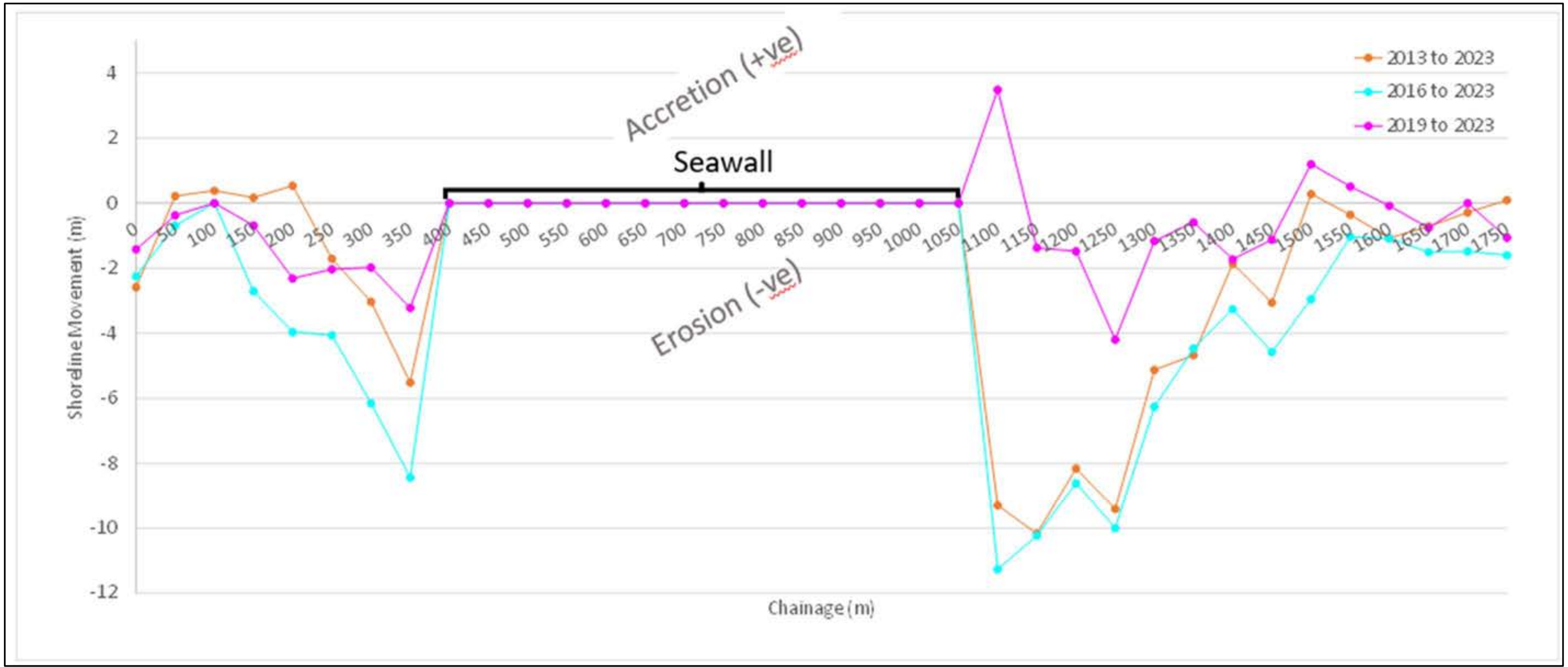

Figure 3-10: Results of Seabird shoreline changes, showing short and mid-term changes, for chainage reference refer Figure 3-9

4. Quinns Beach

ID	Category	Content	
1.	**Site name / Date review complete**	Quinns Beach	May 2024
2.	**Key details**	LGA: City of Wanneroo (CoW) Townsite: Quinns Rocks: Hotspot ID: #22	
3.	**Summary of erosion issue**	Located on the western side of a cuspate foreland and has experienced erosion from the southern end of the sandy beach since before 1970 (Seashore, 2019). The site was originally beach shacks, with ongoing development in proximity to the coast and increased recreational use. Erosion at this site has been managed by a sequence of works from the 1970s including: initial removal of beach cottages from the low dune area through to the headland; a detached rock headland; groyne field; renourishment; a geotextile seawall, and most recently modifications to the groyne field and construction of an additional groyne. From the Long Term Coastal Management Plan (Cardno, 2015), beach-side culture has been a focal point of public amenity and recreation at Quinns Beach with significant social pressure relating to maintaining existing recreational use (swimming, walking, fishing, Fred Stubbs Park) and the car park. Beach use is focussed next to car parks and Fred Stubbs park. The City of Wanneroo (CoW) has made a conscious decision to protect the value that Quinns Beach and its adjacent foreshore parks and facilities represent for future generations to enjoy. It should be noted that protective engineering works have the potential to conflict with the desire for a recreational beach, i.e. seawalls may cause loss of their fronting beach. There are active community groups and residents in the area. Erosion has been progressive, linked to landform response to storminess and variability of available coastal sediments; with erosion pressures transferred, primarily to the north, by protective works. Historically, key storm events resulting in significant damage to beach/infrastructure include the following: • 1996, major erosion to the foreshore reserve, and undermining of car park and surf lifesaving infrastructure. • 2008, Emergency coastal protection works including repair of limestone seawall and groynes. • November 2012, Damage to car park during storm; repair of limestone boulder seawall. • September 2013, three successive storm events led to an estimated loss of 19,000 m^3 from the dune system immediately south of Groyne 1, Frederick Stubbs Park was closed and play equipment removed. • Winter 2021, erosion scarp and revetment damage adjacent to Quinns Beach car park (north of Groyne 1) and displacing Geosynthetic Containers (GSC) adjacent to Fred Stubbs park. Twelve publicly owned assets may be at risk of erosion damage in the area (Seashore, 2019), with only two unprotected assets at risk of damage in the short-term, being the car park behind the tipped rock revetment and the seaward end of beach access paths. In the longer-term, Ocean Drive, the services under the roadway and private properties to landward are high-value assets at risk. A three stage Long Term Coastal Management Study (Cardno, 2018) was developed by the City of Wanneroo 2016-2017, and resulted in adopting extension and upgrade of two existing groynes (Groynes 2 & 3), construction of a new groyne (Groyne 4) at Queenscliff Park, and extensive beach nourishment at multiple locations along the Quinns Rocks coastline.	

ID	Category	Content
4.	**Overview of key coastal processes**	Quinns Beach is situated leeward of Spearwood, Marmion and Staggie limestone reefs. Quinns Beach is a cuspate foreland that has formed as a result of the presence of Quinns Rocks in combination with shallower sections of the Staggie and Marmion Reef Ridges. Quinns Beach site is located within the Tertiary Sediment Cell 29b – Mindarie Keys North to Quinns Rocks North (Stul T, Coastal Sediment Cells for the Vlamingh Region between Cape Naturaliste and Moore River, Western Australia., 2015). Little to no sediment enters the study area from the south of Mindarie Keys Marina. Wave induced transport is the dominant transport mechanism occurring at Quinns Beach. From Cardno (2013) it was established that waves at Quinns typically approach from the south-southwest to due west. Sediment transport at Quinns Beach has a complex response to the spatially variable nearshore wave climate (Cardno, 2015). Wave shoaling and breaking results in wave set-up over the shallower reef areas which forces complex nearshore circulation and drives sediment transport pathways with the reef system. At the beach face, the variation in nearshore wave angle caused by the reefs results in complex, seasonal, littoral drift to the both the north (typically in summer) and south (typically in winter). Monitoring undertaken by CoW, biannually and annually (City of Wanneroo, 2023) has observed a consistent trend of accretion in summer on south side of groynes (northward transport) and winter accretion on north sides of groynes. This observation was confirmed from the CoW fixed photo monitoring. Surveys across past 4 years (2019-2023) within the shoreline region of the study area (including beaches adjacent within the same tertiary sediment cell) indicate a gross annual loss of sediment between 3,228 m^3 (post winter) to 4,352 m^3 (post summer) despite an average of 12,500 m^3 nourished annually (City of Wanneroo, 2023). Therefore, when including the nourishment volumes, over the last four years, an annual net loss of 15,728 m^3 – 16,852 m^3 has been observed along the Quinns Beach profiles. This finding aligns with past studies reviewing 2002 – 2012 datasets indicating an annual net deficit of 20,000 m^3 (Cardno, 2015). It is understood that the deficit represents a combination of offshore transport to deeper water in winter, and intermittent loss of sand to the north during years of strong northward transport (Cardno, 2015).
5.	**Overview of historical coastal management actions**	Historical coastal management at Quinns Beach has utilised a network of rock groynes combined with ongoing sand nourishment. In addition, localised protection of infrastructure with seawalls has been incorporated. The following key management actions have been taken at this site (not including emergency repairs/measures): • 2023, sand scraping trial at south side of Groyne 4. On two occasions (Feb 2023, and Dec 2023) ~500-1,000 m3 of sand was scraped from the south side of Groyne 4 and placed against an eroding dune berm on the south side of the groyne. • Placement of ~50,000 m3 of sand nourishment between October 2018 and April 2023, or approximately 11,000 m3 annually[2]. • 2019, extension to Groyne 2 and Groyne 3. • 2018, construction of fourth groyne 60m in length (Groyne 4). • 2014, construction of 280 m of Geosynthetic Container seawall in front of Fred Stubbs park. • 2004, a third groyne construction completed, along with 67,000 m3 f beach nourishment (Groyne 3)1. • 2003, 2x rock groynes construction completed (Groyne 1 & Groyne 2),

[2] *Density conversion of 1.55T/m^3 of trucked sand (tonnes) placed in situ (m^3).*

ID	Category	Content
		beaches were nourished with approximately 60,000 m3. • 2002, informal limestone seawall constructed with the intention of protecting the carpark following significant erosion. This has been constructed with a single layer of primary armour, placed directly on the existing sand supporting the carpark, with no clear footing present. • 1977, construction of the artificial headland.
6.	**Management issues and challenges**	• There is no formal seawall in front of the beach carpark, when exposed during storm events the robustness of this protection is a concern. Reinforcement of the seawall has occurred opportunistically over time. • From discussion with CoW (Ellyard, 2023), the beach parking is due for renewal in the next 3 years. It is understood that one current design features an ~8m setback/retreat to increase buffer distance on beach adjacent to the carpark. • Down drift (north of Groyne 4) erosion pressures are expected to be observed in the medium term associated with slowing of northward littoral transport due to the extension and construction of Groyne field conducted in the past four years. • Geotechnical campaign undertaken by CoW indicated that subsurface rock becomes more prevalent north of the carpark, which may limit the impacts of erosion on downdrift coastline. • Current land-based nourishment works are disruptive to the local community through beach closures, the extending timing of the works and the associated truck and machinery movements. • Rips in the geosynthetic seawall occur from time to time, with repairs undertaken by CoW. • CoW is aware that beach scraping may lead to downdrift effects within beach Section 6 due to trapping north bound sediment within Section 5. CoW intend to monitor the down drift effects closely. • In the past groynes have required substantial maintenance every 5 years. As part of the recent upgrade groynes have been designed for a 50 year design life.
7.	**Current management focus**	• CoW are currently undertaking investigations into alternative sand sources for renourishment, with a focus on offshore sand sources. Sand placement from offshore sand sources may be more cost effective and reduce community impacts from the current land-based nourishment practices. • CoW are collecting coastal monitoring datasets that can be used to inform future decision making. • The protect management strategy is being closely followed, with various groynes combining with regular planned nourishment to provide increased beach width, and buffer distances critical to protect infrastructure and dune vegetation from damaging impacts of winter storm events. • Although protection remains the management measure of choice along this section of coast, upcoming renewal of at-risk carpark infrastructure has considered some minor retreat (~8m) in order to increase the beach buffer available within Section 3 of beach.
8.	**Performance / Effectiveness of coastal management measure/s**	Recent construction and modification of the groyne field between 2018 to 2021, limits assessment of longer-term management actions at the Quinns Beach site. The following observations have been made from the site inspection and monitoring data: **Section 1 –Southern boundary to artificial headland** • While the artificial headland is in poor condition, the continued retention of sand at the cuspate indicates this structure is still performing suitably. • Photo monitoring from 2013 – 2023 indicates accretion of both beach and dune system. • Survey results (intertidal to dune system) have shown net accretion (average ~1m width /year from 2019 - 2023. **Section 2 – Artificial headland to Groyne 1.** • Photo monitoring from 2013 – 2023 indicates minor erosion of both beach and dune system, although the construction of the GSC seawall limits the

ID	Category	Content
		accuracy of assessment. • Survey results (intertidal to dune system) have shown negligible net changes from 2019 - 2023. • GSC seawall appears in good condition, and well protected with significant sand buffer adjacent (~50m as at December 2023). • From site visit (Ellyard, 2023) it is understood that some GSC's were removed from the structure toe following storm damage, but it is still functioning as intended, as last line of defence protecting park & associated infrastructure. • Groyne 1 has been recently refurbished (2021) and is in excellent condition. **Section 3 – Groyne 1 to Groyne 2** • Photo monitoring from 2013 – 2023 indicates minor erosion of both beach and dune system to the north of the section, and mild accretion adjacent to the carpark. • Survey results (intertidal to dune system) have shown negligible net changes from 2019 - 2023. • Groyne 2 is in excellent condition, functioning as intended. • Northern half of Shoreline is indicating a changed alignment (~+5 degrees to the west) since capital nourishment and extension of Groyne 2, negligible changes noticed to southern end of Section. Some early indicators of beach widening from historical imagery analysis at the northern half of section. **Section 4 –Groyne 2 to Groyne 3** • Photo monitoring from 2013 – 2023 indicates minor erosion of both beach and dune system to the south of the section, and mild accretion/negligible changes to the north (City of Wanneroo, 2023). • Survey results (intertidal to dune system) have shown negligible net changes from 2019 - 2023. • Groyne 3 is in excellent condition, functioning as intended. • Northern half of shoreline is indicating a changed alignment (~+8 degrees to the west) since capital nourishment and extension of Groyne 3, negligible changes noticed to southern end of Section. Some early indicators of beach widening from historical imagery analysis at the northern half of section. **Section 5 – Groyne 3 to Groyne 4** • Photo monitoring from 2013 – 2023 indicates minor accretion to the dune system to the south of the section, and mild erosion changes to the beach and dune to the north (City of Wanneroo, 2023). • Survey results (intertidal to dune system) have shown negligible net changes from 2019 - 2023 (City of Wanneroo, 2023). • Groyne 4 is in excellent condition, functioning as intended. **Section 6 -Groyne 4 northwards** • Photo monitoring from 2013 – 2023 indicates minor erosion to the dune system and beach (City of Wanneroo, 2023). • Variable minor erosion/accretion observed annually over the last four years (City of Wanneroo, 2023). • Survey results (intertidal to dune system) have shown negligible net changes from 2019 - 2023. **Overall** • CoW currently budget for ~ 10,000 m^3 of nourishment annually. This is less than the average, annual net loss of sediment from the beaches in the past four years of 15-17,000 m^3. It is understood that the CoW uses an informal risk-based approach to ensure that sand is used to protect specific assets and popular beach areas of importance to the city. This nourishment volume may be sufficient to protect key infrastructure managed by the city, however, it does not completely balance the net loss from the beach. This 5-7,000 m^3 annual sediment budget deficit will likely lead to future erosion of dune system and continued advance on the coastal buffer. • The groyne field appears to be functioning well in northern sections of beaches by offering increased beach buffer from damaging winter storms. Despite appearance of improvement to the north, Figure 4-4 shows minimal sand buffer to protect the informal seawall and carpark, requiring continued

ID	Category	Content
		ad hoc, targeted nourishment by CoW. • All groynes are in excellent condition.
9.	**Recommendations & lessons learnt**	**Coastal monitoring** • In the absence of surveyed beach volumes (for long term monitoring), the photo monitoring campaigns undertaken have proven valuable to allow assessment of individual sections of Quinns Beach. Continuation of remote photo monitoring and bi-annual beach survey monitoring campaigns is recommended for consistent assessment. • Seasonal beach surveys have been beneficial to quantify strong/mild seasons of erosion/accretion, and adjust nourishment accordingly. Continuation of bi-annual beach survey monitoring campaigns is recommended to expand monitoring period to cover longer term changes. **Coastal management actions** • Consider increasing annual nourishment volumes, to match the net annual loss of sediment in addition to the risk-based nourishment being applied by the CoW. This may be achieved by utilising offshore sand supply and nourishment of the nearshore environment. • Small scraping campaigns have shown short-term benefit to nourishing dune systems immediately adjacent experiencing erosion. It is recommended to continue the beach scraping trial (providing impacts downdrift are of acceptable nature) and review the effectiveness on an annual basis. • The spacing of Groynes 1-4 is notably larger than typical industry rules of thumb. USACE (2008) recommends a width between groynes of 2-3 times the length of the structures for proper functioning of shore-normal groynes (Quinns groyne field is approximately 5-10). Despite this rule of thumb the site features strong cross-shore transport pathways and multi-directional littoral drift which complicates the effectiveness of a traditional groyne application. Should future beach monitoring determine that no changes are being observed at the southern end of Section 3, a new groyne at the mid-point between Groyne 2 and 3 should be investigated, to directly increase the beach width adjacent to the carpark. **Coastal investigations** • An in-depth review into the effectiveness of the groyne changes is recommended within the next 5 years to better understand the coastline's future ability to resist erosion. • Recommend the continued investigation into offshore sand supply options discussed by CoW during site visit (Ellyard, 2023). • A new groyne at the mid-point between groyne 2 and 3 should be investigated, to directly increase the beach width adjacent to the carpark, and may relieve the requirement for reactive management at this location. **Coastal adaptation design** • It is recommended that a formal, engineered seawall is considered within the new carpark design at Quinns Beach (in addition to the minor retreat of the refurbished carpark).

Figure 4-1: Quinns Beach – coastal management schematic

Figure 4-2: Photos taken from Groyne 1 fixed monitoring camera, looking north towards Section 3 (left) 30 January 2023 (right) 26 August 2023. Images show the extremes of seasonal morphological changes adjacent to the carpark.

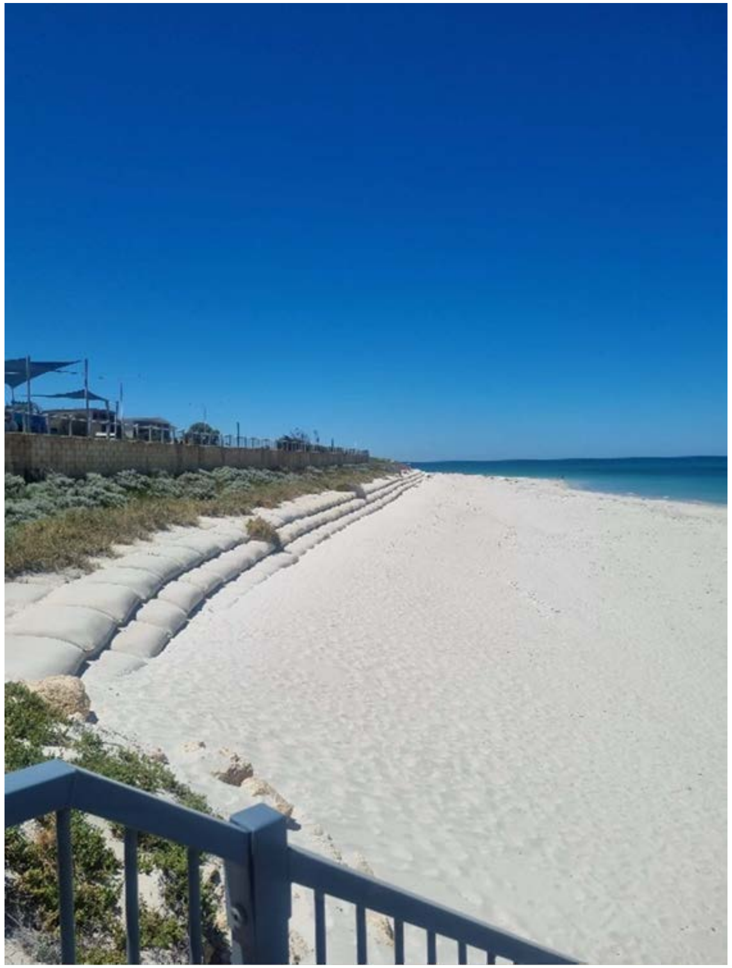

Figure 4-3: Photo taken south from access stairs at north end of section 2. GSC seawall, with lower tier containers buried, ~50m wide beach buffer (taken 11 December 2023)

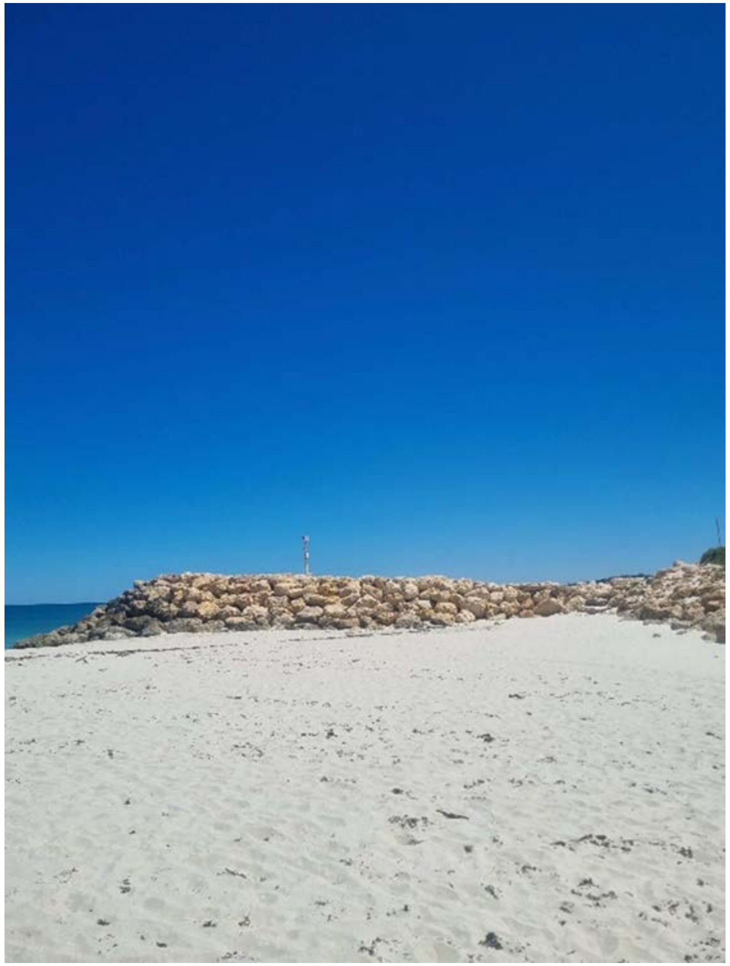

Figure 4-4: Photo taken north from access stairs, north end of section 2. Groyne 1 shown with ~50m beach width (taken 11 December 2023)

Figure 4-5: Placement of 'scraped' beach sand at base of eroding dune, taken from Groyne 4, facing south (Ellyard, 2023).

Figure 4-6: 'Scraping' sand from swash zone adjacent to Groyne 4, north end of Section 5, facing south (Ellyard, 2023)

5. C.Y. O'Connor Beach

ID	Category	Content	
1.	**Site name / Date review complete**	C.Y. O'Connor Beach	August 2024
2.	**Key details**	LGA: City of Cockburn (CoC) Townsite: North Coogee Hotspot ID: #29	
3.	**Summary of erosion issue**	This hotspot is made up of two sections: • southern side of a foreland between the Catherine Point Groyne and the northern breakwater of Port Coogee • northern side of the foreland extending from Catherine Point Groyne approximately 2 km north C.Y. O'Connor beach offers recreational value for a broad community of users, including for horse exercise and as a dog beach. Landward of the beach is a vegetated reserve with ecological value, and a dual use path running north-south for walkers and cyclists traversing between South Beach and Port Coogee. To the east of the reserve are Robb Road and the freight rail line. The latter is a vitally important artery for goods into and out of Fremantle Port (City of Cockburn, 2017). On the north side of Catherine Point Groyne a playground, toilet block and carpark were constructed at the end of Rollinson Road in 2017. Historical erosion on both the north and south side of Catherine Point Groyne has created an unstable scarp, impeded public access to the beach, and reduced beach amenity, typically following winter storm events. Erosion of this hotspot is ongoing and has been the subject of various coastal monitoring, interpretive studies, and management actions over the past two decades. The progressive recession of this section of coastline has been observed for at least the past 15 years, and will threaten adjacent dune, park, and transport assets if responsive measures are not taken (City of Cockburn, 2020). Historically, key storm events that have resulted in significant damage to beach/infrastructure include the following: • 2023, winter storms lead to erosion and relocation of 40 m section of dual use pathway (north of Catherine Point) • 2021, winter storms resulting in an estimated loss of 15-20 m of beach • 2020, ex tropical cyclone 'Mangga' caused significant scarping of dune and beach access on the north side of Catherine Point Groyne • 2020, winter storms caused significant scarping of dune system on south side of Catherine Point Groyne. Despite the recent erosive trend on the north and south of Catherine Point, according to M P Rogers (2014) the area north of Catherine Point was still seaward of its position in 1942.	
4.	**Overview of key coastal processes**	The hotpot is stretched across secondary and tertiary sediment cell boundaries, with Catherine Point splitting the cell boundary between secondary cell 21 and 22 (Stul T, Coastal Sediment Cells for the Vlamingh Region between Cape Naturaliste and Moore River, Western Australia., 2015). Cell 22 extends up to South Mole Fremantle, and cell 21 to Woodman Point. The natural coastal processes have been interrupted since the introduction of a network of groynes at Island Street, Catherine Point, Robb Road, and the South Fremantle Power Station (M P Rogers & Associates, 2014). The following coastal trends have been documented relevant to this site: • Generally, moderate and severe storm events in Owen Anchorage move sediment from the north to the south resulting in sediment moving south from Catherine Point towards Port Coogee (M P Rogers & Associates pl, 2016).	

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		• Storm events with elevated water levels also cause cross-shore or offshore movement of sand, resulting in erosion of the beach and dune. • The shoreline in this area accreted between 1942 to 1994 and has slowly receded since (DoT, 2017). M P Rogers (2014) has attributed long term accretion of this shoreline with onshore feed of dredge material, associated with the Success and Parmelia Channel dredging undertaken in 1940-50's (Oceanica, 2007). Replenishment of sand from this offshore source in recent years is considered limited due to diminished reserves of sand at success bank (refer Figure 5-2). • Sea breeze events during the summer months typically result in the net movement of available sediment northwards along the coastline. This generally results in the build-up of sediment in the northern end of the compartments of a coastline such as the south side of the Island Street Groyne. • Swell events in the Owen Anchorage area are generally assumed to be moving sand from the banks and nearshore areas onto the beach. This can assist the shoreline in recovering after stormy winters (M P Rogers and Associates, 2000). • There have been 31 severe storms in the 10 years following 2006, compared to only 19 severe storms in the 10 years before 2006. The increased number of severe storms may have resulted in increased cross-shore erosion of the beach and dune within the hotspot (M P Rogers & Associates pl, 2016).

5.	**Overview of historical coastal management actions**	CoC undertook a staged CHRMAP, with the resulting adaptation plan (GHD, 2018) recommending the following adaptation measures:
		• interim measures – beach nourishment and dune development, proactive coastal management to manage dunes and renourish beaches
		• long term measures – offshore breakwaters and groynes, design and implement protection structures to control erosion and longshore transport so as to defend this section of coast, due the high environmental, economic and social values of this foreshore and a lack of viable retreat options
		
		The following management measures have been taken at this site (not including emergency repairs/measures):
		
		Interim
		• Periodic sand nourishment (typically every one to two years), both north and south of the Catherine Point Groyne. Sand sources have included (City of Cockburn, 2017):
		    • Sand trap beach known as Chelydra beach immediately north of Port Coogee.
		    • Scraping of beaches north of C.Y. O'Connor, immediately south of the Island Street Groyne.
		
		Long term
		• Construction of an artificial fringing reef (AFR) in 2021. This was the preferred solution selected by CoC during an MCA analysis from a social and environmental perspective undertaken for the site.
		• Construction of two geosynthetic container (GSC) seawalls north/south of the engineered fringing reef.
		• Minor infrastructure retreat (shared path relocation to the South in 2013) (City of Cockburn, 2020).
		
		Small-scale emergency sand nourishment actions were undertaken in response to severe scarping at the base of Catherine Point groyne in February 2020, to address public safety issues and protect the base of Catherine Point Groyne (City of Cockburn, 2020).
		
		Historic engineering works that have been documented to have impacted sediment movement, destabilising the shoreline include (Seashore, 2019):
		• construction and lengthening of the Catherine Point Groyne (see below),
		• ceased dumping of dredged material immediately offshore (Success & Parmelia channel side casting undertaken in the 1940-50's).

ID	Category	Content
		Additionally, the beach position to the southern end, is also locally influenced by the wreck near the remains of Robb's Jetty (Seashore 2019). The Catherine Point Groyne was initially constructed in 1959 in response to siltation issues at the power station to its south and to restore South Beach to the north). Rapid shoreline accretion was observed on its northern side following construction, leading to extension in 1962. Investigation into a possible extension of the Catherine Point Groyne by M P Rogers (2009) indicated that a 30 m extension would lead to reduced erosion north of the structure. This finding, and the need to improve pedestrian access, led to the extension of the groyne in 2012 to its current length of approximately 160 m.
6.	**Management issues and challenges**	Erosion of the coastline north of the Catherine Point Groyne is currently the City's key coastal management concern. Erosion south of the Catherine Point Groyne is currently a lesser concern due to fewer CoC assets adjacent. Although sand nourishment has been an effective management measure at this site, it is evident that the slowing of the onshore feed of sand is leading to reduced quantity of sand within the hotspot cell. Supplementing the feed of sand into the system will be required to minimise effects of erosion. Removal of sands offshore, located within Success bank and near Seal Rock (refer Figure 5-2) is impacting the wave climate, as reported by BMT Oceanica (2017). Modelling of the wave climate indicated changes to wave direction have occurred between 5-20 degrees since 1994. Such changes to the wave climate could explain the reorientation of the shorelines and associated longshore transport changes at the site. Recreational infrastructure has been constructed on dune systems, leaving minimal buffer for shoreline response. In addition to this, pedestrian pathways continue to squeeze the remaining sand dune into smaller corridors, limiting the ability for the system to weather winter storm systems. Erosion is reportedly uncovering legacy building materials, assumed to be from the previous land uses with the area, resulting in building material fragments washing onto the beach (City of Cockburn, 2020).
7.	**Current management focus**	Although back-passing is being undertaken on both sides of the Catherine Point Groyne, alternate management approaches are being undertaken on either side. North of the groyne, recreational infrastructure has been constructed in recent years, and CoC are investing in protecting their assets with two engineered GSC seawalls and an offshore fringing reef. An additional stage to the fringing reef is planned, consisting of a replication of the offshore fringing reef closer to shore. To the south of the groyne, sand nourishment from back passing remains the continued management measure to protect the coastline in the short-term. The dual use path was recently shifted landward of the 1976 shoreline indicating the adoption of a retreat strategy being taken here. Back-passing appears to be driven by the availability of source sand (north of Island Road groyne, and south of Port Coogee marina). Over the past 6 years nourishment has alternated between annual and every two years with annual nourishment averaging ~8,000 m^3 across beaches north and south of Catherine Point.
8.	**Performance / Effectiveness of coastal management measure/s**	Short and mid-term vegetation line mapping has been undertaken using satellite imagery, and beach changes in 50m increments are presented in Figure 5-9. **South of Catherine Point (+0m to +900m)** Milder erosion has been observed south of the Catherine Point Groyne. Minor vegetation retreat (up to eight metres) between 2016 to 2024 and (up to three metres) between 2019 to 2024. Milder erosion in the shorter-term analysis suggests that the nourishment being

ID	Category	Content
		undertaken here is nearly sufficient to keep up with sediment loss from the system here. **North of Catherine Point (+900m to +1600m)** Mapping has confirmed that the coastline north of the Catherine Point Groyne has been undergoing erosion (up to 25 m) between 2016 and 2024, with up to 15 m of this erosion occurring between 2019 and 2024. On an annualised rate, the coastline has been receding at similar rates across both periods, up to 3m per year. The most significant erosion has been observed within the 300 m of beach immediately north of the Catherine Point Groyne. Despite the regular nourishment of this beach, erosion is still being observed, with hard structures now being incorporated to reduce direct impacts on adjacent CoC assets. In addition to the analysis above, monitoring undertaken of the beach response to the AFR (UWA, 2024) concluded that the beach response (in the last 2 years) is in a more eroded state than its typical, seasonally averaged position. The report suggested that results at this stage are inconclusive, and longer-term monitoring of the impact of the AFR is required.
9.	**Recommendations & lessons learnt**	**Coastal monitoring** • It is recommended that shoreline monitoring continues adjacent to the AFR and the GSC seawalls to understand the impacts that the reef is having on adjacent beach. Surveyed transects and laser scanning (undertaken on a three-to-six-month basis) will assist to determine volume of sand being retained within the sub-aerial beach and ascertain long-term trends in net longshore sediment transport rates and directions. • Cockburn Cement have been undertaking coastal monitoring of wave conditions, and shoreline monitoring associated with their approval to dredge offshore of this site. It is recommended that access to this data is requested by DoT/CoC in order to avoid duplication of coastal monitoring efforts. **Coastal management actions** • Back-passing activities are recommended to continue (both north and south of Catherine Point) although sand available will continue to decline in years to come. Significant consideration should be given to impacts on downstream beaches, (north of Island Road groyne, and south of Port Coogee marina) prior to removing sand. Increased nourishment (from external sources) is recommended in the short term to avoid recession of the shoreline indicated by vegetation line mapping. • Infrastructure development has put pressure on the buffer of dune between the beach and footpath north of Catherine point. CoC should consider relocating the path to eastern side of the recreational area to increase coastal buffer. **Coastal investigation** • Recommend investigation into offshore sand supply options to supplement the diminishing feed of sand onshore from Success Bank. This could use indirect methods (placing dredge spoil offshore in future dredging campaigns in the region) or directly placing material into the nearshore zone using rainbowing methods similar those recently trialled in March 2023 at Port Beach in North Fremantle. • Alternative nourishment sources from outside of the sediment cell should be investigated to supplement the diminishing feed of sand from Success Bank. • Any modifications to Catherine Point Groyne should be investigated in detailed studies. Coastal realignment following modifications to it could lead to significant loss of dune, and infrastructure located within the Rollinson Road recreational area. **Coastal adaptation design** • Infrastructure development has put pressure on the buffer of dune between the beach and footpath north of Catherine point. CoC should consider relocating the path to eastern side of the recreational area to increase coastal buffer.

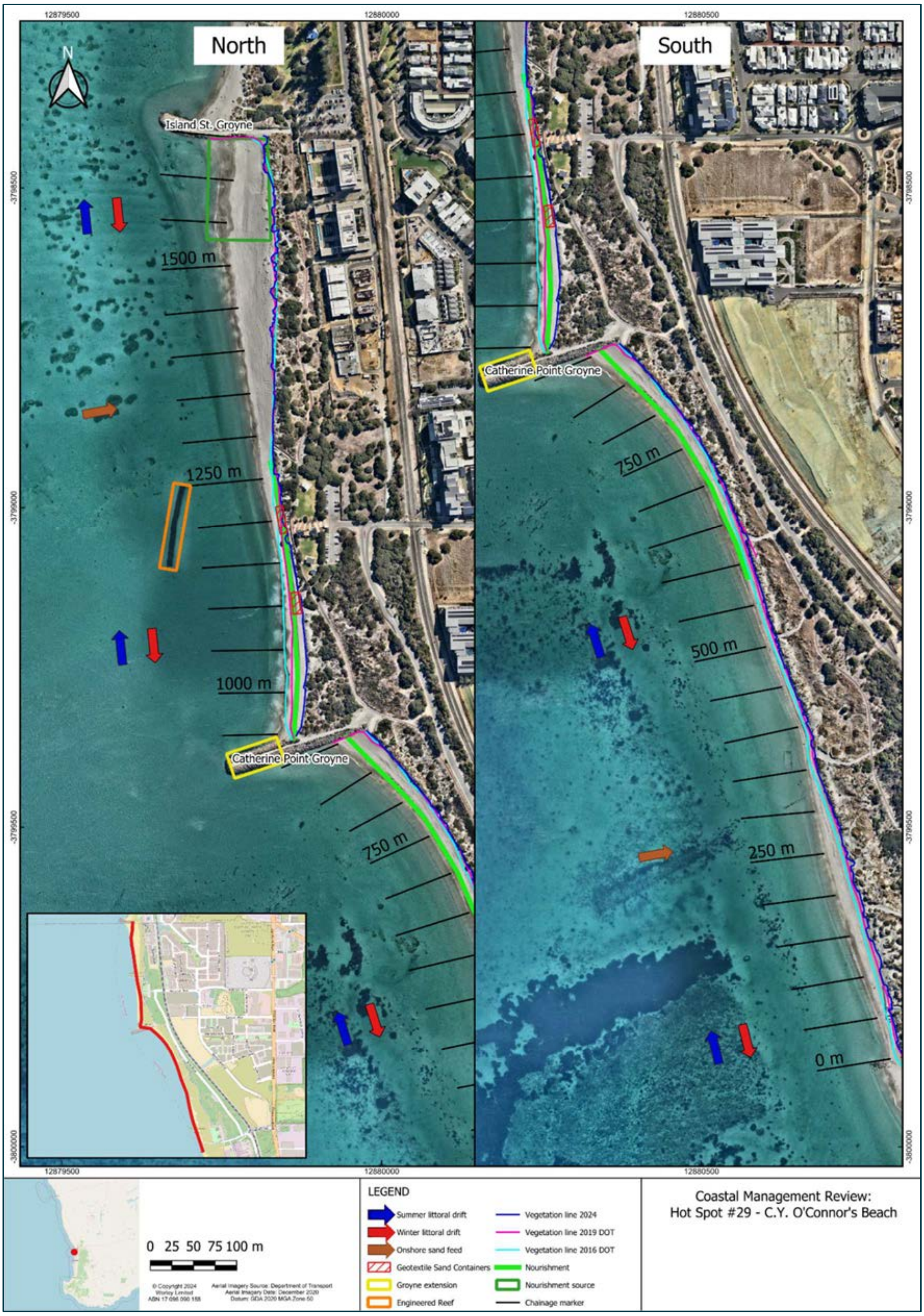

Figure 5-1: C.Y. O'Connor hotspot - coastal management schematic

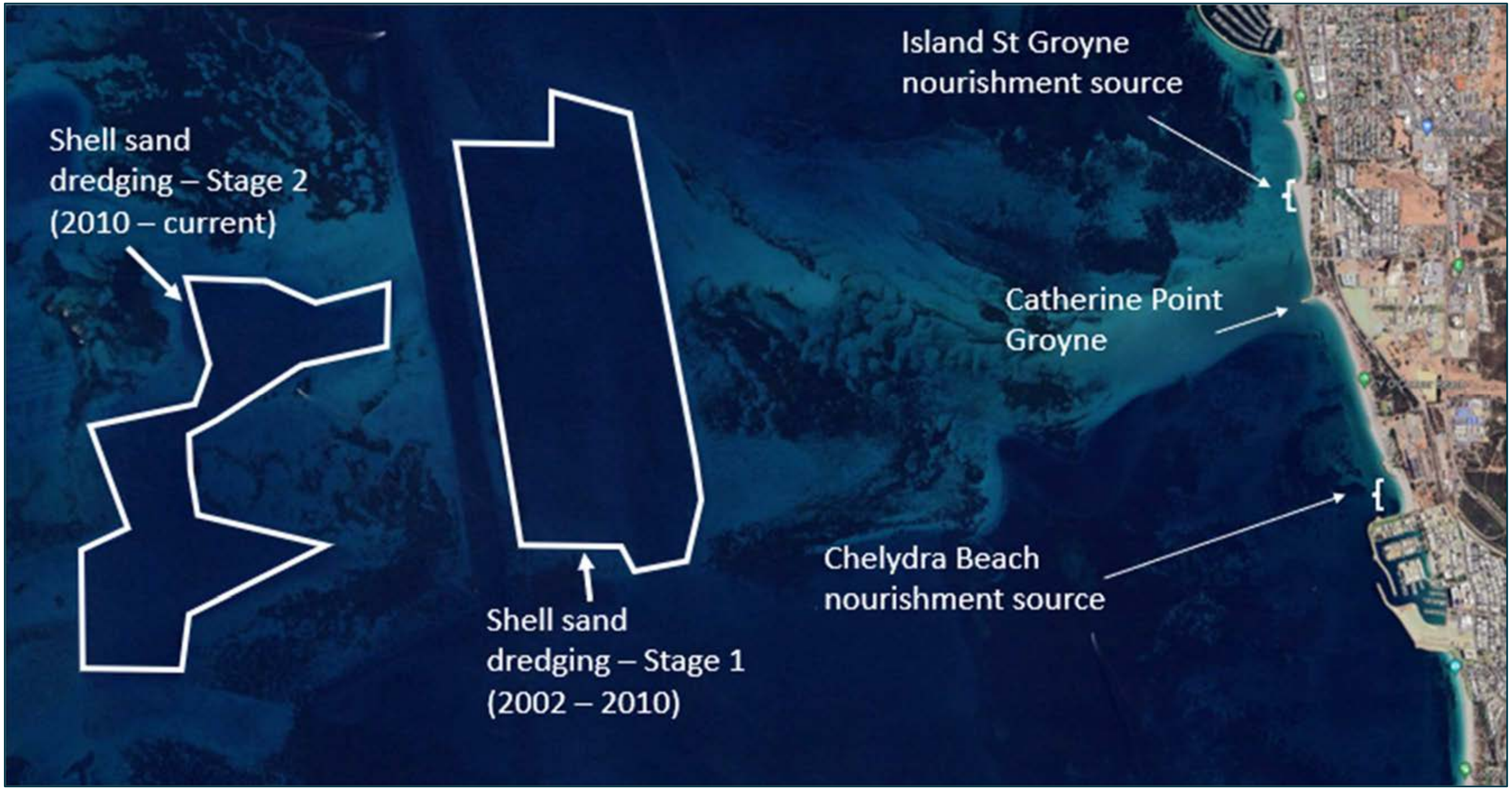

Figure 5-2: Cockburn Cement permitted dredge area staging in relation to Catherine Point and it's nourishment sources, imagery sourced from Google Earth, 2024.

Figure 5-3: Photo taken of C.Y. O'Connor beach dune/beach profile (north of Catherine Point Groyne), during site visit 9 May 2024

Figure 5-4: Photo taken of C.Y. O'Connor beach dune/beach profile (south of Catherine Point Groyne), during site visit 9 May 2024

Figure 5-5: Photo taken of C.Y. O'Connor beach dune/beach profile, looking south from Catherine Point Groyne during site visit 9 May 2024

Figure 5-6: Vegetation on top dunes at C.Y. O'Connor beach (taken during site visit 9 May 2024)

Figure 5-7: Catherine Point Groyne and beach dune/beach profile, looking south (taken during site visit 9 May 2024)

Figure 5-8: North side of Catherine Point Groyne (taken during site visit 9 May 2024)

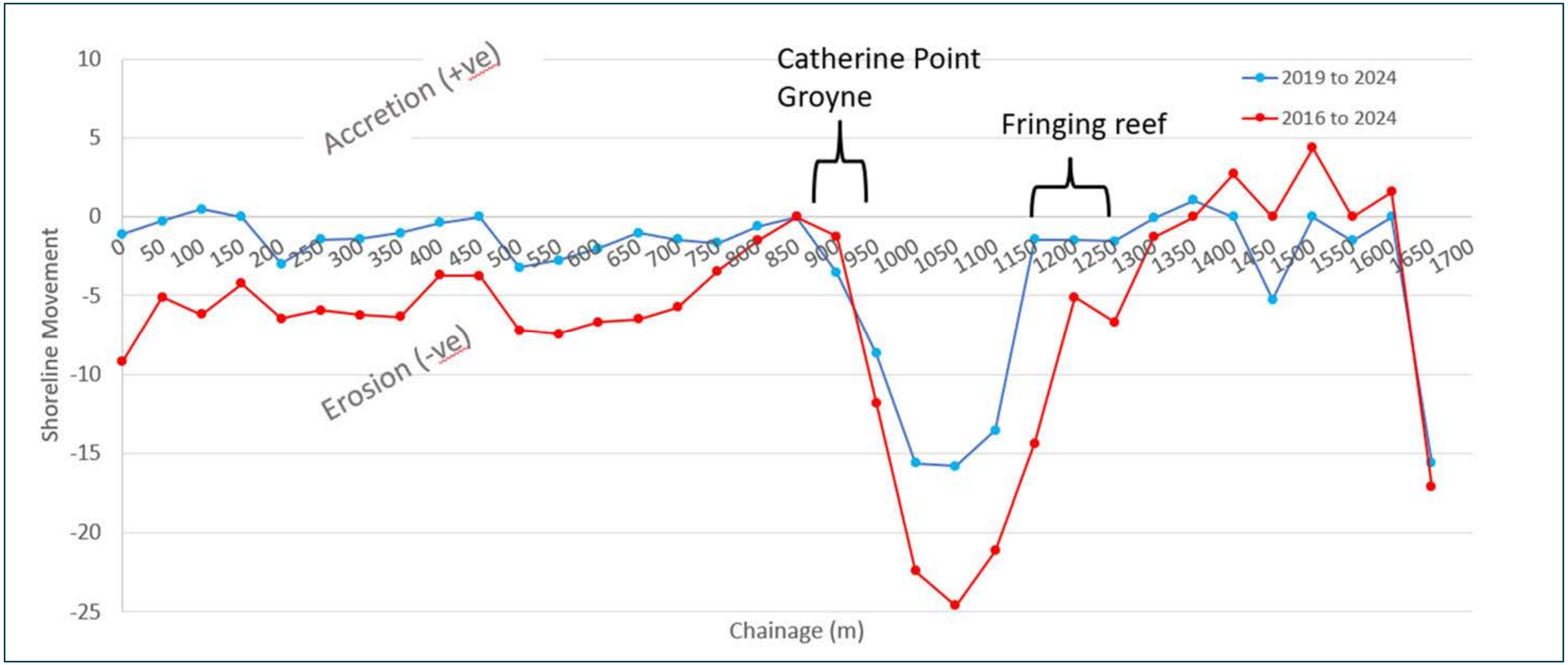

Figure 5-9: Results of C Y O'Connor beach shoreline changes, showing short and mid-term changes, for chainage reference refer to Figure 5-1

6. Kwinana Waterfront Industrial

ID	Category	Content	
1.	**Site name / Date review complete**	Kwinana Waterfront Industrial	May 2025
2.	**Key details**	LGA: City of Kwinana (CoK) Townsite: Kwinana Hotspot ID: #30	
3.	**Summary of erosion issue**	The coast between Wells Park and Challenger Boat ramp is mainly comprised of waterfront industrial leases fronted by a narrow foreshore reserve. It is one of Western Australia's larger hotspot sites, extending for approximately nine kilometres. Many coastal structures exist with the hotspot divided into smaller beaches between groynes, breakwaters, seawalls, jetties, water intakes and discharge pipes. The coast is partially exposed to north-westerly and northerly storms, and erosion is often observed following these storms. Erosion is expected to be enhanced immediately adjacent to structures due to transfer of erosion stress. The public beach at Barter Road and the Challenger boat ramp are two focal areas of public use. The Westport development's preferred design is located along the northern end of the study area. It is understood that the current preferred footprint extends from the bp Kwinana Energy Hub (former refinery) coastal lease in the south to the southern extent of the Water Corporation desalination facility. Key erosion events include: • Winter 2021, dune scarping and damage revegetation along Challenger beach and dunes adjacent to Water Corporation leases (Barter Road). Winter 2020, damage to the revetment at the southern section of Kwinana Bulk Terminal (KBT).Because of the relatively low energy nature of this coastline, there has typically been a lag response to structural intervention, and the system as a whole is likely to still be responding to some of the historical changes made (Coastal Zone Management, UWA, Damara, Oceanica, 2013).	
4.	**Overview of key coastal processes**	The site encompasses a broad salient in the lee of Garden Island (James Point) and a submerged rocky ridge which has been modified over the past 60 years by works along the shore and the disposal of dredged material. As reported by the Department of Conservation and Environment (1984), the Garden-Rottnest island chain creates a low energy environment with very calm waters. During summer months prevailing south westerly winds propagate waves from the south creating northerly littoral drift. Northerly storm wave conditions reverse the summer trend creating southerly littoral drift. As reported in Stul et al. (2014) Kwinana Industrial is split across two secondary cells 17 and 18 with the boundary occurring at James Point. Cell 17 extends south to Palm Beach in Rockingham while Cell 18 extends north to the Australian Maritime Complex. The James Point boundary is reported as fixed and open due to the shoreline aspect variation restricting sediment transport.	
5.	**Overview of historical coastal management actions**	The following key actions have been or are currently being taken at this site: • Synergy (Verve) revetment construction (date unknown) • Revetment construction at the base of the dunes north of Kwinana Bulk Jetty (KBJ) adjacent to expansion loop pipelines (believed to be 2008). • 2013, Revetment construction at southern section of KBT adjacent to conveyor system. In 2020 the revetment was damaged during a storm, it was upgrade and extended 50m in 2021. • Annual dune revegetation/restoration works – Alcoa (Challenger Beach)	

ID	Category	Content
		• Annual dune revegetation/restoration works 'Pro-Alliance' Watercorp/Suez, (adjacent to the desalination site) • 1970's, construction of seven artificial headlands around James Point, bp coastline.
6.	**Management issues and challenges**	• The BP refinery site has been classed as contaminated due to the presence of The bp site has been classed as contaminated due to the presence of hydrocarbons, metals and PFAS substances in the groundwater beneath the site. In addition, pesticide and phenol compounds are present in the groundwater east of the site, and arsenic and ammonia are present as a plume in groundwater on the southern portion of the site (DWER, 2024). • Redundant groundwater wells located on bp land, have already been lost (refer Figure 6-3 and Figure 6-4), and those remaining are at risk of being lost in the longer term due to erosion (assuming three metres of beach is eroded in 10 years). • Uncertainty about future leases and the impact/extent of the Westport development seem to impact most of the coastal sites along this hotspot. • The land adjacent to the coast is managed by many individual landowners, primarily for industrial purposes. As a result, past, present and future coastal management actions and plans are not publicly available for all sections of the coastline. Extremely high value infrastructure of statewide importance along this coast is identified in the existing CHRMAP as being in the coastal hazard zone. CHRMAP revision (initiated in 2025 by the City of Kwinana) and implementation along this section of the coast will be challenging if coastal protection and future land uses are unknown.
7.	**Current management focus**	In 2016, the Cockburn Sound Coastal Alliance released stage three of their Cockburn Sound Coastal Vulnerability and Flexible Adaptation Pathways Project (GHD, 2016). The alliance is made up of the Cities of Kwinana, Fremantle, Cockburn and Rockingham. Within this report, the Kwinana Industrial hotspot was identified as becoming increasingly vulnerable to erosion and loss of beach area from coastal processes and sea level rise. Stage three of the project consisted of a Coastal Adaptation Plan with specific implementation recommendations. Within the CSCA final Stage 3 report, multi-criteria decision analysis (MCDA) was used to compare interim measures; retreat, with alternate interim protection measures. Intolerable erosion risk assessed at these sites recommended a decision made in the immediate planning horizon on whether retreat or protection pathways are followed. The Kwinana Industrial Strip reached trigger 3 for erosion (intolerable risk, interim protection may be viable) (GHD, 2016). MCDA resulted in offshore breakwaters combined with beach nourishment being the highest ranked pathway (ahead of other protect options, and retreat). It was recommended that less publicly accessed beaches, in most cases those adjacent to industrial properties would implement seawalls in order to conserve limited sand resource available for nourishment. Specific adaptation actions recommended for this hotspot included: • Undertake concept design and detailed project scoping for establishment of seawalls to manage immediate risks (to be led by state government and Kwinana Industries) • Undertake a regular program of dune management and revegetation for coastal reserves Additionally the following investigations were recommended: • Investigate materials availability and cost for all potential long-term coastal protection options across Owen Anchorage and Cockburn Sound • Undertake strategic environmental impact review of cumulative impact of all potential long-term coastal protection options across Owen Anchorage and Cockburn Sound Develop and implement coordinated coastal risk monitoring

ID	Category	Content
		program.
8.	**Performance/ Effectiveness of coastal management measure/s**	Mid and short-term shoreline mapping has been undertaken using satellite imagery, and beach changes in 50 m increments are presented in Figure 6-23. **North Wells Park to bp small boat harbour (+0m to +1000m)** Mid-term shoreline mapping indicates that this stretch of coastline has been undergoing erosion (up to 15 m) between 2016 and 2024. The most significant erosion occurs within the 300 m immediately south of the bp small boat harbour. This is equivalent to two metres per year. Short-term shoreline mapping between 2019 and 2024, indicates that the overall erosion trend has slowed in more recent years, with widespread minor erosion up to one metre per year. Aerial imagery analysis has indicated scarping immediately behind the KBJ revetment, suggesting this structure has either been overtopped or run-off drainage has led to slope failure behind the structure. This is of particular concern, as it appears to be protecting pipeline infrastructure less than five to ten metres adjacent. This revetment was not inspected during the site visit. **bp Waterfront (+1000m to +3500m)** Mid-term shoreline mapping indicates that this stretch of coastline has been undergoing erosion (up to 13 m) between 2016 and 2024. The most significant erosion occurs within the 500 m immediately north of the redundant bp flume. This is equivalent to two metres per year. Short-term shoreline mapping between 2019 and 2024, indicates a slightly reduced trend of erosion equivalent to one metre per year along the same stretch of coastline. The seven artificial headlands appear to influence the variability of the historical shoreline adjacent. Specifically, immediately north of headlands five and six, and south of headland three indicate signs of stability. All seven headlands continue to support the tombolo/salient morphology in their lee, and hence are considered functional despite poor structural assessments (collapsed slopes, and lack of any interlocking) during the site visit (14/08/2024). Salt water discharge at the bp cooling water outflow (+3225m) ceased in September 2021. Analysis of aerial imagery indicates turbidity and plume generated from when this was operational appears to have mobilised sediments offshore and simulated a bypassing process assisting accretion along beaches north of artificial headland six. **Kwinana Bulk Terminal (+3500m to +4400m)** Mid-term shoreline mapping indicates that this stretch of coastline has been undergoing erosion (up to 20 m) between 2016 and 2024, equivalent to 2.5 metres per year. The most significant erosion occurs within the 300 m immediately north of the KBT revetment. Short-term shoreline mapping between 2019 and 2024, indicates a continued erosion trend south of the KBT jetty (up to two metres per year). North of the jetty there has been minor accretion (up to one metre per year), extending until the BHP jetty. The partial demolition of the BHP jetty (+4325m) appears to have impacted the vegetation immediately adjacent to the structure, appearing as a significant erosion spike (up to 17 m) in the mid-term. Aerial imagery shows a neat, 2013 constructed and 2021 upgraded revetment protecting conveyor infrastructure at the southern end of the KBT lease. This revetment was not accessed during the site visit. **Water Corp to Synergy (+4400m to +5950m)** Mid-term shoreline mapping indicates that this stretch of coastline has been undergoing erosion (up to 20 m) between 2016 and 2024, equivalent to 2.5 m per year. The most significant erosion occurs in the 200 m stretching north of the

ID	Category	Content
		Synergy cooling water flume. (Cardno, 2013). Another significant erosion area occurs 200 m immediately south of the Barter Road road access to the Naval Base Horse Beach equivalent to two metres per year. The remaining stretch of beach is limited to uniform minor erosion (less than one metre per year). Short-term shoreline mapping between 2019 and 2024, indicates minor erosion along the entire stretch (less than one metre). The 'NewGen' power station and Synergy offices appear to be located immediately south of the Synergy revetment, where approximately five metres of erosion has been experienced across the mid-term. The revetment was not inspected during the site visit. **Alcoa site to Alcoa jetty (+5950m to +6700m)** Mid-term shoreline mapping indicates that this stretch of coastline has been undergoing erosion (up to 15 m) between 2016 and 2024, equivalent to two metres per year. The most significant erosion occurs uniformly across the southern 700m until the Alcoa jetty. Short-term analysis indicates a stable shoreline with negligible changes. **Challenger Beach (+6700m to +8200m)** Mid and short-term analysis indicates a stable shoreline north of the Alcoa jetty, extending until the Navy shacks revetment and boat ramp. The Navy shacks revetment appeared in good condition during site visit (24/10/24), with slopes appearing to be stable and good interlocking of armour rock.

9.	**Recommendations & lessons learnt**	**Coastal monitoring**
		• It is recommended that shoreline monitoring using LIDAR equipped drones or equivalent survey alternatives are undertaken along this hotspot at a minimum, annual frequency subject to safety and necessary access approvals. Specific areas of concern include:
		  • shoreline/dune adjacent to KBJ seawall
		  • shoreline/dune system protecting NewGen power station
		  • shoreline/dune foreshore along bp land
		• It is recommended that a detailed inspection of the revetment adjacent to the KBJ seawall is undertaken, and renewal/refurbishment considered based on the inspection outcome.
		• Consideration should be given to monitoring and management requirements for Westport or other major projects.
		Coastal investigation
		• It is recommended that a holistic revision of the CHRMAP is undertaken considering all possible future uses of the individual leases (including Westport).
		• It is recommended that private leaseholders individually assess the risk of coastal erosion/inundation impacting their assets, and establish protect strategies best suited to their individual circumstance.
		Coastal management actions
		• Revetments remain the preferred protect strategy for all industrial leases (GHD, 2016), and are recommended to be installed in a staged manner as individual leases reach risk thresholds requiring mitigation. Any protection concepts should consider a design life tailored to the individual lease expiry.
		• Where suitable, staged protection outlined above will need to consider impact on neighbouring lease holders, and revetment concepts grouped to ensure that resources can be shared during the construction of such infrastructure.

Figure 6-1: Photo taken of dune immediately north of BP flume (+2300m) taken during site visit 20 May 2024.

Figure 6-2 :Coastal scarping and natural revegetation (+2600m) along the BP coastline, taken during site visit 14 August 2024

Figure 6-3: Coastal scarping and damaged ground water monitoring wells (chainage +2725m), taken during site visit 14 August 2024

Figure 6-4: Coastal scarping and damaged ground water monitoring wells (chainage +2750m), taken during site visit 14 August 2024.

Figure 6-5: Coastal scarping and vegetation reestablishment along BP refinery foreshore (chainage +3000m), facing north during site visit 14 August 2024.

Figure 6-6: Artificial headland five (chainage +3075m) with submerged salient, taken during site visit 14 August 2024.

Figure 6-7: BP refinery storm water outfall, and informal armouring (chainage +3200) taken facing north during site visit 14 August 2024.

Figure 6-8: BP refinery storm water outfall, and scarping above (chainage +3250) taken facing northwest during site visit 14 August 2024.

Figure 6-9: Artificial headland six (+3275m) with scattered armour, taken facing west during site visit 14 August 2024.

Figure 6-10: Artificial headland seven (+3400m) taken facing north during site visit 14 August 2024.

Figure 6-11: Jute matting stabilisation installed adjacent to WaterCorp desalination site (Barter Rd), taken during site visit 14 August 2024.

Figure 6-12: Scarping along dune face adjacent to NewGen power station (chainage +taken during site visit 14 August 2024.

Figure 6-13: Jute matting stabilisation installed directly north of Alcoa Jetty, taken during site visit 14 August 2024.

Figure 6-14: Cement stabilisation of beach directly north of Alcoa Jetty, taken during site visit 14 August 2024.

Figure 6-15: Southern end of Navy shacks rubble mound revetment, taken facing north during site visit 25 October 2024.

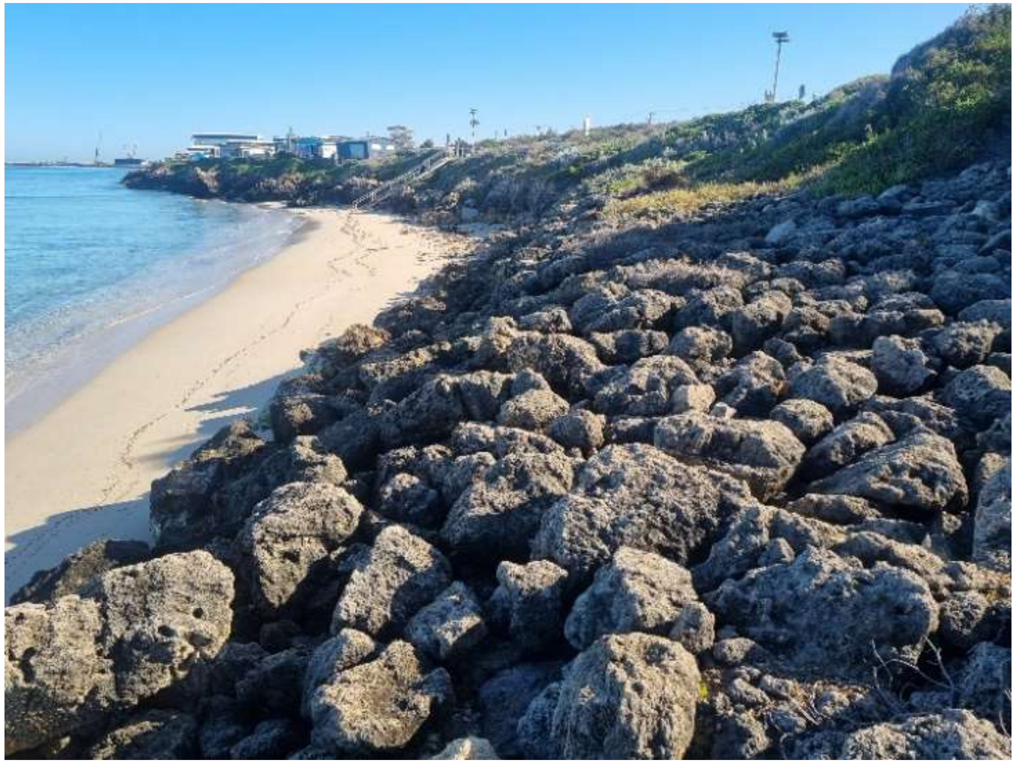

Figure 6-16: Northern end of Navy shacks rubble mound revetment, taken facing north during site visit 25 October 2024.

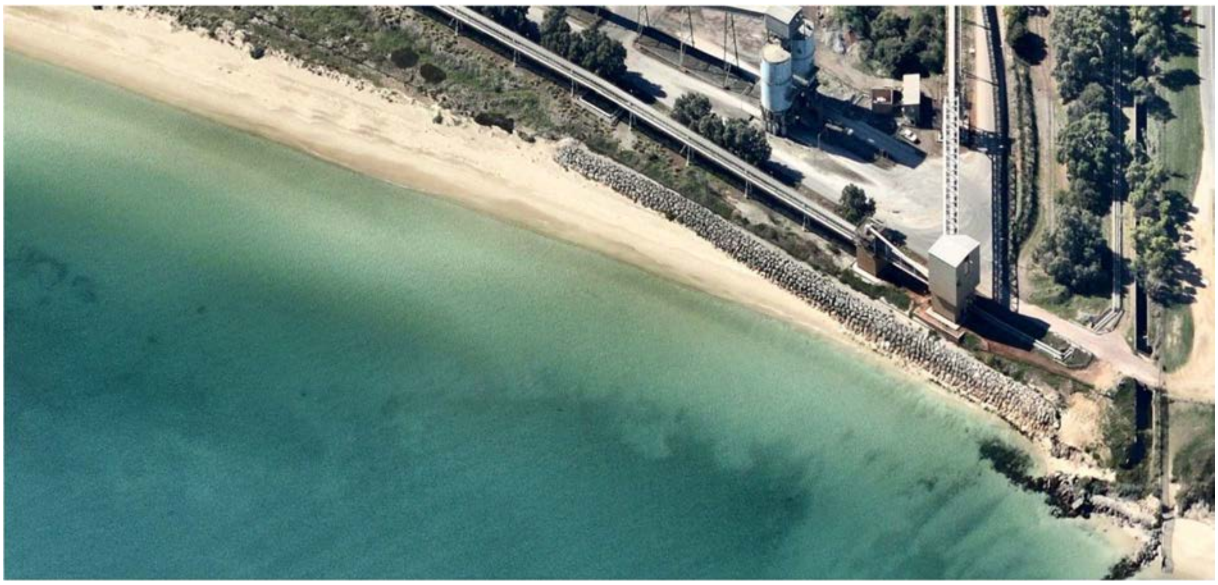

Figure 6-17: Oblique imagery of seawall adjacent to KBT conveyors. Nearmap imagery captured 29 April 2023.

Figure 6-18: Oblique imagery of seawall adjacent to CSBP export/import pipelines to KBJ. Nearmap imagery captured 14 September 2024

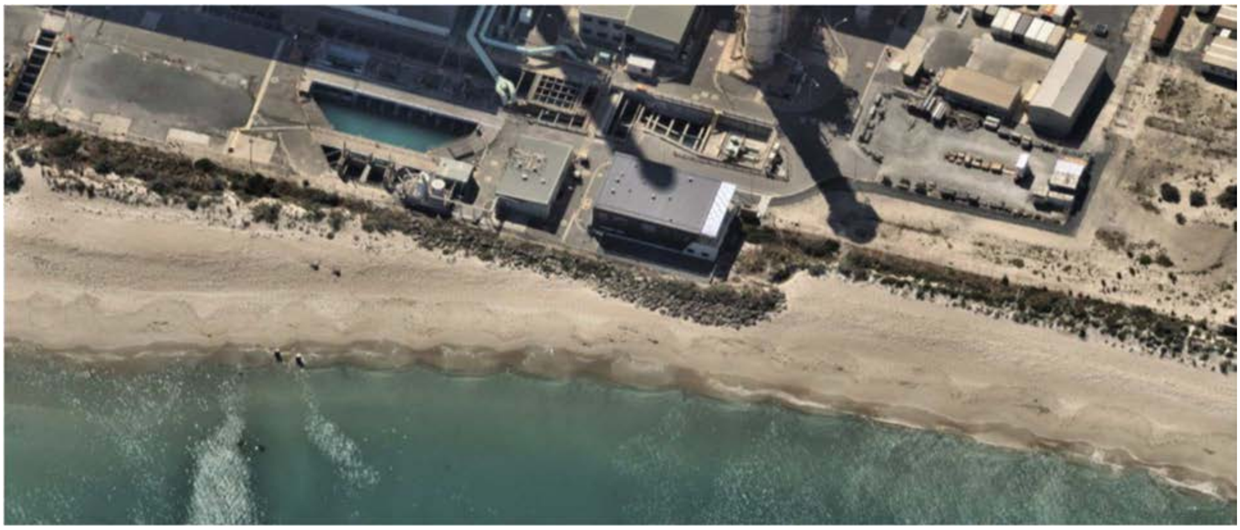

Figure 6-19: Oblique imagery of seawall adjacent to Synergy office and Kwinana Power Station. Nearmap imagery captured 15 October 2023.

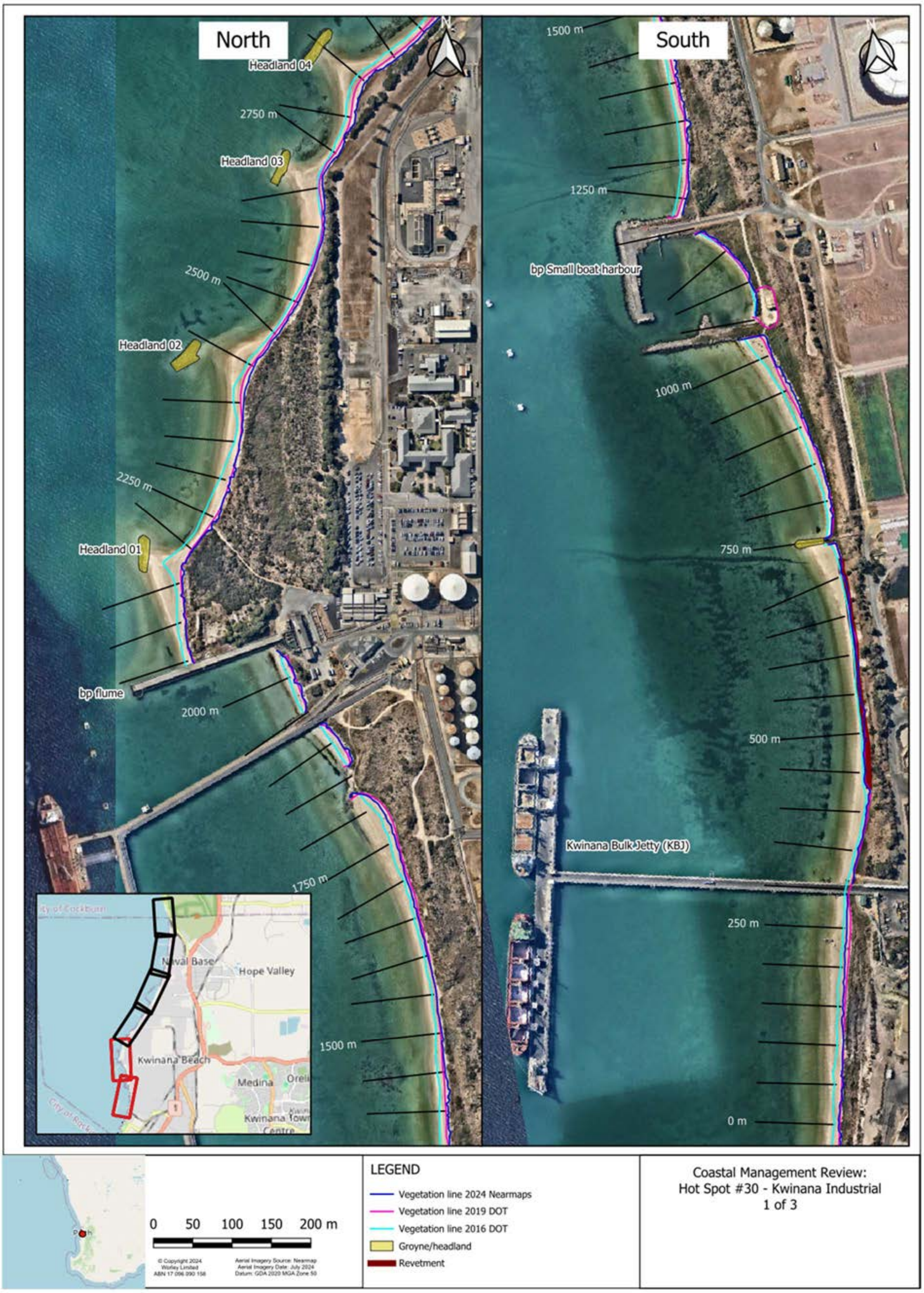

Figure 6-20: Kwinana Industrial hotspot - coastal management schematic, 1 of 3

Figure 6-21: Kwinana Industrial hotspot - coastal management schematic, 2 of 3

Figure 6-22: Kwinana Industrial hotspot - coastal management schematic, 3 of 3

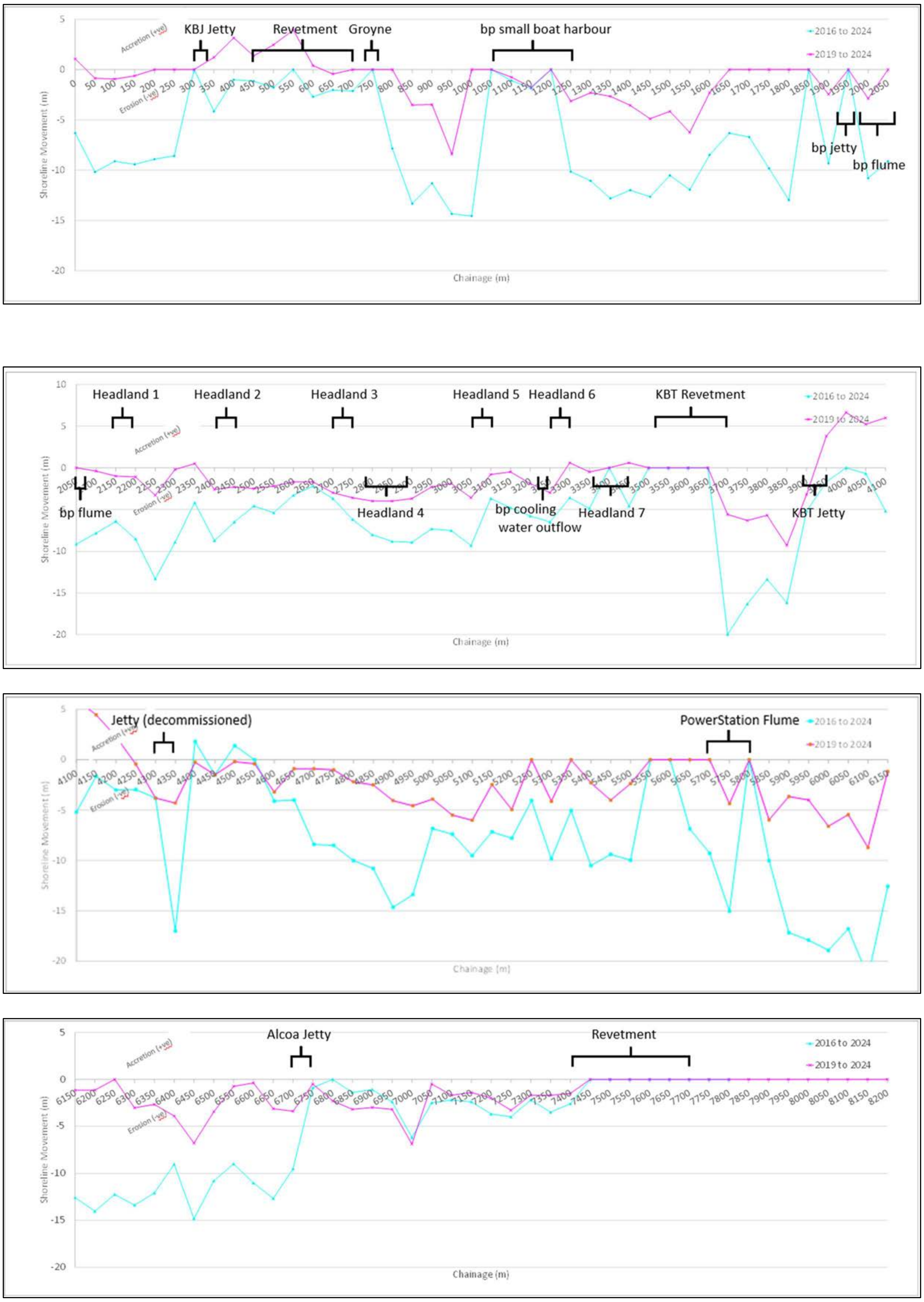

Figure 6-23: Results of Kwinana Industrial shoreline mapping, showing short and mid-term changes, for chainage reference refer to Figure 6-20, Figure 6-21 and Figure 6-22

7. Kwinana Beach

ID	Category	Content	
1.	**Site name / Date review complete**	Kwinana Beach	February 2025
2.	**Key details**	LGA: City of Kwinana (CoK) Townsite: Kwinana Hotspot ID: #31	
3.	**Summary of erosion issue**	The Kwinana Beach hotspot lies directly south of the Kwinana Industrial hotspot (#30). The hotspot includes Wells Park recreational area which resides on the artificially formed headland associated with the stabilisation of the 'SS *Kwinana*' wreck (1922), which formed a tombolo. Recreational facilities were later built along the accreting foreshore on the tombolo, which were then impacted by erosion south of the wreck. The beach south of the Kwinana Wreck has been eroding since at least 1976. The main causes of this erosion are the formation of the tombola in the lee of the Kwinana Wreck, cutting the supply of sand to this beach from the north (DPI, 2004). Another contributing factor has been the construction of the Garden Island causeway which has reduced the potential for occasional compensating sand supply from the south. To combat the erosion a rubble mound seawall was constructed south of the wreck in 1981 to protect the foredune from erosion, with multiple extensions undertaken in the years to follow. This seawall has held the shoreline further seaward than its stable alignment. Two artificial headlands forming tombolos in their lee were constructed at Kwinana Beach in 2008 with the cost for the works shared three ways between DoT (previously Department of Planning and Infrastructure [DPI]), City of Rockingham (CoR), and City of Kwinana (CoK). Periodic sand nourishment has been undertaken with sand sourced from the Point Peron sand trap in Rockingham, and the works coordinated by CoR. Key erosion events include: • Winter 2023, overtopping and scour resulted in damage to the limestone retaining wall that extends north from the "SS *Kwinana*' tombolo. The damage includes rotational failure and cracking. • 2015, jetty extending offshore of the SS *Kwinana* was damaged and later demolished. • Winter 2012, damage observed to the seawall south of Wells Park, including scouring, backslope erosion, and total failure of the seawall. Damage was also observed along the Wells Park (SS *Kwinana*) seawall. In addition to the above periodic damage, it is understood that continual damage is being sustained along the seawall south of Wells Park, including slope failures, and scouring associated with overtopping.	
4.	**Overview of key coastal processes**	As reported in Stul et al. (2014) the Kwinana Beach hotspot is located within a tertiary and secondary sediment cell stretching from Palm Beach (Rockingham) in the south to James Point in the north (approximately two kilometres north of the Kwinana Beach hotspot). This boundary at Palm Beach is reported as fixed, with sediment transfer likely occurring across the boundary based on seasonal trends. The hotspot as reported by M P Rogers (2012) is relatively well protected, with the largest waves typically sea waves generated across the fetch of Cockburn Sound. Some swell can enter Cockburn Sound from the north, diffracting around the northern tip of Garden Island. Previous coastal studies (DPI, 2004) undertaken have determined that south of Wells Park the net longshore transport is southwards. North of Wells Park is understood to feature minor southward transport up to 500m^3 per year	

ID	Category	Content
		(WorleyParsons, 2007).
5.	**Overview of historical coastal management actions**	The following key actions have been taken at this site, including emergency repairs/measures: • 2024, 2021, 2012, 2008, 2003, nourishment of the artificial headlands south of Wells Park (typically 6,000m^3 - 15,000m^3 per campaign) • 2023, revegetation of foreshore at northern end of Wells Park • 2022, revegetation of foreshore at northern end of Wells Park • 2012, closure of Wells Park Jetty access • 2008, two artificial headlands (approximately 60 m long spaced 280 m apart) were constructed at Kwinana Beach. Capital sand nourishment to support the work was also carried out. • 2001, nourishment of beaches south of Wells Park (prior to artificial headland construction) • 1981, seawall was constructed to protect south side of tombolo against erosion (associated with wreck outlined below) (M P Rogers and Associates, 2012) including subsequent extensions • Late 1970s, limestone retaining wall constructed north of the SS *Kwinana* • The stranding of the SS *Kwinana* on the shoreline of Wells Park in 1922, and subsequent limestone filling (1959) resulted in the formation of a tombolo and interrupted the southerly transport of sediment (M P Rogers and Associates, 2012).
6.	**Management issues and challenges**	• Within the Cockburn Sound Coastal Alliance (CSCA) final Stage 3 report (GHD, 2016), erosion risk at Wells Park was assessed as low, and determined that no immediate decision was recommended between retreat or protection pathways. Multi-criteria analysis (MCA) concluded that in a longer-term decision context, retreat pathways serve as a more appropriate management measure at this site when compared with protect options. • CoK have been granted funding from DPLH (2024/2025 CMPAP grants) to undertake an updated CHRMAP study. • M P Rogers & Associates (2012) provided recommendation to rebuild the seawall south of Wells Park. The seawall is in very poor condition and the City has insufficient funding to rebuild/refurbish the seawall in the immediate future. The dune crest behind the seawall will continue to erode and may soon impact the coastal path immediately behind. • CoK and Kwinana businesses have expressed concern that Rockingham Beach Road directly behind the seawall and artificial headlands serves as alternative entry/exit from the Kwinana Industrial area should Patterson Rd be obstructed. Future erosion hazards impacting this road should be considered in the latest CHRMAP. • There is disagreement between the Coastal Adaptation Plan MCA findings (GHD, 2016) and the potential future of Wells Park recreational area. The Kwinana Adaptation Plan (GHD, 2016) assessed hard protection alternatives against retreat at Wells Park. MCA findings suggested that retreat is the preferred approach. Despite this CoK would prefer protect Wells Park as it is popular public space. Recently the CoK submitted an unsuccessful Disaster Ready Fund application for a GSC seawall along the eroding coastline north of Well's Park. Determining future pathways for Well's Park will be an important outcome of the CHRMAP revision. • CoK is considering a third artificial headland to be constructed in between the northern artificial headland, and Wells Park headland.
7.	**Current management focus**	• Perth NRM have partnered with community groups to undertake native planting/revegetation of northern coastal land adjacent to Wells Park. • Carpark immediately south of Wells Park has been gated off from the public for future revegetation activities. • CoK priority is to protect the Wells Park beach and are considering revetment implementation along beach north of the tombolo (Burtenshaw, 2024).
8.	**Performance / Effectiveness of coastal management**	Mid (eight year) and short-term (five year) shoreline mapping has been undertaken using satellite imagery, and beach changes in 50 m increments are presented in Figure 7-18. No changes were observed along the seawall stretch of coastline.

ID	Category	Content
	measure/s	**South of southern artificial headland (0 to +550m)** Mid-term shoreline mapping indicates that the coastline has undergone minor erosion (up to two metres per year). The erosion is milder closer towards the artificial headland. Short-term mapping indicates shoreline changes varying from minor erosion at the hotspot's southernmost extent (one metre per year) to minor accretion (one metre per year) adjacent to the southern artificial headland. It is understood that nourishment may have led to the accretion associated with the most recent, 2024 vegetation line. **Southern artificial headland to northern artificial headland (+550m to +850m)** Mid-term shoreline mapping indicates that the coastline has been on average, relatively stable, with some accretion observed adjacent to the northern headland (up to one metre per year). Short-term mapping indicates recent accretion along this stretch of shoreline, with the most significant changes showing up to 20 metres of accretion directly behind the artificial headlands (up to four metres per year). Analysis of aerial imagery, and site observations indicate significant vehicle use on the beaches in the lee of both artificial headland structures. This could be impacting the establishment of vegetation and the reliability of satellite imagery monitoring methods. Site inspection undertaken 18/09/2024 confirmed that both artificial headlands are in acceptable condition. Most of the armour remains well interlocked, slopes appear stable, and core sufficiently protected to ensure the structure is functioning as intended. Recent nourishment undertaken by CoR may have led to the accretion associated with the most recent, 2024 vegetation line. Given the vegetation has been able to establish confirms that the structures are continuing to support tombolo/salient formation and erosion protection in their lee. **Wells Park headland north (+1350m to +1600m)** Mid-term shoreline mapping indicates that the coastline has been eroding for 250m immediately north of the Wells Park headland (up to two metres per year). Shorter term analysis indicates the rate of erosion has slowed but still indicates up to one metre per year erosion. Clear damage to the limestone retaining wall structure (Chainage +1475m to +1550m) was observed onsite (14/08/2024) with specific damage most noticeable at the southern end (refer Figure 7-3). Rotation and cracking of the structure is likely to be associated with storm wave overtopping and scour at the structure's toe. **Seawall** From the site inspection conducted (14/08/2024) and the site report conducted by M P Rogers & Associates (2024) (2012) the seawall is in very poor condition, with signs of exposed core, poorly interlocked armour units, and minimal crest width. There is also erosion along the slope face associated with overtopping in several locations. Additionally, there are signs where complete slope failure has led to core material washout. Generally, the seawall condition deteriorates along chainages further south. **Wells Park Headland (SS *Kwinana*) seawall** From the site inspection conducted (24/10/2024) the armour slope appears to be reasonably well interlocked, and it is understood given the nature of the concrete filled wreck-structure, no core material is present requiring protection. Crest height and width is lacking in some locations which could lead to increased overtopping; however, it is understood that overtopping is already occurring consistently along this structure (refer Figure 7-1). This is not of significant concern to the structure's integrity; however it may be of concern from a public safety perspective.

ID	Category	Content
9.	**Recommendations & lessons learnt**	**Coastal monitoring** • It is recommended that shoreline mapping is continued in future years to monitor the erosion trend north of Wells Park. Continuing the mapping south of Wells Park (+400 to +850m) will be beneficial to manage the scheduling of future sand nourishment. • It is recommended that any future repairs/maintenance done at either seawall is well documented, including pre and post laser surveys. • It is recommended that the location, timings, and quantity of any future sand nourishment at either headland is recorded by CoK/CoR. **Coastal investigation** • The existing limestone retaining wall north of Wells Park is damaged beyond repair, and currently seaward of the adjacent vegetation line. This misalignment may have led to increased wave attack during winter storms. Following the removal of the damaged retaining wall, it is recommended that the beach is left to realign prior to considering future protection options in this location. This may result in minor loss of park area as the beach transitions. • Future construction of a third artificial headland south of Wells Park will need to consider the impact of wave reflection along the seawall. As the wave reflection may hinder retention of sand behind the headland. In addition, a new headland may create a steep dune on the tombolo beach which could create considerable hazard to public safety. **Coastal management actions** • Future CHRMAP review and update should consider the community value associated with Wells Park, to ensure community sentiment is best reflected in proposed strategy. In addition, the value of the Rockingham Beach Road should be considered and the CHRMAP assess whether future protection of this asset is warranted. • CoK should investigate the cost/benefit of rebuilding the seawall south of Wells Park. In addition this structure should be carefully monitored to ensure that public safety risks remain acceptable if the structure is left in its current condition. • Vehicle use observed on beaches south of the Wells Park is likely to hinder vegetation growth following accretion and nourishment events. CoK(with collaboration with CoR) should consider restricting four-wheel-drive access to the beach to encourage vegetation establishment following natural or artificial beach accretion. • Exposed sections of unstable limestone block wall should be removed or buried with nourishment sand in the interest of public safety. This has been recommended in the condition assessment undertaken in 2023 (M P Rogers and Associates).

Figure 7-1: Photo taken of Wells Park headland (+1350m) showing overtopping during site visit 14/08/2024.

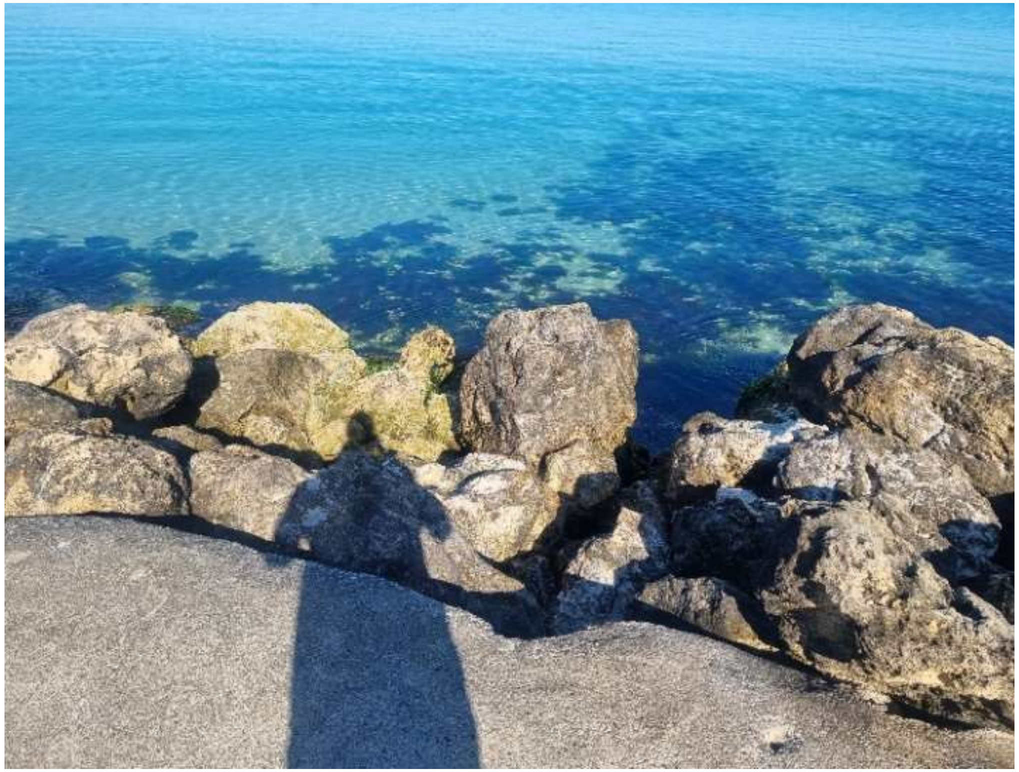

Figure 7-2: Photo taken of Wells Park seawall (+1370m) showing poor interlocking, and gaps in armour during site visit 24/10/2024.

Figure 7-3: Photo taken of damaged limestone retaining wall (+1500m) with scattered armour loosely placed adjacent, facing east during site visit 14/08/2024.

Figure 7-4: Photo taken of damaged limestone retaining wall (+1500m) eroded slope behind, facing northeast during site visit 14/08/2024.

Figure 7-5: Photo taken of damaged limestone retaining wall (+1500m) with scattered armour loosely placed adjacent, facing east during site visit 14/08/2024.

Figure 7-6: Scarping along dune toe (+1550m), north of Wells Park, during site visit 14/08/2024.

Figure 7-7: Limestone seawall (+1100m) south of Wells Park, showing eroded dune face above, facing northwest during site visit 14/08/2024.

Figure 7-8: Concrete flex-mat along seawall crest (+1100m), adjacent to old boat ramp, taken during site visit 14/08/2024.

Figure 7-9: Damaged geotextile along seawall crest (+1100m), adjacent to old boat ramp, taken during site visit 14/08/2024.

Figure 7-10: Limestone seawall south of Wells Park (+1100m), showing eroded dune face above, facing south during site visit 14/08/2024.

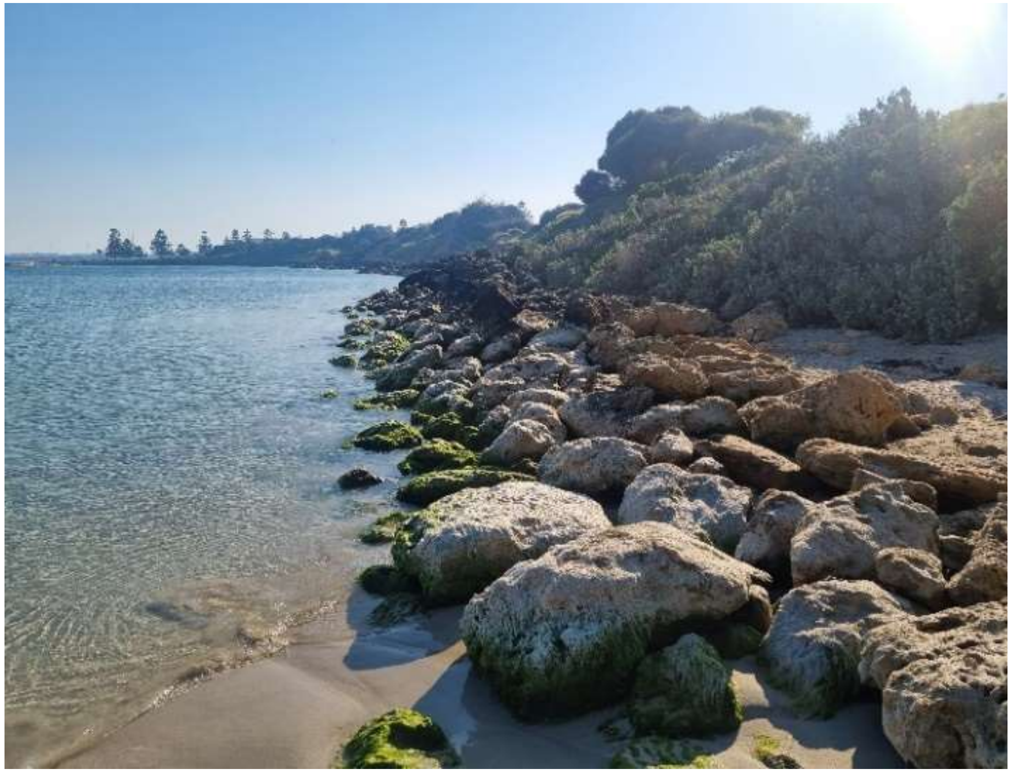

Figure 7-11: Limestone seawall south of Wells Park (+850m), showing southern end, facing northeast during site visit 18/09/2024.

Figure 7-12: Limestone seawall south of Wells Park (+850m), showing southern end, facing east during site visit 18/09/2024.

Figure 7-13: Dune adjacent to southern artificial headland (+500m), facing north-east during site visit 18/09/2024.

Figure 7-14: Dune adjacent to southern artificial headland (+500m), facing south-west during site visit 18/09/2024.

Figure 7-15: Southern artificial headland, taken from crest, during site visit 18/09/2024.

Figure 7-16: Southern artificial headland, taken from crest, during site visit 18/09/2024.

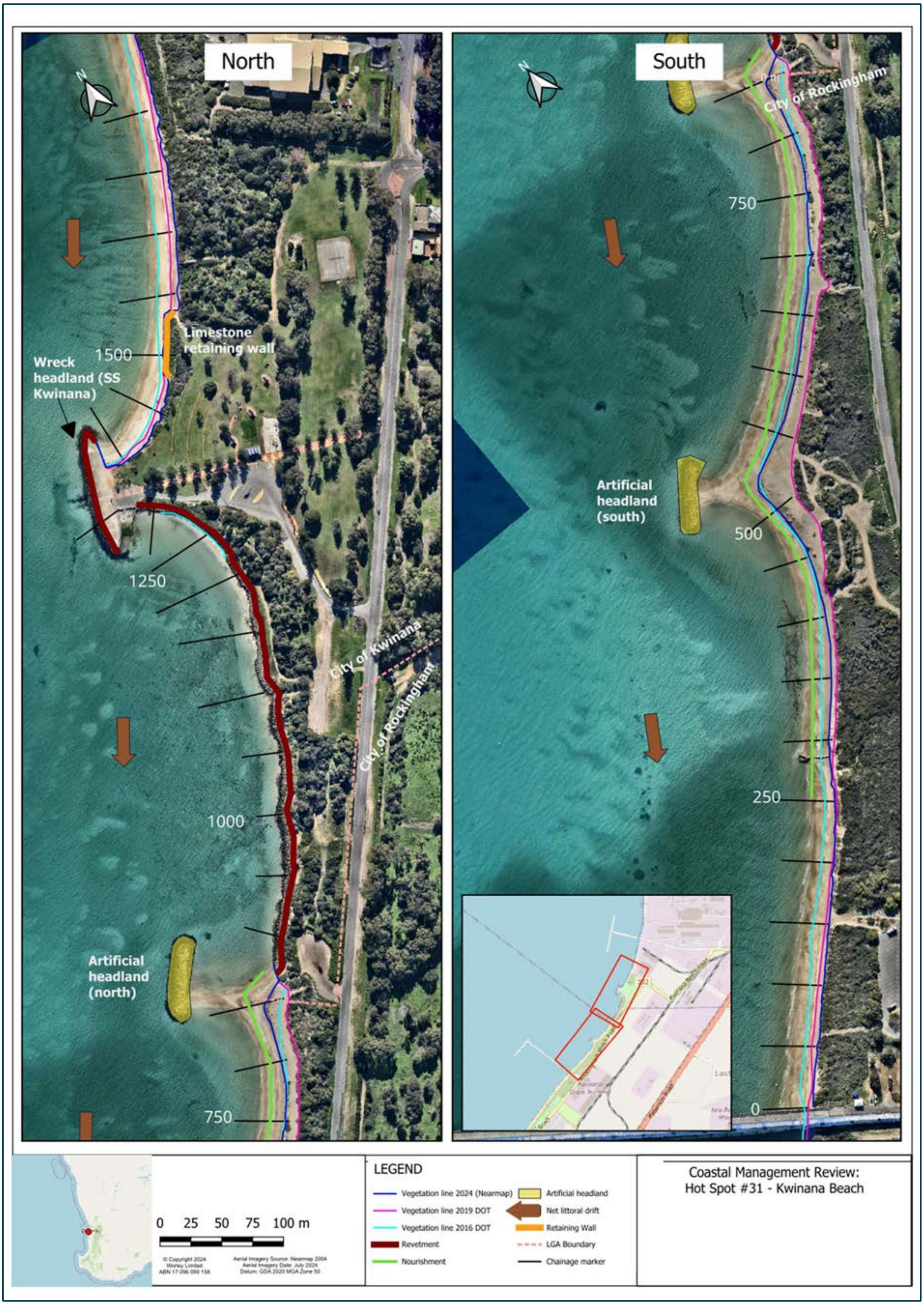

Figure 7-17: Kwinana Beach hotspot - coastal management schematic.

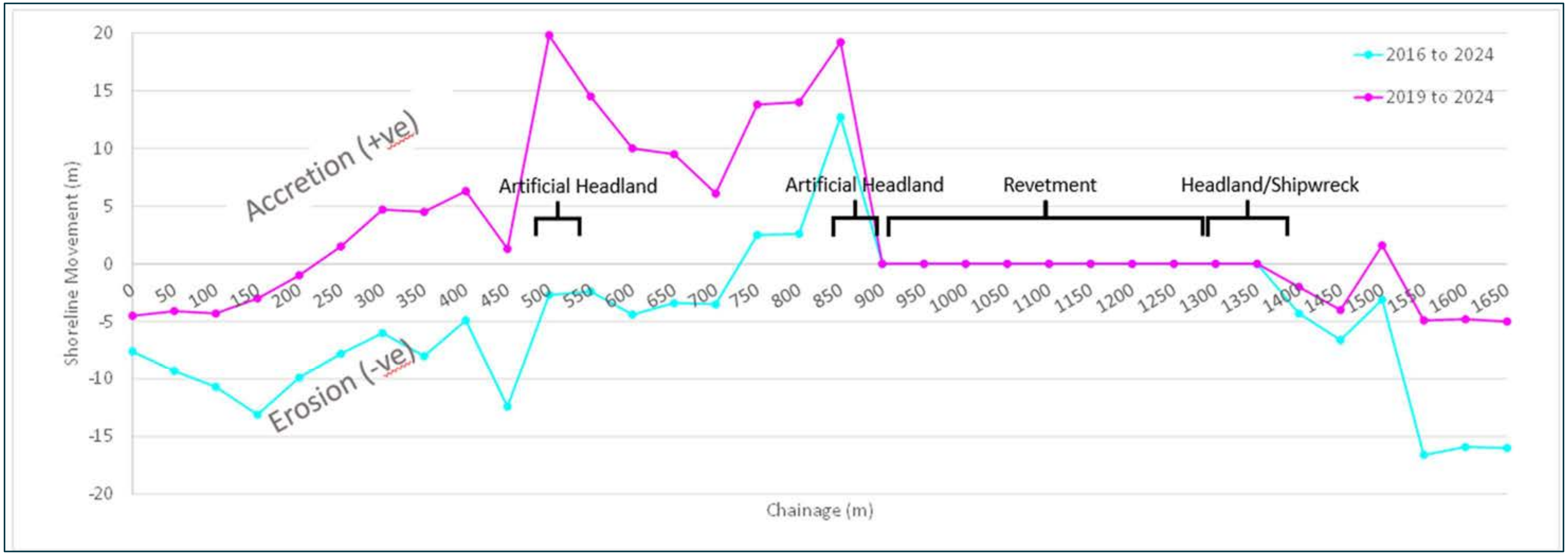

Figure 7-18: Results of Kwinana Beach shoreline changes, showing short and mid-term changes, for chainage reference refer to Figure 7-17

8. Rockingham Townsite to Causeway

ID	Category	Content	
1.	**Site name / Date review complete**	Rockingham Townsite to Causeway	February 2025
2.	**Key details**	LGA: City of Rockingham (CoR) Townsite: Rockingham Hotspot ID: #32	
3.	**Summary of erosion issue**	The hotspot extends for 3.6 km along the north facing shores between the Garden Island Causeway to the Esplanade Park at Rockingham Beach. Removal of the foredune during early development of the railway and original jetties (1940's-1950's), along with construction of the Causeway (1970's) has led to retreat of the foreshore (Seashore, 2019). Modern development has continued to reduce this coastal buffer, increasing vulnerability to erosion and inundation. The City of Rockingham has recognised the coastal zone as highly valuable underpinning the City's identity, prosperity, and lifestyle. Extensive infrastructure exists within proximity to the coastline, with City of Rockingham recognising over $234M of assets at risk by 2110 when this section is combined with North Point Peron (hotspot #33) (City of Rockingham, 2019). This stretch of coast features the eastern end of the Garden Island causeway, jetties, seawalls, boat ramps, retaining structures, and numerous coastal access paths. According to the City of Rockingham, the coastline adjacent to the Hymus St. seawall, extending eastwards towards the Palm Beach West boat ramp facility, is presently experiencing significant erosion. Erosion events: • Winter 2021 - erosion west of Palm Beach boat ramp, loss of tuart trees • 2000-2010 - repeated winter storms leading to erosion between Val and Victoria St. • May 2003 - foreshore erosion, various locations.	
4.	**Overview of key coastal processes**	As described by Stul et. al (2015) the Rockingham hotpot is stretched across primary, secondary, and tertiary sediment cells at the Palm Beach cell boundary. This cell boundary has been reported as a fixed and open, with limited sediment transport occurring across it at both seasonal and decadal scales. Cell 16A represents the western cell extending from Garden Island Causeway to Palm Beach. Cell 17A represents the eastern cell extending from Palm Beach to James Point (also shared with the Kwinana Beach hotspot). The coastline of Rockingham Townsite to Garden Island Causeway is exposed to sea waves generated from winter storms which arrive from the northwest. The coastline is also subjected to swell waves from the southwest that may wrap around the Garden Island and reach Mangles Bay (DPI, 2009). Along the eastern coast of Cockburn Sound from Kwinana Beach towards Palm Beach, sediment is transported southwards towards Mangles Bay due to refraction of south-westerly swell waves into Cockburn Sound. Prior to the construction of the causeway sediment was most likely transported eastwards from Point Peron and into the system along the Rockingham Townsite foreshore, with potential for transport reversal in summer driven by easterly wind conditions (DPI, 2009)	
5.	**Overview of historical coastal management actions**	The coastal protection measures undertaken along this hotspot include: • 2019, construction of the Rockingham Foreshore Beach Plaza Redevelopment Project, including seawall construction and scour protection at the toe of the reinforced concrete seawall. Estimated installation of 700 GSC's. • 2015, Installation of scour protection (213 GSC's) to support the Val St. jetty abutment and seawall. • 2015, Construction of a terraced, concrete seawall between Val St and Railway Tce.	

ID	Category	Content

		• 2012, informal rock placement seawall in front of the Mangles Bay Fishing Club (western end).
		• 2009, Installation of Palm Beach limestone seawall as part of the jetty.
		• 2004, Construction of a GSC buried seawall at Flinders Lane either side of the limestone lookout.
		• 2000, Installation of an informal limestone wall and 30m timber groyne at the suburban boundary of Palm Beach and Peron (Hymus St).
		• Periodic sand nourishment sourced from the Point Peron Sand Trap (refer hot spot #33) has been undertaken at the following locations:
		    • 2020, 2013, 2012 - Victoria St carpark beach (typically 1,000 m^3 per campaign)
		    • 2024, 2022, 2021, 2011, 2010 - Hymus St to Palm Beach boat ramp (typically 1,500 to 3,000 m^3 per campaign)
		    • 2014, 2011 - Flinders Ln to Wanliss St (typically 2,000 to 4,000 m^3 per campaign)
		    • 2015 - Mangles Bay Fishing Club (200 m^3).

6.	**Management issues and challenges**	The Hymus St seawall is in poor condition and requires refurbishment. CoR are currently investigating replacement of the Hymus St. seawall with a purpose-built structure to accommodate planned road and median strip widening works. The Seaside Camp for Children situated immediately west of this site have requested that this design is extended to protect their frontage (City of Rockingham, 2024).

7.	**Current management focus**	• The CoR currently utilises sand accumulated within the Point Peron sand trap to undertake acute responsive sand renourishment along the coastline. Nourishment is typically undertaken prior to summer and/or school holidays.
		• During the site visit CoR communicated the intention to widen the Hymus St road and upgrade the seawall currently protecting the road (Clee, 2024) (refer Figure 8-17 to Figure 8-20.
		• CoR aims to avoid pre-summer nourishment due to the wind-blown sand that can come with wider beaches. Alternatively, CoR also like to have wide beaches for summer public amenity.
		• CoR completed a CHRMAP in 2019 (City of Rockingham, 2019) endorsed by council in September that same year. Findings and recommendations included:
		    • Significant public infrastructure and residential and commercial property is predicted to be highly vulnerable in the short term, requiring interim protection. For this area, avoiding further development is the recommended long-term pathway, with managed retreat of infrastructure recommended when it becomes either unsafe or unserviceable.
		    • CoR recommended a study be undertaken to develop short-term mitigation options addressing the vulnerability of the coastline adjacent to the Hymus St. coastal access (Chainage +1300m).
		    • Managed retreat (long-term) of all built assets is recommended for the coastline extending from the Causeway (+0m) to Hymus St (+1300m). Long-term protection has been recommended from Hymus to Victoria St (+1300m to 600m NE of hotspot boundary).

8.	**Performance / Effectiveness of coastal management measure/s**	**Causeway to Palm Beach boat ramp (west) (+0m to +1750m)** Mid-term shoreline mapping (10 years) indicates that this coastline has remained very stable with some accretion observed the westernmost 200m adjacent to the Causeway (one metre per year). Short term mapping (five years) indicates a similar trend of accretion at the westernmost 200m (one metre per year), and stable coastline the remaining section. The informal seawall adjacent to Hymus St is in poor condition, with erosion above limestone armour, likely caused by storm run-off or wave overtopping. Very little frontage exists between this location and the road immediately adjacent, increasing the importance on this structure to perform as intended. From the site visit undertaken, scarping is also present immediately west of the seawall structure (refer Figure 8-21). **Palm Beach boat ramp (west) to Wanliss St carpark (+1750m to +3650m)** Both mid (10 year) and short-term (five year) mapping indicates stability along this

ID	Category	Content
		stretch of coastline. The Flinders Lane GSC seawall is functioning as intended (last line of defence) with significant sand and vegetation burying the structure. Some bags appeared damaged during the site visit (19 September 2025) with emptied containers and vandalised holes present in those exposed. The ability for vegetation to establish above the GSC seawall is a strong indicator that this section of coastline has remained sufficiently nourished, since the seawall construction in 2004.
9.	Recommendations & lessons learnt	**Coastal monitoring** • As described in the CHRMAP (City of Rockingham, 2019), we recommend the continuation of regular monitoring of coastal transects by CoR. Enabling them to make informed decisions for acute nourishment of threatened beaches. • Given the limited coastal buffer separating infrastructure and shoreline, detection of small changes to the vegetation line may be observed after damage has already been incurred. Typical accuracy of vegetation line mapping +-3m, and the use of vegetation as a proxy for shoreline movement therefore is limited along this shoreline, and instead regular inspection and photo monitoring should be prioritised, particularly following storm events. • It is recommended that bathymetric survey within the nearshore coastline (up to 100m offshore) is undertaken on a 5-year interval to support the vegetation line mapping findings. **Coastal investigation** • It is recommended that an additional groyne structure (west of the existing groyne) is investigated to support the Hymus St. seawall, as well as a rebuild of the existing structure to better protect the adjacent road infrastructure. Additionally, fencing should be modified to restrict pedestrians climbing down the seawall. CoR have estimated a cost of $1.7M to replace the seawall with a new design suitable to accommodate the road extension. **Coastal management actions** • Active beach nourishment undertaken by CoR is continuing to be a successful management action maintaining a stable coastline. • Minor volumes of accreted sand from chainage 0 to +300m could be considered to nourish beaches west of Hymus St. seawall on an ad hoc basis. • It is recommended that CoR undertakes patch repairs to exposed GSC holes from vandalism at the Flinders Lane seawall (refer Figure 8-1). Any rebuild of this structure should be delayed as long as possible, using acute nourishment to defend the structure from potential scour. Future rebuild is best planned once repeated scour scenarios are observed and will likely require significant works to complete.

Figure 8-1: Photo taken of vandalised GSC located within the Flinders Ln seawall, approximate chainage +3300 m. Taken during site visit 18 September 2024.

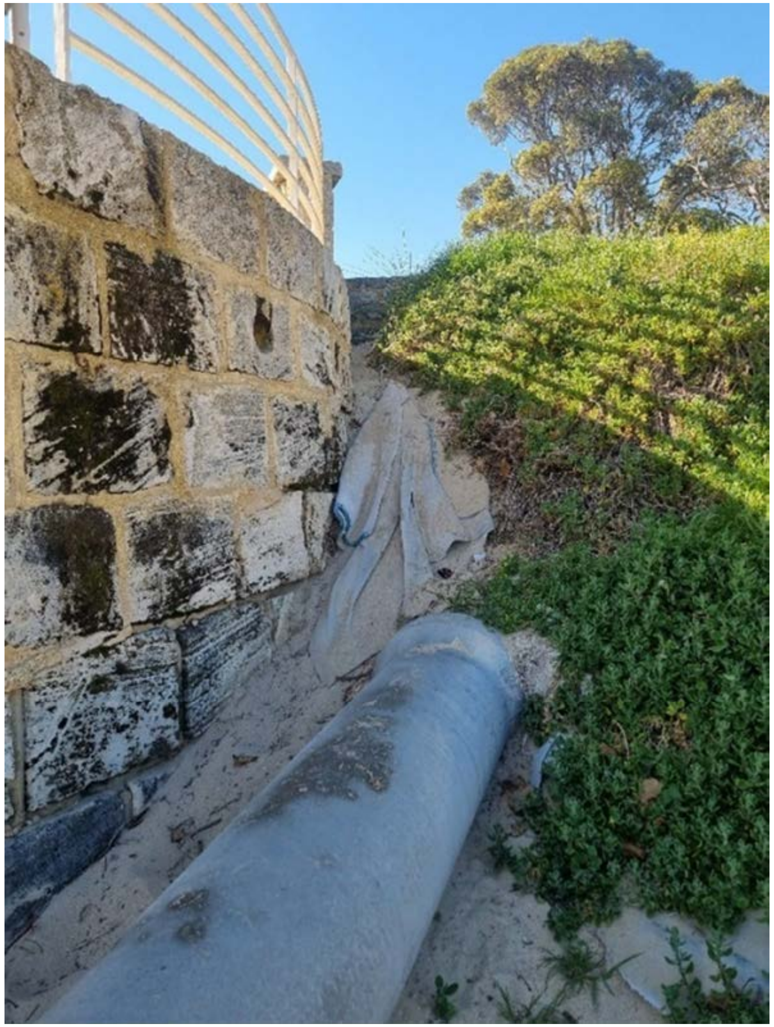

Figure 8-2: Photo taken of empty/damaged GSC within the Flinders Ln seawall, approximate chainage +3300 m. Taken during site visit 18 September 2024.

Figure 8-3: Photo taken of empty/damaged GSC within the Flinders Ln seawall, approximate chainage +3300 m. Taken during site visit 18 September 2024

Figure 8-4: Photo taken of revegetation above Flinders Ln GSC seawall, approximate chainage +3350 m. Taken during site visit 18 September 2024.

Figure 8-5: Photo taken of damaged GSC within the Flinders Ln seawall, approximate chainage +3375 m. Taken during site visit 18 September 2024.

Figure 8-6: Photo taken of revegetation above Flinders Ln GSC seawall, approximate chainage +3370 m. Taken during site visit 18 September 2024.

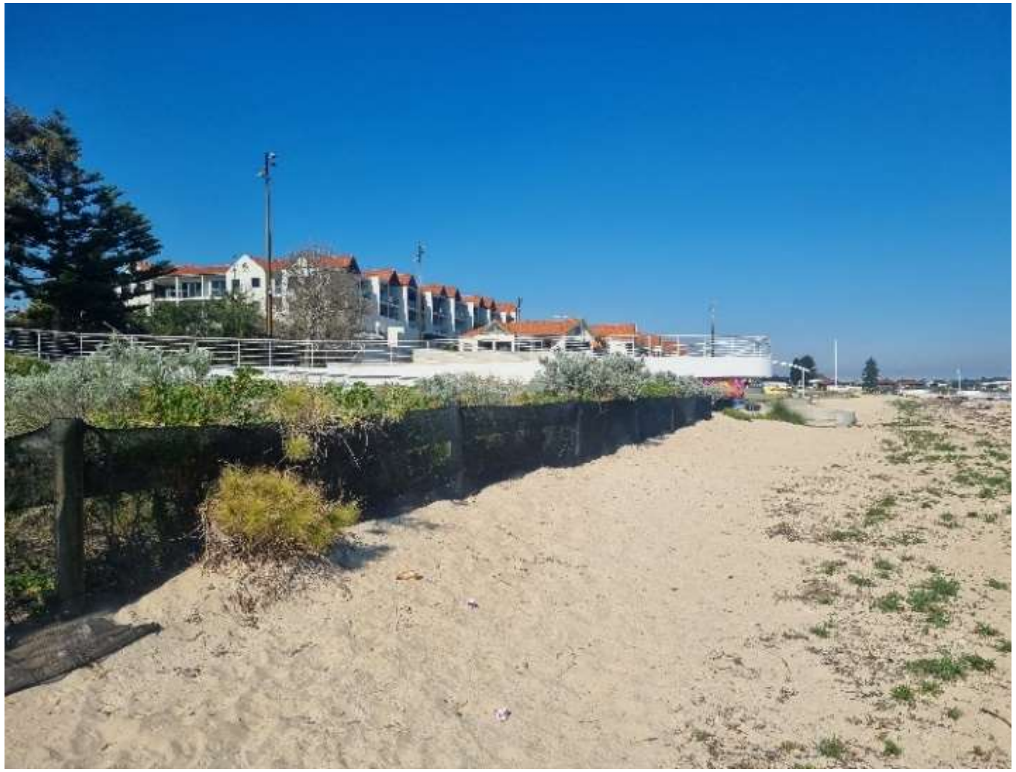

Figure 8-7: Dune vegetation fencing along the Val St. foreshore (+3025m). Taken during site visit 18 September 2024.

Figure 8-8: Val St. foreshore concrete retaining structures (+3000m). Taken during site visit 18 September 2024.

Figure 8-9: Val St. foreshore concrete retaining structures (+2925m). Taken during site visit 18 September 2024.

Figure 8-10: Val St. foreshore concrete retaining structures (+2925m). Taken during site visit 18 September 2024.

Figure 8-11: Hymus St. timber groyne (+1350m). Taken during site visit 18 September 2024.

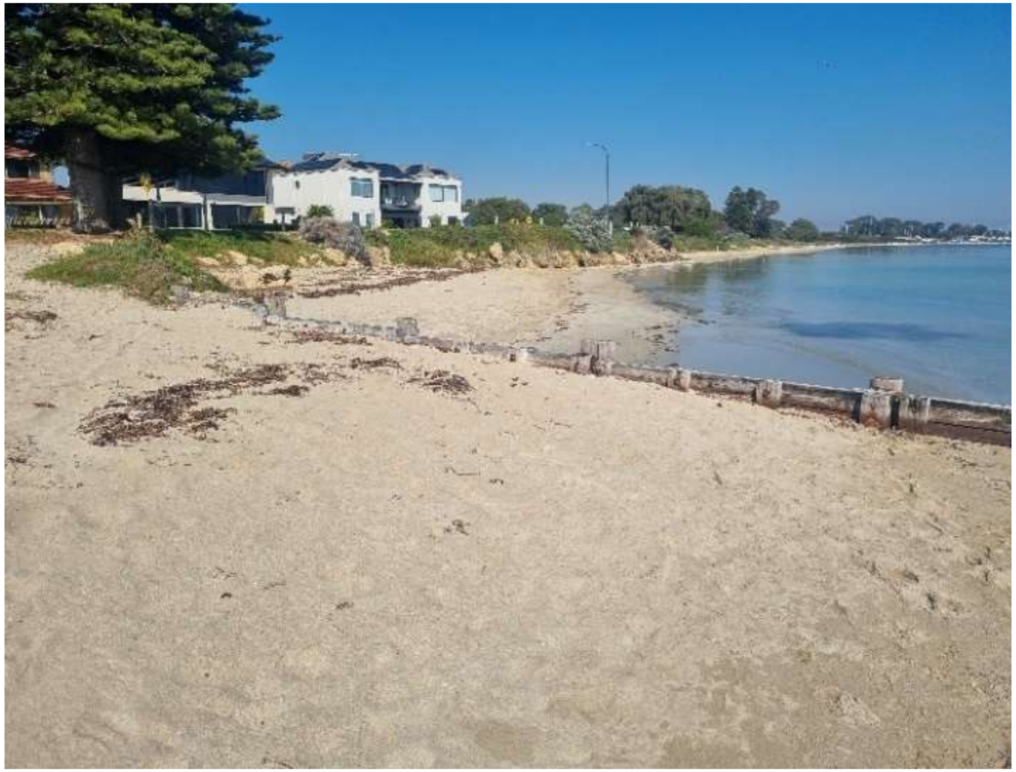

Figure 8-12: Hymus St. timber groyne and informal seawall (+1350m). Taken during site visit 18 September 2024.

Figure 8-13: Hymus St. timber groyne and informal seawall (+1375m). Taken during site visit 18 September 2024.

Figure 8-14: Hymus St. timber groyne (+1350m). Taken during site visit 18 September 2024.

Figure 8-15: Hymus St. informal seawall (+1375m). Taken during site visit 18 September 2024.

Figure 8-16: Slope erosion at Hymus St. informal seawall (+1375m). Taken during site visit 18 September 2024.

Figure 8-17: Slope erosion at Hymus St. informal seawall (+1375m). Taken during site visit 18 September 2024.

Figure 8-18: Brushing applied to erosion at Hymus St. informal seawall (+1375m). Taken during site visit 18 September 2024.

Figure 8-19: Scarping present immediately west of Hymus St. informal seawall (+1300m). Taken during site visit 18 September 2024.

Figure 8-20: Slope erosion at Hymus St. informal seawall (+1375m). Taken during site visit 18 September 2024.

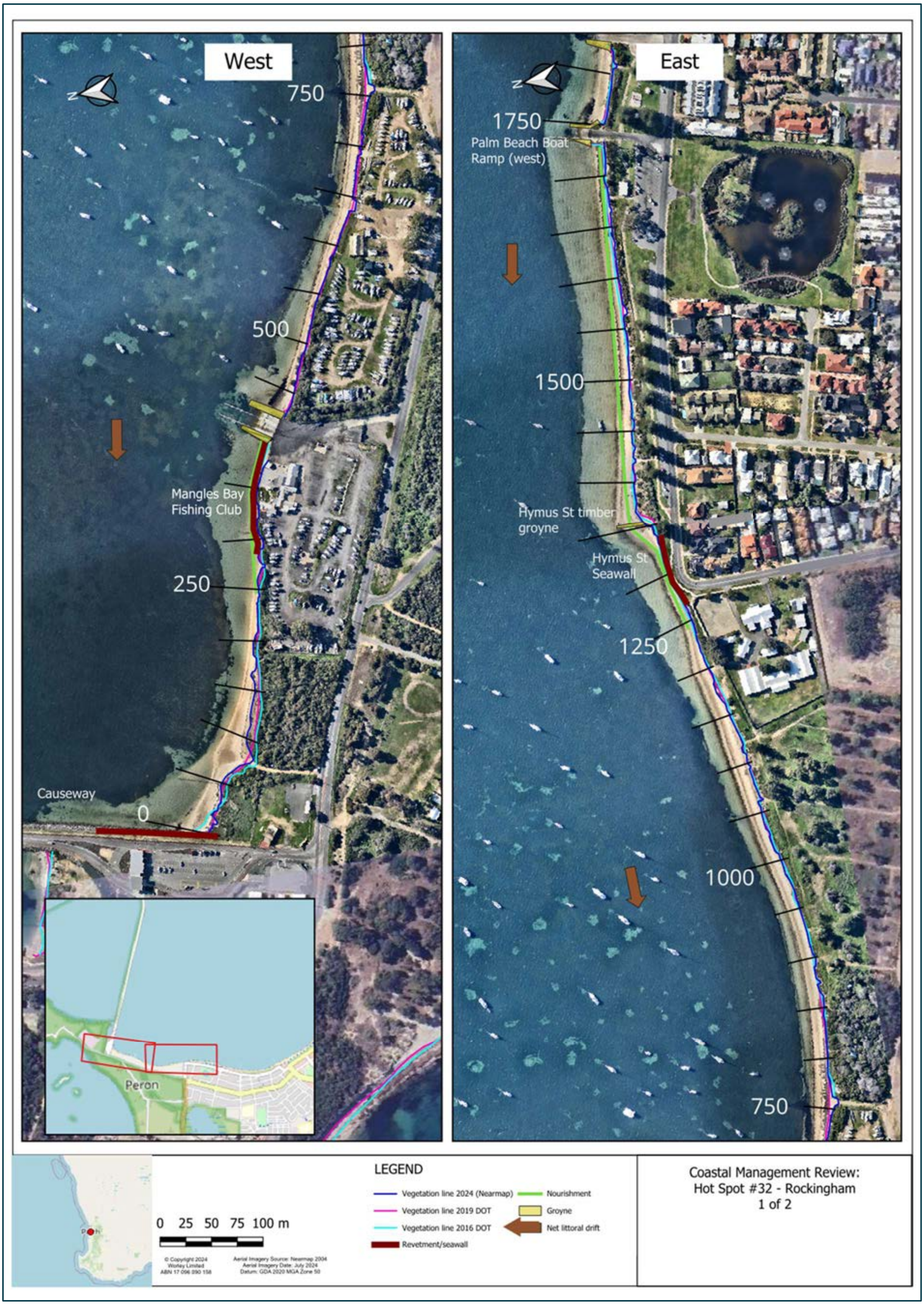

Figure 8-21: Rockingham - coastal management schematic (1 of 2)

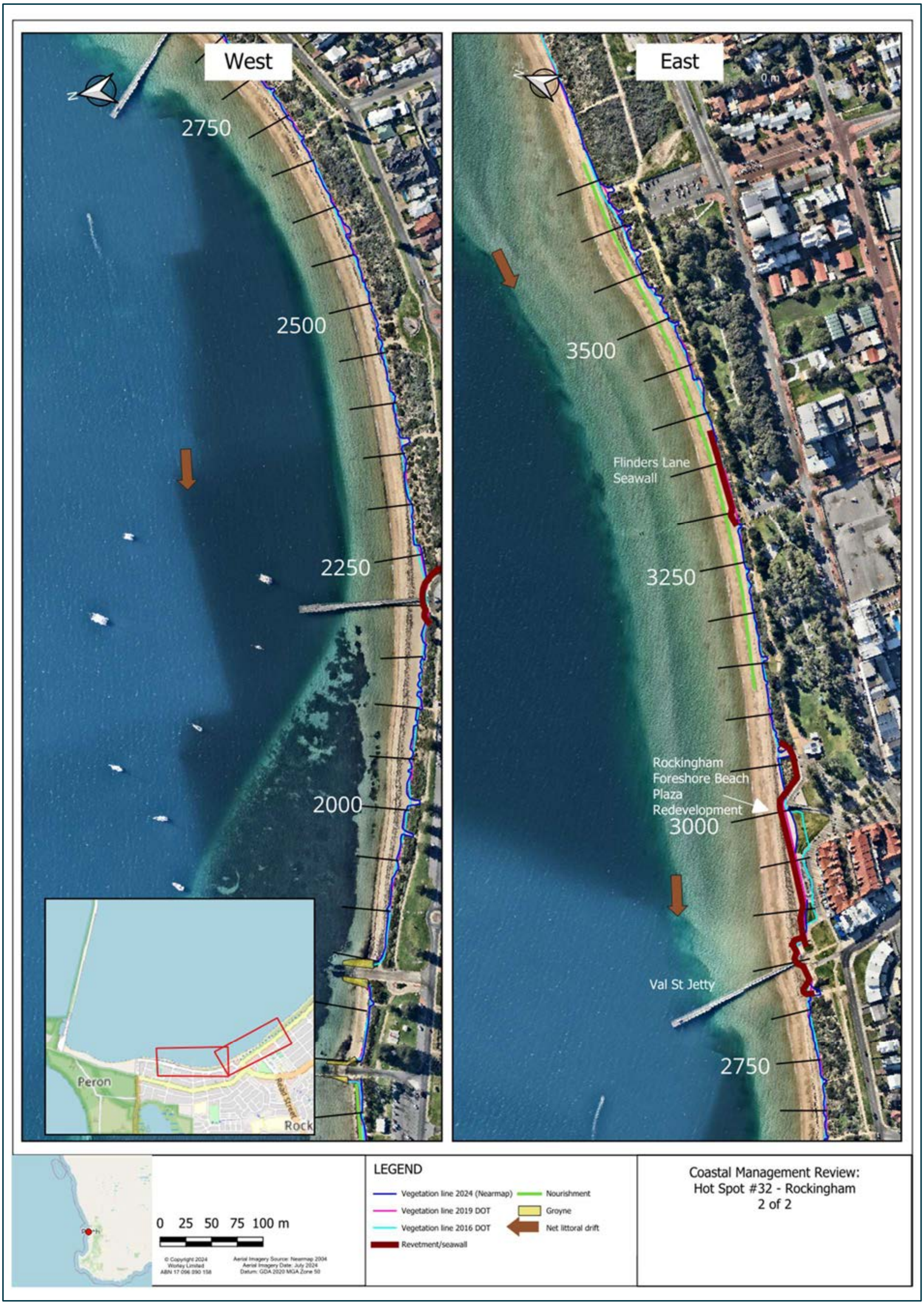

Figure 8-22: Rockingham - coastal management schematic (2 of 2)

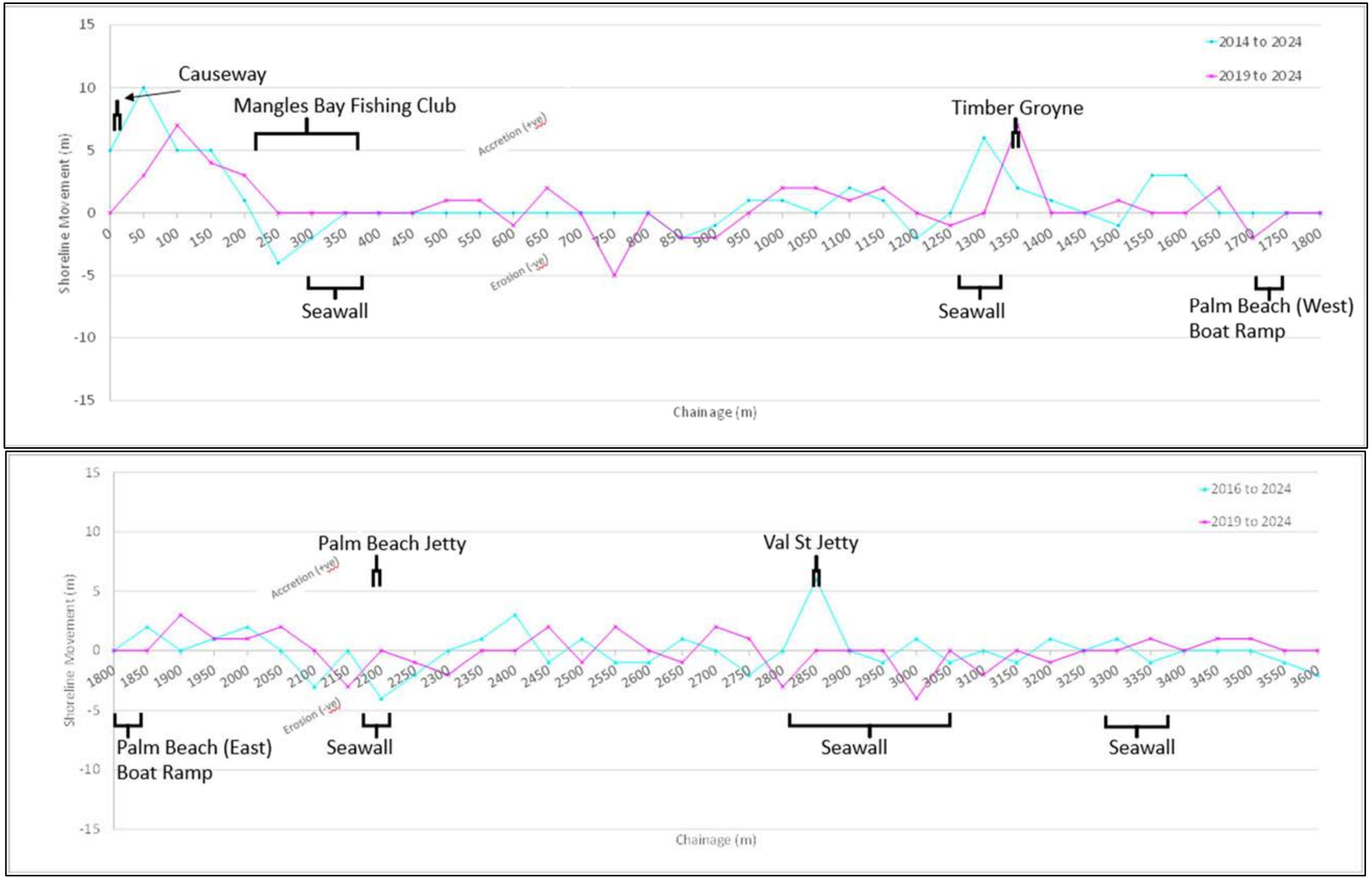

Figure 8-23: Results of Rockingham shoreline mapping, showing short and mid-term changes, for chainage reference refer to Figure 8-21 and Figure 8-22

9. North Point Peron

ID	Category	Content	
1.	**Site name / Date review complete**	North Point Peron	February 2025
2.	**Key details**	LGA: City of Rockingham (CoR) Townsite: Rockingham Hotspot ID: #33	
3.	**Summary of erosion issue**	This coastline from Point Peron to the Garden Island Causeway has been classed as a DoT coastal erosion hotspot with significant shoreline movements occurring since construction of the Causeway in 1976. As a result of the construction, the sediment movement between Mangles Bay and Cape Peron was interrupted resulting in erosion at the western end of the coastline and accretion at the eastern end (M P Rogers & Associates, 2010). The area includes the Point Peron Boat Ramp Facility, which is located immediately to the west of the Garden Island Causeway. The facility's ocean entrance has a large limestone breakwater and a spur groyne, which were extended and refurbished in 2022. The Department of Biodiversity Conservation and Attractions (DBCA) is responsible for the management of the Rockingham Lakes Regional Park, which includes all land and the foreshore extending west of the sand trap. The eastern portion of the hotspot has accreted some 90m since the causeway was constructed, with 50m of this occurring after construction of the spur groyne outside of the Point Peron Boat Ramp Facility (DoT, 2009). Throughout the past 50 years, the western end of the hotspot has been relatively stable when compared to the eastern end. Excavation of sand accumulated at the boat ramp, and the sand trap was undertaken periodically during the 1990's. Since 2000, excavation has been undertaken twice yearly. During 2006 storms 15 m of acute erosion was observed in front of the oval of the Point Peron Camp School (DoT, 2009).	
4.	**Overview of key coastal processes**	The Northern Point Peron coastline from Point Peron to the Garden Island Causeway coastline stretch is highly dynamic and is exposed to ongoing tidal action, wave processes, storm surges, longshore drift, erosion, and deposition. Over time, the coastal area will face effects of sea level rise, storm surges, and alterations in sediment patterns. The tidal environment in Rockingham is known as microtidal experiencing a tidal range of less than two metres between high and low tides. The swell waves reaching the coastline typically originate from the southwest. During summer months, sea waves are driven by easterly winds in the mornings and south-south westerly in the afternoons. During winter months, the sea waves are generated from winter storms often arriving from the northwest (DoT, 2009). Along this coastline. sediment is transported to the east towards the causeway resulting in erosion at the western section of the beach and accretion at the eastern section of the beach due to swell waves from the southwest. The annual net sediment transport has been estimated in the order of 10,000 m3 to the east (DoT, 2009). The eastern portion of the beach has accreted 90 m since the construction of the causeway, with 50 m of this occurring after the construction of the additional spur groyne in 1990. Prior to the Point Peron structural upgrade in 2021, there was significant leakage of sand over and around the breakwater into the Point Peron Boating Facility (M P Rogers, 2010). As reported in Stul et al. (2014) this hotspot stretches along the entire secondary sediment cell #15 from Cape Peron to the west, and the Causeway to the east. The boundary at Cape Peron is reported as a point type that is fixed due to the rocky headland restricting the movement of sediment annually. The boundary at the causeway is also a point type that is fixed due to the engineered structure being a hard barrier to sediment transport west-east.	

ID	Category	Content
5.	**Overview of historical coastal management actions**	The following coastal management measures have been taken along this hotspot: • 1973, construction of Garden Island Causeway, initial groyne and boat launching facility at Point Peron • 1986, construction of eastern spur groyne at the entrance to Point Peron Boat Ramp Facility • 1988, original 170m long State Government seawall constructed • 1990, northern spur added to groyne • 2013, GSC groyne construction and capital nourishment of beach north-east of Point Peron Camp School • 2013, 2014 and 2024, nourishment (backpassing) of beaches west of sand trap • 2021, informal GSC revetment built adjacent to the Camp School gate/fence line • 2022, extension and upgrade to Point Peron seawall and spur groynes • 2022, Rock rubble revetment built by DBCA • Excavation of sand trap, twice annually, before and after winter. The screened sand is then reused by CoR for beach renourishment activities, including at Kwinana Beach. Each excavation is approximately 5,000 m^3 (with a total annual excavation of approximately 10,000 m^3) it should be noted that excavation volumes seem to have increased in recent years (21,000m^3 – 22,000m^3 removed in 2020). • In addition to the excavation outlined above, it has been reported that twice annual excavation of sand from the boat ramp harbour typically consisted of 2,500m^3 per campaign (prior to the 2021 upgrade), or 5,000m^3 annually (Advisian, 2021).
6.	**Management issues and challenges**	• GSC groyne is at end of design life, DBCA has concerns about the impact that degradation of plastics is having on the adjacent marine park (Fisher, 2024). • There has been gradual erosion of the foreshore adjacent to the GSC groyne, resulting in erosion at the terminal end of the groyne. As surge can now pass behind the groyne it's effectiveness is expected to reduce. Increased damage and breaching of the structure is expected in the future. • There is a division in coastal management responsibilities across the hotspot, which in turn influences coastal management responses e.g. a memorandum of understanding between DBCA and CoR is required to undertake sand nourishment of the DBCA managed area using sand from the Point Peron sand trap • The playing fields that belong to the Point Peron Camp School are very low lying, falling within a 1 and 5 year annual recurrence interval (ARI) inundation experienced in 2017 (Cardno, 2018). • The Point Peron Camp School is a significant recreational asset for DBCA. It is understood that DBCA may upgrade some facilities in the Camp School lease area in the future, with consideration of potential risks identified through the CHRMAP and the facilities to be upgraded. • Water Corporation is currently constructing a new treated wastewater transition tower at the Point Peron Wastewater Treatment Plant site, with the new tower expected to be operational until 2040. The new tower will enable the closure of the Point Peron Wastewater Treatment Plant, expected 2030 (City of Rockingham, 2019). • CoR are required to balance multiple coastal impacts when making coastal management decisions at this hotspot: a) erosion of the beach adjacent to GSC groyne, b) capacity of the sand trap and c) accumulation of sediment at the Point Peron boat ramps if the sand traps reach capacity.

7.	**Current management focus**	• The CHRMAP (Cardno, 2018) outlined that due to the low concentration of vulnerable assets in the sector and their lower economic value compared to other CoR assets, a managed retreat approach should be adopted for all built assets along this hotspot. Potentially vulnerable land uses and responsible authorities in this sector include:
		  ◦ Point Peron Reserve and leased land, DBCA
		  ◦ Point Peron Wastewater Treatment Plant, Water Corporation (Water Corporation to consider protection of individual assets in the long-term)
		  ◦ Garden Island Causeway abutment, Department of Defence (expected to protect assets as necessary to maintain causeway access to Garden Island)

ID	Category	Content
		• Point Peron boat ramp, City of Rockingham (not expected to be impacted until end of design life) Ongoing short-term management includes: • sand extraction at the Point Peron Boat Harbour Facility's sand trap of approximately 10,000 m^3 per annum. • ad hoc extraction of sand from within the Point Peron Boat Harbour Facility (prior to 2021 upgrade 5,000m^3 annually). Additionally in 2024 (for the first time since it's construction in 2013) CoR undertook ad hoc nourishment of the beach adjacent to Point Person GSC Groyne using approximately 3,000m^3 of sand sourced from the Point Person sand trap.
8.	**Performance / Effectiveness of coastal management measure/s**	**Causeway to GSC Groyne (+0m to +750m)** The most significant changes have been observed along a 300m stretch of beach between the two groynes (+500 to +800m). In this location, mid-term shoreline mapping indicates that up to 37 metres of beach has been lost to erosion in the last eight years, averaging four to five metres per year. Short-term monitoring has confirmed that this erosion trend has become more severe in the most recent five years, losing approximately 28m, an average of five to six metres per year. Survey profiles undertaken at the same location between July 2018 and February 2020 (JBA Surveys, 2020) also confirm the loss of ~13m of aerial beach width. Although not directly impacted by the sand scraping/trap activities, it is understood that littoral transport stressors are being transferred updrift of the sand trap. **GSC Groyne to end (+750m to +1650m)** Mid-term shoreline mapping indicates that erosion has occurred along the entire pocket beach extending from +800m to +1100m with the most significant up to 17 metres of beach occurring immediately east of the DBCA revetment, averaging two metres per year. Short-term monitoring has confirmed that this erosion trend has accelerated in the past four years, losing approximately 17m, an average of four metres per year. Analysis of aerial imagery shows the dune blow-out worsening where this erosive trend has been observed in both short and mid-term vegetation line mapping. It is likely that wave reflection off the DBCA revetement is continuing to focus wave action and erosive forces onto this location. **Point Peron Boat Ramp Facility – rock structures** The condition was not assessed due to excavation activities occurring during the site visit. It is assumed that this is in excellent condition due to the recent upgrade works. **GSC Groyne** The GSC groyne is deteriorating with bags slumping and rips apparent (refer Figure 9-2 and Figure 9-3. The combination of overtopping (associated with the low crest) and erosion on the down drift side could have led to recent erosion immediately west of the structure. In addition, it appears that the upgraded DBCA revetment may have interrupted the sediment supply into the compartment west of the groyne contributing to retreat on either side of the groyne. The groyne appears to be holding the vegetation line, however it is understood that this will erode quickly once more bags continue to fail and slump. **DBCA revetment** During the site visit 18 September 2024 , the revetment appeared in excellent condition, with well interlocked armour, consistent slopes (refer Figure 9-7 and Figure 9-8), and no signs of core exposure. This is expected given the recent upgrade was completed 2022.
9.	**Recommendations & lessons learnt**	**Coastal monitoring** • It is recommended that beach monitoring is continued on a biannual basis via

ID	Category	Content
		use of LIDAR equipped drones, or RTK transects to quantify sand present, and justify the excavation volumes targeted for removal from the sand trap. **Coastal investigation** • It is recommended that excavation/scraping volumes taken from the sand trap are re-assessed to confirm the correct volumes are removed by CoR on a campaign and annual basis. Removing excessive sands beyond the net littoral transport volume could have resulted in the shoreline attempting to correct the orientation and erode between chainage +450m to +750m. It is understood that spur groyne extension modelling has predicted sediment accumulation between 9,000m^3 to 16,000m^3 depending on the storminess of the season (Advisian, 2021). • It is recommended that to ease the demand of sand from the Point Peron sand trap, alternate sand sources are investigated to support the nourishment of City of Rockingham beaches in the longer-term horizon. • Should the GSC groyne undergo replacement, it is recommended that the new structure is either extended, raised or rebuilt. Alternatively, replacement with a short, low crested groyne could be combined with an additional small groyne updrift in order to directly widen the beach adjacent to the Camp School. Coastal investigation should compare the viability of each of these options, and costs associated with protecting against future inundation events. **Coastal management actions** • The GSC groyne is deteriorating and due for replacement with bags slumping and rips apparent. Replacement should consider the outcome of the investigation above. • Allowance for some of the sand trap material to be backpassed on a periodic basis should be considered to ensure that the beaches west of the sand trap do not erode excessively and risk impacting infrastructure adjacent. • During the site visit (18/09/24), it was noticed that a gap between fencing and the north-western end of the DBCA revetment is being used by pedestrians to informally access the beach adjacent. It is recommended that this is addressed by extending the fence or positioning armour rock to reduce the impact to the dune. • It is recommended that the dune scarping/blow-out (+1050m), is revegetated with the use of jute matting and access restricted to reduce impact of foot traffic on this dune. • Future planning of land use at the Point Peron Camp School should consider the latest CHRMAP, specifically the hazards, the lifespan and nature of any future infrastructure and adaptation proposed. Consultation with DBCA during future revisions of the CHRMAP is recommended given they are a coastal land manager.

Figure 9-1: GSC groyne neck, approximate chainage +750 m. Taken during site visit 18 September 2024.

Figure 9-2: Sagging GSC groyne. Taken facing north during site visit 18 September 2024.

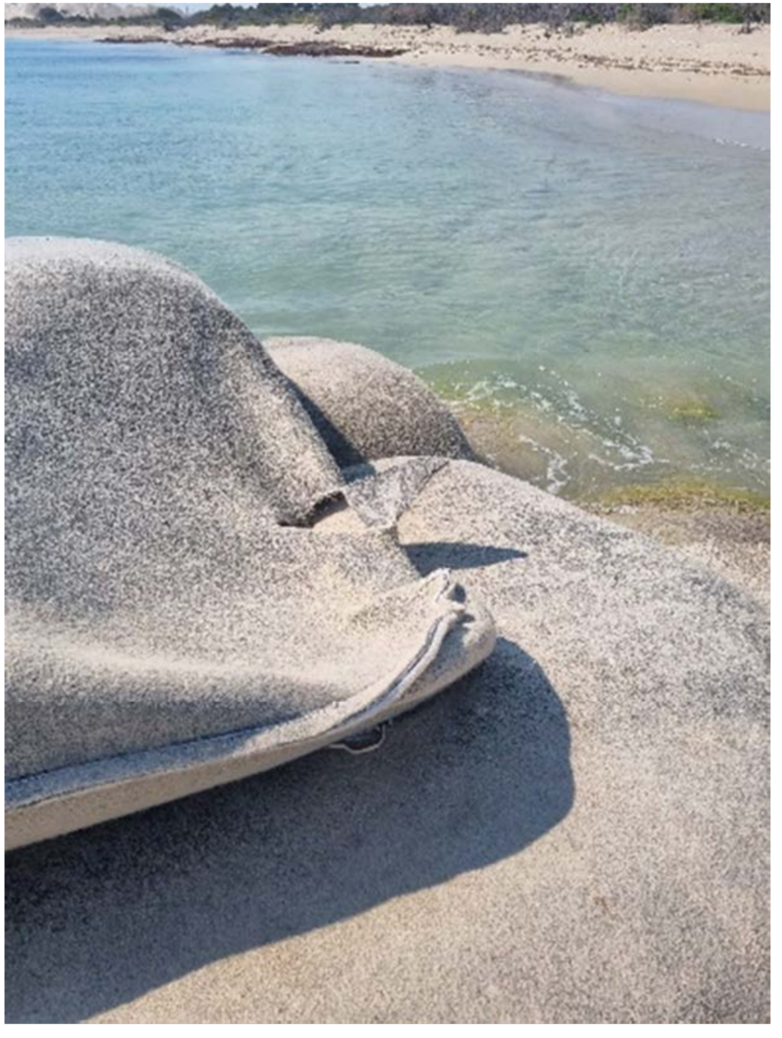

Figure 9-3: Ripped bags at neck end of GSC groyne. Taken during site visit 18 September 2024.

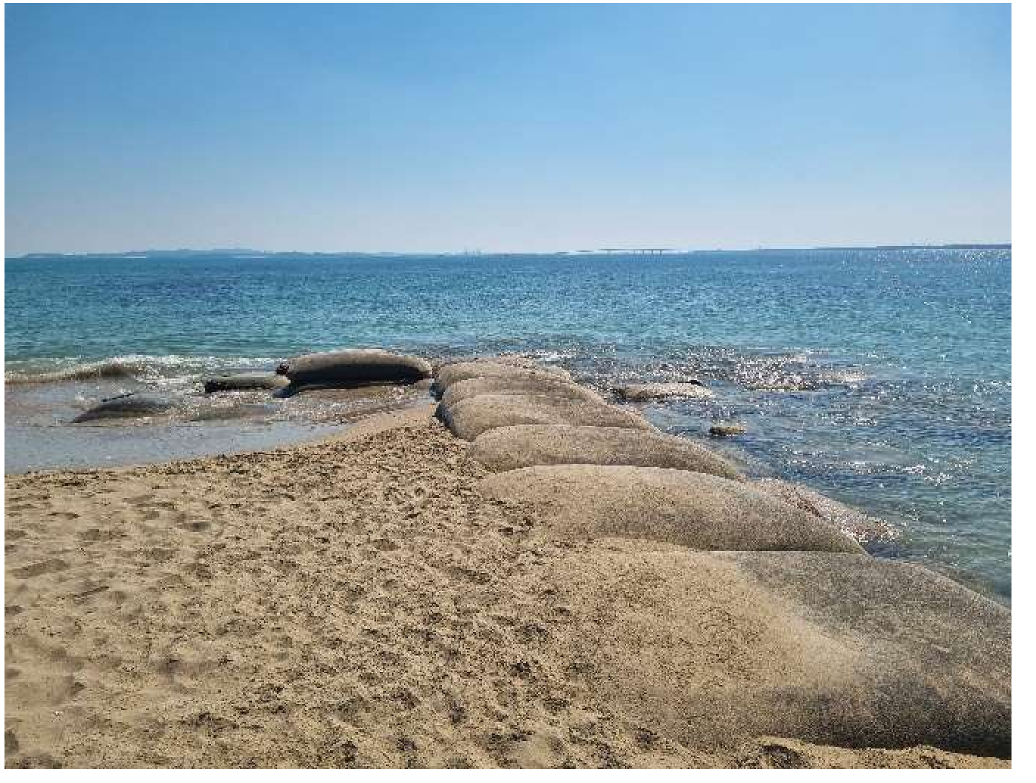

Figure 9-4: Slumping at head of GSC groyne. Taken during site visit 18 September 2024.

Figure 9-5: Dune scarping in distance (+3050m), adjacent to the Point Peron holiday camp. Taken facing west during site visit 18 September 2024.

Figure 9-6: Carpark end of DBCA revetment (+3100m) taken facing west during site visit 18 September 2024.

Figure 9-7: DBCA Revetment (+1200m). Taken during site visit 18 September 2024.

Figure 9-8: DBCA Revetment (+1150m). Taken during site visit 18 September 2024.

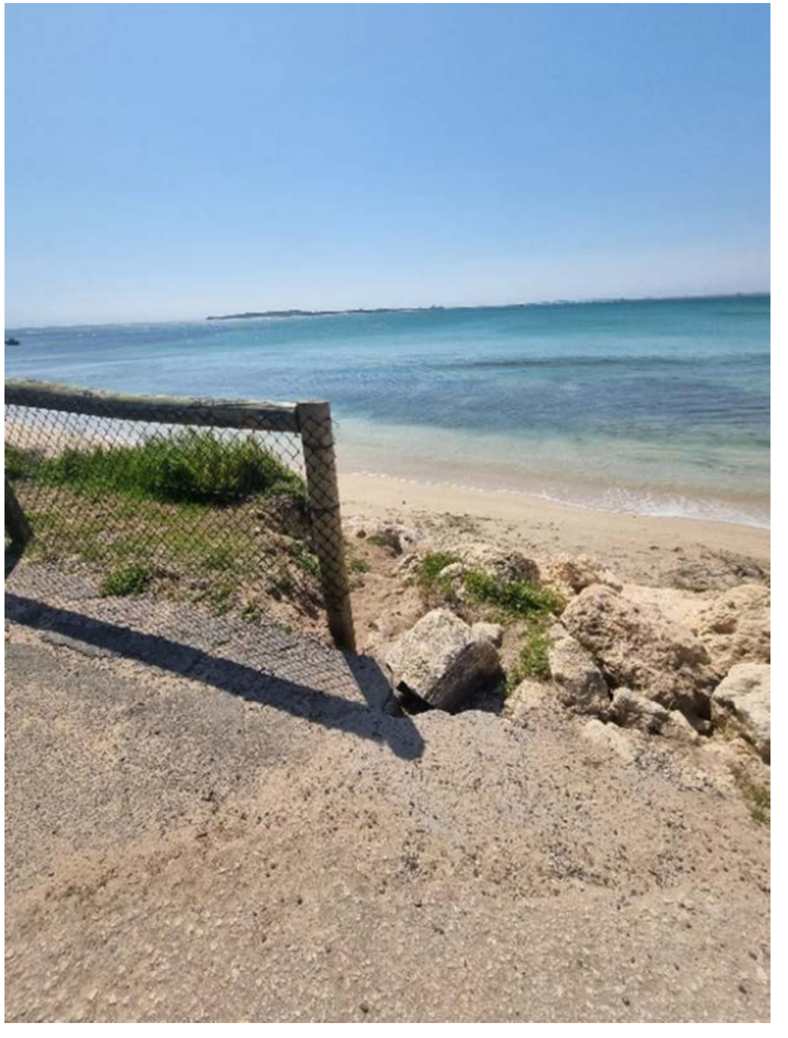

Figure 9-9: Informal beach access (+1270m) at western end of DBCA revetment. Taken during site visit 18 September 2024.

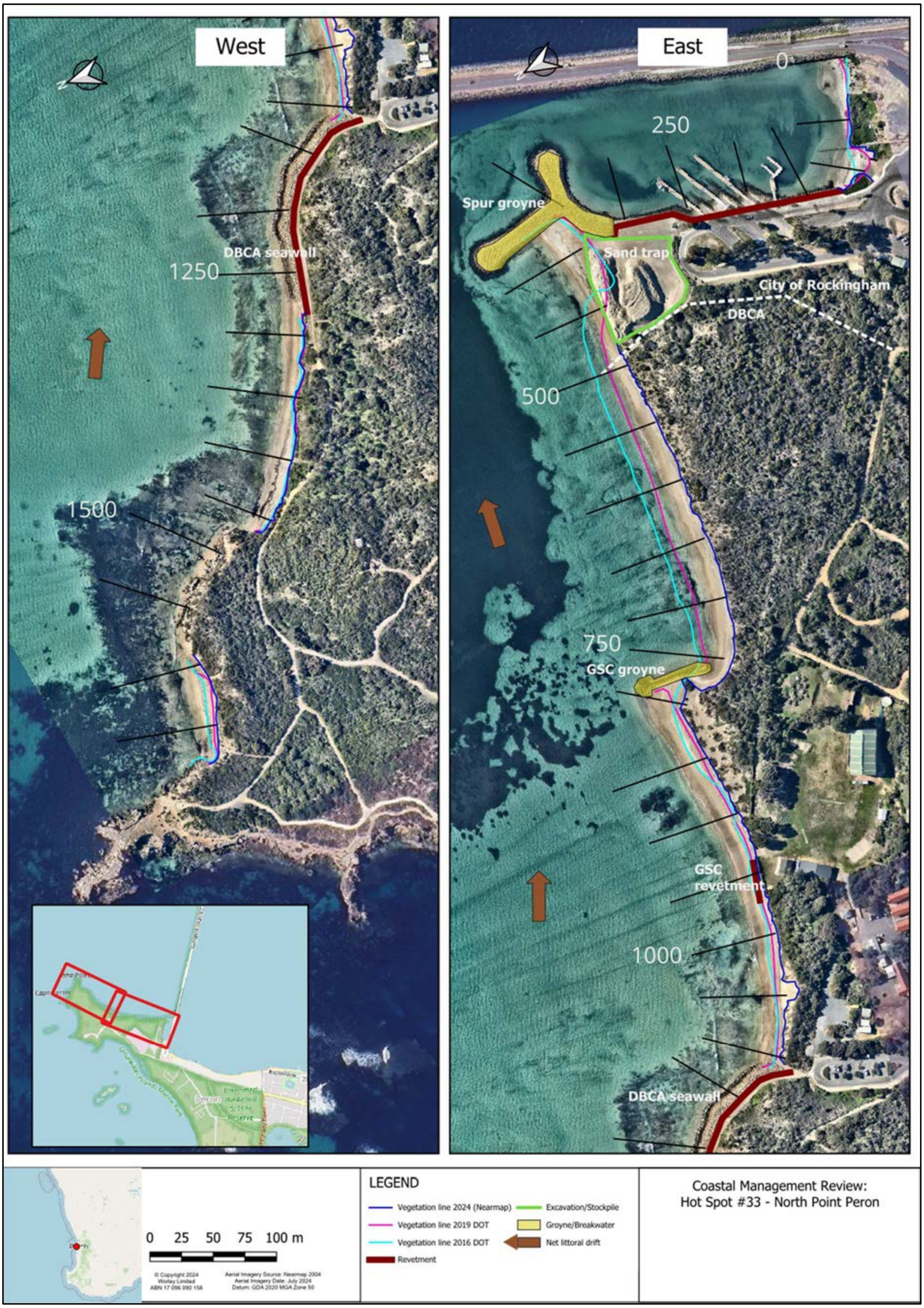

Figure 9-10: North Point Peron - coastal management schematic.

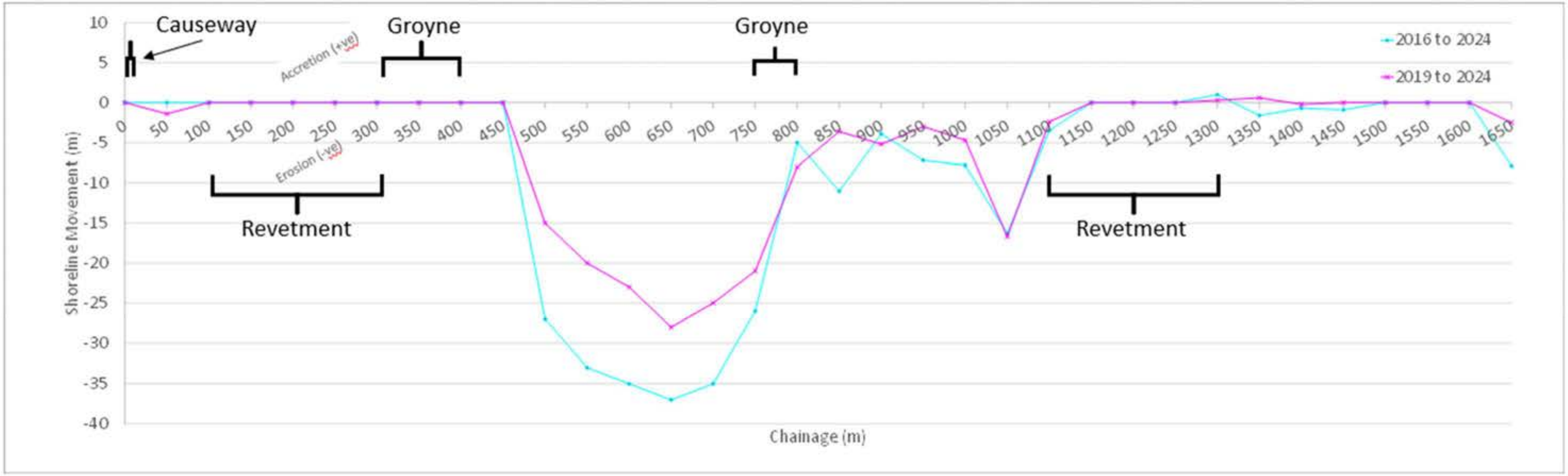

Figure 9-11: Results of North Point Peron shoreline mapping, showing short and mid-term changes, for chainage reference refer to Figure 9-10.

10. Mandurah Northern Beaches

ID	Category	Content	
1.	**Site name / Date review complete**	Mandurah Northern Beaches	October 2024
2.	**Key details**	LGA: City of Mandurah (CoM) Townsite: Mandurah Hotspot ID: #36	
3.	**Summary of erosion issue**	The Mandurah Northern Beaches have had an ongoing erosion problem since initial development modified the foredune. Downdrift erosion trends along these northern beaches have been caused by training walls at the Mandurah channel and marina seawalls limiting sediment availability. The site under analysis has been expanded from the 1.7 km extent covered by hotspot 36 (Seashore, 2019) to 5.5 km within this report. The new extent now includes the southern extent of the Town Beach seawall, extending up to 500 m north of the Fifth Groyne (San Remo) to include watchlist site 23, Old San Remo Townsite (refer Figure 10-10, Figure 10-11Figure 12-21, and Figure 10-12). Annual sand bypassing introduces sand at the Town Beach southernmost end , and a series of five rubble mound groynes have been the key measure used to combat erosion trends. The foreshore is reliant on this sand bypassing, with the rate of bypassing not always matching the sediment demand required to stabilise the coast (Seashore, 2019) Seashore (2019) originally identified San Remo as a watch spot site (W23) which warranted it's inclusion in the northern end of this site summary. San Remo has observed significant erosion stress in recent years. More than 40 access ways exist along the site extents, for pedestrian and emergency vehicle access. Annual storm events create scarping, ranging from one to three metres along path and beach transitions. The majority of these require annual fencing and earthwork maintenance by CoM following erosion events. As described in the Mandurah Northern Beaches CHRMAP (GHD, 2022), generally the northern beaches have more exposure to erosion risk than inundation, with risk from inundation primarily observed around lower lying areas of the Mandurah Marina. Erosion events: • Winter 2021, Watersun Drive lookout observation deck • Winter 2021, five metres of dune were lost horizontally at San Remo Beach • 2009 and 2011, erosion to emergency vehicle access and Fourth Groyne (Wade St) Groyne neck. • Winter 2009, Watersun beach dune scarping and access stair erosion • Annual scarping of all access ways	
4.	**Overview of key coastal processes**	As reported in Stul et al. (2014) Mandurah Northern Beaches are located within a secondary sediment cell stretching from Robert Point in the south, to San Remo in the north. Mandurah Northern Beaches fall within the tertiary cell 10a. The boundary at Robert Point is reported as a zone type and ambulatory with sediment transport crossing the cell openly. The boundary at San Remo is reported as a point type with fixed location where sediment is also transported across the cell openly. Doddi's beach (where bypassed sand is excavated) is located within the same tertiary system as the Northern Beaches. Therefore any changes to the quantity and timing of the bypassing will have direct impact on the sediment accumulation along the Northern Beaches. The typical rate of net sediment transport at the Mandurah Northern Beaches was estimated at approximately 120,000 m^3/year from south to north by M P Rogers and Associates in 1999. Approximately 110,000 $m^3$of this was assumed introduced from bypassing activities, and 10,000 m^3 is from the onshore feed of material from Fairbridge Bank. Since this estimate, bypassing quantities have increased significantly, with coastal response still indicating an erosive trend. Therefore, the net longshore drift may be as high as ~200,000 m^3/year.	

ID	Category	Content
5.	**Overview of historical coastal management actions**	• Up until 1995 sand bypassing of the Mandurah Channel was relatively ad hoc, typically undertaken prior to the commencement of the rock lobster season (M P Rogers & Associates, 1999). • Sand bypassing (excavated from Doddi's beach, with slurry discharged at Town Beach) since 1995 has been undertaken as an annual campaign during winter/spring months, with quantities trending higher each year (180,000 m^3 was pumped during 2023). • Between 1998 to 2005 bypassing quantities remained relatively consistent ~100,000m^3 annually. • Bypassing quantities have increased an average of 4,500 m^3 every year (BMT, 2023) since 1995. • CoM maintains more than 40 access ways along this section of the coast every year. This typically involves fence trimming where posts have been washed out at the beach end of access ways, pushing of wind-transported sand back down access ways to regrade surfaces and small-scale beach scrapings used to build up erosion scarps at the end of the beach access ways and drop-offs from a few staircases.
6.	**Management issues and challenges**	• Public safety concerns from steep erosion scarps along the beach following erosion events are frequent. Scarps up to five metres high have been experienced along Watersun Beach. They can be unstable and collapse if not managed carefully. • Discharge of bypassed slurry onto Town Beach has remained a consistent risk during annual campaigns. • Town beach seawall was never constructed as per the original design. In addition CoM fills in voids annually along crest of seawall to minimise risk to public safety. • Sand bypassing is undertaken for only half of the year –during this operation slugs of sand accumulate at Town Beach and erosion relief from accretion to beaches further north is delayed until material is transported northwards from natural processes. • In 2018 the seawall along Town Beach was inspected, and a new design was developed for its upgrade and extension. The extent of the upgrade was reduced in 2024. • Investigation of numerous alterations to the northern beach's groyne fields, has been undertaken by M P Rogers & Associates (2011). Within this study, it was determined that breaking annual bypassing into a two stage regime is likely to soften the erosion pressures along the coastline. In addition, the study recommended back-passing sand from north of San Remo in order to manage acute nourishment at various locations along the coastline.
7.	**Current management focus**	Prior to the formalisation of the WA CHRMAP guidelines (supporting SPP 2.6) CoM commissioned a risk assessment and adaptation plan in 2009 (Coastal Zone Management, 2009). This study outlined key risks to the coastline and offered potential solutions available. Following this a CHRMAP in line with state planning guidelines, was undertaken by GHD (2022) for the Mandurah Northern Beaches. This was adopted by CoM in 2022. Coastal hazard risks that were assessed against the immediate horizon were classed as intolerable for a combination of residential, and public infrastructure along this coastline. Within this study, a key assumption for the recommended adaptation pathways was that sand bypassing is continued on an annual basis (both at Mandurah and Dawesville ocean entrances). Additionally it was recommended that a fixed bypassing solution be investigated, in order to better mimic natural sediment transport processes. This recommendation has been actioned, with such an investigation determining that a fixed, cluster jet pump system is the most feasible option for permanent sand bypassing at Doddi's Beach (BMT, 2023). A general adaptation pathway was recommended for northern beaches including: • Nourish, dune revegetation, maintain groynes/existing protection where relevant. General short term action plan included the following immediate actions: • Continue general foreshore and coastal hazard monitoring program for the whole assessment area. • Engage with state government, private industry, and the community to complete a Cost Benefit Analysis then use the results to prepare a long-term funding strategy for strategic, appropriate coastal adaptation (Benefit Distribution Analysis).

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Amend Local Planning Scheme No.12 to apply provisions of State Planning Policy 2.6 as part of the scheme and incorporate a Special Control Area over residential areas at risk by 2070.
Review and update the Local Planning Strategy to consider the incorporation of a Special Control Area over the area at risk of coastal inundation and erosion over the 100-year timeframe.

Specific short term action plan includes the following immediate actions:

Undertake sand nourishment and dune stabilisation at acute erosion points to provide a buffer from the immediate erosion hazard.
Develop and implement revegetation program, with focus on erosion prone areas identified during monitoring activities.
Continue to implement regular condition assessment and maintenance program for existing protection structures and develop where not already in place. Frequency of condition inspection and maintenance activities to be relevant to the structure’s condition and value of protected assets. Include allowance for inspections immediately after significant storm events.

Additionally:

Continue/update the existing monitoring program at fixed locations along the shoreline to monitor key erosion locations for targeted sand nourishment and revegetation campaigns, comprising both quantitative and qualitative monitoring. Monitoring should be undertaken at a minimum of biannually (winter/summer) and during/post significant storm events.

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<tr><td>8.</td><td>Performance / Effectiveness of coastal management measure/s</td><td>
Mid and short-term shoreline mapping has been undertaken using satellite imagery, and beach changes in 50 m increments are presented in Figure 10-14.
Analysis of 2024 aerial imagery indicates that Groynes 1-5 are all at saturation. Therefore, sand introduced into the system from offshore sources and bypassing discharge, is typically transported northward during littoral transport and expected to continue uninterrupted along this stretch of coastline.
Town Beach to First Groyne (Aileen St)
The Town Beach seawall condition has been reported in 2018 (M P Rogers and Associates) and most recently in 2024 (M P Rogers & Associates). This condition assessment classed the seawall from fair to good condition across chainages 100 to 380 m. Chainages 0 to 100 and 380 to 420 are understood to be buried and not visible for inspection.
Upgrade of the seawall was originally proposed for 360 m of the seawall, but the scope was since reduced to a 200 m section immediately adjacent to the Seashells Resort.
During the site visit conducted on 1 July 2024 voids adjacent to the footpath were observed (refer Figure 10-1. Such voids were documented in both 2018, and 2024 inspections, expected to be from a combination of wave overtopping washing through the voids, as well as settlement of the structure leading to toe scour and loss of material. The proposed seawall upgrade intends to build the new crest higher than the pedestrian access, to minimise pedestrian access over the seawall.
Mid-term shoreline mapping indicates that the coastline, up to 400 m north of the seawall, has been undergoing erosion (up to 18 m) between 2016 and 2024. The most significant erosion occurs 100 to 250 m north of the revetment. This is equivalent to approximately two metres per year. Beyond this stretch, up to the First Groyne the vegetation lines indicate a stable shoreline.
Short-term mapping between 2019 and 2024, indicates that the erosion trend north of the seawall has continued at approximately one to two metres per year. The vegetation lines immediately south of the First Groyne indicate a stable shoreline.
First Groyne to Groyne (Orion Rd.)
Short and mid-term shoreline mapping indicates that the coastline, between the First Groyne and Second Groyne (Henson St.), has been undergoing erosion (less than one metre per year annually).
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ID	Category	Content
		From the Second Groyne to the Third Groyne the erosion trend typically increases. Short-term mapping has indicated erosion immediately north of the Second Groyne, extending for 300 m (up to three metres per year) where this rate has increased in the short-term. Beyond this the erosion reduced to less than one metre per year up to the Third Groyne. **Third Groyne (Orion Rd) to Fifth Groyne (San Remo) – Watersun Beach and San Remo Beach** Mid and short-term shoreline mapping indicates erosion has been occurring immediately north of the Third Groyne for 200 m (up to two metres per year). Milder erosion continues up until the Fourth Groyne (Wade St) (less than one metre per year), however, this rate of erosion has increased in the shorter term (up to two metres per year). Between the Fourth and Fifth Groyne, mid-term and short-term erosion has continued for most of the coast (up to two metres per year). Mid-way between these two groynes, a section of beach extending for approximately 700 m shows an increasing trend of erosion. Significant erosion is observed 400 m south of the Fifth Groyne (up to three metres per year). Both mid-term and short-term analysis indicates erosion continuing north of the Fifth Groyne (up to two metres per year).
9.	**Recommendations & lessons learnt**	**Coastal monitoring** • CoM intend to conduct drone flights internally suitable for determining volume assessment at northern beaches. It is recommended that this is undertaken at sufficient accuracy to develop meaningful volumes, on a half yearly or quarterly basis. Such volumes can be used to estimate seasonal variation in sediment transport, and validate any future modelling estimates. • Currently all five groynes are of mixed condition, however all are still functioning to a satisfactory level. It is recommended that future groyne condition inspections are conducted on an annual and post storm event basis to address any deterioration that compromises public safety or structure function. **Coastal investigation** • Despite sand-bypassing volumes and nourishment being increased annually, erosion trend has continued along northern beaches. This indicates that the previous net transport estimate (120,000 m^3/year) should be investigated to reflect current observations at the site. • Current bypassing is undertaken as a single, annual campaign (typically early winter). Although spreading each campaign (by implementing fixed bypassing infrastructure) over a longer season is seen positively (BMT, 2023), no coastal process study has investigated the impacts that this will have on the overall system. This should be modelled, with particular focus on the impact to northern beaches. Such a study could estimate the system’s net sand transport volume, as well as the impacts of moving the start date for individual bypassing campaigns. Model validation could use the drone measured beach volumes collected by CoM. **Coastal management actions** • Typical industry rules of thumb from USACE (2008) recommend a width between groynes of 2-3 times the length of the structures to ensure proper functioning of shore-normal groynes. The spacing of the First and Second groynes fall within this recommendation. The remaining groynes do not. Should erosion trend continue along these northern beaches, construction of additional groynes could be investigated to increase beach buffer (as per the functioning rule of thumb suggested by USACE). • CoM have removed/lowered vehicle access track along the Fourth Groyne, as well as minor armouring of the access track. This armour rock was relocated to the northern end of the groyne neck.

ID	Category	Content
		• During the site visit (1/07/24), it was noticed that the dune adjacent to the Fourth Groyne (Wade St) had been accessed by pedestrians (near access stairs). It is recommended that existing fencing is enhanced to ensure that this is minimised. Such dune is important as it is in a vulnerable location immediately north of the groyne structure. • We are of the opinion that, providing there is adequate sand buffer adjacent to the Town Beach seawall (maintained by annual bypassing), the existing seawall does not require an urgent upgrade. The seawall upgrade and corresponding wave calculation undertaken by M P Rogers & Associates (2024) assumes a scenario where annual sand bypassing is not undertaken and limited sand buffer exists creating impactful wave and overtopping scenarios along the seawall. Sand scraping, to artificially build beach and dune sand buffer adjacent to the seawall, could be undertaken to build resilience and mitigate risk of seawall damage associated with bypassing commencement delays. • Interim fencing to restrict pedestrian access onto the Town Beach seawall should be considered if seawall upgrades are not undertaken.

Figure 10-1: Photo taken of voids at crest of Town Beach seawall, approximate chainage +325 m. Taken during site visit 1 July 2024.

Figure 10-2: Example of modifications made to Groyne 3 (Orion Rd). Taken facing north during site visit 1 July 2024.

Figure 10-3: Scattered armour transition between Groyne 2 (Henson St.) neck and dune system. Taken facing north-east during site visit 1 July 2024.

Figure 10-4: Scattered armour transition between Groyne 2 (Henson St.) neck and dune system. Taken facing south-west during site visit 1 July 2024.

Figure 10-5: *Footprints and erosion on northern side dune adjacent to Groyne 4 (Wade St.). Taken facing north-east during site visit 1 July 2024.*

Figure 10-6: *'CoastSnap' station located at Groyne 4 (Wade St.). with frame facing north along Silver Sands beach.*

Figure 10-7: Groyne 4 (Wade St.)., some signs of poor interlocking and slope instability. Taken during site visit 1 July 2024.

Figure 10-8: Watersun beach lookout, dune stabilisation works recently completed. Taken facing south during site visit 1 July 2024.

Figure 10-9: Groyne 5 (San Remo) in good condition. Taken during site visit 1 July 2024.

Figure 10-10: Brushing dune stabilisation adjacent to Groyne 5 (San Remo), Taken during site visit 1 July 2024.

Figure 10-11: Mandurah Northern Beaches - coastal management schematic (1 of 3)

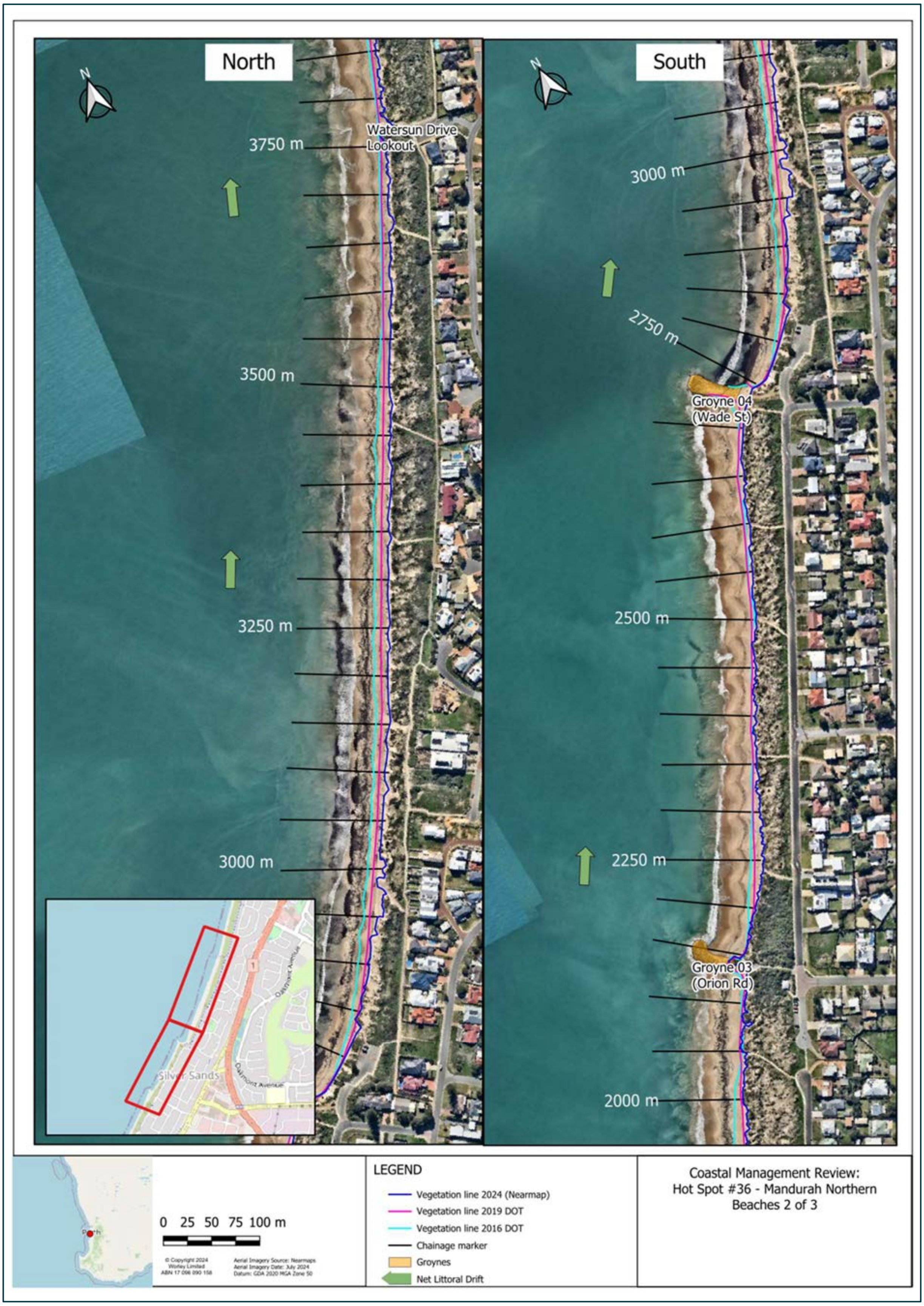

Figure 10-12: Mandurah Northern Beaches - coastal management schematic (2 of 3)

Figure 10-13: Mandurah Northern Beaches - coastal management schematic (3 of 3)

Figure 10-14: Results of Mandurah northern beach shoreline mapping, showing short and mid-term changes, for chainage reference refer to Figure 10-11, Figure 10-12 and Figure 10-13.

11. Wonnerup

ID	Category	Content	
1.	**Site name / Date review complete**	Wonnerup	June 2025
2.	**Key details**	LGA: City of Busselton (CoB) Townsite: East Busselton Hotspot ID: #42 & 43	
3.	**Summary of erosion issue**	The Wonnerup hotspot covered within this report, includes two adjacent coastal erosion hotspots (42 and 43). Hotspot 42 is a NE section of coast extending NE of the six rubble mound groynes east of Port Geographe until the mouth of the Vasse-Wonnerup estuary. Hotspot 43 extends from the eastern Port Geographe Marina revetment including the six rubble mound groynes immediately ENE of the revetment. The Wonnerup beach is backed landward by a narrow, low-lying beach-ridge plain formed on an elongate spit at the mouth of the Vasse-Wonnerup estuary (Seashore, 2019). Sand nourishment of the western end of Wonnerup Beach is being managed by the Department of Transport, as harbour managers, through an Environmental Monitoring and Management Plan (EMMP) (BMT, 2021). This foreshore has had a marina and associated revetments, six rubble mound groynes, four GSC groynes and a significant reconfiguration of the Port Geographe coastal structures in the last 30 years. The groyne fields feature low profile designs to trap sufficient sand to improve beach levels, without completely interrupting the alongshore sand transport and down-drift beaches. Bypassing and annual nourishment is being undertaken to address erosion issues resulting from the interruption of sediment transport by the Port Geographe coastal structures. Annual sand bypassing of Port Geographe took place over an 18-year period from 1996 to 2013. During 1996-2003, insufficient bypassing/nourishment of Wonnerup beaches was undertaken, contributing to the erosion adjacent to Layman Road, and damage to the new groynes (Pattiaratchi & Wijeratne, 2016). Following reconfiguration of Port Geographe sand bypassing from the Western Beach has not been conducted by DoT for 2014 to 2019 to allow the coastline to adjust to the newly reconfigured coastal structures. From 2020, DoT has bypassed sand for nourishment via dredging. Regular beach monitoring is currently being undertaken at the site (Seashore, 2019). Key erosion events at the site include: • Winter 2007, reports of significant damage sustained to the groyne field and seawall. • 1996 to 2003, continuous erosion reported immediately north of Port Geographe revetment threatening Layman Road. The above events have impacted Wonnerup beaches immediately adjacent to the Port Geographe development. Further down-drift impacts in hotspot 42 have been more gradual with beach recession documented within the vegetation line mapping (Figure 11-22).	
4.	**Overview of key coastal processes**	The Wonnerup Coastal Reserves lie adjacent to Geographe Bay, which is a unique feature on the Western Australian coastline, due to its northerly aspect and the fact that it is largely protected by Cape Naturaliste, from prevailing south-westerly seas and swell. Within Geographe Bay, sediment transport generally occurs along the shoreline from west to east (O2 Marine, 2016) and is driven by nearshore currents generated from both local seas and swells refracting around Cape Naturaliste. The sediment transport is also influenced by transverse sandbar migration and the presence of coastal infrastructure on the coast, such as the coastal structures	

ID	Category	Content
		associated with Port Geographe Marina and canal development. As described by Pattiaratchi et. al. (2017) the Wonnerup coastal environment has been described as highly complex with strong year-to-year variability, sand exchange and re-cycling between the shoreline and offshore sand bars and impacts from artificial modifications to the coastline. In combination, all these factors provide a highly challenging task to estimate sand budgets in the region. Despite this, prior to construction of Port Geographe, the assumed average annual littoral drift potential at the site was estimated at 50,000-60,000 m^3/year west to east. (Department of Transport, 2009) (Shore Coastal, 2015).

5.	**Overview of historical coastal management actions**	The coastal protection and other notable works undertaken along this hotspot include:
		• 2020, refurbishment of groynes 3-6 (including placement of additional granite)
		• 2020, construction of two additional GSC groynes at Baudin Reserve
		• 2017, construction of two GSC groynes at Baudin Reserve
		• 2016, refurbishment of groyne 1 & 2
		• 2015, major reconfiguration of Port Geographe groynes and seawall complete
		• 2008, refurbishment of groyne 1 & 2
		• 2007, seawall and limestone crown wall constructed connecting Port Geographe eastern breakwater to groyne 1
		• 2006, refurbishment of groyne 2
		• 2006, initial construction of westernmost rubble mound laterite groyne (groyne 1)
		• 2003, construction of five rubble mound laterite groynes immediately east of Port Geographe revetment
		• 2001, initial construction of eastern Port Geographe seawall
		• 1999, informal dumping of rock, to protect Layman Road erosion
		• 1997, construction of the initial Port Geographe Marine configuration
		• 1996 to 2003, Wonnerup nourishment averaged 32,500m^3 annually
		• Annual nourishment with typical quantities as follows (refer Figure 11-29):
		  ◦ 1996 to 1999 (0 – 82,000m^3/yr)
		  ◦ 1999 to 2003 (5,000 – 28,000m^3/yr)
		  ◦ 2003 to 2008 (42,000 – 131,000 m^3/yr)
		  ◦ 2008 to 2013 (45,000 – 124,000 m^3/yr)
		  ◦ 2013 to 2016 (10,000 – 25,000 m^3/yr)
		  ◦ 2016 to 2021 (12,000 – 44,000 m^3/yr)
		  ◦ 2021 to 2025 (22,000 – 31,000 m^3/yr).
		• Periodic dredging of Port Geographe has also disposed harbour material offshore of Wonnerup (such volumes have not been captured in those provided above)

6.	**Management issues and challenges**	• The 'low profile' groyne design employed at the site, has led to each of the groynes requiring multiple refurbishment campaigns. When originally built community pressure was placed on the designer to lower the crest for aesthetic reasons, and Seaport (developer) accepted the higher probability of damage associated. • Despite ongoing management of Wonnerup Beach immediately east of Port Geographe by the Department of Transport, significant erosion has occurred east of the Port Geographe Management Area due to the influence of Port Geographe. The down-drift extent of this coastline (hotspot 42) has consistently featured up to 4m of erosion annually over the past 10 years (where very little has been observed within the PGCMU). This combined with analysis of bathymetric surveys indicates that the rate of bypassing of Port Geographe to Wonnerup Beach has for the last 10 years, been insufficient to solely sustain the Wonnerup Beach (East) foreshore.

ID	Category	Content
		• Western Beach saturation is expected to improve the rates of natural wrack bypassing (Chamizo, 2020). This consideration has impacted the extent and frequency of bypassing undertaken by DoT since the reconfiguration. • Within the Port Geographe Coastal Structures EMMP (BMT, 2021) management targets have been set to maintain natural alongshore sediment movement around the Port Geographe Marina. The plan states less than 30,000m^3 of erosion is acceptable within Wonnerup Beach (ie. within the eastern extent of the Port Geographe Coastal management area). As shown within Figure 12-21 this management area extends to approximately chainage +1075m. Nourishment is preferred at the western end of Wonnerup, to allow natural eastward littoral drift of material. • Sand placed on the western end of Wonnerup Beach in recent years is coarser than naturally occurring sediment. As a result, natural coastal processes are insufficient to transport this sand downdrift along the beach to the eastern extents of the hotspot. • Four-wheel-drive vehicles have been accessing closed areas of the beach by driving over the low profile GSC groynes, damaging the groynes and foreshore vegetation. • There are a small number of private lots and residences behind GSC groynes 9 and 10. With ongoing erosion the foreshore reserve/buffer between these private lots and the ocean is decreasing. There is also continued private investment in the housing on these lots. • A crushed limestone access path along the foreshore (between groynes 8 and 10) has been progressively eroding away since 2010.
7.	**Current management focus**	• DoT has been focusing on meeting the conditions placed on the Port Geographe development via the EMMP, specifically the monitoring and execution of bypassing/sand nourishment campaigns. Conditions relate to both sand and wrack management which requires DoT to balance multiple coastal pressures. To monitor EMMP targets, DoT have committed to hydrographic and/or topographic surveys on a small and large-scale extent (small-scale surveys bi-annually, large-scale annually). • The Busselton CHRMAP released in 2022 (City of Busselton) recommends construction of a buried seawall/bund along the Wonnerup foreshore, supplementing this with groynes and regular nourishment to protect the beach and beach amenity. • The impact of vehicles accessing beaches west of the Layman Road Boat Ramp, and actions to close access has been documented within CoB's historical management plan (O2 Marine, 2016).
8.	**Performance/** **Effectiveness of coastal management measure/s**	**Eastern Port Geographe Coastal Management Unit (+0m to +1075m)** Mid-term shoreline mapping indicates that this coastline has mostly remained stable with some minor erosion (up to one metre annually) noticeable at the last 50m of the NE extent of the management unit. Short-term shoreline mapping indicates stability along this stretch of coastline. Groyne one to six (rubble mound), are in poor to moderate condition, with minimal interlocking and exposed core in the first two groynes. Despite this, analysis of aerial imagery indicates that they are continuing to maintain their respective sand compartments and improving the natural sand buffer available along this stretch of coast. **NE Wonnerup beach (+1075m to +2050m)** Mid-term shoreline mapping indicates increasing erosion until the most severe section at chainage +1450m, where erosion has averaged up to four metres annually. NE of this location the erosion trend reduces to one to two metres annually up until the end of the hotspot (+2050m). Short term shoreline mapping indicates a similar erosion trend, up to four metres per year at the most severe chainage +1450m.

ID	Category	Content
		There is noticeable slowing of erosion since construction of GSC groyne's 7-9, (+950 to +1100m). Analysis of bathymetric surveys undertaken by DoT between Summer 2009 and 2023 (refer Figure 11-30) confirms the erosion trend within the nearshore environment. Between 0.5-1.0m of seabed deepening is noticeable within 50-100m of the shoreline from chainage +1250 extending approximately 1.3km to the NE. All four GSC groynes appear to be relatively stable with no slumping present. However, those located within the sub-aerial beach appear vulnerable to damage, specifically from vehicle contact. Exposed bags have been damaged in these locations with some repair patches applied by CoB. Despite the damage to the onshore containers, as shown in vegetation line mapping, these containers are continuing to perform as required.
9.	**Recommendations & lessons learnt**	**Coastal monitoring** • It is recommended that DoT continues with current laser and bathymetric survey program (annual and bi-annual) as per the Port Geographe EMMP requirements. **Coastal investigation** • Given the widespread accretion along 2-3km of beach west of Port Geographe (updrift), it is suggested that wide-spread scraping and bypassing of recovered sand is investigated (as an alternative to trucking sand from Bunbury). Such works will act to mimic the natural process, and sand will be more likely to move down-drift to beaches currently receding. **Coastal management actions** • Four-wheel-drive access is recommended to be restricted south of the existing beach access. Vehicles are damaging the GSC groynes by driving over buried bags and tearing exposed containers. • Although nourishment of Western Wonnerup beach with coarser sediment may offer a more resilient beach profile during storm events, it will limit the potential for littoral transport down-drift to beaches that have been most significantly impacted by erosion. Collaboration between CoB and DoT is important to ensure positive outcomes for both parties following future nourishment campaigns. • The laterite (ironstone) armour used in the low profile groynes has been reported as difficult to achieve interlocking during construction due to the angular rock profile. This has reportedly led to more frequent repairs than comparable granite groyne structures.

Figure 11-1: Port Geographe eastern revetment, approximate chainage +25 m. Showing dredged material being pumped onto Wonnerup beach during site visit 27 November 2024.

Figure 11-2: West Wonnerup aerial beach nourished with trucked sand taken during site visit 27 November 2024.

Figure 11-3: Groyne 1 (+250m), laterite rock core exposed with minimal armour cover. during site visit 27 November 2024.

Figure 11-4: Groyne 1 (+250m), laterite rock core exposed with minimal armour cover. during site visit 27 November 2024.

Figure 11-5: Beach compartment between Groyne 1 & 2 (+300m), beach crest consisting of recently nourished sand taken during site visit 27 November 2024.

Figure 11-6: Immediately north of Groyne 2, laterite armour rock scattered on beach and informal seawall present (+360m) taken during site visit 27 November 2024.

Figure 11-7: Wrack accumulated on crest of Groyne 2 (+350m) taken during site visit 27 November 2024.

Figure 11-8: Informal seawall (+370m) taken during site visit 27 November 2024.

Figure 11-9: Groyne 3 (+475m), some scattered laterite immediately north, taken during site visit 27 November 2024.

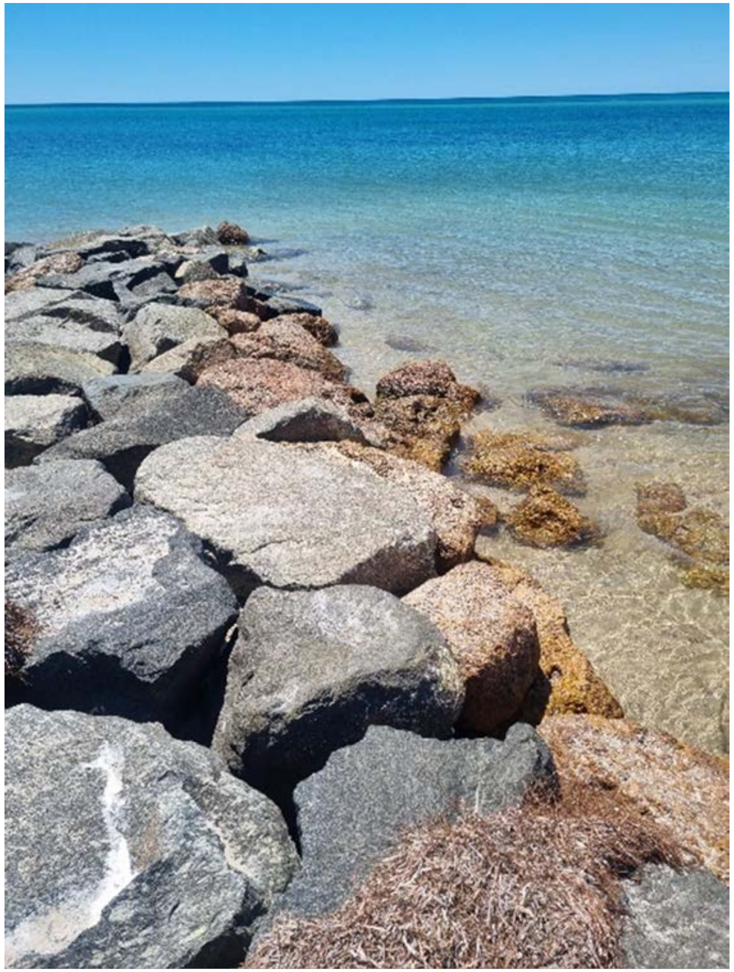

Figure 11-10: Groyne 3 (+475m), some scattered laterite immediately north, taken during site visit 27 November 2024.

Figure 11-11: Groyne 4 taken during site visit 27 November 2024.

Figure 11-12: Groyne 4 taken during site visit 27 November 2024.

Figure 11-13: Remote image capture station (+575m), taken during site visit 27 November 2024.

Figure 11-14: Beach access for nourishment equipment (+525m) taken during site visit 27 November 2024.

Figure 11-15: informal seawall behind primary dune (+500m), taken during site visit 27 November 2024.

Figure 11-16: Buried informal seawall behind primary dune (+500m), taken during site visit 27 November 2024.

Figure 11-17: Four-wheel-drive beach access/trailer launch (+1875m) taken during site visit 27 November 2024.

Figure 11-18: Buried informal seawall behind primary dune (+1800m), taken during site visit 27 November 2024.

Figure 11-19: GSC Groyne 8, exposed bags driven over by four-wheel-drives taken during site visit 27 November 2024.

Figure 11-20: Scarping to vegetation between Groyne 9 and 10 taken during site visit 27 November 2024.

Figure 11-21: Ripped hole within GSC at Groyne 10 taken during site visit 27 November 2024.

Figure 11-22: Informal groyne extension with laterite armouring at Groyne 10 (+1240m) taken during site visit 27 November 2024.

Figure 11-23: Eroded access track immediately north of groyne 10 (+1260m) taken during site visit 27 November 2024.

Figure 11-24: Eroded access track immediately north of groyne 10 (+1260m) taken during site visit 27 November 2024.

Figure 11-25: GSC Groyne 9 with damaged bag spilling sand (+1240m) taken during site visit 27 November 2024.

Figure 11-26: Vehicle tracks into primary dune vegetation (+1040) taken during site visit 27 November 2024.

Figure 11-27: Wonnerup - coastal management schematic.

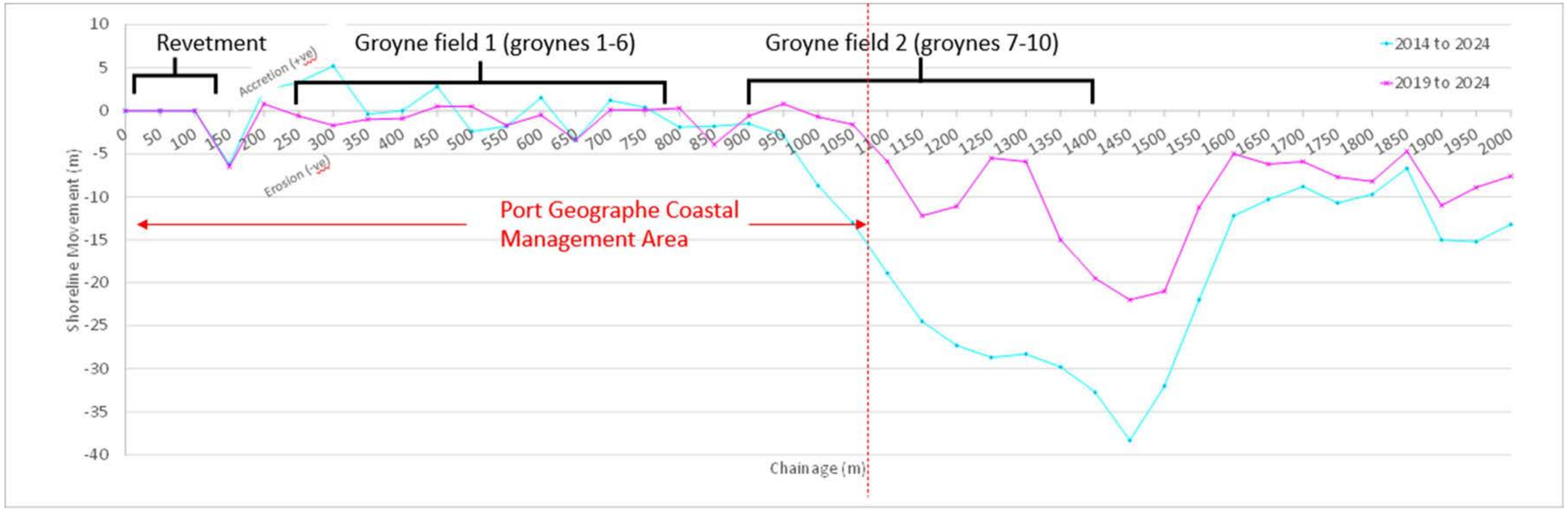

Figure 11-28: Results of Wonnerup shoreline mapping, showing short and mid-term changes, for chainage reference refer to Figure 11-27.

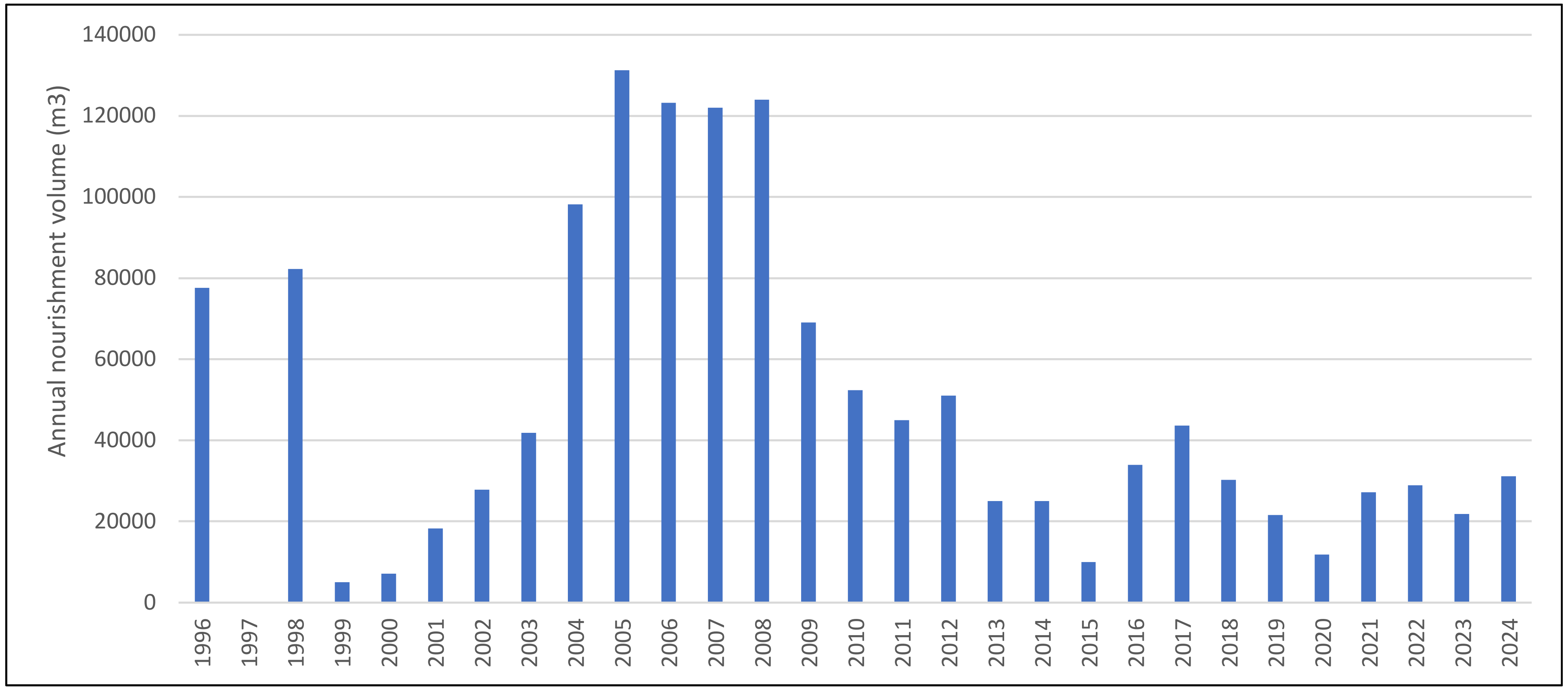

Figure 11-29: Historical nourishment volumes – Wonnerup Beach

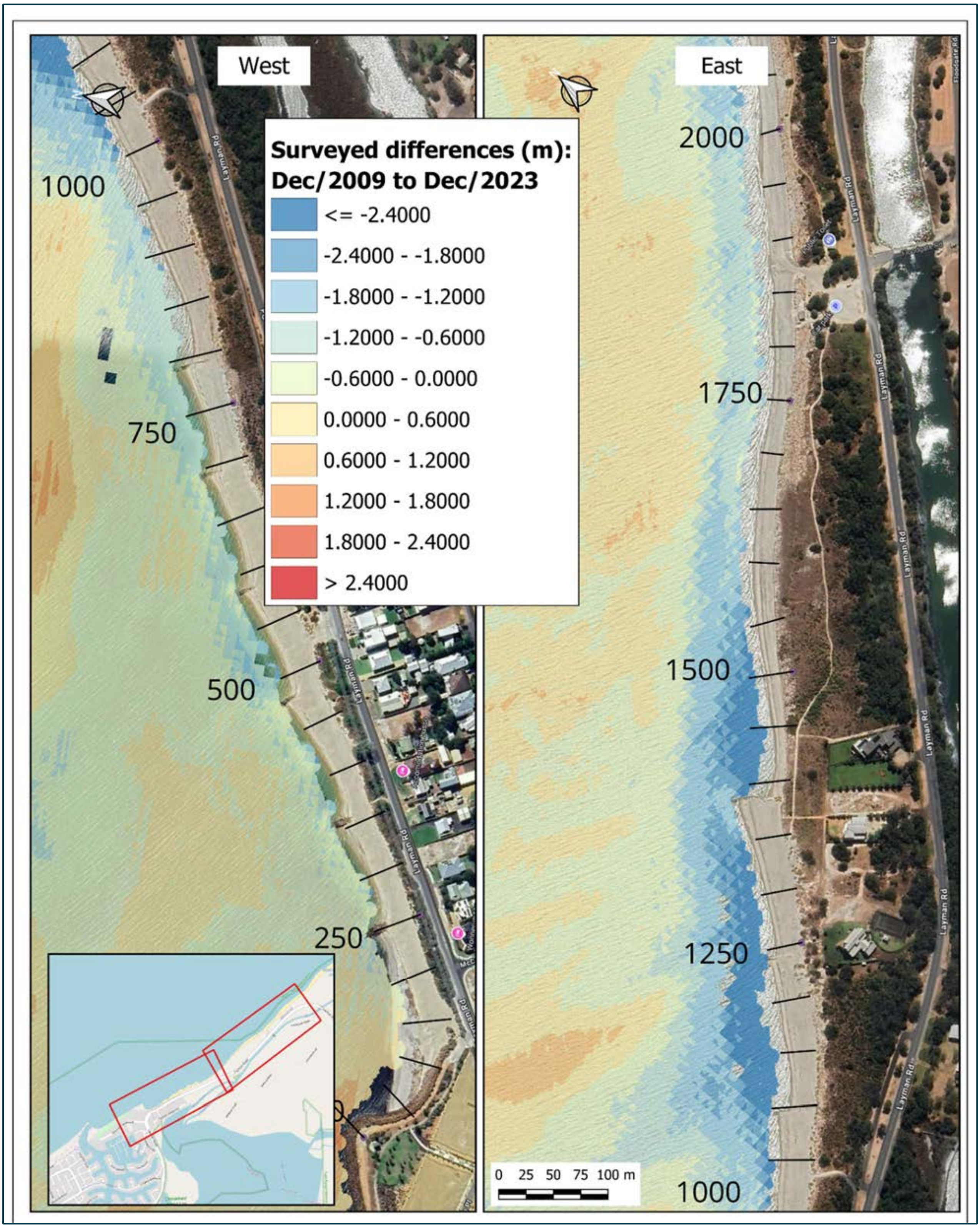

Figure 11-30: Wonnerup bathymetric survey- difference plot showing changes from December 2009 to December 2023.

12. Emu Point

ID	Category	Content	
1.	**Site name / Date review complete**	Emu Point	April 2025
2.	**Key details**	LGA: City of Albany (CoA) Townsite: Emu Point Hotspot ID: #52	
3.	**Summary of erosion issue**	Emu Point is located approximately 8.5 kms from the centre of Albany. The Emu Point hotspot wraps around the coastline connecting Oyster Harbour to the north-eastern end of Middleton Beach. The hotspot falls within the City of Albany municipality. It is understood that the Emu Point and Albany communities highly value the social and recreational amenity of this hotspot area, including retaining the character of the coastal zone between Emu Point and Middleton Beach. As documented by Seashore (2019) erosion was initially reported in the 1990's with the loss of beach shacks along the shoreline. Nearshore changes also occurred, with the loss of sheltering sea grass beds. Numerous coastal studies have been undertaken in this region, and protective structures have been built consecutively over the past 35 years, transferring the erosion stress westwards along the hotspot. Erosion events: • Winter 2020 to 2021, erosion removing up to 10m of beach crest, from western extent of hotspot • Autumn 2003, significant erosion from storm event and unusually high sea levels at Emu Beach • Autumn 1999, severe erosion along 600m of Emu Beach threatened to undermine the car park at the end of Boongarrie St. Understood to have occurred without a significant storm. • Winter 1992, significant erosion from storm event along Emu Beach, high tides and heavy seas reported to have removed up to four metres of sand along the southern end of the beach. • Winter 1987, extreme storm event combined with high water level • August 1984, severe erosion from a south-easterly storm (1 in 100yr ARI event) at Emu Beach, significant loss of sea grass and dune systems.	
4.	**Overview of key coastal processes**	Middleton Beach and Emu Point together have previously been classed as separate sediment sub cells to Oyster Harbour, falling within a shared parent sediment cell (URS, 2012) (RHDHV, 2017). All these sediment cells fall within in the larger cell (primary) of King George Sound. Sediment is not expected to be lost (alongshore) beyond the western (Ellen Cove) and eastern rocky headland boundaries (Emu Point). It is understood that the sediment transport process along the hotspot is driven by a complex mix of wave, wind, and tidal forcing which produces a net transport pattern that has been known to reverse, changing between westward and eastward alongshore transport directions across multi-year periods. The loss of seagrass in the region has been documented to have removed the near-shore coastal defence and resulted in beach realignment under storm conditions (URS, 2012). This process is understood to have further worsened the loss of seagrass as storm erosion creates turbidity and smothering events which in turn accelerates the loss of seagrass and consequential continuation of erosion events (DPI, 2004) . Lockyer Shoal, located immediately offshore of the hotspot, causes refraction of wave trains leading to multi-directional wave attack on the shoreline. Changes to the Lockyer Shoal appear to have influenced erosion patterns at this site (refer Figure 12-1). Between 2006 to 2014 the shoal was reported to have eroded (PRDW, 2014), whilst between 2012 to 2024 accretion has been observed (approximately 11,000m^3 across the shoal).	

ID	Category	Content
		It is understood that onshore movement of dredged sand placed offshore of Middleton Beach on multiple occasions has historically provided a continual influx of sediment into the Emu Point sediment cell. Historic spoil grounds used during Port of Albany capital and maintenance dredging campaigns were located 1-3km offshore of Middleton beach (1925, 1955, 1977, 1979, and 1985). Net onshore movement of these offshore sand sources has since slowed, with the system now fed by fewer offshore sources.
5.	**Overview of historical coastal management actions**	The following coastal management measures have been taken along this hotspot: • 2024, CAP-funded sand nourishment (including wrack), spring and autumn, (typically 4,000m^3 per campaign) • 2024, removal of GSC seawall • 2014, repairs to the training wall undertaken • 2014, trial construction of two GSC groynes • 2013, 200m of dual use path relocated landward (+1050m to +1250m) • 2011, revetment extended using GSC's westwards • 2005, revetment extended west • 2001, revetment extended west • 1999, original emergency rock revetment • 1995, construction of artificial headland • 1995, southern groyne extended by 20m • 1991, revetment/training wall and groyne construction southwards • 1989, initial groyne constructed at northern end • Mid 1980's, training wall

6.	**Management issues and challenges**	• PRDW (2015) and RHDHV (2017) assessment of the trial GSC groynes concluded that:
		  ◦ No major build-up of sand on either side of the two groynes was evident
		  ◦ A relatively small difference in coastline orientation around the groynes can be seen (2.1 degrees)
		  ◦ Minor erosion to the west of the two groynes indicating a small rate of net westerly transport
		  ◦ Sand can be seen to bypass the structures
		  ◦ Transects and aerial photographs show evidence that the ongoing erosion has stabilised (since groyne construction)
		• In 2020 (Bluecoast) recommended that these groynes were upgraded in the short term (0-5 years) extending them seaward and raising the profile height.
		• Stantec (formerly Cardno) (2022) undertook an optimisation study, to determine the preferred concept design for a groyne field west of the existing revetment (refer Figure 12-2). The study reported that a two short T-groynes with a seawall spur realignment and sunken trunk would be the most effective design, minimising the loss of sand from the system. Works were estimated to cost $4.8M for 50yr design life structures. It is understood that this design (70%) was subsequently paused due to the cost associated and lack of public support.
		•

7.	**Current management focus**	As outlined in the CHRMAP (Aurora Environmental, 2019) the Emu Point hotspot falls into management units #3 (Emu Point Beach) and #4 (Emu Point). Within the CHRMAP, Emu Point Beach had the following management strategies recommended based on technical evaluation (capital and maintenance costs, environmental impacts, social and amenity impacts, reversibility, and effectiveness at mitigating coastal hazards): • Sand nourishment, to the beach adjacent to Griffiths St properties • Managed retreat/relocation of southernmost assets at the Caravan Park

ID	Category	Content
		• Continued protection using seawalls and parklands (combined with seagrass rehabilitation) for structures along the Emu Point foreshore reserve. Additionally, the following monitoring was recommended to determine the status of erosion and timing for coastal strategy implementation including: • 3D beach scan and hydrographic survey (every 2-4 years) or after a severe storm event. • Aerial photography and digitisation of the coastline position (every 5 years) • Beach survey profiles collected every 6 months and post significant erosion event. • Condition inspection of revetment annually. Since this outcome, it understood that CoA has undertaken sand nourishment program on two occasions utilising sand from Griffith St beach (chainage +1550 to +2050m). CoA has communicated that it will continue with two annual nourishment campaigns of similar scale until a longer term solution is in place. The City of Albany has undertaken beach monitoring and coastal zone data collection (wave/current data) in recent years. Monitoring has included waves, currents, anemometers, tide gauge, fixed cameras, beach photos, structure assessments and beach profiles (Seashore, 2019). In consultation with DoT in 2024, CoA reported they are hoping to better consult with community about adaptation pathways, whereby sand nourishment is an interim measure before implementing long-term options such as the 2022 design, once community support can be secured. The city expressed a desire to apply for future grant funding when the community approves such options.
8.	**Performance / Effectiveness of coastal management measure/s**	**Emu Harbour to end of northern training wall (+0m to +225m)** At the northern groyne and along the training wall there are zones of isolated slope failure with core left exposed. Additionally, there are signs that overtopping has occurred behind the crest. This structure has been documented as being in poor to moderate condition previously by PRDW (2015) and Evocoast (2017). Additionally loose armour rock can be seen scattered along seabed adjacent to the training wall. **Headland Beach (+225m to +475m)** Analysis of satellite imagery shows the vegetation line in the lee of the artificial headland has shifted with the tombolo, 15m to the northeast in the short-term (5 years). Further analysis confirms this trend has been occurring since 2005. Additionally, the headland beach appears to have accreted up to 18m in the mid-term (up to 2m per year), with the most significant growth seen in the centre of the embayment. Small quarry run/core material was visible (refer Figure 12-9) extending landwards of the artificial headland during the site visit (5 December 2024). This material is likely a remnant from the initial construction of the rock headland structure (1995) previously buried by beach sand. During the site visit, the artificial headland appeared in good condition with neat defined slopes, good interlocking, and thorough protection of core material apparent. Coastal vegetation and tree roots east of the damaged revetment have been eroded with up to three metres of exposed slope and vertical scour apparent. There appears to be fencing restricting public access to pathways. The eastern end of the seawall (+475m) is severely damaged, with complete slope failure leaving fill material and geotextile material exposed. **Rubble mound seawall (+475m to +950m)** During the site visit, the seawall appeared in moderate condition, with some steeper sections observed with exterior armour scattered at the toe, indicating isolated slope collapse. Geotextile material is exposed along large sections of the seawall crest. **Emu Point Beach (+950m to +2250m)** Mid-term analysis indicates up to 18m of erosion (two metres per year) has been experienced along the eastern section of this beach. The most significant is located immediately adjacent to the end of the revetment (+950m). Accretion up to 19m (two metres per year) has been observed along a 600m section of beach near the Griffiths St access area.

ID	Category	Content
		Short-term analysis indicates similar erosion extents up to 16m of erosion (up to three metres per year) up the eastern end of the beach. Trends indicate that the erosion has worsened in recent years. The beach adjacent to the Griffiths St access appears stable in the short-term analysis.
9.	**Recommendations & lessons learnt**	**Coastal monitoring** • Given the complexity of the coastal processes at this site, management requires a flexible approach to be taken. Sand nourishment with regular monitoring of beach transects undertaken by CoA (and drone LIDAR surveys), will continue provide significant management baselines to develop triggers for acute nourishment. • Griffiths St beach should be monitored closely following each back-passing campaign to confirm its resilience to beach scraping. • It is recommended that periodic bathymetric surveys (3-5 yearly) are continued to monitor the changes to the seabed with specific focus on the Lockyer Shoal. It is understood that DoT are planning to undertake a hydrographic survey from Ellen Cove to Emu Point in 2025. **Coastal investigation** • Seagrass and its significant influence on wave environment/coastal erosion has been a key finding at this location. Other coastal hotspots could consider seagrass health as a possible stressor on erosion. • Future dredging works within Oyster Harbour/Emu Point Marina should assess material properties and suitability for disposal on Emu Point beach. • Investigation is required to assess the repair options for the damaged seawall at +475m. Extension of the seawall may be a suitable upgrade, along with nourishment to this corner of the beach. Any investigation will need to place significant importance on beach amenity as extending the seawall could lead to the loss of sandy beach to the public. **Coastal management actions** Recommended actions as a result of this review include: • Temporary repair of the seawall at +475m is required to limit damage to exposed fill sections, prior to decisions on future works (coastal investigations above). Additionally, increased fencing is suggested to improve public safety and possible further erosion risk in this location. • There is potential to scrape/back-pass sand that has accreted within the Headland Beach (immediately east) to nourish and provide resilience to storm attack along the western facing tombolo shoreline. Additionally, this sand can be used to bury the existing rock and restore the beach profile. • Backpassing from Griffiths St. (and/or other areas experiencing accretion) appears to be a practical solution to manage erosion at the eastern end of Emu Beach, this should be adjusted and continued depending on material availability and beach resilience. • Nourishment of the artificial headland tombolo should be considered to improve buffer and resilience to storm events at this location. • The most recent nourishment campaign (December 2024) utilised a combination of layered wrack and sand to make up fill volume. This is an innovative technique not common in WA. Follow-up campaigns, and similar nourishment projects should consider the effectiveness of this and whether it is worth undertaking to help improve shoreline buffer from storm damage. • Long-term solutions to erosion on the western and eastern flanks of the rubble mound seawall may require further hard protection works if past erosion trends continue. These will need to be further assessed for feasibility in the context of cost, effectiveness, environmental, and community outcomes. This may entail refinement of the 2022 adaptation design for the eastern end of Emu Point Beach (+950m), though entirely new design/upgrade work will be required for the erosion at the western end of the seawall (+475m). • Analysis by Seashore (2024) post December 2024 nourishment campaign recommended to continue the twice annual nourishment campaign whilst the longer-term solution is refined, however it is noted that nourishment may remain the preferred solution.

Figure 12-1: Sediment pathways as influenced by erosion of Lockyer Shoal (PRDW 2013)

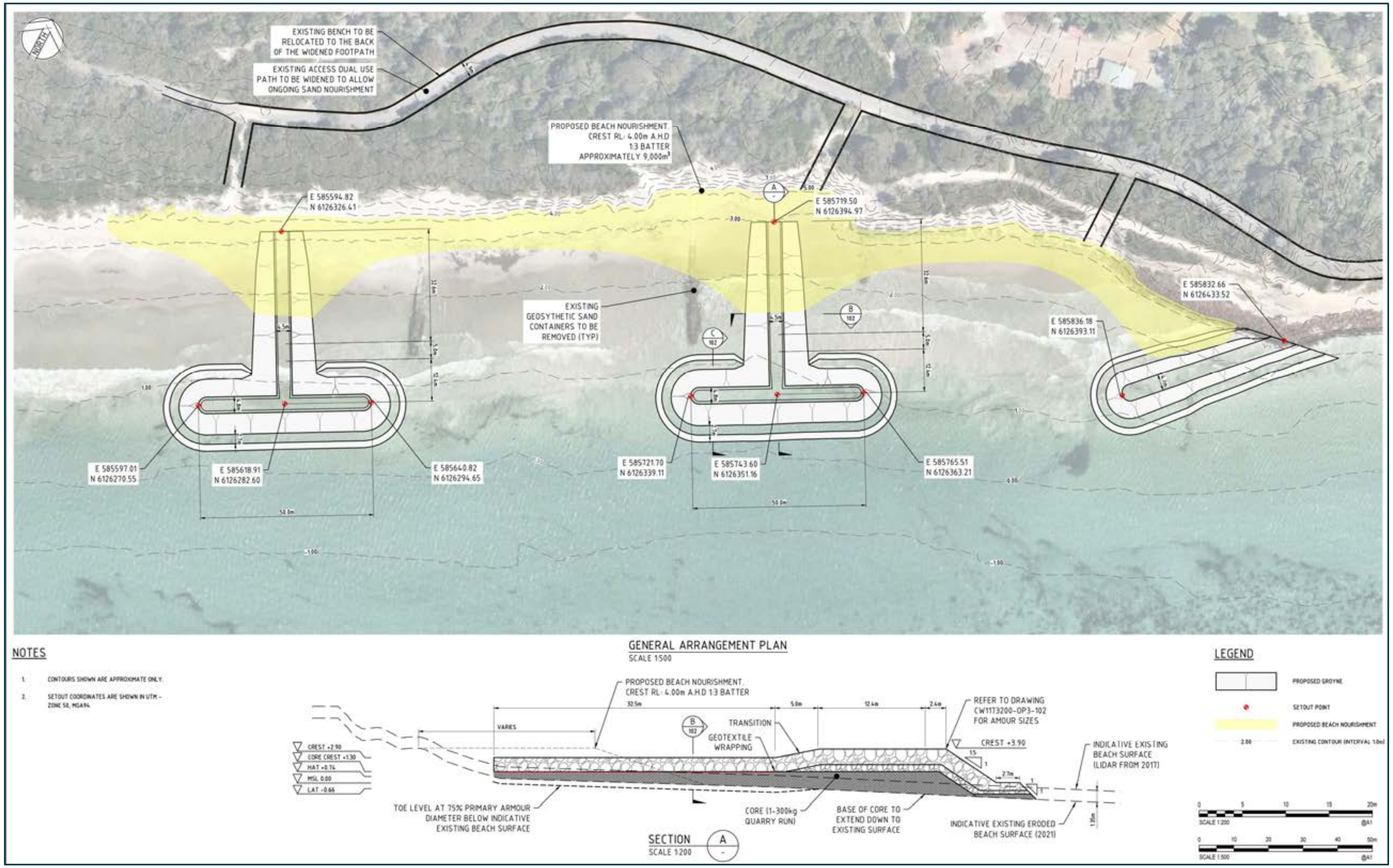

Figure 12-2: Concept for T-head groynes (Stantec 2022)

Figure 12-3: Northern groyne taken facing northeast during site visit 5 December 2024.

Figure 12-4: Northern seawall end, taken facing east during site visit 5 December 2024

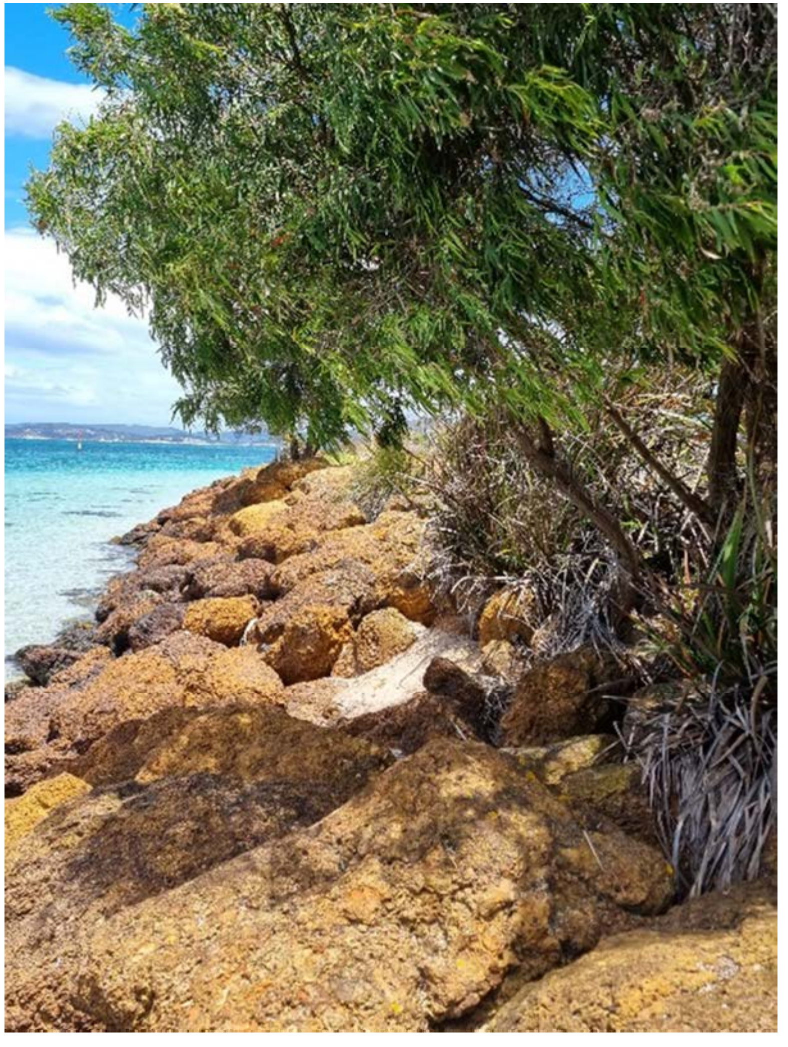

Figure 12-5: Exposed underlayer/slope failure along training wall (chainage +75m). Taken facing southwest during site visit 5 December 2024.

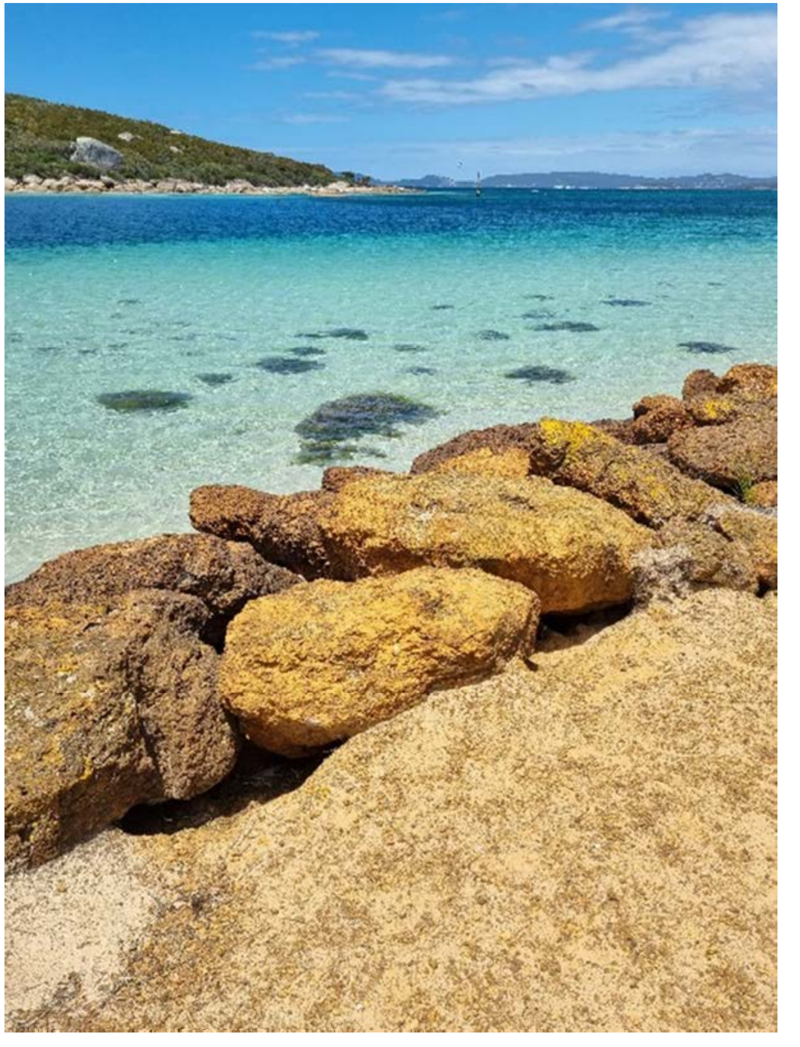

Figure 12-6: Scattered armour offshore of training wall. Taken facing south during site visit 5 December 2024.

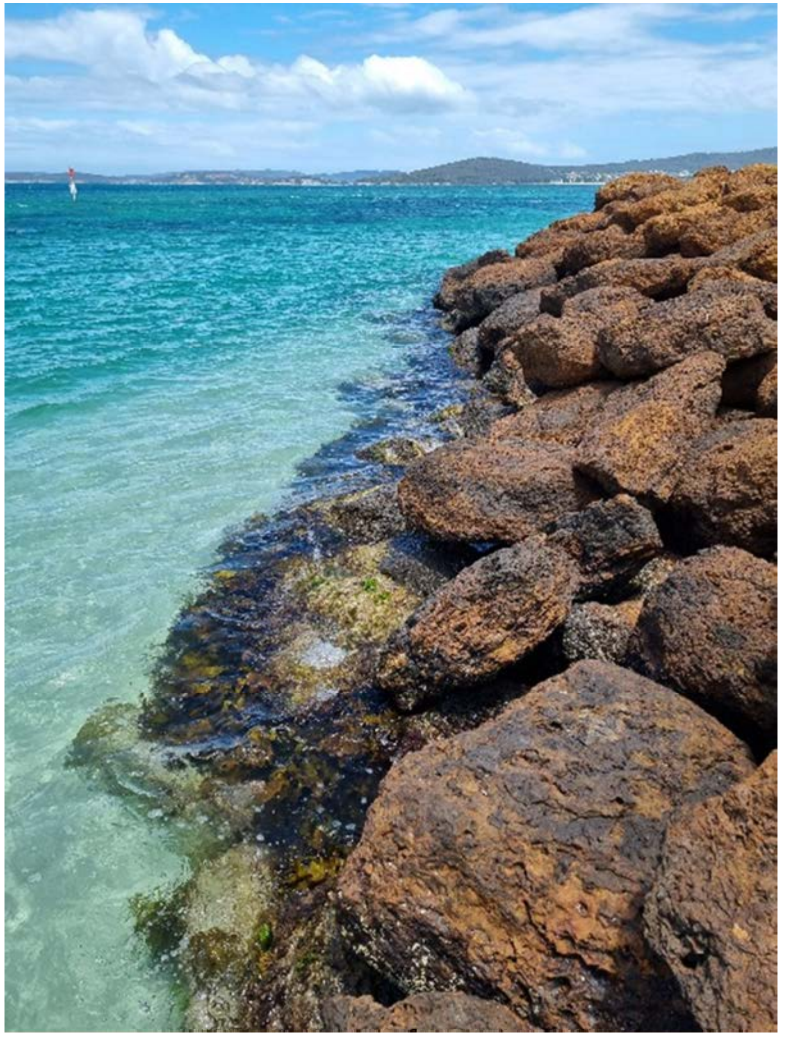

Figure 12-7: Artificial headland, taken facing southwest during site visit 5 December 2024.

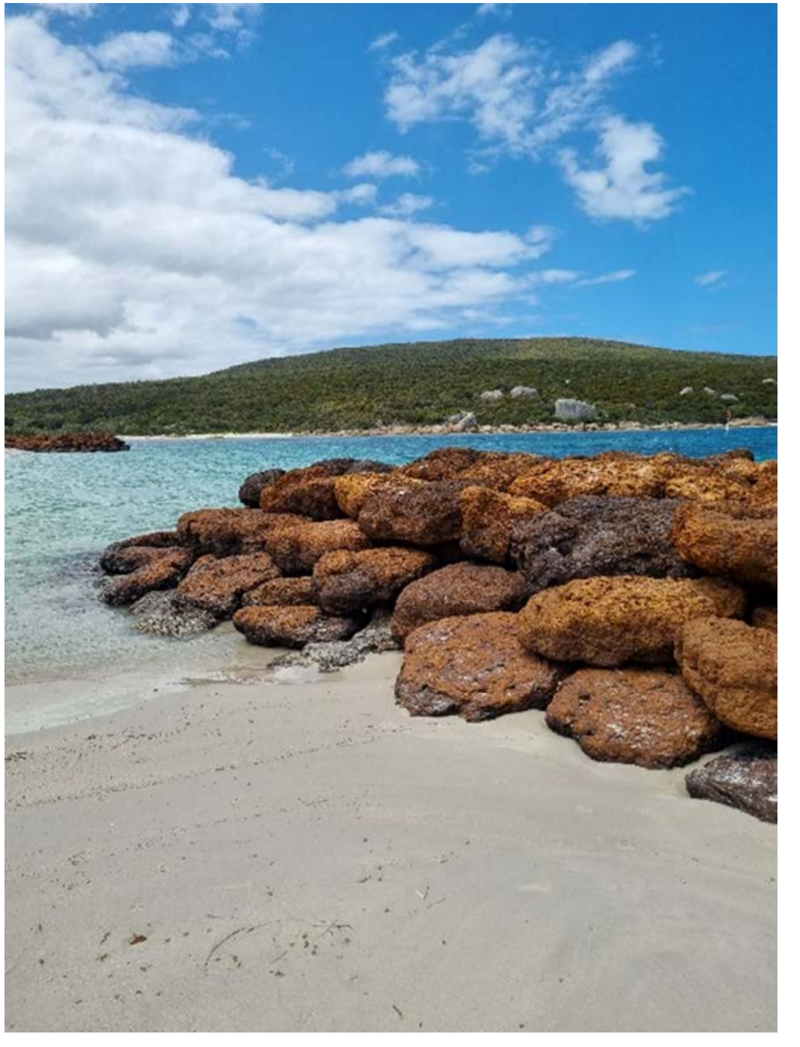

Figure 12-8 : Artificial headland, taken facing east during site visit 5 December 2024.

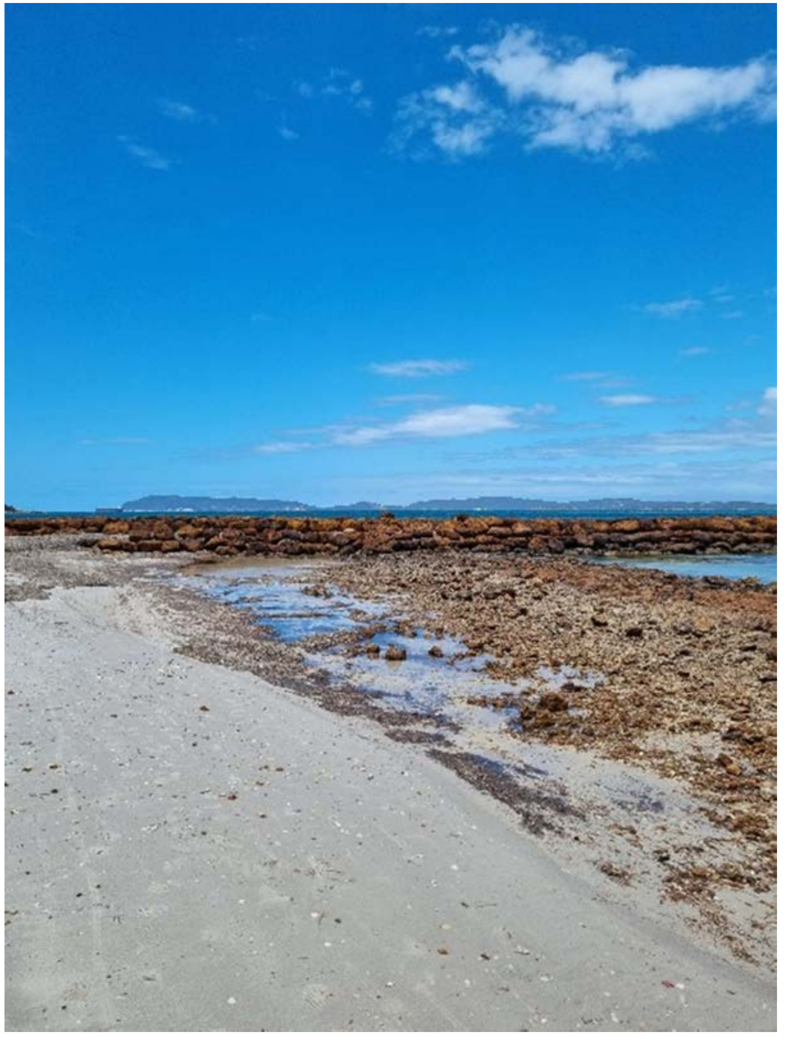

Figure 12-9: Exposed rock along artificial headland tombolo, taken facing southeast during site visit 5 December 2024.

Figure 12-10: Scour along headland beach taken facing east during site visit 5 December 2024.

Figure 12-11: Exposed rock along artificial headland tombolo. Damaged seawall and dune erosion in background. Taken facing northwest during site visit 5 December 2024

Figure 12-12: Damaged seawall and dune erosion (~+475m). Taken facing northwest during site visit 5 December 2024.

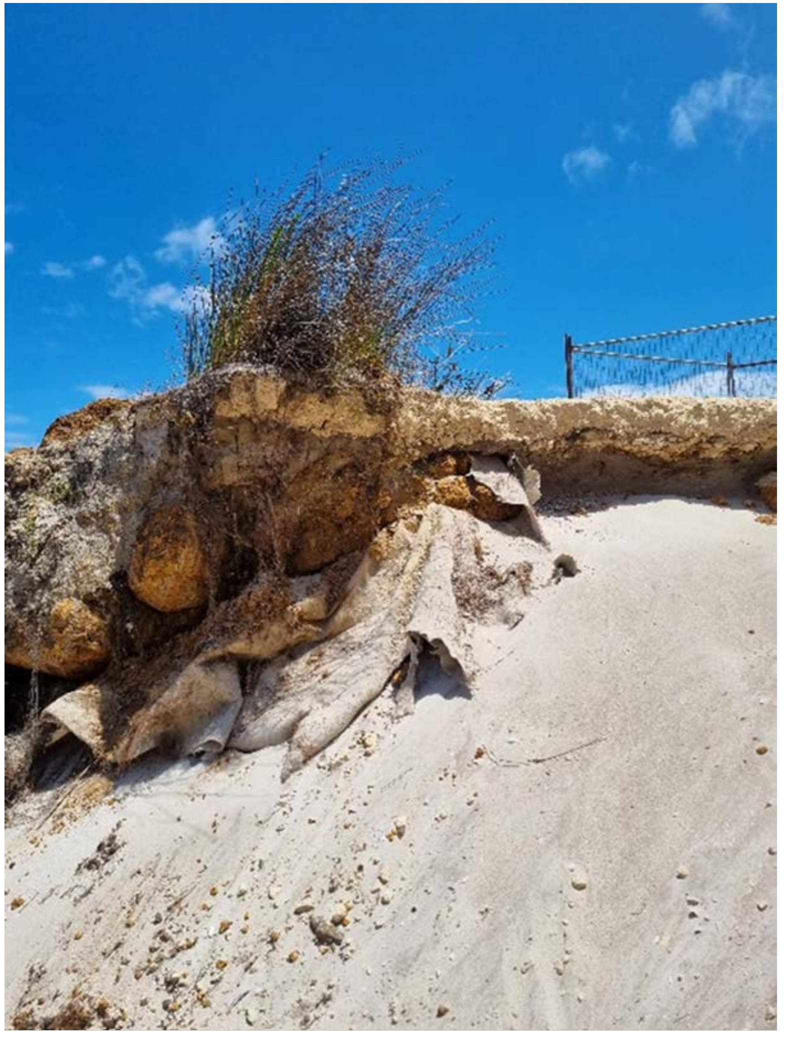

Figure 12-13: Damaged seawall with slope failure and geotextile exposed (~+475m), taken during site visit 5 December 2024.

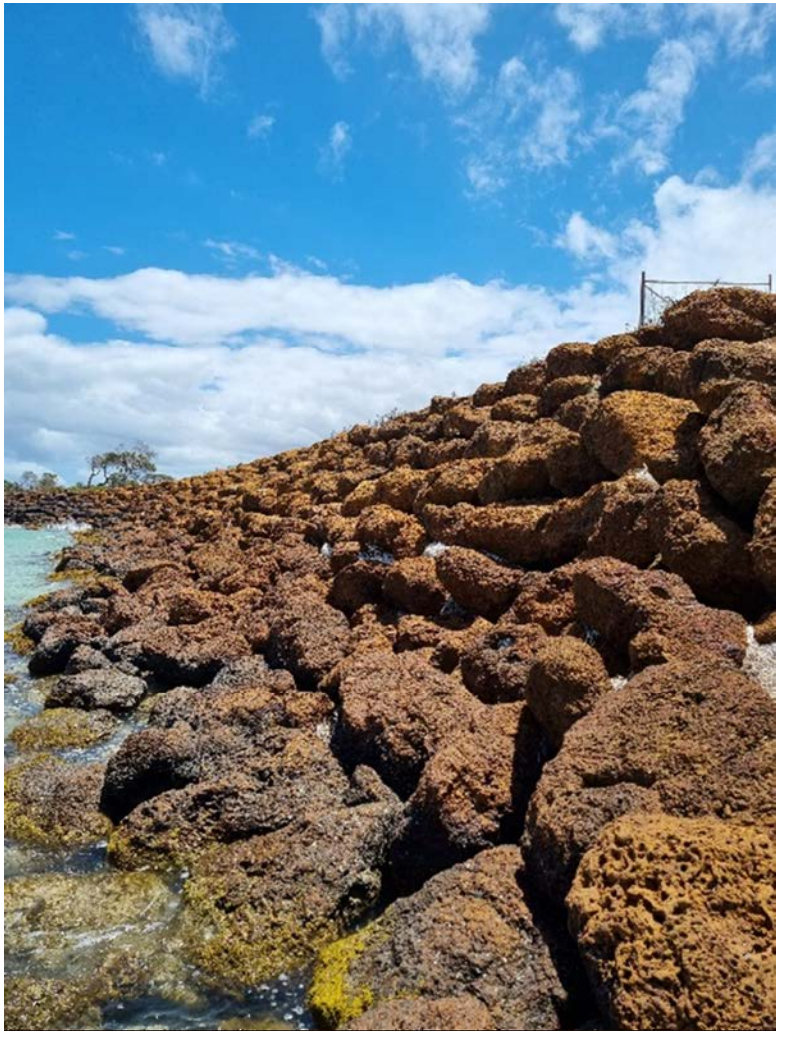

Figure 12-14: Seawall extending south-west of damaged section, taken during site visit 5 December 2024.

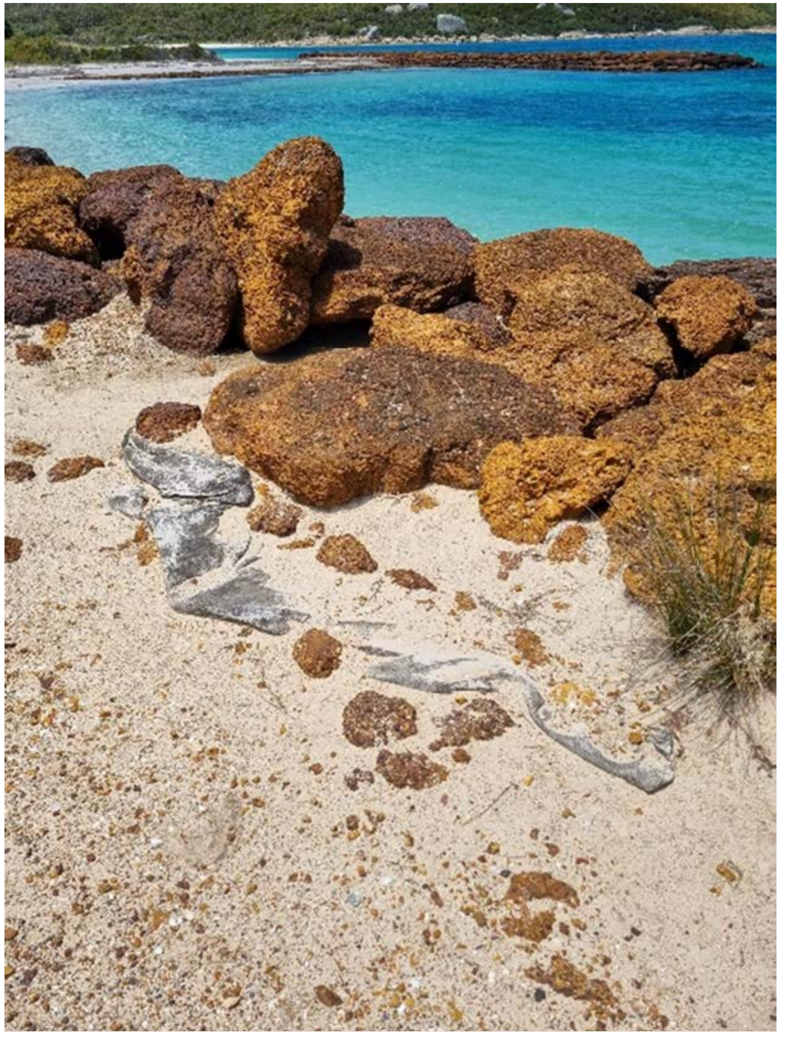

Figure 12-15: Exposed geotextile along seawall (+600m) taken during site visit 5 December 2024.

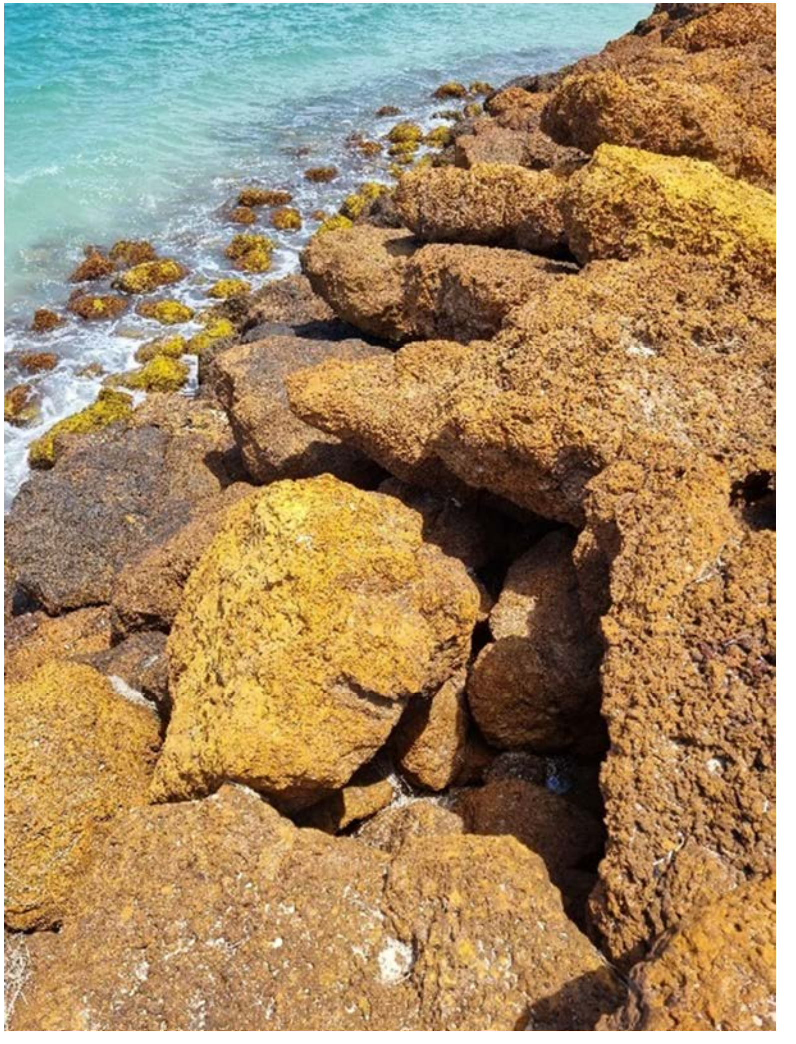

Figure 12-16: Poor interlocking and scattered toe armour (+625m), taken during site visit 5 December 2024.

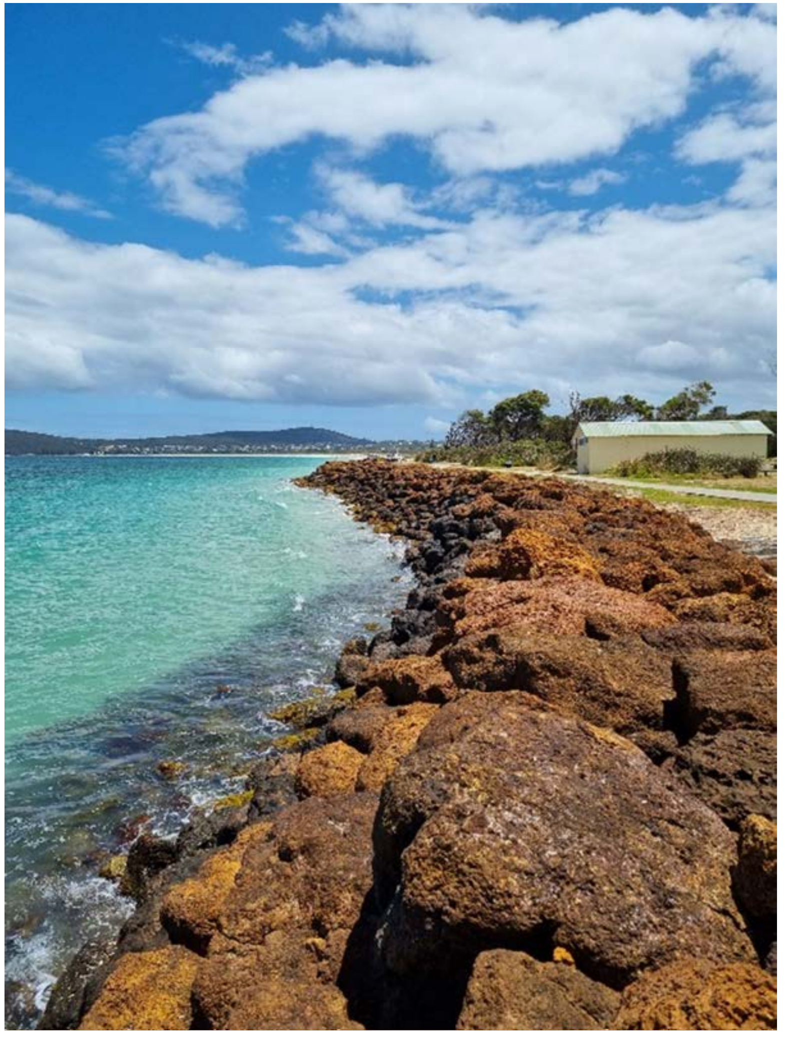

Figure 12-17: Seawall extending west (+700m) taken during site visit 5 December 2024.

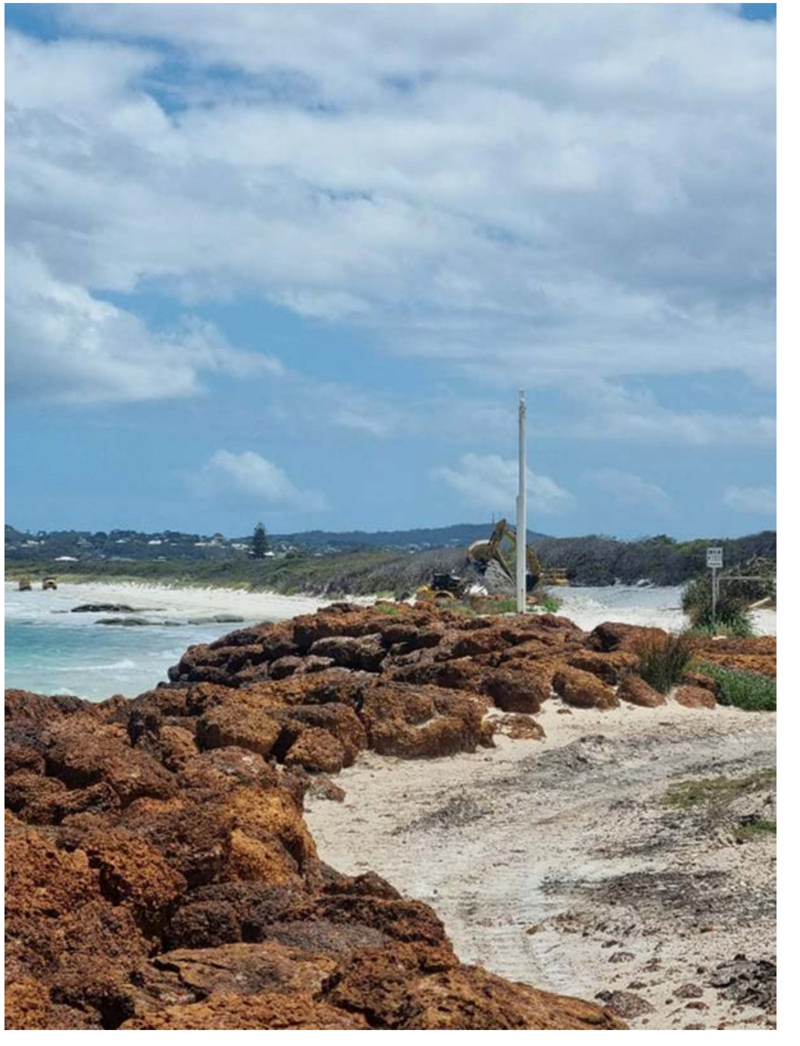

Figure 12-18: Sand nourishment works at eastern end of Emu Beach (+1000m), taken during site visit 5 December 2024.

Figure 12-19: Sand nourishment works (excavation) at Griffiths St beach access (+2000m), taken during site visit 5 December 2024.

Figure 12-20: Sand nourishment works at eastern end of Emu Beach (+1000m) with relocated dual access pathway shown on the right. Taken during site visit 5 December 2024.

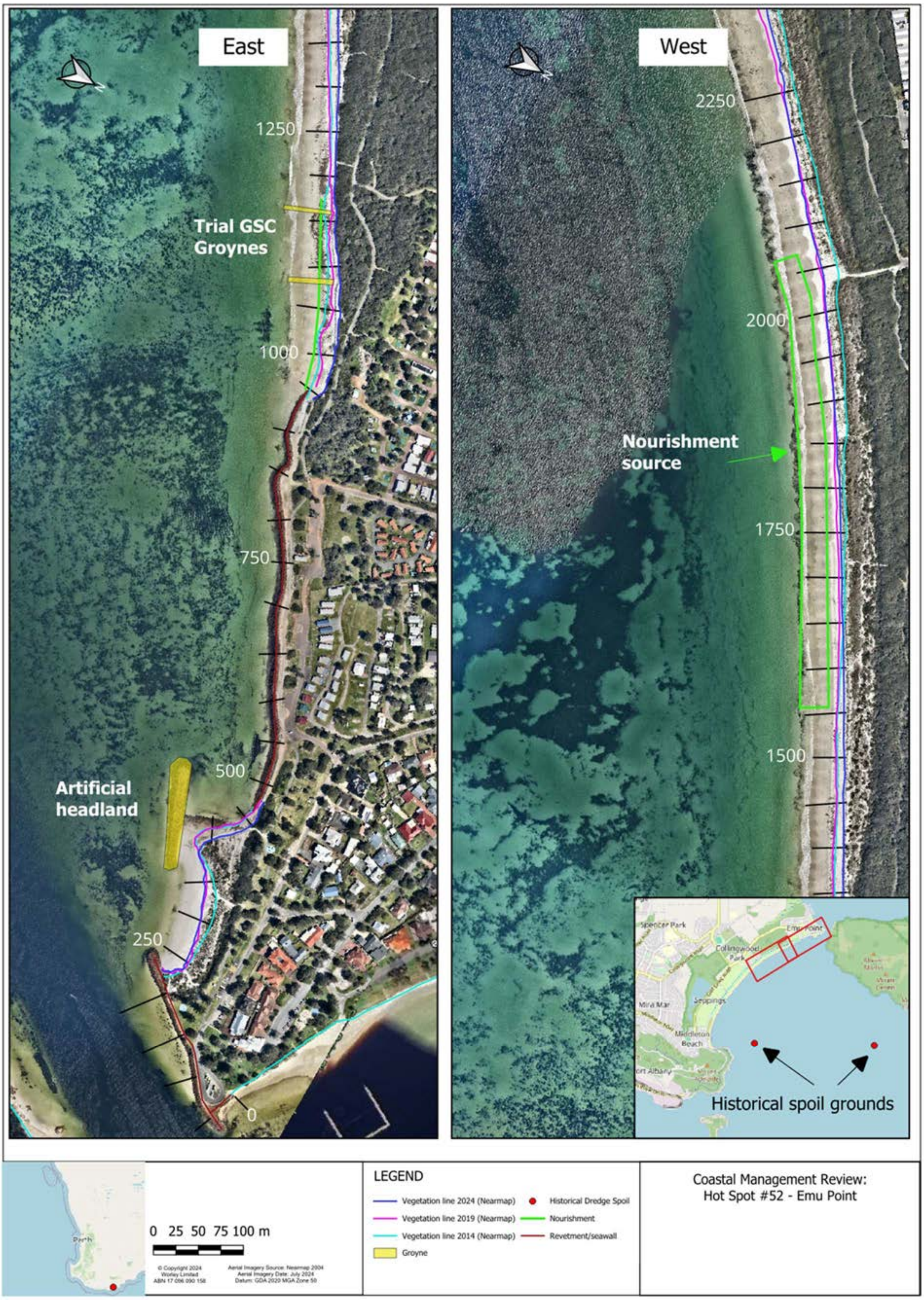

Figure 12-21: Emu Point - coastal management schematic.

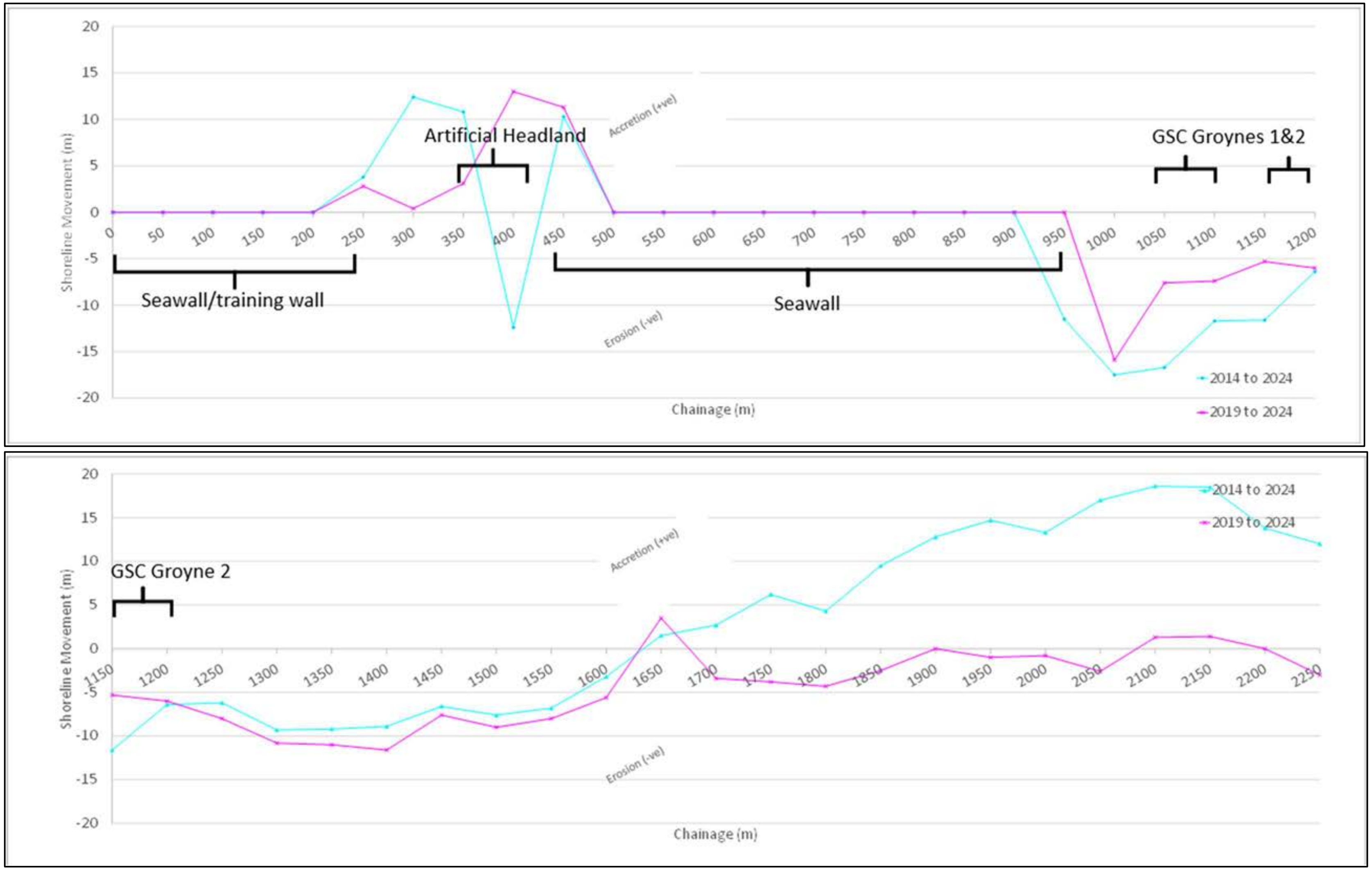

Figure 12-22: Results of Emu Point shoreline mapping, showing short and mid-term changes, for chainage reference refer to Figure 12-21

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Appendix B. Compiled Database of Coastal Management at 12 Sites

Government of Western Australia
Department of Transport

Department of Transport
Quinns Beach
Database of Coastal Management History
Date Populated: 15/01/2024

5 = Good condition, fully functional
3 = Moderate condition, still functional
1 = Poor condition, not functional

Offshore breakwater: Length, material (rock/GSC), distance to shore, spacing/interval; crest level
(rock/GSC), distance to shore, spacing/interval; crest level

Groyne: Length, material (rock/GSC/timber), spacing/interval; crest level

Seawall or revetment: Length, material (rock/GSC); crest level

Site	Name	Mgmt Hierarchy	Description	Year of Construction (completion)	Current Condition	Structure Information (see above)	Remaining design life (while performing intended function);
Quinns Beach	Sand nourishment	Protect	2580m3 of sand placed at QB13 (north side of Groyne 3)	1/05/2023			
Quinns Beach	Sand nourishment	Protect	3225m3 of sand placed at FS Carpark	1/05/2023			
Quinns Beach	Dune fencing repairs and sand redistribution	Protect	Dune and windbreak fencing repairs and sand redistribution	1/02/2023			
Quinns Beach	GSC Repairs	Protect	Recovered buried and dislodged GSC from beach	1/08/2022			
Quinns Beach	Staircase repairs	Protect	Stair repairs - minor	1/08/2022			
Quinns Beach	Sand nourishment	Protect	2580m3 of sand placed at QB13 (north side of Groyne 3)	1/04/2022			
Quinns Beach	Sand nourishment	Protect	2580m3 of sand placed at FS Carpark (north side of Groyne 1)	1/04/2022			
Quinns Beach	Sand nourishment	Protect	1935m3 of sand placed at FS Carpark (north side of Groyne 1)	1/11/2021			
Quinns Beach	Refurbishment of groyne 1	Protect	Maintenance and upgrade	1/04/2021	5		48
Quinns Beach	Sand nourishment	Protect		1/04/2021			
Quinns Beach	Sand nourishment	Protect	1290m3 of sand placed north of groyne 3	1/04/2021			
Quinns Beach	Sand nourishment	Protect	1290m3 of sand placed north of groyne 4	1/04/2021			
Quinns Beach	Sand nourishment	Protect	4970m3 of sand placed at FS carpark	1/06/2020			
Quinns Beach	Sand nourishment	Protect	2130m3 of sand placed at Groyne 3	1/06/2020			
Quinns Beach	Sand nourishment	Protect	1935m3 of sand placed at Groyne 4	1/06/2020			
Quinns Beach	Extension of existing groyne 3	Protect	Extended by 15m	1/12/2019	5	75m long, limestone, crest = 4.5-6.0m, max armour 6.6	46
Quinns Beach	Sand nourishment	Protect	1935m3 of sand placed at Groyne 4	1/06/2019			
Quinns Beach	Sand nourishment	Protect	12260m3 of nourishment associated with groyne 2 upgrades	2/02/2019			
Quinns Beach	Extension of existing groyne 2	Protect	Extended by 45m	1/02/2019	5	85m long, limestone, crest = 4.5-6.0m, max armour 6.6	46
Quinns Beach	Sand nourishment	Protect	7097m3 of sand placed (assumed apart of Groyne 4)	2/06/2018			
Quinns Beach	Groyne 4 construction	Protect	60m long northern groyne	1/06/2018	5	60m long, limestone, crest = 4.5-6.0m, max armour 6.6	45
Quinns Beach	Access ramp construction	Protect	Associated with groyne 4 construction	1/06/2018			
Quinns Beach	Sand nourishment	Protect	8065m3 of sand placed at FS Carpark	1/02/2018			
Quinns Beach	Sand nourishment	Protect	6450m3 placed at FS Carpark	1/03/2017			
Quinns Beach	Sand nourishment	Protect	6450m3 placed at Groyne 3	1/03/2017			
Quinns Beach	Sand nourishment	Protect	5806m3 placed at groyne 3	1/05/2016			
Quinns Beach	Sand nourishment	Protect	1290m3 placed at Carpark	1/05/2016			
Quinns Beach	Sand nourishment	Protect	3870m3 of sand placed at FS Carpark	1/05/2015			
Quinns Beach	GSC Seawall Construction	Protect	280m of GSC along FS Park & dune rehabilitation	1/01/2014	5		
Quinns Beach	Sand nourishment	Protect	16780m3 at FS carpark	1/01/2014			
Quinns Beach	Seawall repairs	Protect	Adhoc repair of limestone seawall	1/11/2012	2		
Quinns Beach	Groyne Maintenance (1-3) & Seawall repairs	Protect	Required to improve the condition of the three groyne structures a	1/01/2008			
Quinns Beach	Sand nourishment	Protect	19355m3 nourishment	1/10/2006			
Quinns Beach	Sand nourishment	Protect	32258m3 nourishment	1/11/2004			
Quinns Beach	Sand nourishment	Protect	67097m3 nourished to support new groyne	1/02/2004			
Quinns Beach	Groyne 3 construction	Protect		1/02/2004	5		
Quinns Beach	Sand nourishment	Protect	60645m3 nourished to support new groyne	1/03/2003			
Quinns Beach	Groyne 1 construction	Protect		1/03/2003	5		
Quinns Beach	Groyne 2 construction	Protect		1/03/2003	5		
Quinns Beach	Seawall Construction	Protect	Emergency coastal protection works; limestone boulder seawall	1/01/2002	2		
Quinns Beach	Artificial Headland Construction	Protect	Construction of artificial headlandat cusp where Quinns beach natu	1/01/1977	1		

Government of Western Australia
Department of Transport

Department of Transport
Grannies Beach
Database of Coastal Management History
Date Populated: 01/05/2024

5 = Good condition, fully functional
3 = Moderate condition, still functional
1 = Poor condition, not functional

Offshore breakwater: Length, material (rock/GSC), distance to shore, spacing/interval; crest level
(rock/GSC), distance to shore, spacing/interval; crest level

Groyne: Length, material (rock/GSC/timber), spacing/interval; crest level

Site	Name	Mgmt Hierarchy	Description	Year of Construction (completion)	Current Condition	Structure Information	Remaining design life (while performing intended function);
Grannies/Surf beach	Sand/stabilisation - Stage 3 revegetation	Protect	Surf beach nature-based stablisation	1/04/2024			
Grannies/Surf beach	Sand/stabilisation - Stage 3 Concrete	Protect	80m Surf beach stablisation works, insitu sand/concrete mixture	1/11/2023	N/A		
Grannies/Surf beach	Sand/stabilisation - Stage 2 Concrete + revegetation	Protect	150m Surf beach stablisation works, insitu sand/concrete mixture. Includes removal of excess rock from seawall.	1/02/2021	N/A		
Grannies/Surf beach	Grannies retaining wall emergency repairs	Protect	Concrete poured to provide support to cracking retaining wall	1/02/2021	3		
Grannies/Surf beach	Sand/stabilisation - Stage 1 Concrete + revegetation	Protect	50m Surf beach stablisation works, insitu sand/concrete mixture	1/01/2020			
Grannies/Surf beach	Seawall stage 3	Protect	30m extension north of phase 2	1/01/2014	5	Seawall or revetment: Length = 30m, Rock (basalt); crest level	
Grannies/Surf beach	Sand nourishment	Protect	1,000m3 placed at Grannies Beach (sourced from Dune Sand)	1/12/2011			
Grannies/Surf beach	Sand nourishment	Protect	1,800m3 placed at Grannies Beach (sourced from Dune Sand)	1/07/2011			
Grannies/Surf beach	Sand nourishment	Protect	2,500m3 of sand placed at Grannies and surf beach	1/01/2011			
Grannies/Surf beach	Sand nourishment	Protect	500m3 placed at Surf Beach (sourced from Dune Sand)	1/01/2011			
Grannies/Surf beach	Seawall stage 2	Protect	Grannies seawall - 170m northwards of phase 1	1/01/2011	5	Seawall or revetment: Length = 170m, Rock (basalt); crest	
Grannies/Surf beach	Seawall stage 1	Protect	Grannies seawall - 30m at southern end of caravan park	1/06/2010	5	Seawall or revetment: Length = 30m, Rock (basalt); crest level	
Grannies/Surf beach	Coastal Protection Works	Protect	Coastal Protection Works - Grannies Beach	1/01/2010			
Grannies/Surf beach	Emergency protection works	Protect	Emergency protection works - Grannies beach	1/01/2010			
Grannies/Surf beach	Sand nourishment	Protect	13,500m3 placed at Grannies and Surf Beach (sourced from coarse sand/shells from south of Port Denison)	1/01/2010			
Grannies/Surf beach	GSC protextion	Protect	GSCs placed at toe of limestone retaining wall at Grannies Beach, repairs also made to retaining wall.	1/01/2009			
Grannies/Surf beach	Sand nourishment	Protect	20,000m3 placed in front of Caravan Park (sourced from Dune Sand at Airstrip)	1/01/1999			
Grannies/Surf beach	Port Denison Breakwater Construction		Marina opened	1/01/1979			

Government of Western Australia
Department of Transport

Department of Transport
Grace Darling Park
Database of Coastal Management History
Date Populated: 01/08/2024

5 = Good condition, fully functional
3 = Moderate condition, still functional
1 = Poor condition, not functional

Offshore breakwater: Length, material (rock/GSC), distance to shore, spacing/interval; crest level (rock/GSC), distance to shore, spacing/interval; crest level

Groyne: Length, material (rock/GSC/timber), spacing/interval; crest level

Site	Name	Mgmt Hierarchy	Description	Year of Construction (completion)	Current Condition	Structure Information (see above)	Remaining design life (while performing intended function);
Lancelin	Sand nourishment	Protect	2654m3 used to nourish Grace Darling beaches, sourced from local sand pits	1/12/2023			
Lancelin	Sand nourishment	Protect	4460m3 used to nourish Grace Darling beaches	1/12/2022			
Lancelin	Sand nourishment	Protect	2194m3 used to nourish Grace Darling beaches	1/12/2021			
Lancelin	Sand nourishment (dredge disposal)	Protect	8000m3 of dredge disposal used to nourish Grace Darling beaches, DoT dredging campaign brought forward due to erosion at GD	1/05/2020			
Lancelin	Sand nourishment	Protect	1613m3 used to nourish Grace Darling beaches	1/12/2019			
Lancelin	Sand nourishment	Protect	429m3 used to nourish Grace Darling beaches	1/06/2019			
Lancelin	Sand nourishment	Protect	382m3 used to nourish Grace Darling beaches	1/12/2018			
Lancelin	Sand nourishment (dredge disposal)	Protect	4500m3 of dredge disposal used to nourish Grace Darling beaches	1/05/2017			
Lancelin	Sand nourishment	Protect	1185m3 used to nourish Grace Darling beaches	1/12/2016			
Lancelin	Sand nourishment	Protect	1613m3 used to nourish Grace Darling beaches	1/04/2016			
Lancelin	Sand nourishment	Protect	3500m3 used to nourish Grace Darling beaches	1/05/2015			
Lancelin	Sand nourishment	Protect	1200m3 used to nourish Grace Darling beaches	1/11/2014			
Lancelin	Sand nourishment	Protect	4500m3 used to nourish Grace Darling beaches	1/12/2013			
Lancelin	Sand nourishment	Protect	1000m3 used to nourish Grace Darling beaches	1/12/2012			
Lancelin			Initial construction of Grace Darling Park facilities	1/01/1994			

Department of Transport
Seabird
Database of Coastal Management History
Date populated: 01/01/2025

5 = Good condition, fully functional
3 = Moderate condition, still functional
1 = Poor condition, not functional

Offshore breakwater: Length, material (rock/GSC), distance to shore, spacing/interval; crest level (rock/GSC), distance to shore, spacing/interval; crest level

Groyne: Length, material (rock/GSC/timber), spacing/interval; crest level

Seawall or revetment: Length, material (rock/GSC); crest level

Site	Name	Mgmt Hierarchy	Description	Year of Construction (completion)	Current Condition	Structure Information	Remaining design life (while performing intended function);
Seabird	Sand nourishment	Protect	Approximately 730m3 of sand nourishment	1/05/2023			
Seabird	Dune revegetation	Protect	Undertaken in conjunction with seawall works	1/09/2016			
Seabird	Limestone revetment construction, flex-mat removal	Protect	Approximately 700m in length	1/07/2016		Seawall or revetment: Length = 700m, material=limestone; crest level=4m AHD, crest width=3.3m, rock armour =x2 layers of 2-3T	12yr (estimated)
Seabird	Temporary protection works	Protect	Installation of concrete flex-mat and 3500m3 sand nourishment	1/07/2015			
Seabird	Sand nourishment Turner Street	Protect	Approximately 3500m3 of nourishment	1/01/2015			
Seabird	Sand nourishment Turner Street	Protect	Approximately 1800m3 of nourishment at Jackson road	1/01/2014			
Seabird	Sand nourishment Turner Street	Protect	Approximately 2000m3 of sand nourishment, emergency foreshore	7/10/2002			
Seabird							
Seabird							
Seabird							
Seabird							
Seabird							

Department of Transport
C.Y. O'Connor
Database of Coastal Management History
Date Populated: 01/08/2024

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(rock/GSC), distance to shore, spacing/interval; crest level

Groyne: Length, material (rock/GSC/timber), spacing/interval; crest level

Seawall or revetment: Length, material (rock/GSC); crest level

Site	Name	Mgmt Hierarchy	Description	Year of Construction (completion)	Current Condition	Structure Information (see above)	Remaining design life (while performing intended function);
CY Oconnor Beach South	Sand nourishment		17 675 m3 of sand sourced from Chelydra Beach	1/03/2024			
CY Oconnor Beach North	Reconstruction of dual use path		40 m bend section of dual use pathway (north of Catherine Point) relocated inland, straight section	1/12/2023			
CY Oconnor Beach North	Sand nourishment		6 750 m3 of sand sourced from Island St Groyne	1/07/2023			
CY Oconnor Beach North	Geotextile Sand Container revetment		North wall construction	1/01/2022	n/a (buried)	Crest Level = ~3.3m CD, GSC size = 1.2m3, length = 51m	3
CY Oconnor Beach North	Sand nourishment		1 500 m3 of sand sourced from Island Street Groyne	1/12/2021			
CY Oconnor Beach North	Engineered fringing reef		Installation of a modular engineered fringing reef comprising a 100 m long, curved section of bespoke concrete armour units in three rows was fabricated and installed by S	1/12/2021		Crest Level = ~3.8m CD, GSC size = 1.2m3, length = 20m	
CY Oconnor Beach North	Sand nourishment		4 386 m3 of sand sourced from Island St Groyne and haulage south along the beach to the nourishment site.	1/12/2020			
CY Oconnor Beach South	Sand nourishment		4 956 m3 of sand sourced from Chelydra Beach (involving excavation of sand from the sand trap (Power Station) beach north of Port Coogee and haulage north along the be	1/11/2020			
CY Oconnor Beach North	Sand nourishment		600 m3 of sand sourced from C.Y. O'Connor Beach North was used to nourish North of Catherine Point Groyne (Small-scale emergency sand nourishment actions were und	1/02/2020			
CY Oconnor Beach North	Geotextile Sand Container revetment		South wall construction	1/01/2020			
CY Oconnor Beach South	Sand nourishment		15000 m3 of sand sourced from Chelydra Beach	1/11/2019			
CY Oconnor Beach South	Sand nourishment		4500 m3 of sand sourced from Chelydra Beach	1/09/2018			
CY Oconnor Beach North	Sand nourishment		15 750 m3 of sand sourced from Chelydra Beach (sand back-passing from the power station sand trap)	1/08/2018			
CY Oconnor Beach South	Sand nourishment		21000 m3 of sand sourced from Chelydra Beach (campaign halved before/after winter)	1/10/2016			
CY Oconnor Beach South	Sand nourishment		21001 m3 of sand sourced from Chelydra Beach (campaign halved before/after winter)	1/05/2016			
CY Oconnor Beach North	Reconstruction of dual use path		Reconstruction/retreat of the dual-use shared path running along the coast - reconstructed further inland in 2013 (north of the Catherine Point) in response to shoreline rec	1/01/2013			
Catherine Point	Groyne remediation and extension		Groyne extension by 30m and access upgrades	1/03/2012	4	Crest Level = ~5.25m CD, Armour size 4T, length = 160m	
CY Oconnor Beach South	Reconstruction of dual use path		Reconstruction/retreat of the dual-use shared path running along the coast - reconstructed further inland in 2009 (south of Catherine Point) in response to shoreline recessi	1/01/2009			
CY Oconnor Beach South	Breakwaters at Port Coogee		Construction of breakwaters at Port Coogee	2/01/2006			
Island Point	Rock revetment		Rock revetment protection placed on south side of the groyne	1/01/2006			
Island Point	Groyne Extension		Groyne extended 80 m	1/01/1996			
Island Point	Groyne Construction		Initial groyne construction of 107m length	1/01/1962			
Catherine Point	Groyne Extension		Groyne extended 60 m due to saturation	1/01/1962			
Catherine Point	Groyne Construction		Initial groyne construction of 70 m length	1/01/1959			
Success Bank	Channel Dredging		Offshore placement of dredge material to the west of the navigation channel (side-casting) during construction of Success Channel (1942-1945)	1/01/1942			

Department of Transport
Kwinana Industrial
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Groyne: Length, material (rock/GSC/timber), spacing/interval; crest level

Seawall or revetment: Length, material (rock/GSC); crest level

Site	Name	Mgmt Hierarchy	Year of Construction (completion)	Current Condition	Structure Information	Remaining design life (while performing intended function);
Kwinana Industrial	Revegation works - Challenger Beach		1/01/2023			
Kwinana Industrial	Revegation works - Challenger Beach		1/01/2022			
Kwinana Industrial	Revegation works - Watercorp/Suez beaches		1/01/2022			
Kwinana Industrial	BHP Jetty - partial demolition		1/01/2021			
Kwinana Industrial	Revegation works - Challenger Beach		1/01/2021			
Kwinana Industrial	Kwinana Bulk Terminals - revetment		1/01/2013			
Kwinana Industrial	Kwinana Bulk Jetty - northern revetment		1/02/2008			
Kwinana Industrial	Challenger Beach revetment (DoT ID S12)		1/01/2000	3.25		
Kwinana Industrial	BP Headland 1		1/01/1970	2.25		
Kwinana Industrial	BP Headland 2		1/01/1970	2.25		
Kwinana Industrial	BP Headland 3		1/01/1970	2.25		
Kwinana Industrial	BP Headland 4		1/01/1970	2.25		
Kwinana Industrial	BP Headland 5		1/01/1970	2		
Kwinana Industrial	BP Headland 6		1/01/1970	2		
Kwinana Industrial	BP Headland 7		1/01/1970	2		
Kwinana Industrial	Kwinana Power Station seawall					

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Kwinana Town Beach
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Groyne: Length, material (rock/GSC/timber), spacing/interval; crest level

Seawall or revetment: Length, material (rock/GSC); crest level

Site	Name	Mgmt Hierarchy	Description	Year of Construction (completion)	Current Condition	Structure Information	Remaining design life (while performing intended function);
Kwinana	3191m3 sand nourishment - headland	Protect	Sand nourishment via trucking undertaken by City of Rockingham from Point Peron Sand trap	1/11/2024			
Kwinana	14584m3 sand nourishment - headland	Protect	Sand nourishment via trucking undertaken by City of Rockingham from Point Peron Sand trap	1/02/2021			
Kwinana	13500m3 sand nourishment - headland	Protect	Sand nourishment via trucking undertaken by City of Rockingham from Point Peron Sand trap	9/03/2012			
Kwinana	6600m3 sand nourishment - headland	Protect	Sand nourishment via trucking undertaken by City of Rockingham from Point Peron Sand trap	1/02/2008			
Kwinana	Initial construction of southern artificial headland	Protect	Initial construction estimated	1/07/2007	3.25	50m x 20m, limestone, 3-5T external armour, 1-3T internal armour, crest 2.35m CD	
Kwinana	Initial construction of northern artificial headland	Protect	Initial construction estimated	1/07/2007	3.25	50m x 20m, limestone, 3-5T external armour, 1-3T internal armour, crest 2.35m CD	
Kwinana	10000m3 sand nourishment - south Wells Park	Protect	Sand nourishment undertaken by City of Rockingham building out the dune, 500m south of the Well Park wreck	1/07/2003			
Kwinana	11500m3 sand nourishment - south Wells Park	Protect	Sand nourishment undertaken by City of Rockingham building out the dune, 500m south of the Well Park wreck	1/01/2003			
Kwinana	4650m3 sand nourishment - south Wells Park	Protect	Sand nourishment undertaken by City of Rockingham building out the dune, 500m south of the Well Park wreck	1/10/2001			
Kwinana	Rubble mound revetment extension	Protect	Extension of southern end of rubble mound revetment south of Wells Park	1/01/1997	2	Crest estimated in 2012, 1.5-2.0m AHD	N/A
Kwinana	Rubble mound revetment construction	Protect	Initial construction	1/01/1981	2	Varied crest height estimated in 2012, 3.2m AHD at northern end, 1.6m AHD at 110m	N/A
Kwinana	Limestone retaining wall construction	Protect	Initial construction	1/01/1978	2		

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Rockingham Townsite
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(rock/GSC), distance to shore, spacing/interval; crest level

Groyne: Length, material (rock/GSC/timber), spacing/interval; crest level

Seawall or revetment: Length, material (rock/GSC); crest level

Site	Name	Mgmt Hierarchy	Description	Year of Construction (completion)	Current Condition	Structure Information	Remaining design life (while performing intended function);
Rockingham Townsite	Sand nourishment - Proposed	Protect	Hymus street seawall	1/09/2024		Informal rubble mound revetment	
Rockingham Townsite	Sand Nourishment	Protect	3000m3 nourished at Palm beach west boat ramp to Hymus St	22/10/2022			
Rockingham Townsite	Sand Nourishment	Protect	1773m3 nourished at Palm beach west boat ramp to Hymus St	1/10/2021			
Rockingham Townsite	Rockingham foreshore redevelopment	Protect	Rockingham Foreshore Beach Plaza Redevelopment Project , including seawall construction and scour protection at the toe of	1/09/2019			
Rockingham Townsite	Sand Nourishment	Protect	200m3 nourished at Mangles Bay Fishing Club	12/08/2015			
Rockingham Townsite	Construction of Val Street Seawall and scour prote	Protect	Construction of Val Street Jetty 0-100m Jetty Approach Section. Demolition of existing approach and old jetty head. Onshore R	1/03/2015			
Rockingham Townsite	Sand Nourishment	Protect	400m3 nourished at Mangles Bay Fishing Club	1/01/2015			
Rockingham Townsite	Sand Nourishment	Protect	2000m3 nourished at Flinders lane to Wanliss St	8/08/2014			
Rockingham Townsite	Sand Nourishment	Protect	1000m3 nourished at Victoria St Car Park	16/01/2013			
Rockingham Townsite	Sand Nourishment	Protect	1000m3 nourished at Victoria St Car Park	8/11/2012			
Rockingham Townsite	Informal rock placement at Mangles Bay Fishing C	Protect	Rock placement up western end of coastline. (Evidenced from aerial imagery)	1/01/2012			
Rockingham Townsite	Sand Nourishment	Protect	4500m3 nourished at Palm beach west boat ramp to Hymus St	18/07/2011			
Rockingham Townsite	Sand Nourishment	Protect	1500m3 nourished at Hymus St beach	11/07/2011			
Rockingham Townsite	Sand Nourishment	Protect	4000m3 nourished at Wanliss St beach	30/06/2011			
Rockingham Townsite	Sand Nourishment	Protect	1500m3 nourished at Hymus St beach	21/05/2011			
Rockingham Townsite	Sand Nourishment	Protect	1500m3 nourished at Hymus St beach	9/04/2010			
Rockingham Townsite	Sand Nourishment	Protect	1000m3 nourished at Victoria St Car Park beach	29/01/2010			
Rockingham Townsite	Palm Beach Seawall and scour protection (apart o	Protect	Limestone Seawall; 350mm x 350mm x 1000mm Reconstituted Limestone Blocks, with x251 0.75m3 Elco Rock Geotextile	10/08/2009			
Rockingham Townsite	Geotextile sand container revetment (Flinders lan	Protect	GSC revetment installed either side of limestone lookout. Local beach sand use for backfill over scour protection	1/01/2004			
Rockingham Townsite	Timber groynes construction	Protect	30m Timber Groyne (Jarrah) constructed 67m east of cnr Hymus St/The Esplanade at Palm Beach Foreshore. A second Jarrah G	1/01/2000			
Rockingham Townsite	Informal limestone revetment construction	Protect	Informal limestone revetment armouring footpath and road bend at Hymus street	1/01/2000			

Department of Transport
North Point Peron
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Groyne: Length, material (rock/GSC/timber), spacing/interval; crest level

Seawall or revetment: Length, material (rock/GSC); crest level

Site	Name	Mgmt Hierarchy	Description	Year of Construction (completion)	Current Condition	Structure Information	Remaining design life (while performing intended function);
North Point Peron	Sand backpassing/nourishment	Protect	Estimated 3000m3 nourished western side of GSC groyne and some used to	1/10/2024			
North Point Peron	Sand Trap Scraping & Stockpiling	Protect	Estimated 12000m3 scraped and stockpiled in sandtrap and used for CoR nourishmen	1/01/2024			
North Point Peron	Sand Trap Scraping & Stockpiling	Protect	Estimated 5000m3 scraped and stockpiled in sandtrap and used for CoR nourishmen	1/01/2023			
North Point Peron	Spur groyne extension and breakwater upgrade	Protect	Extension and upgrade to spur groyne, upgrade to breakwater/revetment	1/06/2022		Spur groyne 75m, BW and revetemnet 125m. Crest = 4.25m CD, Limestone, W50 = 4T	48
North Point Peron	Rock seawall upgrade (DBCA)	Protect	Reconfigured rock seawall, and upgrade/widening of dual use pathway	1/01/2022	4.75		
North Point Peron	Sand Trap Scraping & Stockpiling	Protect	Estimated 15000m3 scraped and stockpiled in sandtrap and used for CoR nourishmen	1/01/2022			
North Point Peron	GSC revetment installation	Protect	Estimated 50m length, understood to be installed by Camp School, using Neo Civil 2.5	1/08/2021			
North Point Peron	Sand Trap Scraping & Stockpiling	Protect	Estimated 22000m3 scraped and stockpiled in sandtrap and used for CoR nourishmen	1/01/2021			
North Point Peron	Sand Trap Scraping & Stockpiling	Protect	Estimated 16000m3 scraped and stockpiled in sandtrap and used for CoR nourishmen	1/01/2020			
North Point Peron	Sand Trap Scraping & Stockpiling	Protect	Estimated 15000m3 scraped and stockpiled in sandtrap and used for CoR nourishmen	1/01/2019			
North Point Peron	Sand Trap Scraping & Stockpiling	Protect	Estimated 20000m3 scraped and stockpiled in sandtrap and used for CoR nourishmen	1/01/2018			
North Point Peron	Sand Trap Scraping & Stockpiling	Protect	Estimated 19000m3 scraped and stockpiled in sandtrap and used for CoR nourishmen	1/01/2017			
North Point Peron	Sand Trap Scraping & Stockpiling	Protect	Estimated 12000m3 scraped and stockpiled in sandtrap and used for CoR nourishmen	1/01/2016			
North Point Peron	Sand Trap Scraping & Stockpiling	Protect	Estimated 10500m3 scraped and stockpiled in sandtrap and used for CoR nourishmen	1/01/2015			
North Point Peron	Sand backpassing/nourishment	Protect	4500m3 to reinstsate of beach profile between Pt. Peron Limestone Seawall, east to t	1/04/2014			
North Point Peron	Sand Nourishment - west of camp school	Protect	Estimated 4500m3 removed from sand trap stockpile	31/03/2014			
North Point Peron	Sand Trap Scraping & Stockpiling	Protect	Estimated 21000m3 scraped and stockpiled in sandtrap and used for CoR nourishmen	1/01/2014			
North Point Peron	Sand Nourishment - west of GSC groyne	Protect	Estimated 15000m3 removed from sand trap	21/05/2013			
North Point Peron	Sand Nourishment - west of camp school	Protect	Estimated 1000m3 removed from sand trap	12/03/2013			
North Point Peron	GSC groyne installation	Protect	Constructed at eastern side of School Camp foreshore	1/01/2013	1.67	61m length, trunk ~1.5m AHD, head ~0.9m AHD, Up to 4 layers of 2.5m3 bags (3m3 bags)	0
North Point Peron	Sand Trap Scraping & Stockpiling		Estimated 15000m3 scraped and stockpiled in sandtrap and used for CoR nourishmen	1/01/2013			
North Point Peron	Sand Trap Excavation	Protect	Estimated 15000m3 removed from sand trap	1/01/2014			
North Point Peron	Sand Trap Excavation	Protect	Estimated 10000m3 removed from sand trap	1/01/2015			
North Point Peron	Sand Trap Excavation	Protect	Estimated 17000m3 removed from sand trap	1/01/2016			
North Point Peron	Sand Trap Excavation	Protect	Estimated 6000m3 removed from sand trap	1/01/2017			
North Point Peron	Sand Trap Excavation	Protect	Estimated 12000m3 removed from sand trap	1/01/2018			
North Point Peron	Sand Trap Excavation	Protect	Estimated 12000m3 removed from sand trap	1/01/2019			
North Point Peron	Sand Trap Excavation	Protect	Estimated 10000m3 removed from sand trap	1/01/2020			
North Point Peron	Sand Trap Excavation	Protect	Unknown m3 removed from sand trap	1/01/2021			
North Point Peron	Sand Trap Excavation	Protect	Estimated 9000m3 removed from sand trap	1/01/2022			
North Point Peron	Sand Trap Excavation	Protect	Estimated 11000m3 removed from sand trap	1/01/2023			
North Point Peron	Sand Trap Excavation	Protect	Estimated 11000m3 removed from sand trap	1/01/2024			
North Point Peron	Sand Trap Excavation	Protect	Estimated 11000m3 removed from sand trap	1/01/2001			
North Point Peron	Sand Trap Excavation	Protect	Estimated 11000m3 removed from sand trap	1/01/2000			
North Point Peron	Spur extension to sand trap groyne	Protect	Spur groyne added northwards ~50m	1/01/1990			
North Point Peron	Rock seawall	Protect	Seawall built by DEC protecting path access, ~170m long	1/01/1988			
North Point Peron	Extension to sand trap groyne	Protect	90 degree, ~65m extension to sand trap groyne eastwards	1/01/1986			
North Point Peron	Original sand trap groyne	Protect	Original construction west of causeway abutment, ~200m	1/01/1973			
North Point Peron	Original boat launch construction	Protect	Boat launching facility and straight groyne	1/01/1973			

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Department of Transport
Mandurah Northern Beaches
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Groyne: Length, material (rock/GSC/timber), spacing/interval; crest level

Seawall or revetment: Length, material (rock/GSC); crest level

Site	Name	Description	Year of Construction (completion)	Current Condition (/5)	Structure Information (see above)	Remaining design life (while performing intended function);
Mandurah Northern Beaches	Sand Bypassing	180577 m3 pumped sand bypassing from Doddi's beach sandtrap	1/11/2023			
Mandurah Northern Beaches	Sand Bypassing	181329 m3 pumped sand bypassing from Doddi's beach sandtrap	1/11/2022			
Mandurah Northern Beaches	Sand Bypassing	220003 m3 pumped sand bypassing from Doddi's beach sandtrap	1/11/2021			
Mandurah Northern Beaches	Sand Bypassing	191659 m3 pumped sand bypassing from Doddi's beach sandtrap	1/11/2020			
Mandurah Northern Beaches	Sand Bypassing	160000 m3 pumped sand bypassing from Doddi's beach sandtrap	1/11/2019			
Mandurah Northern Beaches	Sand nourishment/scraping	Fifth groyne (San Remo) sand scraped from adjacent to groyne and used to protect scarp	1/01/2019			
Mandurah Northern Beaches	Sand Bypassing	170000 m3 pumped sand bypassing from Doddi's beach sandtrap	1/11/2018			
Mandurah Northern Beaches	Sand Bypassing	175007 m3 pumped sand bypassing from Doddi's beach sandtrap	1/11/2017			
Mandurah Northern Beaches	Sand Bypassing	166600 m3 pumped sand bypassing from Doddi's beach sandtrap	1/11/2016			
Mandurah Northern Beaches	Sand Bypassing	196400 m3 pumped sand bypassing from Doddi's beach sandtrap	1/11/2015			
Mandurah Northern Beaches	Sand Bypassing	149930 m3 pumped sand bypassing from Doddi's beach sandtrap	1/11/2014			
Mandurah Northern Beaches	Sand Bypassing	133000 m3 pumped sand bypassing from Doddi's beach sandtrap	1/11/2013			
Mandurah Northern Beaches	Sand Bypassing	150043 m3 pumped sand bypassing from Doddi's beach sandtrap	1/11/2012			
Mandurah Northern Beaches	Sand Bypassing	130409 m3 pumped sand bypassing from Doddi's beach sandtrap	1/11/2011			
Mandurah Northern Beaches	Groyne maintenance/reconfiguratior	Fourth groyne (Wade St) reconfiguration, some armour on neck of groyne moved to prote	1/01/2011	3		N/A (Dependant on sand management)
Mandurah Northern Beaches	Sand Bypassing	101886 m3 pumped sand bypassing from Doddi's beach sandtrap	1/11/2010			
Mandurah Northern Beaches	Sand Bypassing	112129 m3 pumped sand bypassing from Doddi's beach sandtrap	1/11/2009			
Mandurah Northern Beaches	Sand nourishment	Fourth groyne (Wade St), unknown qty/source	1/01/2009			
Mandurah Northern Beaches	Groyne maintenance	Fifth groyne (San Remo) Approximately 12 large rocks worked into existing voids in groyn	1/01/2009	5		
Mandurah Northern Beaches	Sand Bypassing	164278 m3 pumped sand bypassing from Doddi's beach sandtrap	1/11/2008			
Mandurah Northern Beaches	Sand Bypassing	120000 m3 pumped sand bypassing from Doddi's beach sandtrap	1/11/2007			
Mandurah Northern Beaches	Sand nourishment	5000m3 or nourishment at Second groyne (Henson St) sourced from Doddis sand trap -	1/03/2007			
Mandurah Northern Beaches	Sand nourishment	Remedial sand nourishment at Fourth groyne (Wade St). Unknown volume	1/01/2007			
Mandurah Northern Beaches	Sand Bypassing	74000 m3 pumped sand bypassing from Doddi's beach sandtrap	1/11/2006			
Mandurah Northern Beaches	Sand Bypassing	100000 m3 pumped sand bypassing from Doddi's beach sandtrap	1/11/2005			
Mandurah Northern Beaches	Groyne construction	Fifth groyne (San Remo) construction	1/01/2005	5	Length=50m, limestone armour, 4-8T armour,crest level 4.6m CD (3.841m)	
Mandurah Northern Beaches	Sand nourishment	Approximately 50000m3 nourishment to accompany Fifth groyne construction	1/01/2005			
Mandurah Northern Beaches	Sand Bypassing	99000 m3 pumped sand bypassing from Doddi's beach sandtrap	1/11/2004			
Mandurah Northern Beaches	Groyne repairs	Minor repairs to Fourth groyne, replacement of rocks along the length of the trunk and	1/01/2004	3	Length = 65m, limestone armour, 2-8T	20
Mandurah Northern Beaches	Groyne repairs	Minor repairs to Third groyne, replacement of rocks along the length of the trunk and	1/01/2004	3	Length = 40m, limestone armour, 2-8T	20
Mandurah Northern Beaches	Groyne repairs	Minor repairs to Second groyne, replacement of rocks along the length of the trunk and	1/01/2004	3	Length = 40m, limestone armour, 2-8T	20
Mandurah Northern Beaches	Groyne repairs	Minor repairs to First groyne, replacement of rocks along the length of the trunk and	1/01/2004	3	Length = 60m, limestone armour, 2-8T	20
Mandurah Northern Beaches	Sand Bypassing	100000 m3 pumped sand bypassing from Doddi's beach sandtrap	1/11/2003			
Mandurah Northern Beaches	Seawall construction	Town beach seawall upgrade (TABEC). Chainages 180m to 380m	1/01/2003	3.5	Length = 360m, limestone armour <1T (MPR estimates)	5 (providing sand buffer maintained)
Mandurah Northern Beaches	Sand Bypassing	100000 m3 pumped sand bypassing from Doddi's beach sandtrap	1/11/2002			
Mandurah Northern Beaches	Sand Bypassing	100000 m3 pumped sand bypassing from Doddi's beach sandtrap	1/11/2001			
Mandurah Northern Beaches	Sand Bypassing	108000 m3 pumped sand bypassing from Doddi's beach sandtrap	1/11/2000			
Mandurah Northern Beaches	Sand Bypassing	112000 m3 pumped sand bypassing from Doddi's beach sandtrap	1/11/1999			
Mandurah Northern Beaches	Sand Bypassing	105000 m3 pumped sand bypassing from Doddi's beach sandtrap	1/11/1998			
Mandurah Northern Beaches	Seawall construction	Town beach seawall construction as part of the Mandurah Ocean Marina development (d	1/01/1998			
Mandurah Northern Beaches	Sand Bypassing	58000 m3 pumped sand bypassing from Doddi's beach sandtrap	1/11/1997			
Mandurah Northern Beaches	Sand Bypassing	39000 m3 pumped sand bypassing from Doddi's beach sandtrap	1/11/1996			
Mandurah Northern Beaches	Sand Bypassing	142000 m3 pumped sand bypassing from Doddi's beach sandtrap (initiation of 5 year con	1/11/1995			
Mandurah Northern Beaches	Sand Bypassing	26000 m3 pumped sand bypassing from Doddi's beach sandtrap	1/11/1994			
Mandurah Northern Beaches	Sand Bypassing	44000 m3 pumped sand bypassing from Doddi's beach sandtrap	1/11/1993			
Mandurah Entrance Channel	Seawall construction	Eastern seawall construction	1/01/1975			
Mandurah Northern Beaches	Groyne construction	Fourth groyne (Wade st) construction	1/01/1975			
Mandurah Northern Beaches	Groyne construction	Third groyne (Orion Rd) construction	1/01/1975			
Mandurah Northern Beaches	Groyne construction	Second groyne (Henson St)	1/01/1975			
Mandurah Northern Beaches	Groyne construction	First groyne (Aileen St)	1/01/1975			
Mandurah Entrance Channel	Training wall construction	Training wall built to define entrance channel west and eastern shores	1/01/1969			

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Wonnerup
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Date Populated: 01/06/2025

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Offshore breakwater: Length, material (rock/GSC), distance to shore, spacing/interval; crest level (rock/GSC), distance to shore, spacing/interval; crest level

Groyne: Length, material (rock/GSC/timber), spacing/interval; crest level

Seawall or revetment: Length, material (rock/GSC); crest level

Site	Name	Description	Year of Construction (completion)	Current Condition2	Structure Information (see above)	Remaining design life (while performing intended function);
Busselton - Wonnerup	19799m3 nourishment volume at Wonnerup from PG Dredging disposal		1/12/2024			
Busselton - Wonnerup	11360m3 nourishment at Wonnerup from external trucking		1/01/2024			
Busselton - Wonnerup	9590m3 nourishment at Wonnerup from external trucking		1/01/2023			
Busselton - Wonnerup	12190m3 nourishment at Wonnerup from PG Dredging disposal		1/01/2023			
Busselton - Wonnerup	15160m3 nourishment at Wonnerup from external trucking		1/01/2022			
Busselton - Wonnerup	13760m3 of nourishment at Wonnerup from PG Dredging disposal		1/01/2022			
Busselton - Wonnerup	18700m3 of nourishment at Wonnerup from PG Dredging disposal		1/01/2021			
Busselton - Wonnerup	8500m3 of nourishment at Wonnerup from external truckin		1/01/2021			
Busselton - Wonnerup	Construction of GSC groyne 9		1/01/2020			
Busselton - Wonnerup	Construction of GSC groyne 10		1/01/2020			
Busselton - Wonnerup	11800m3 nourishment volume at Wonnerup from external trucking		1/01/2020			
Busselton - Wonnerup	21580m3 nourishment volume at Wonnerup		1/01/2019			
Busselton - Wonnerup	Groyne 3 refurbishment		1/01/2019	3	Length 35m. Rock (Ironstone and Granite), Armour: M50 = 2T Ironstone, Crest height 0.5m AHD	20
Busselton - Wonnerup	Groyne 4 refurbishment		1/01/2019	3	Length 35m. Rock (Ironstone and Granite), Armour: M50 = 2T Ironstone, Crest height 0.2m AHD	20
Busselton - Wonnerup	Groyne 5 refurbishment		1/01/2019	3	Length 35m. Rock (Ironstone and Granite), Armour: M50 = 2T Ironstone, Crest height 0.1m AHD	20
Busselton - Wonnerup	Groyne 6 refurbishment		1/01/2019	3	Length 35m. Rock (Ironstone and Granite), Armour: M50 = 2T Ironstone, Crest height 0.0m AHD	20
Busselton - Wonnerup	30291m3 nourishment at Wonnerup from external trucking		1/01/2018			
Busselton - Wonnerup	43628m3 nourishment at Wonnerup from external trucking		1/01/2017			
Busselton - Wonnerup	Construction of GSC groyne 7	Relatively short (<40m) and low	1/01/2017			
Busselton - Wonnerup	Construction of GSC groyne 8	Relatively short (<40m) and low	1/01/2017			
Busselton - Wonnerup	Groyne 1 refurbishment	Refurbished by developer (Seaport) based on MRA des	1/01/2016	2.25	. Rock (Ironstone), Armour: Double layer of M50, 3T Ironstone, Crest height 2.5m AHD, Crest width 3m	
Busselton - Wonnerup	Groyne 2 refurbishment	Refurbished by developer (Seaport) based on MRA des	1/01/2016	2.75	. Rock (Ironstone), Armour: Double layer of M50, 3T Ironstone, Crest height 2.5m AHD, Crest width 3m	
Busselton - Wonnerup	10000m3 nourishment at Wonnerup from external trucking		1/01/2015			
Busselton - Wonnerup	Port Geographe - major groyne and revetment reconfiguration	Reconfiguration undertaken between Nov2013 to June	1/01/2015			
Busselton - Wonnerup	35000m3 nourishment volume at Wonnerup		1/01/2014			
Busselton - Wonnerup	Nourishment of ~25000m3		1/01/2013			
Busselton - Wonnerup	Nourishment of ~51000m3		1/01/2012			
Busselton - Wonnerup	Nourishment of ~45000m3		1/01/2011			
Busselton - Wonnerup	Nourishment of ~52400m3		1/01/2010			
Busselton - Wonnerup	Nourishment of ~69000m3		1/01/2009			
Busselton - Wonnerup	Nourishment of ~124000m3		1/01/2008			
Busselton - Wonnerup	Groyne 1 refurbishment	Refurbished by developer (Seaport) based on MRA des	1/01/2008	2.25	. Rock (Ironstone), Armour: Double layer of M50, 3T Ironstone, Crest height 2.5m AHD, Crest width 3m	
Busselton - Wonnerup	Groyne 2 refurbishment	Refurbished by developer (Seaport) based on MRA des	1/01/2008	2.75	. Rock (Ironstone), Armour: Double layer of M50, 3T Ironstone, Crest height 2.5m AHD, Crest width 3m	
Busselton - Wonnerup	Seawall construction	Constructed connecting the PG eastern breakwater to	1/05/2007			
Busselton - Wonnerup	Nourishment of ~122000m3		1/01/2007			
Busselton - Wonnerup	Initial construction Groyne 1 - laterite ironstone		1/05/2006			
Busselton - Wonnerup	Groyne 2 refurbishment		1/05/2006			
Busselton - Wonnerup	Nourishment of 123200m4		1/01/2006			
Busselton - Wonnerup	Nourishment of 141234m3		1/01/2005			
Busselton - Wonnerup	Nourishment of 98200m3		1/01/2004			
Busselton - Wonnerup	Initial construction Groyne 2 - laterite ironstone	Low profile ironstone (laterite) groyne	1/01/2003	2.25	Length 35m. No design details	
Busselton - Wonnerup	Initial construction Groyne 3 - laterite ironstone	Low profile ironstone (laterite) groyne	1/01/2003	2.75	Length 35m. No design details	
Busselton - Wonnerup	Initial construction Groyne 4 - laterite ironstone	Low profile ironstone (laterite) groyne	1/01/2003	3	Length 35m. No design details	
Busselton - Wonnerup	Initial construction Groyne 5 - laterite ironstone	Low profile ironstone (laterite) groyne	1/01/2003	3	Length 35m. No design details	
Busselton - Wonnerup	Initial construction Groyne 6 - laterite ironstone	Low profile ironstone (laterite) groyne	1/01/2003	3	Length 35m. No design details	
Busselton - Wonnerup	Nourishment of 41800m3		1/01/2003			
Busselton - Wonnerup	Nourishment of 27825m3		1/01/2002			
Busselton - Wonnerup	Construction of Eastern PG Seawall		1/04/2001			
Busselton - Wonnerup	Nourishment of 18303m6		1/01/2001			
Busselton - Wonnerup	Nourishment of 7042m3		1/01/2000			
Busselton - Wonnerup	Temporary seawall construction	Emergency rubble mound seawall constructed to prev	1/07/1999			
Busselton - Wonnerup	Nourishment of 5000m3		1/01/1999			
Busselton - Wonnerup	Nourishment of 82220m3		1/01/1998			
Busselton - Wonnerup	Construction of Port Geographe Marina		1/01/1997			
Busselton - Wonnerup	Nourishment of 77590m3		1/01/1996			

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Emu Point
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Offshore breakwater: Length, material (rock/GSC), distance to shore, spacing/interval; crest level
(rock/GSC), distance to shore, spacing/interval; crest level

Groyne: Length, material (rock/GSC/timber), spacing/interval; crest level

Seawall or revetment: Length, material (rock/GSC); crest level

Site	Name	Description	Year of Construction (completion)	Current Condition	Structure Information (see above)	Remaining design life (while performing intended function);
Emu Point	Sand nourishment campaign (sand sourced from Griffiths St Beach)		1/12/2024			
Emu Point	Sand nourishment campaign (sand sourced from Griffiths St Beach)		1/04/2024			
Emu Point	Training wall repairs and maintenance	Reinstatement of laterite rocks to increase the stability and height of the wall, and stabilising backfill with cement to protect it from scouring out when waves wash over the top	1/07/2014			
Emu Point	GSC groyne construction	Construction of x2 GSC sandbag groynes, initially undertaken as a trial	1/01/2014			
Emu Point	Sand nourishment, 10000m3 (to support GSC groyne trial)	Sand sourced from Ellen Cove	1/01/2014			
Emu Point	Dual use path relocated (approximate chainage 1050 to 1250m)	200m of dual use footpath realignment due to erosion risk	1/01/2013			
Emu Point	GSC revetment construction	Emergency management measure to avoid relocation of footpath.	1/08/2011			
Emu Point	Revetment extension		1/01/2011			
Emu Point	Revetment extension		1/01/2005			
Emu Point	Revetment extension		1/01/2001			
Emu Point	Emergency revetment		1/01/1999			
Emu Point	Rock headland construction (artificial headland)	Photo records indicate dredged material used to nourish beach in lee of newly constructed headland	1/01/1995		Headland, 100m length, x2 layers of 1-3T laterite, crest height ~1.5m AHD	
Emu Point	Groyne extension	Extended by 20m	1/01/1995			
Emu Point	Beach renourishment, 36000m3 (accompanying headland construction)		1/01/1995			
Emu Point	Revetment extension and Oyster harbour groyne construction		1/01/1991			
Emu Point	Initial groyne construction	Constructed off Cunningham St.	1/01/1989		~80m length, laterite rock, x2 layers of 1-3T rock, ~1.95m AHD crest	
Emu Point	Beach nourishment (accompanying groyne construction)		1/01/1989			
Emu Point	Dredging spoil dumped offshore of Middleton Beach	Unknown quantity	1/01/1985			
Emu Point	Dredging spoil dumped offshore of Middleton Beach	Unknown quantity	1/01/1979			
Emu Point	Dredging spoil dumped offshore of Middleton Beach	Unknown quantity	1/01/1977			
Emu Point	Dredging spoil dumped offshore of Middleton Beach	Unknown quantity	1/01/1955			
Emu Point	Dredging spoil dumped offshore of Middleton Beach	Described as 1.53M m3	1/01/1925			
Emu Point	Dredging spoil dumped offshore of Middleton Beach	Unknown quantity				