"Where will our knowledge take you?"

ESPERANCE BAY

Coastal Erosion Options

Reference: R-J18004.00
Date: July 2018

SHIRE OF ESPERANCE

ESPERANCE BAY

COASTAL EROSION OPTIONS

Prepared for

By

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TABLE OF CONTENTS

EXECUTIVE SUMMARY

This study provides an insight into Castletown Beach erosion management issue. A central issue at Castletown Beach, which is shared with any section of sandy coast with a deficit of sand supply upstream and a disruption of the littoral drift exacerbated by the presence of coastal protection structures, is that it is unlikely that the shoreline position will stop moving landward without some form of erosion management strategy. This situation poses a growing risk to the neighbouring infrastructures and foreshore amenities over time.

The current sand nourishment practice (“status-quo”) partially addresses the erosion risk. This strategy is implemented in response to shoreline erosion events by pushing sand (trucked from the land fill site 10km away) from the berm to the beach. The resulting sand buffer has proven to be sufficient to accommodate typical weather conditions, however it may be insufficient to offer meaningful protection against extreme erosive storm event. The current erosion management strategy at Castletown Beach costs the Shire approximately $190k per year, or about $3.1m (discounted) over 20 years. This strategy is not perceived as a sustainable solution by the community.

After considering the opportunities and constraints present at the site, various coastal erosion management options were defined and a preferred option was selected following a structured appraisal process. It was demonstrated that significant improvement could be achieved over the status-quo by implementing an enhanced beach nourishment program at Castletown Beach implemented in collaboration with the Department of Transport during their two-yearly maintenance dredging works of Bandy Creek Boat Harbour. The quality and quantity of sand available from these works is sufficient to be “back-passed” hydraulically and placed gently to form a wide natural beach, which could accommodate design erosion events. The Shire’s cost contribution for such coordinated strategy is expected to be about $150k every two years, or approximately $1.2m (discounted) over 20 years – a saving of more than 50% compared to the current practice.

The coordination of Bandy Creek Boat Harbour dredging and sand nourishment at Castletown Beach would bring together long-established practices currently implemented separately. This slight variation around a common theme presents demonstrable benefits to the Shire and the Department of Transport who both recognised a latent “Win-Win” solution during the early consultation sessions undertaken to date.

Realising the benefits of the preferred option however is subject to practical considerations for its success. Directions are provided to guide the timely and effective development of this enhanced erosion management strategy, should the proposed *Coordinated Bandy Creek Boat Harbour Dredging & Sand Back-Passing* at Castletown Beach be further considered.

1 INTRODUCTION

1.1 Background

The Castletown Beach has required annual sand renourishment of 20,000 - 25,000 m^3 since the total trapping of the littoral sand volume by the port breakwater. The nourishment operations are typically undertaken in winter.

The Shire has commissioned many reports over the years to find a better solution to the erosion problem, all proposing significant upfront capital costs that have not progressed further, as sand renourishment was found to be the most cost-effective defence process (Figure 1-1). However, sand renourishment in its current form is not seen as a favourable option in the eyes of many in the community as it does not seem like a long term solution to the erosion problem at Castletown Beach.

Figure 1-1: Foredune scarp following beach nourishment indicative of high erosion rate at Castletown Beach

1.2 Objectives of the study

The Shire of Esperance engaged coastal and maritime engineering and environmental science consultants BMT to review the Shire's current approach to costal erosion management in the Esperance Bay and recommend improvements to its current practice including a combination of options.

1.3 Scope of the report

The scope of services comprises the following:

- Review current practice of sand renourishment
- Review previous reports and work undertaken
- Look at a combination of options improve its current practice including:
  - T – Groynes (geo fabric tubes preferred)
  - Breakwaters (geo fabric tubes preferred)
  - Back passing sand from Bandy Creek
  - Other viable options
- Liaise with DOT regarding Bandy Creek Boat Harbour impacts on any potential recommendations
- Estimate of costs for options (in consultation with the Shire)
- Detail any social / amenity aspects of the options; and
- Detail environmental approvals required (if applicable); and
- Provide recommendations for improvement of costal erosion management

1.4 Structure of the report

This report is structured as follow:

- Section 2 introduces some background information relevant to the study, including an overview of the coastal geomorphology, sediment dynamics, benthic habitats and anthropogenic activities in Esperance Bay.
- Section 3 summarises our coastal erosion management options review, definition and appraisal, including the selection of a preferred option.
- Section 4 outlines the environmental permit and approval consideration relevant to the preferred option.
- Section 5 summarises the early consultation conducted with the Department of Transport.
- Section 6 concludes the study with a summary of the outcomes and recommendations.

2 BACKGROUND INFORMATION REVIEW

2.1 Coastal sediments, benthic habitats and anthropogenic activities

A recent review of the coastal geomorphology, sediment dynamics, benthic habitats and anthropogenic activities in Esperance Bay is presented in Curtin (2017) research report.

The development of the Port and Bandy Creek boat harbour, together with Tanker Jetty headland and a range of smaller groynes and seawalls, dissected the once continuous 10 km beach that ran from Wylie Head to Dempster Head.

The prevalent sediment transport direction is from west to east. Part of the town foreshore is characterised by a seawall, with a lack of a sandy beach on the seaward side of it. The town foreshore lacks a natural dune system due to development close to shore. Only the eastern part of Castletown beach shows a well-developed dune system.

The nearshore zone is well-developed from Castletown to Wylie Head with increasing width towards the east and sandy substrates at depths < 5m. Seagrass meadows are the most common benthic habitat between 5 and 30 m water depth, however mixed sandy, seagrass and macroalgal communities are also common at similar depths.

Sand bypassing and dredging are ongoing activities along the Esperance coast. Soft sediment resulting from the port dredging operations is disposed offshore or used to nourish the coast surrounding the Port infrastructure. Bandy Creek boat harbour is dredged regularly and the sediment resulting from dredging operations is dumped to the east of the boat harbour eastern groyne. Also, beach nourishment activities have taken place for several years, downstream of Esperance Seawall at Castletown Beach.

Bandy Creek is the only river flowing to Esperance Bay and the boat harbour is located at the river mouth. The sediments collected within the Bandy Creek Boat Harbour show high carbonate content (up to 85%) and variable degree of sorting indicating mixed sediment provenance of both terrestrial and marine origin. Both Bandy Creek Boat Harbour and the Port of Esperance are subject to regular dredging activities intercepting 100 % of littoral sand drift, consequently they are considered sediment sinks in terms of sediment budget.

A detailed historical account and reference to other sources of information on coastal processes, including the impact of the Port Development since 1962, and coastal management strategies is available in MJP (2001).

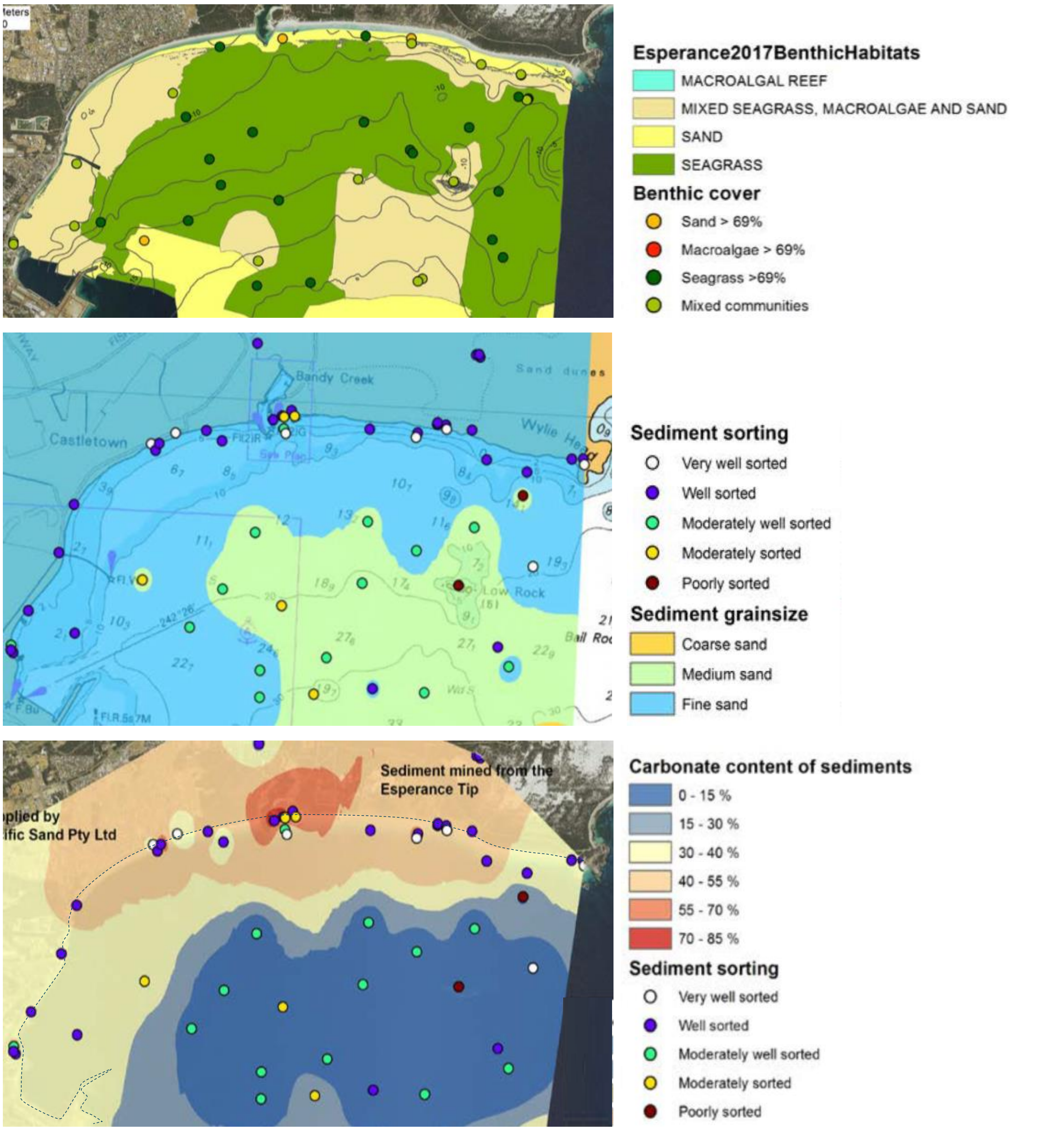

Figure 2-1: Esperance Bay Benthic habitat map (top), Sediment sorting and carbonate content (middle and bottom) (after Curtin, 2017).

2.2 Erosion in Esperance Bay

Beach erosion in Esperance Bay has been documented as a problem since 1914, when wooden revetments were built to prevent undermining of The Esplanade. Since the construction of the Esperance Port between 1962 and 1965 when the main breakwater and navigation channel were constructed, the erosion problem has been exacerbated.

The Port breakwater, breakwater groyne and dredged navigation channel into the Port intercepts 100 % of littoral sand drift. The purpose of the breakwater groyne is to stop sand from getting into the harbour navigation channel that is essential to Port shipping operations, and to limit the need for maintenance dredging of the harbour basin. These structures have influenced the erosion and sedimentation processes occurring elsewhere in Esperance Bay, as acknowledged in Esperance Ports Sea & Land Environmental Management Plan (EPSL, 2008).

The main erosion control problem was along the Esperance Bay between the Esperance Port and Castletown Quays. It was particularly problematic between Kemp Street and Goldfields Road. An annual sand renourishment program and placement of concrete revetment mattresses was the method being applied to control the erosion problem. This was covered through a cost sharing arrangement between the Esperance Port Authority, Shire of Esperance and Department of Transport (Shire of Esperance, 2002). This problem was recently partially resolved by the construction of the Esperance Foreshore seawall and headland, however and as anticipated (MJP, 2001) erosion remains a persistent problem downstream of these coastal protection structures.

An assessment of erosion issues in Esperance Bay was conducted by Dr Hsu and reported in DALSE (2003) using the parabolic bay shape algorithm (Hsu and Evans, 1989). The report outlines the great erosive potential that exist to the south of Castletown due to the divergence of Esperance Bay shoreline away from the general static equilibrium bay shape (Figure 2-2). The simple parabolic bay shape examined the formation of bays under the influence of a single dominant wave direction, with the morphology of the highly curved portion of the bay controlled by diffraction of waves into the shadowed region. As such, it should be noted that this empirical model may not fully capture the variability in the wave field introduced by irregular bathymetries or the presence of channels, although it may explain changes in wave angle due to new diffraction point. So, this approach may be more suitable to smaller areas less susceptible to bathymetric effects. Accordingly, DALSE (2003) also provided a preliminary assessment of the shoreline response to the potential installation of headland control (as presented in section 3.2.5).

A more detailed shoreline evolution modelling study between James Street and the Tanker Jetty was undertaken in the Esperance Town Beach Rejuvenation study (WorleyParsons, 2007). Although the area of interest differs, the modelling also shows the presence of the erosion hot spot in the lee of the last groyne at Castletown Beach but appears to underestimate its extent.

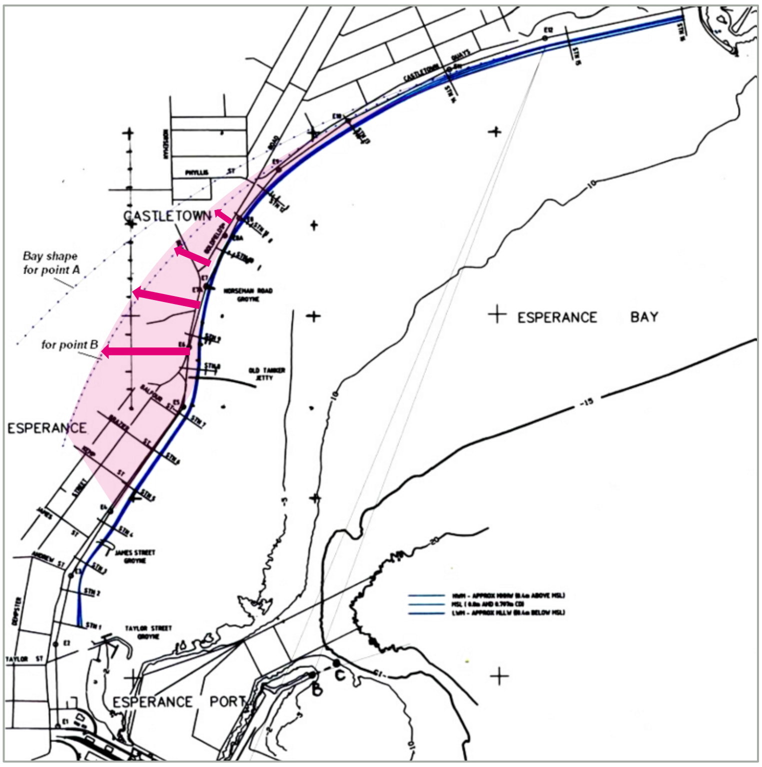

Figure 2-2: Static equilibrium bay shape shoreline (---) for Esperance Bay (under layer after DALSE, 2003) showing increasing erosion potential south of Castletown (■).

2.3 Esperance Coastal Hazard Adaptation Strategy (2016)

The Shire of Esperance Coastal Hazard Adaptation Strategy (BMT, 2016) highlights that the likely threat posed by coastal erosion to the infrastructures and amenities at Castletown Beach represent an elevated level of risk for the Shire in the near and medium term (Figure 2-3), so that appropriate controls should be put in place and monitored accordingly as an effective risk mitigation measure.

A range of coastal protection options have been considered to mitigate the risk, including the use groynes and sand nourishment (as summarised hereafter). To this point, the sand nourishment approach was adopted as the most cost effective coastal management solution to the ongoing erosion problem at Castletown Beach.

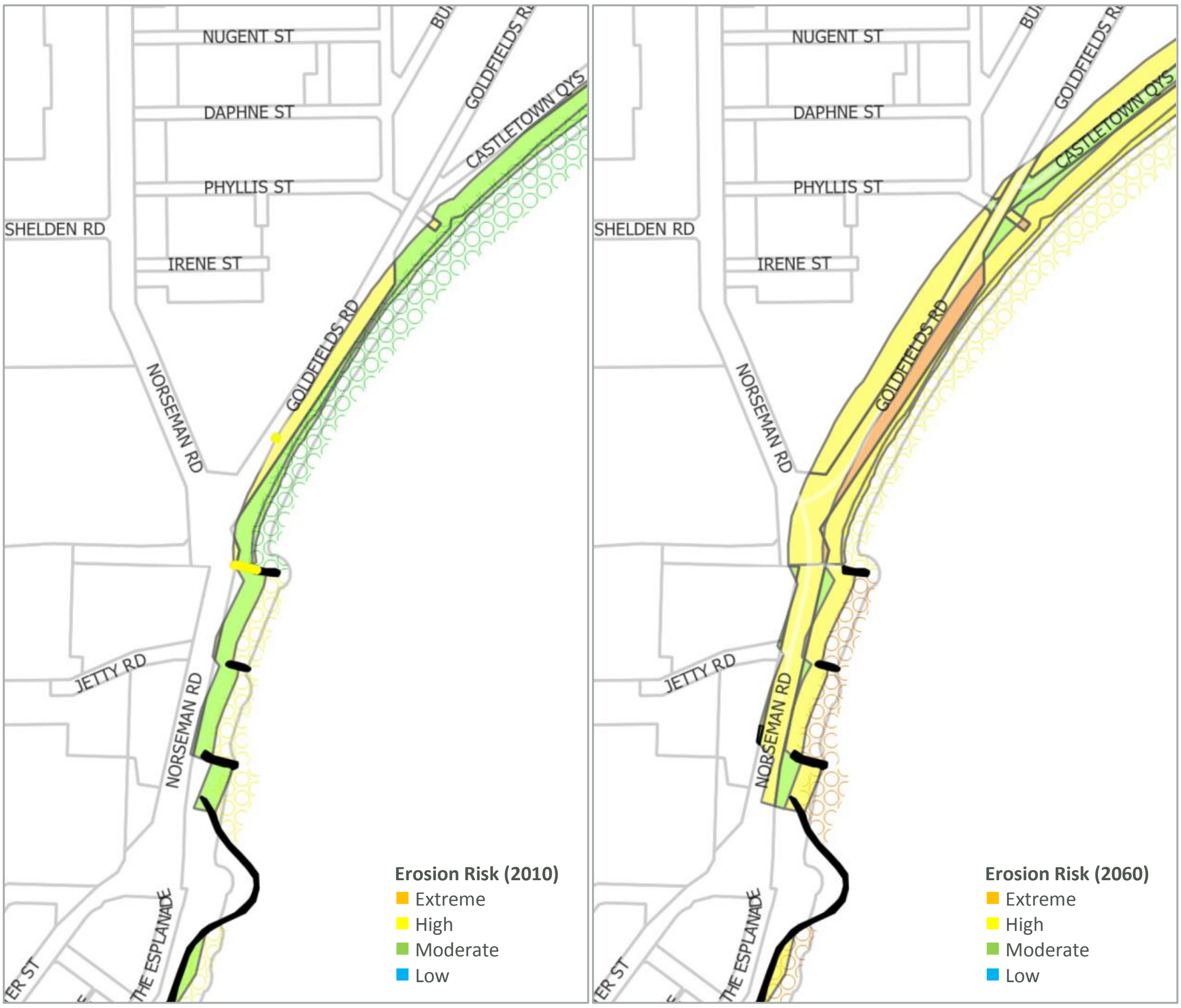

Figure 2-3: Castletown Beach erosion risk increasing from high to extreme by 2060 (after BMT, 2016).

2.4 Castletown Beach sand nourishment program (ongoing)

Castletown Beach sand nourishment areas stretches approximatively 700m between Esperance foreshore seawall and Esperance YHA hostel and encompasses Norseman Road groyne field (Figure 2-4).

The Shire sand nourishment record (Shire of Esperance, 2018) for the period Jul-2013 to Feb-2018 is illustrated in Figure 2-5. The record shows that approximately 100,000m^3 of sand has been placed in this five-year period, with an average of 20,000m^3 per year, a minimum of 12,600m^3 per year and a maximum of 23,700m^3 per year. Although the nourishment activities have been regularly undertaken in July and August, more sporadic interventions also occurred throughout the year, with typical volumes in the order of 5,000m^3 per month.

The current sand nourishment method is summarised as follow:

- Sand is sourced from coastal dunes at Wylie Bay land fill
- Sand is carted 8.5km on road to site by trucks

- Sand is dumped over the erosion face
- Wheel loader spreads and levels the sand
- The top layer is stabilised with gravel to control the sand drift issue and facilitate trucks movement.

The average cost of the sand nourishment over the period was approximately \$10 per m^3 or \$185,000 per year. The Shire received financial assistance from the Department of Transport - Coastal Infrastructure Business Unit - Maritime Planning Branch (through the Coastal Adaptation and Protection grants which assist with funding requirements up to 50% of the total cost of sustainable management projects).

This approach has some sustainability issues, including:

- The sand is not an infinite source with current area depleted
- The coastal dune system along Castletown Quays has increased by around 10m+ from 2000 to 2016.
- The sand renourishment the Shire undertake will affect Bandy Creek boat harbour
- The gravel binding is washing down onto the beach causing amenity issues
- The presence of seagrass wrack on the beach is perceived positively by the Shire as it tends to offer some degree of protection against the attack of waves at the toe of foredune scarp.

Figure 2-4: Castletown Beach sand nourishment areas

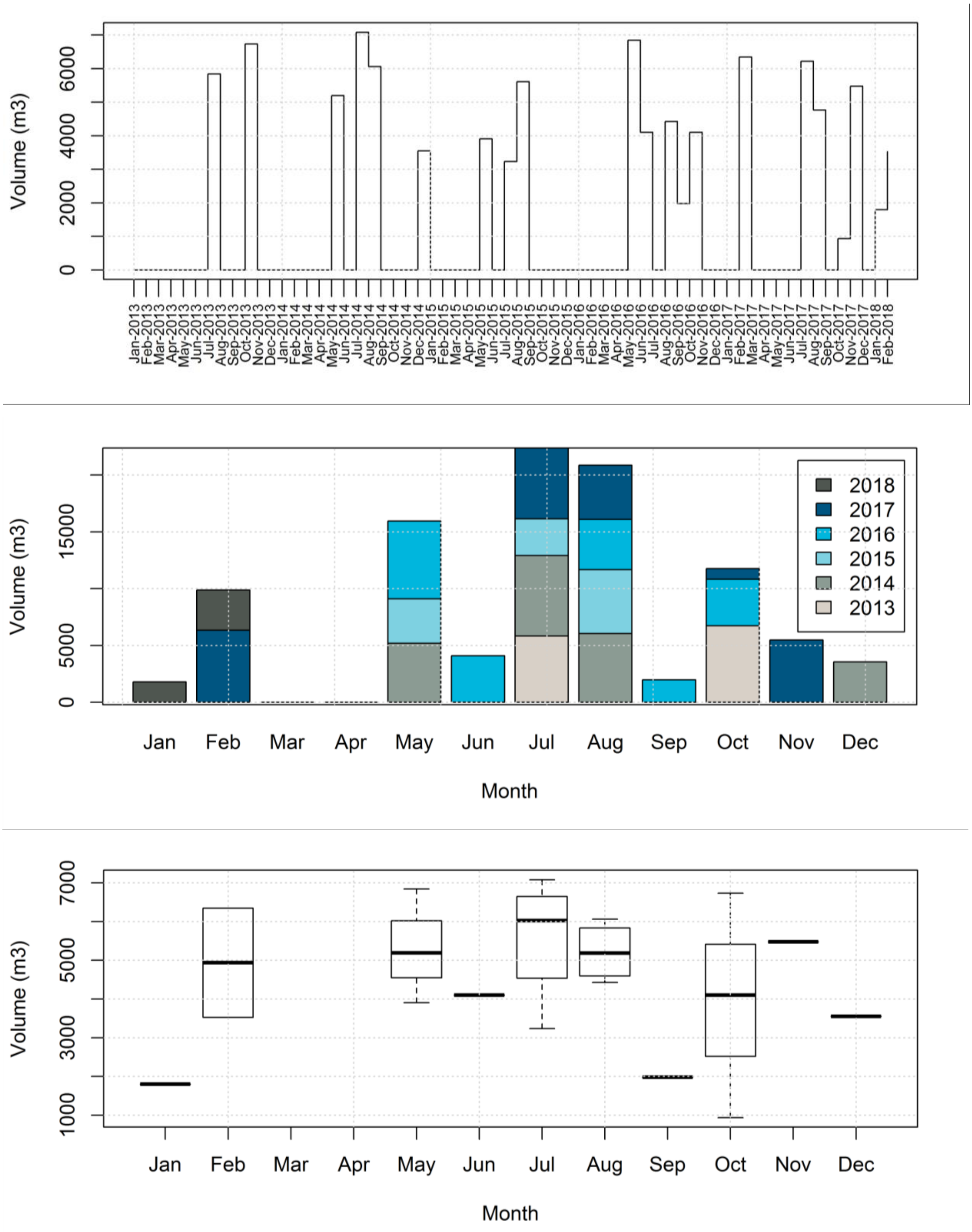

Figure 2-5: Sand nourishment log (Jul-2013 to Feb-2018): time series plot of monthly volume (top), stacked bar chart of cumulative monthly volume (middle) and boxplot of monthly volume (bottom).

2.5 Bandy Creek Boat Harbour maintenance dredging

Notwithstanding the Castletown Beach erosion issue, it is important to take note of the ongoing accretion issue 3km downstream at Bandy Creek Boat Harbour, where the impounding capacity of the breakwater has been reached, so requiring the Department of Transport (DoT) to regularly dredge the navigation channel to maintain the depth of the waterway for recreational and commercial users.

Over the last 25 years, the dredged volumes have averaged approximately 30,000m^3 per year, with maintenance dredging works undertaken every two years using a small cutter suction dredged and delivering dredged material via a series of floating, submerged and onshore pipelines to the beach disposal site, located approximately 1.5km east of the Harbour (Figure 2-6).

The average cost of the Bandy Creek Boat Harbour maintenance dredging is approximately $1M every two years. The program is fully funded by the - Coastal Infrastructure Business Unit - Coastal Facilities Management Branch.

Figure 2-6: Aerial view of Bandy Creek Boat Harbour and surround during biennial maintenance dredging operation.

2.6 Summary of Esperance Bay active sand management

The indicative pattern of active sand management in Esperance Bay is shown on Figure 2-7. This illustrates the direct impact of sand management activities at Castletown Beach on the dredging activities at Bandy Creek. This also suggests that potential synergies could result from a more coordinated approach to coastal management in the area.

Currently, two active sand management programs are taking place in Esperance Bay, both managed independently by distinct coastal managers without a high degree of coordination. Key coastal managers include:

- Shire of Esperance - Asset Management (Mathew Walker)
- Department of Transport - Coast Infrastructure - Maritime Planning - Coastal Management (Fangjun Li)
- Department of Transport, Coast Infrastructure - Coastal Facilities Management - Asset management (Peter Wilkins)

Engagement with the DoT on this issue could be sought, should reasonable enhancement of coastal management practices and benefits to key stakeholders can be clear demonstrated.

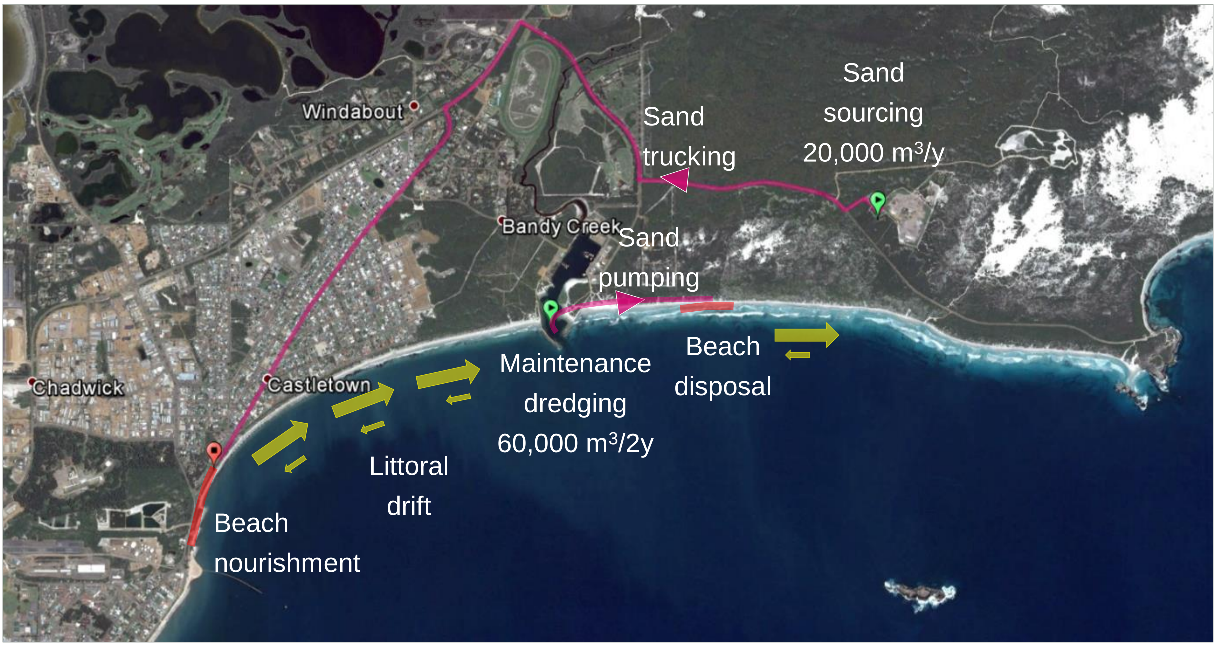

Figure 2-7: Indicative pattern of active sand management in Esperance Bay: Sand "sources" (●), Sand "mechanical" transport (➔), beach disposal (-), natural sand drift (➔).

3 COASTAL EROSION MANAGEMENT OPTION ASSESSMENT

As mentioned before, the sand renourishment in its current form may not be the most effective long-term solution to the erosion problem at Castletown Beach, so alternative erosion management strategies to address the problem should be considered. These are presented in more detailed in the following section.

3.1 Statement of objectives and constraints

The coastal management problem objective is to minimise the risk of coastal erosion at Castletown Beach, subject to the following constraints:

- Natural beach profile
- Retain existing infrastructure (e.g. footpath, local and regional road, utilities)
- Retain beach amenity (e.g. parks, recreation and conservation areas)
- Length of protection works 700m (similar to current management footprint)
- Design life 20 years
- Consider minimum allowances to maintain an open sand buffer cell:
  - Extreme event erosion demand[i] (in the order of +30m)
  - Shoreline recession to littoral drift imbalance (in the order of +10m per year, or 18,500m^3 per year)
  - Shoreline recession due to sea level rise demand (in the order of +10m)
- Consider sustainability trade-offs, including environmental impact, public acceptance, public safety and economics
- Consider industry best practices

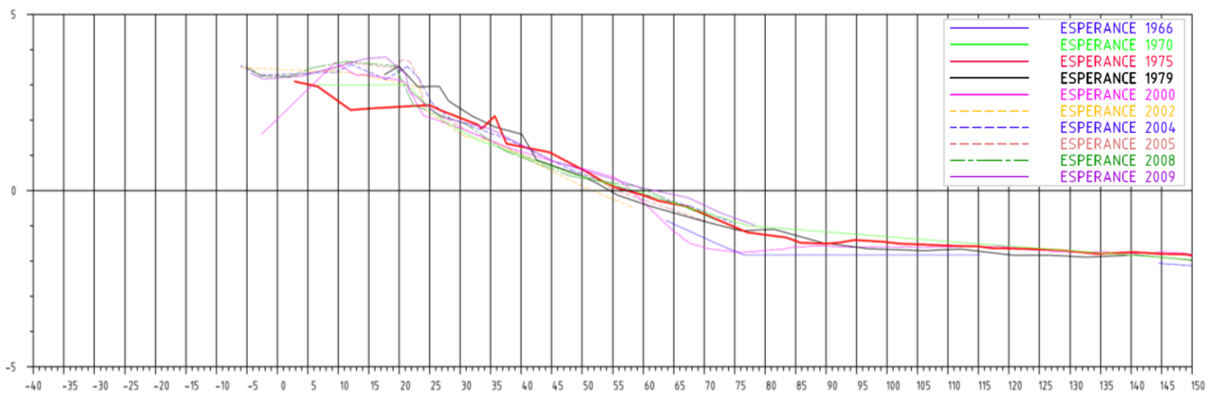

Figure 3-1: Typical beach profile at the site (DPI, 2009).

[i] There is less than 20% chance that an extreme 30m erosion event will occur over the 20 year design life. This extreme erosion event would be expected as a result of a 1 in 100 year return period storm (BMT, 2016).

3.2 Option definition

3.2.1 Option 1 – Status quo (current sand nourishment)

Option 1 consists of continuing the current sand nourishment program detailed in section 2.4. With this option, most of the sand placed on the beach is typically lost downstream, so it is considered as an "active" protection measure and relies essentially on regular replenishments works. Erosion downstream adjacent to the sand nourishment area is expected to be minimal due to the continuous sand supply available from the sand nourishment area.

The simplified cost model of Option 1 – Status quo (current sand nourishment) is as follow:

- Upfront capital expenditures: $0
- Operational expenditures: $185,000 per year
- Other key assumptions and information:
  - Sand cost: $0 per m^3
  - Trucking and placement cost: $10 per m^3
  - Production rate: 900m^3 per day
  - Sand volume requirements: 18,500m^3
  - Frequency: once a year
  - Works duration: 20 days per year (in winter typically)
  - Plant and equipment: 1,680 truckloads, 1 wheel loader
  - Trucking distance: 8.5km

Option 1 – Status quo (current sand nourishment) is characterised against the performance criteria in Table 3-5.

3.2.2 Option 2 - Independent mobile sand back-passing

Option 2 consists of an excavator scraping the beach and loading sand in a mobile slurry track before pumping sand back upstream to Castletown Beach. Similar to option 1, this is an "active" protection measure and relies essentially on regular replenishments works. Similar to option 1, no (limited) erosion downstream adjacent to the sand nourishment area is expected to be minimal disruption of the littoral drift and continuous sand supply available from the sand nourishment area.

The indicative pattern of active sand management for the independent mobile sand back-passing option is illustrated in Figure 3-2. These kinds of operations are illustrated in Figure 3-3 and Figure 3-4.

The simplified cost model of Option 2 - Independent mobile sand back-passing is as follow:

- Upfront capital expenditures: $0
- Operational expenditures: $203,500 per year
- Other key assumptions and information:

- Sand cost: $0 per m³
- Loading, pumping and placement cost: $11 per m³
- Production rate: 1,000m³ per day
- Sand volume requirements: 18,500m³
- Frequency: once a year
- Works duration: 18.5 days per year
- Plant and equipment: 1 excavator, 1 mobile slurry track, 1 front end loader, discharge pipelines
- Pumping distance: less than 1.5km (i.e. no additional booster pump)

Option 2 - Independent mobile sand back-passing is characterised against the performance criteria in Table 3-5.

Figure 3-2: Indicative pattern of active sand management for independent sand back-passing: Sand "sources" (●), Sand "mechanical" transport (➔), beach disposal (▬), natural sand drift (➔).

Figure 3-3: Illustration of mobile sand back-passing - Top two: Dawesville, WA (Excavator, mobile slurry trap and discharge pipeline). Bottom three: Noosa, QLD (Pump station, sand shifter and discharge pipeline).

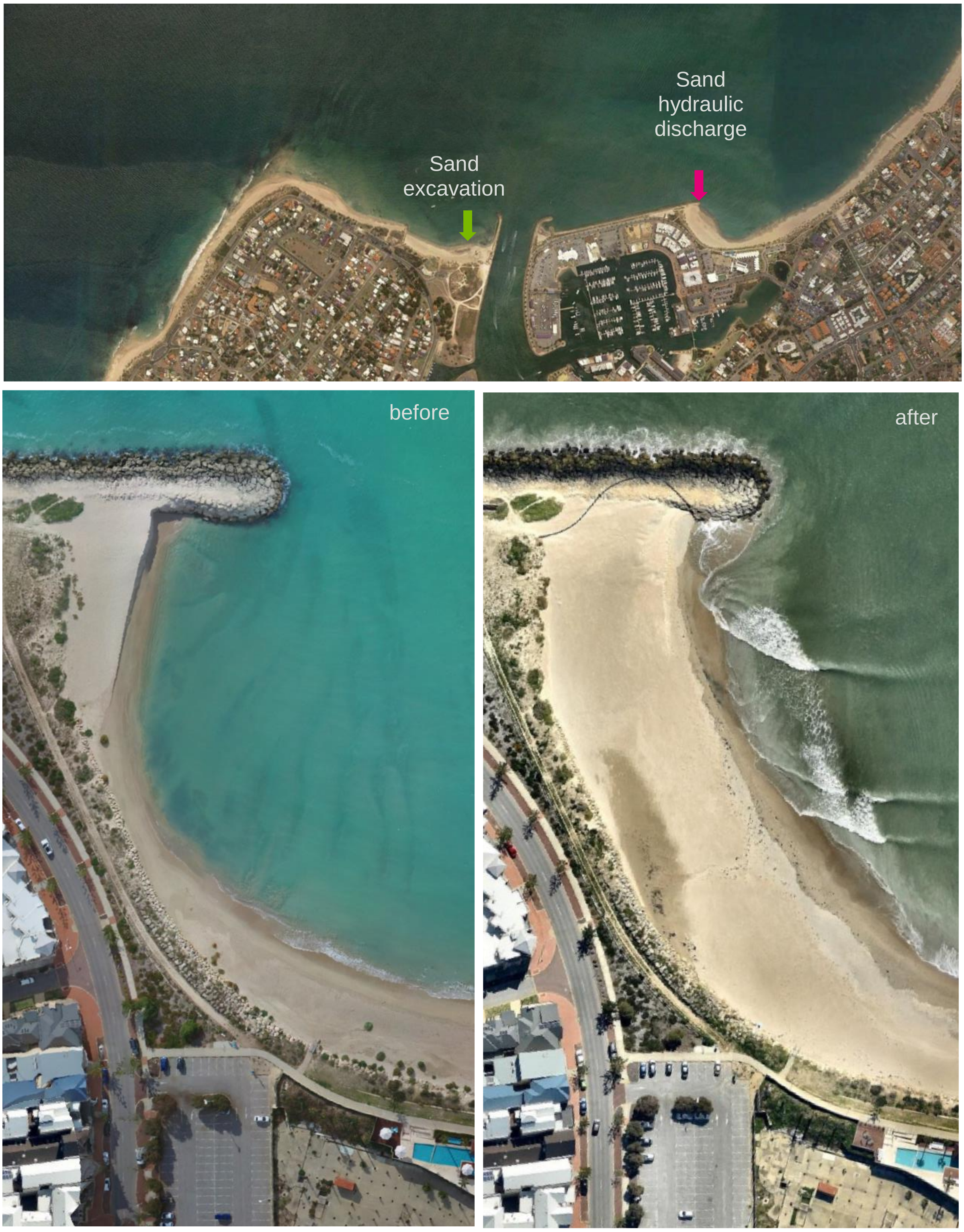

Figure 3-4: Mandurah beach nourishment using hydraulic placement of dredged material.

3.2.3 Option 3 - Coordinated BCBH dredging & sand back-passing

Option 3 consists of pumping sand via a slurry pipeline to Castletown Beach in coordination with the regular maintenance dredging at Bandy Creek Boat Harbour (BCBH) by the Department of Transport.

Similar to option 1 and 2, this is an “active” protection measure and relies essentially on regular replenishments works. Similar to option 1 and 2, no (limited) erosion downstream adjacent to the sand nourishment area is expected to the continuity of sand supply available from the sand nourishment area.

The indicative pattern of active sand management for the coordinated BCBH dredging & sand back-passing option is illustrated in Figure 3-5. These kinds of operations are illustrated in Figure 3-4 and Figure 3-6.

The simplified cost model of Option 3 - Coordinated BCBH dredging & sand back-passing is as follow:

- Upfront capital expenditures: $0
- Operational expenditures: $147,000 every two years
- Other key assumptions and information:
  - Sand cost: $0 per m^3
  - Dredging and pumping (1km) cost by DoT: $1,000,000
  - Pumping cost: $10,000 mobilisation plus $25,000 per month per booster pump
  - Placement cost: $100,000 per campaign
  - Production rate: 60,000m^3 per 2.5 month
  - Sand volume requirements: 37,000m^3 (2 x 18,500m^3)
  - Frequency: once every two years
  - Works duration: 1.5 month
  - Plant and equipment (by DoT): 1 cutter suction dredge, 1 booster pumps, discharge pipelines
  - Plant and equipment (by SoE): 1 booster pumps, 1 loader
  - Pumping distance: 3km

Option 3 - Coordinated BCBH dredging & sand back-passing is characterised against the performance criteria in Table 3-5.

Figure 3-5: Indicative pattern of sand management for coordinated sand back-passing: Sand "sources" (●), Sand "mechanical" transport (➔), beach disposal (-), natural sand drift (➔).

Figure 3-6: Illustration of dredging and beach disposal at Bandy Creek Boat Harbour (dredge, slurry pipeline, booster pump and discharge pipeline).

3.2.4 Option 4 - Seawall

Option 4 consists of a compact arrangement of materials, such as rocks or geotextile sand bags) built parallel to the coast to withstand the direct erosive forces of waves over the length of the shoreline to be protected (i.e. 700m here). There is typically no (or limited) loss of material with this option, so it is considered as a “passive” protection measure and relies essentially on a major initial investment followed by regular maintenance capital requirement. In contrast to the previous options, downstream erosion adjacent to the structure can be expected due to the lack of sediment supply upstream of the structures resulting from the presence of Esperance foreshore seawall and headland.

These kinds of options are illustrated in Figure 3-8.

The simplified cost model of Option 4 - Seawall is as follow:

Rock wall:

- Upfront capital expenditures: $4,800,000
- Operational expenditures: $2,400,000 every 40 years
- Other key assumptions and information:
  - Geometry:
    - Wall length: 700m
    - Wall crest level: +2.7mCD
    - Wall toe level: -3mCD
  - Linear meter rate: $7,000 per m
  - Maintenance expenditure rate: 50% of Capex every 40 years (i.e. 1% compound per year)
  - Frequency of Maintenance: once every 40 years
  - Construction work duration: 6 months
  - Plant and equipment: 1 big excavator, 1 loader, quarry loader and trucks
  - Distance to rock quarry: 10km

Sandbag wall:

- Upfront capital expenditures: $6,600,000
- Operational expenditures: $3,300,000 every 15 years
- Other key assumptions and information:
  - Geometry:
    - Wall length: 700m
    - Wall crest level: +2.7mCD
    - Wall toe level: -1.5mCD
  - Typical geotextile bag: 1.9m x 2.5m x 0.6m (i.e. circa 2.5m^3, 5 ton)
  - Total number of bags: 6,595 bags
  - Placement rate: $1,000 per bag
  - Maintenance expenditure rate: 50% of Capex every 15 years (i.e. 2.5% compound per year)
  - Frequency of Maintenance: once every 15 years
  - Construction work duration: 6 months
  - Plant and equipment: 1 big excavator, 1 loader, quarry loader and trucks
  - Distance to sand quarry: 10km

Option 4 - Seawall is characterised against the performance criteria in Table 3-5.

Figure 3-7: Indicative alignment of seawall (-).

Figure 3-8: Illustration of seawall options – top: Esperance Foreshore, WA (rubble-mound seawall); bottom: Quinn's Beach - Wanneroo, WA (geotextile seawall, photo credit: http://www.tessilbrenta.com).

3.2.5 Option 5 – Groyne(s)

Option 5 consists of a compact arrangement of materials, such as rocks or geotextile sand bags, built perpendicular to the coast thereby reducing the littoral drift within each sediment cell formed between two groynes. Similar to option 4, this option is considered as a “passive” protection measure and relies essentially on a major initial investment followed by regular maintenance capital requirement. Also, similar to option 4, in general, downstream erosion adjacent to the structure can be expected due to the lack of supply upstream of the structures.

Large groynes

One of the most relevant historical erosion study presenting an assessment of various large T-groynes option at Castletown Beach was done by Dr Hsu and reported in DALSE (2003). The report provided a preliminary assessment of the shoreline response to the potential installation of “headland” control. The report suggests that the proposed headland control approach offers a series of embayments in static equilibrium which, following initial nourishment, would not require large-scale ongoing sediment input.

The management options that were considered in the report are as follows:

- Installation of 1 large T-groyne to form a single asymmetric bay
- Installation of 2 medium sized T-groynes to form a single symmetric bay
- Installation of a series of 3 T-groynes to form 2 symmetric bays

The T-groyne field are illustrated in Figure 3-9, with initial sand nourishment proposed to bring the shoreline in a position close to “equilibrium”. Note the use of geotextile for large groynes (e.g. 1 L-Groyne and 2T or 3 T-groynes) is not recommended, so only the rock options have been considered.

Short groynes

An alternative to these large groynes options is the use of short groynes to continue the existing groyne field. The erosion downstream of the terminal groyne is controlling the length the field, to such location as sufficient dune buffer is available. It should be noted that beach nourishment may be required from time to time between the groyne to replenish the beach after large storm events, as sand is being transport away from the sediment cell formed between two groynes. This kind of options are illustrated Figure 3-11.

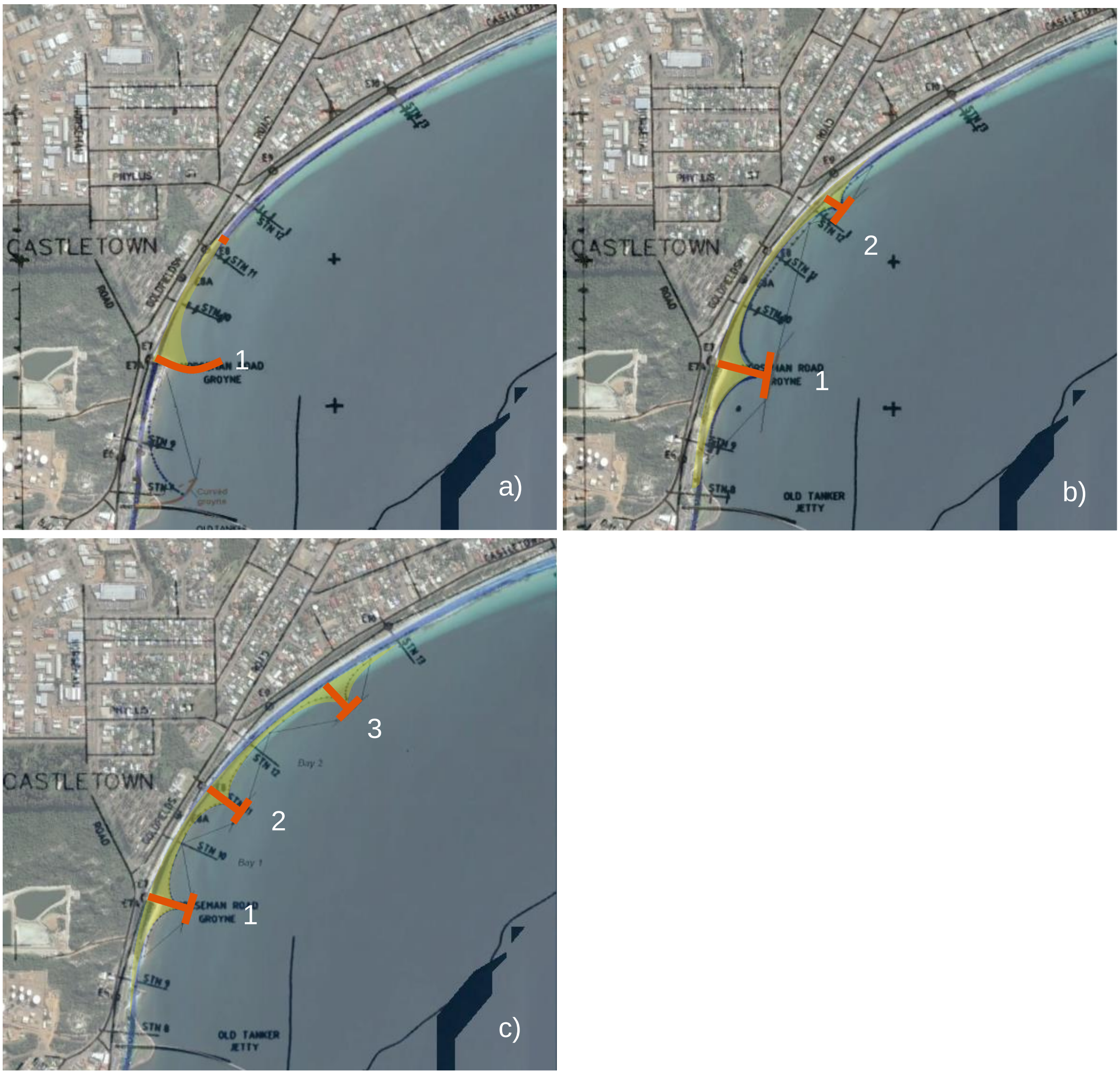

Figure 3-9: Static equilibrium bay shape shoreline response (■) anticipated after installation of T-Groynes (under layer after DALSE, 2003): 1 large L-groyne (a, [150m]), 2 medium sized T-groynes (b, [200m+170m], [65m+80m]) and 3 T-groynes (c, 3x [150m+100m]). Groyne dimension provided as [cross-shore length + longshore length].

Figure 3-10: Illustration of Option 5 – Groyne(s) – 4 short groynes.

The simplified cost model of Option 5 – Groyne(s) is as follow:

<u>Rock groyne:</u>

- Upfront capital expenditures:
  - 1 L-groyne: $3,300,000
  - 2 T-groynes: $8,400,000
  - 3 T-groynes: $10,800,000
  - 4 Short groynes: $3,700,000
- Operational expenditures
  - 1 L-groyne: $1,650,000 every 40 years
  - 2 T-groynes: $4,200,000 every 40 years
  - 3 T-groynes: $5,400,000 every 40 years
  - 4 Short groynes: $1,850,000 every 40 years
- Other key assumptions and information:
  - Geometry:

    - Groyne length:
        - 1 L-groyne: [150m] + [50m]
        - 2 T-groynes: [200m+170m] + [65m+80m]
        - 3 T-groynes: 3x [150m+100m]
        - 4 Short groynes: 4x [50m]
    - Groyne crest level: +2.7mCD
    - Groyne toe level: -1.5mCD
    - Groyne toe depth: 1.5m
  - Linear meter rate: $7,000 per m
  - Initial Nourishment: 100,000m^3 (allowance for storm bight plus 20%)
  - Nourishment cost: $10/m^3
  - Maintenance expenditure rate: 50% of Capex every 40 years (i.e. 1% compound per year)
  - Frequency of Maintenance: once every 40 years
  - Construction work duration: 6 month
  - Plant and equipment: 1 big excavator, 1 loader, quarry loader and trucks
  - Distance to rock quarry: 10km

<u>Sandbag groyne:</u>

- Upfront capital expenditures:
  - 4 Short groynes: $2,450,000
- Operational expenditures
  - 4 Short groynes: $1,225,000 every 15 years
- Other key assumptions and information:
  - Geometry:
    - Groyne length:
      - 4 Short groynes: 4x [50m]
    - Groyne crest level: +2.7mCD
    - Groyne toe level: -1.5mCD
  - Typical geotextile bag: 1.9m x 2.5m x 0.6m (i.e. circa 2.5m^3, 5 ton)
  - Total number of bags:
    - 4 Short groynes: 1,452 bags
  - Placement rate: $1,000 per bag
  - Maintenance expenditure rate: 50% of Capex every 15 years (i.e. 2.5% compound per year)

- Frequency of Maintenance: once every 15 years
- Construction work duration: 6 month
- Plant and equipment: 1 big excavator, 1 loader, quarry loader and trucks
- Distance to sand quarry: 10km

Option 5 – Groyne(s) is characterised against the performance criteria in Table 3-5.

Figure 3-11: Illustration of groyne options: Rubble-mound groynes Esperance Norseman Rd, WA (a,c); Geotextile groynes: Busselton, WA (e) Maroochydore, QLD (b,d). Photo credit: Hilary Darmody (b,d) and Andrew Mozdzen (d).

3.3 Option evaluation

3.3.1 Option economics

A simplified economic model was developed, looking a capital and maintenance cost of each option, to investigate the economics benefit (potential cost saving) of adopting such options. We considered the assumptions and order of magnitude cost estimates provided in section 3.2 to estimate the cumulative cost of each erosion management option. The time value of money was taken into account by using a 1.8% real discount rate (as recommended in IPART, 2017). The discounted cumulative cost curve for each option is shown over a 100-year timeframe in Figure 3-12 to Figure 3-16 . Cost comparison between options and its sensitivity to the real discount rate and planning horizon is shown in Table 3-1 to Table 3-4.

Results show that it would be beneficial to consider Option 3 - Coordinated BCBH dredging & sand back-passing, as it has the potential to reduce the net cumulative cost of erosion management not only compared to Option 1 – Status quo (current sand nourishment) but also compared to all other alternates considered. In addition, this result is consistent over all planning horizons; with increasing savings in the order of +$1.6M, +$2.7M and +$3.4M compared to Option 1 – Status quo (current sand nourishment) with respect to the 20-year, 50-year and 100-year planning horizon. Accordingly, Option 3 - Coordinated BCBH dredging & sand back-passing has the potential to reduce the current erosion management cost by 60% across all planning timeframe from 20 to 100year horizon.

In contrast, the potential to reduce the current erosion management cost by considering the nearest cheapest alternative, i.e. Option 5 – Groyne(s) – L1 Rock, is materially lower than the potential cost benefits of Option 3 - Coordinated BCBH dredging & sand back-passing. In this case, the increasing savings (spending) is in the order of -$0.5M, +$0.9M and $1.8M compared to Option 1 – Status quo (current sand nourishment) with respect to the 20-year, 50-year and 100-year planning horizon. Accordingly, Option 5 – Groyne(s) – L1 Rock has the potential to reduce the current erosion management cost is negative or at best marginal in the 20 to 50-year planning horizon and 25% in the 100-year planning horizon.

The economic model is simple and there may be limitations to achieve such cost saving, for example due to the required coordination between SoE and DoT during BCBH dredging campaign, and subject to the acceptability and suitability of such erosion management option.

Notwithstanding these limitations, the simplified cost model and the economic model provide valuable insight into the economic rational of each option. Thus, from an economic stand-point, Option 3 - Coordinated BCBH dredging & sand back-passing presents an opportunity to significantly improve current erosion management practices at Castletown Beach.

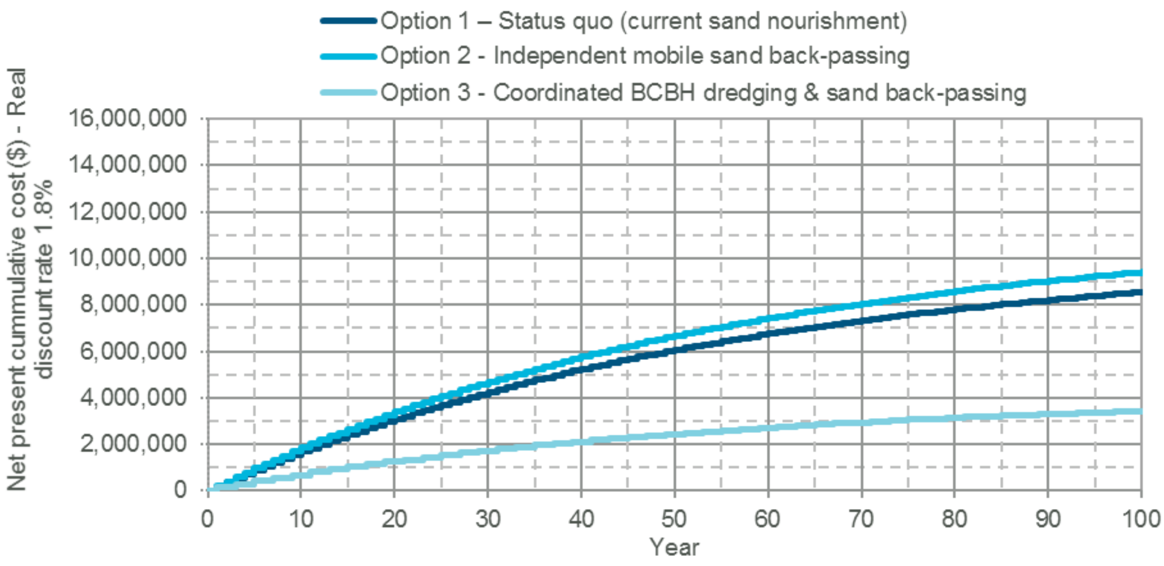

Figure 3-12: Discounted cumulative cost for Option 1 – Status quo (current sand nourishment), Option 2 - Independent mobile sand back-passing and Option 3 - Coordinated BCBH dredging & sand back-passing.

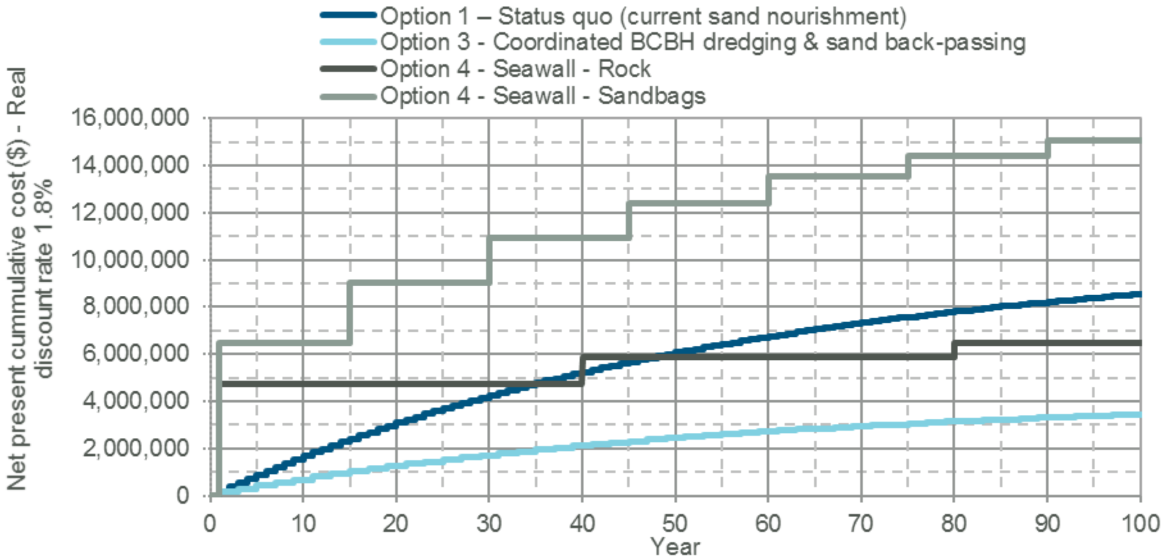

Figure 3-13: Discounted cumulative cost for Option 4 - Seawall – Rock and Sandbags

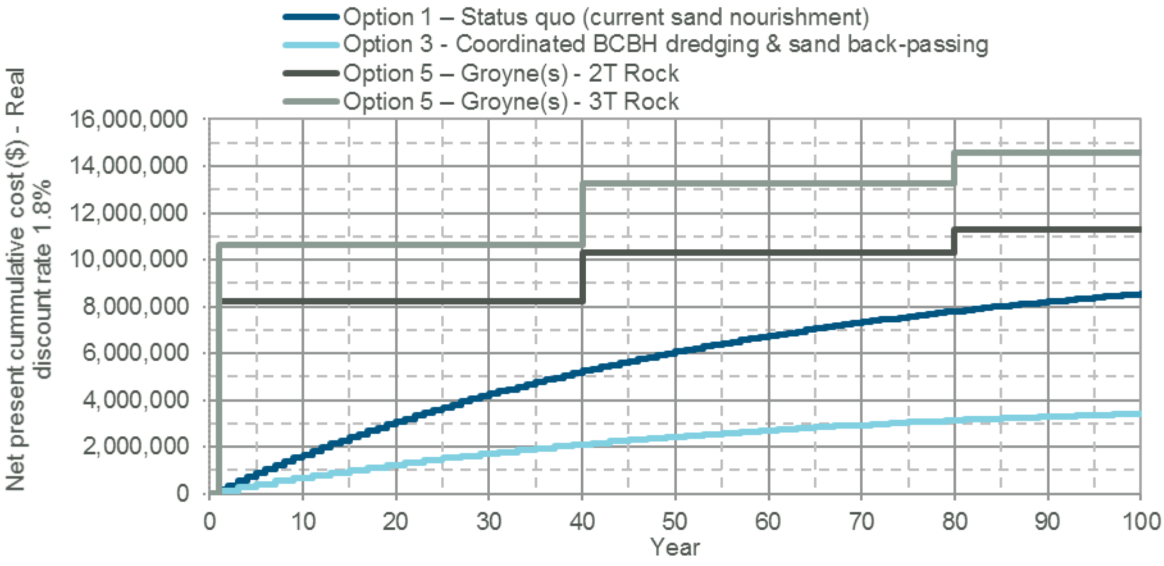

Figure 3-14: Discounted cumulative cost for Option 5 – Groyne(s) – 2T and 3T Rock.

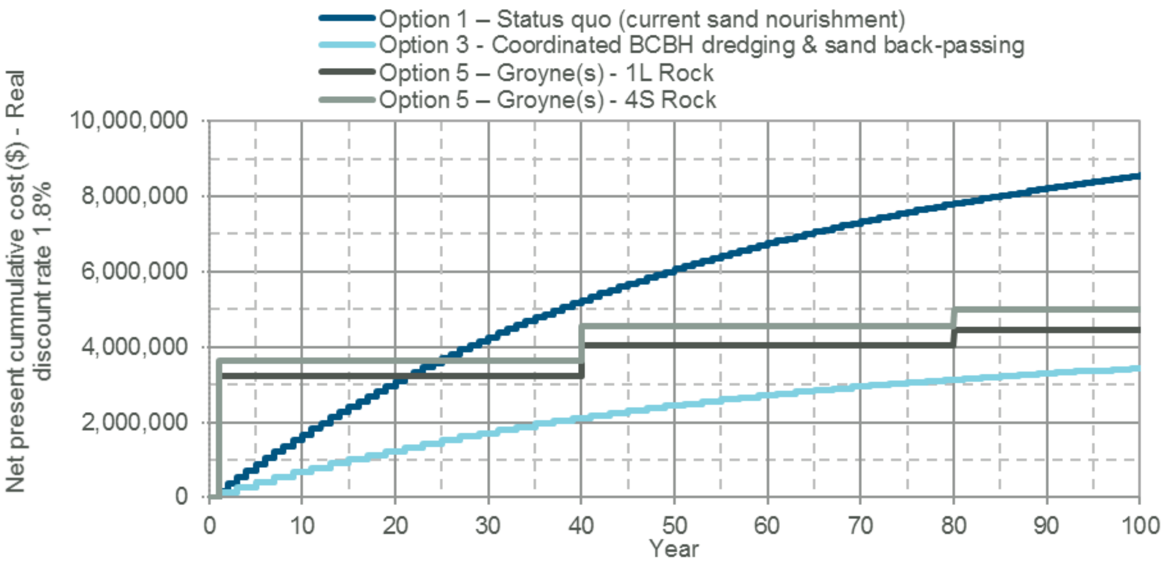

Figure 3-15: Discounted cumulative cost for Option 5 – Groyne(s) – 1L Rock and 4S Sandbag.

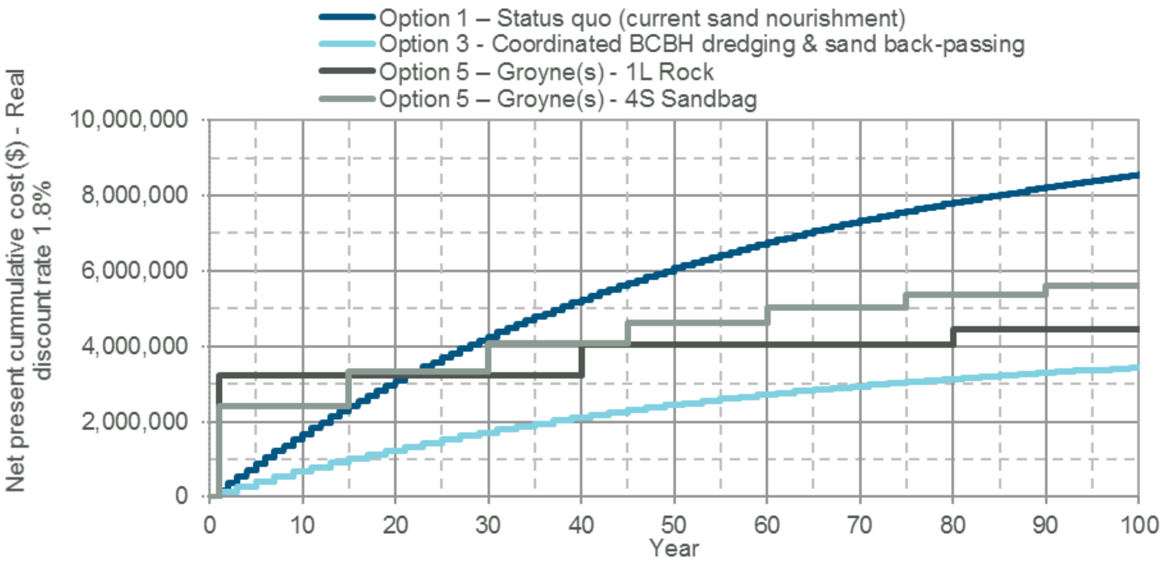

Figure 3-16: Discounted cumulative cost for Option 5 – Groyne(s) – 1L Rock and 4S Sandbag.

Table 3-1: Initial cost (at year 1).

Option	Initial cost	Averaged incremental cost from 1st rank	Rank (low to high inc. cost)
Option 3 - Coordinated BCBH dredging & sand back-passing	$150,000	$0	1
Option 1 – Status quo (current sand nourishment)	$190,000	$40,000	2
Option 2 - Independent mobile sand back-passing	$200,000	$60,000	3
Option 5 – Groyne(s) - 4S Sandbag	$2,450,000	$2,300,000	4
Option 5 – Groyne(s) - 1L Rock	$3,300,000	$3,150,000	5
Option 5 – Groyne(s) - 4S Rock	$3,700,000	$3,550,000	6
Option 4 - Seawall - Rock	$4,800,000	$4,650,000	7
Option 4 - Seawall - Sandbags	$6,600,000	$6,450,000	8
Option 5 – Groyne(s) - 2T Rock	$8,400,000	$8,250,000	9
Option 5 – Groyne(s) - 3T Rock	$10,800,000	$10,650,000	10

Table 3-2: Discounted cumulative cost after 20 years.

Option	Real discount rate			Averaged incremental cost from 1st rank	Rank (low to high inc. cost)
	1.80%	3.60%	5.40%		
Option 3 - Coordinated BCBH dredging & sand back-passing	$1,200,000	$1,100,000	$900,000	$0	1
Option 1 – Status quo (current sand nourishment)	$3,100,000	$2,600,000	$2,200,000	$1,600,000	2
Option 2 - Independent mobile sand back-passing	$3,400,000	$2,900,000	$2,500,000	$1,800,000	3
Option 5 – Groyne(s) - 4S Sandbag	$3,300,000	$3,100,000	$2,900,000	$2,000,000	4
Option 5 – Groyne(s) - 1L Rock	$3,200,000	$3,200,000	$3,100,000	$2,100,000	5
Option 5 – Groyne(s) - 4S Rock	$3,600,000	$3,600,000	$3,500,000	$2,500,000	6
Option 4 - Seawall - Rock	$4,700,000	$4,600,000	$4,600,000	$3,600,000	7
Option 5 – Groyne(s) - 2T Rock	$8,300,000	$8,100,000	$8,000,000	$7,000,000	8
Option 4 - Seawall - Sandbags	$9,000,000	$8,300,000	$7,800,000	$7,300,000	9
Option 5 – Groyne(s) - 3T Rock	$10,600,000	$10,400,000	$10,200,000	$9,400,000	10

Table 3-3: Discounted cumulative cost after 50 years.

Option	Real discount rate			Averaged incremental cost from 1st rank	Rank (low to high inc. cost)
	1.80%	3.60%	5.40%		
Option 3 - Coordinated BCBH dredging & sand back-passing	$2,400,000	$1,700,000	$1,300,000	$0	1
Option 5 – Groyne(s) - 1L Rock	$4,000,000	$3,600,000	$3,300,000	$1,800,000	2
Option 5 – Groyne(s) - 4S Sandbag	$4,600,000	$3,800,000	$3,200,000	$2,100,000	3
Option 5 – Groyne(s) - 4S Rock	$4,500,000	$4,000,000	$3,700,000	$2,300,000	4
Option 1 – Status quo (current sand nourishment)	$6,100,000	$4,300,000	$3,200,000	$2,700,000	5
Option 2 - Independent mobile sand back-passing	$6,700,000	$4,700,000	$3,500,000	$3,100,000	6
Option 4 - Seawall - Rock	$5,900,000	$5,200,000	$4,800,000	$3,500,000	7
Option 5 – Groyne(s) - 2T Rock	$10,300,000	$9,100,000	$8,500,000	$7,500,000	8
Option 4 - Seawall - Sandbags	$12,400,000	$10,100,000	$8,800,000	$8,600,000	9
Option 5 – Groyne(s) - 3T Rock	$13,300,000	$11,700,000	$10,900,000	$10,100,000	10

Table 3-4: Discounted cumulative cost after 100 years.

Option	Real discount rate			Averaged incremental cost from 1st rank	Rank (low to high inc. cost)
	1.80%	3.60%	5.40%		
Option 3 - Coordinated BCBH dredging & sand back-passing	$3,400,000	$2,000,000	$1,400,000	$0	1
Option 5 – Groyne(s) - 1L Rock	$4,400,000	$3,700,000	$3,400,000	$1,600,000	2
Option 5 – Groyne(s) - 4S Rock	$5,000,000	$4,100,000	$3,800,000	$2,000,000	3
Option 5 – Groyne(s) - 4S Sandbag	$5,600,000	$4,000,000	$3,300,000	$2,000,000	4
Option 4 - Seawall - Rock	$6,500,000	$5,400,000	$4,900,000	$3,300,000	5
Option 1 – Status quo (current sand nourishment)	$8,600,000	$5,000,000	$3,400,000	$3,400,000	6
Option 2 - Independent mobile sand back-passing	$9,400,000	$5,500,000	$3,700,000	$3,900,000	7
Option 5 – Groyne(s) - 2T Rock	$11,300,000	$9,400,000	$8,500,000	$7,500,000	8
Option 4 - Seawall - Sandbags	$15,100,000	$10,900,000	$9,000,000	$9,400,000	9
Option 5 – Groyne(s) - 3T Rock	$14,600,000	$12,100,000	$11,000,000	$10,300,000	10

3.3.2 Option multi-criteria analysis

A multi-criteria analysis of each option was conducted to characterise, as far as practicable, each option in absolute term or on a relative basis. A total of 19 criteria were considered, including the following categories and sub-considerations:

- Risk to existing infrastructure
  - Regular drift
  - Storm erosion
  - Sea level rise
  - Residual (exceed design event)
- Retain beach amenity
  - Short term
  - Medium term
  - Long term
- Environmental
  - Impact significance
  - Management requirement - initial
  - Management requirement - regular
- Public acceptance solution/intrusion
- Public disturbance
  - Initial response (e.g. Construction activities)
  - Regular issues (e.g. Seagrass accumulation)
- Public Safety
- Economics
  - CAPEX
  - OPEX
  - Net present cumulative cost
- Interdependence with State Government (e.g. DoT)
- Sustainability

A first pass assessment was conducted to rate each option relative to each other for each criterion and results aggregated as a rank, assuming uniform criteria weighting. In addition, a sensitivity analysis was conducted by randomly adjusting the relative weight of each criteria in the range (0.7%-14.3%), so as to gain an insight into the probable rank for each option under a diverse set of preferences. The multi-criteria analysis is summarised in Table 3-5, with the probable rank provided in Table 3-6.

The findings indicate the clear dominance of Option 3 - Coordinated BCBH dredging & sand back-passing, with a high probable rank skewed toward the top rank. The probable rank distribution of the Option 1 – Status quo (current sand nourishment) is much more spread out and suggest that this option is sensitive to the preference (i.e. criteria relative weight) and that within this multicriteria framework, several other options could be preferable than maintaining the status-quo.

3.4 Option selection

Considering the results of the multi-criteria analysis summarised in Table 3-5 and Table 3-6, Option 3 - Coordinated BCBH dredging & sand back-passing is the top ranked option, followed by Option 4 - Seawall – Rock. Option 3 - Coordinated BCBH dredging & sand back-passing also becomes a clear leader when more relative weight is applied to the economics criteria. Accordingly, Option 3 - Coordinated BCBH dredging & sand back-passing is the preferred selected option.

Table 3-5: Summary multi-criteria analysis for each option.

	Criteria	Weight		Options											Rating scale					
				Option 1 – Status quo (current sand nourishment)	Option 2 - Independent mobile sand back-passing	Option 3 - Coordinated BCBH dredging & sand back-passing	Option 4 - Seawall - Rock	Option 4 - Seawall Sandbags	Option 5 – Groyne(s) - 1L Rock	Option 5 – Groyne(s) - 2T Rock	Option 5 – Groyne(s) - 3T Rock	Option 5 – Groyne(s) - 4S Rock	Option 5 – Groyne(s) - 4S Sandbag		0	1	2	3	4	5
1	Risk to existing infrastructure - Regular drift	1	5.3%	4	4	3	3	3	2	2	2	2	2		Potential failure to perform	Poor performance		Acceptable performance		Best in class
2	Risk to existing infrastructure - Storm erosion	1	5.3%	0	0	3	5	5	4	4	4	3	3		Potential failure to perform	Poor performance		Acceptable performance		Best in class
3	Risk to existing infrastructure - Sea level rise	1	5.3%	0	0	3	5	5	5	3	3	3	3		Potential failure to perform	Poor performance		Acceptable performance		Best in class
4	Risk to existing infrastructure - Residual (exceed design event)	1	5.3%	0	0	1	5	4	2	3	3	1	2		Potential failure to perform	Poor performance		Acceptable performance		Best in class
5	Retain beach amenity - Short term	1	5.3%	3	5	5	2	2	3	3	4	3	3		Potential loss of beach	Significant reduction of beach		Seasonal fluctuation		Beach present at all time
6	Retain beach amenity - Medium term	1	5.3%	3	5	5	1	1	2	2	3	2	2		Potential loss of beach	Significant reduction of beach		Seasonal fluctuation		Beach present at all time
7	Retain beach amenity - Long term	1	5.3%	3	5	5	0	0	1	2	3	1	2		Potential loss of beach	Significant reduction of beach		Seasonal fluctuation		Beach present at all time
8	Environmental impact significance	1	5.3%	5	3	3	4	4	2	1	2	2	1		Protected	Major		Moderate		Insignificant
9	Environmental management requirement - initial	1	5.3%	5	3	3	3	3	2	1	2	2	1		Onerous conditions	High		Moderate		Low
10	Environmental management requirement - regular	1	5.3%	5	3	3	5	5	5	5	5	5	5		Onerous conditions	High		Moderate		Low
11	Public acceptance - solution/intrusion	1	5.3%	2	2	3	4	5	2	1	2	2	1		Taboo	Strong opposition		Indifferent		High support
12	Public disturbance - initial response (e.g. construction activities)	1	5.3%	3	3	4	2	2	2	2	2	2	2		Taboo	Strong opposition		Indifferent		High support
13	Public disturbance - regular issues (e.g. seagrass accumulation, earthworks)	1	5.3%	2	2	3	5	5	3	2	2	3	2		Taboo	Strong opposition		Indifferent		High support
14	Public Safety	1	5.3%	1	2	3	5	5	5	5	5	5	5		Risk of fatality	Unsafe				Negligeable
15	Economics – CAPEX	1	5.3%	5	5	5	2	2	3	1	1	3	3			Most expensive				Cheapest
16	Economics – OPEX (40 year avg.)	1	5.3%	1	1	4	4	1	5	2	2	5	4			Most expensive				Cheapest
17	Economics – NPV (20yrs)	1	5.3%	3	3	5	2	1	3	1	1	3	3			Most expensive				Cheapest
18	Interdependance with State Government	1	5.3%	4	4	1	2	2	2	2	2	2	2		Risk of relationship breakdown	Dependant		Some interactions required		Independent
19	Sustainability	1	5.3%	1	5	5	3	3	3	3	3	3	3		Untenable	Unsustainable				Sustainable
	Normalised Rating	19	100%	2.63	2.89	3.53	3.26	3.05	2.95	2.37	2.68	2.74	2.58							
	Rank			**8**	**5**	**1**	**2**	**3**	**4**	**10**	**7**	**6**	**9**							

Table 3-6: Summary of multi-criteria analysis sensitivity to weights. Probable rank for each option: 256 samples (top), 512 samples (bottom)

Probable Rank	Options										Total (256 random samples)
	Option 1 – Status quo (current sand nourishment)	Option 2 - Independent mobile sand back-passing	Option 3 - Coordinated BCBH dredging & sand back-passing	Option 4 - Seawall - Rock	Option 4 - Seawall - Sandbags	Option 5 – Groyne(s) - 1L Rock	Option 5 – Groyne(s) - 2T Rock	Option 5 – Groyne(s) - 3T Rock	Option 5 – Groyne(s) - 4S Rock	Option 5 – Groyne(s) - 4S Sandbag	
1	0%	0%	80%	20%	0%	0%	0%	0%	0%	0%	100%
2	0%	19%	11%	60%	9%	1%	0%	0%	0%	0%	100%
3	4%	14%	9%	14%	42%	17%	0%	0%	0%	0%	100%
4	6%	19%	0%	6%	23%	45%	0%	1%	1%	0%	100%
5	11%	16%	0%	0%	14%	21%	0%	14%	23%	0%	100%
6	15%	11%	0%	0%	7%	14%	0%	22%	27%	5%	100%
7	15%	10%	0%	0%	2%	2%	1%	25%	33%	13%	100%
8	14%	6%	0%	0%	2%	0%	2%	29%	17%	30%	100%
9	17%	4%	0%	0%	1%	0%	15%	10%	0%	52%	100%
10	17%	0%	0%	0%	0%	0%	81%	0%	0%	1%	100%

Probable Rank	Options										Total (512 random samples)
	Option 1 – Status quo (current sand nourishment)	Option 2 - Independent mobile sand back-passing	Option 3 - Coordinated BCBH dredging & sand back-passing	Option 4 - Seawall - Rock	Option 4 - Seawall - Sandbags	Option 5 – Groyne(s) - 1L Rock	Option 5 – Groyne(s) - 2T Rock	Option 5 – Groyne(s) - 3T Rock	Option 5 – Groyne(s) - 4S Rock	Option 5 – Groyne(s) - 4S Sandbag	
1	0%	0%	80%	20%	0%	0%	0%	0%	0%	0%	100%
2	0%	16%	11%	63%	9%	1%	0%	0%	0%	0%	100%
3	4%	15%	8%	13%	45%	15%	0%	0%	0%	0%	100%
4	5%	17%	1%	4%	21%	49%	0%	2%	1%	0%	100%
5	12%	18%	0%	0%	14%	19%	0%	15%	22%	0%	100%
6	13%	12%	0%	0%	6%	13%	0%	22%	29%	5%	100%
7	14%	9%	0%	0%	2%	1%	1%	25%	32%	15%	100%
8	15%	6%	0%	0%	1%	0%	4%	27%	15%	31%	100%
9	18%	5%	0%	0%	1%	0%	17%	10%	0%	48%	100%
10	20%	1%	0%	0%	0%	0%	79%	0%	0%	1%	100%

4 ENVIRONMENTAL PERMITS AND APPROVALS

This section details the preliminary environmental permits and approvals relevant to the preferred option: Option 3 - Coordinated BCBH dredging & sand back-passing ("the Project"), including a breakdown of anticipated Formal referral and primary approval, secondary approvals and environmental management. This information is based on BMT's experience with current and comparable environmental management practices implemented for BCBH dredging and disposal operation on behalf of DoT. As such, it provides an appropriate insight into the anticipated environmental impact issues, planning/approval requirements and operational compliance requirements of the Project. An indicative timing of potential approvals is also outlined.

4.1 Permits and Approvals

4.1.1 Anticipated formal referral and primary approval

Assuming the adoption of standard environmental management practices, it is anticipated that nourishment of Castletown Beach will not result in significant environmental impacts, and will not require formal assessment under Part IV of the *Environmental Protection Act 1986* (EP Act).

Department of Transport (DoT) completes routine maintenance dredging within BCBH every two years and dredged material is disposed for nourishment approximately 1.5 km east of the BCBH (Figure 4-1). On behalf of DoT, BMT has completed environmental sampling, impact assessments and management plans for maintenance dredging campaigns since early 2000's, and has developed in-depth understanding of the local and regional scale potential environmental impacts from dredging and disposal activities. DoT routine maintenance dredging is conducted under a comprehensive Environmental Management Framework (EMF).

The scope, duration and volumes of the proposed Castletown Beach nourishment does not differ to previous maintenance dredging campaigns completed by DoT, with the exception of the chosen disposal area. Potential environmental impacts from nourishment works that require monitoring and management are likely to be similar to those impacts previously identified for routine maintenance dredging campaigns. The anticipated relevant environmental factors and potential impacts that may require monitoring and management prior to and during nourishment works are outlined in Table 4-1.

Following the selection of final design for nourishment of Castletown Beach, it is recommended environmental sampling is completed to characterise sediments for dredging and disposal, where appropriate. Following sampling, a detailed environmental impact assessment (EIA) is recommended to further assess the level of environmental risk to each factor (Table 4-1; and/or any other environmental factors for consideration). The EIA should include:

- Dredging and disposal methods
- Provide a description of the existing environment
- Review of previous studies/investigations and relevant data (including any existing sediment data, and any other relevant environmental studies/s)

- Detail of potential environmental approvals
- High-level recommendations for monitoring and management of potential environmental impacts during dredging will be provided to inform the preparation of an Environmental Management Plan.

DoT's long-established EMF could be leveraged to possibly strengthen and reduce cost and timing of the submission.

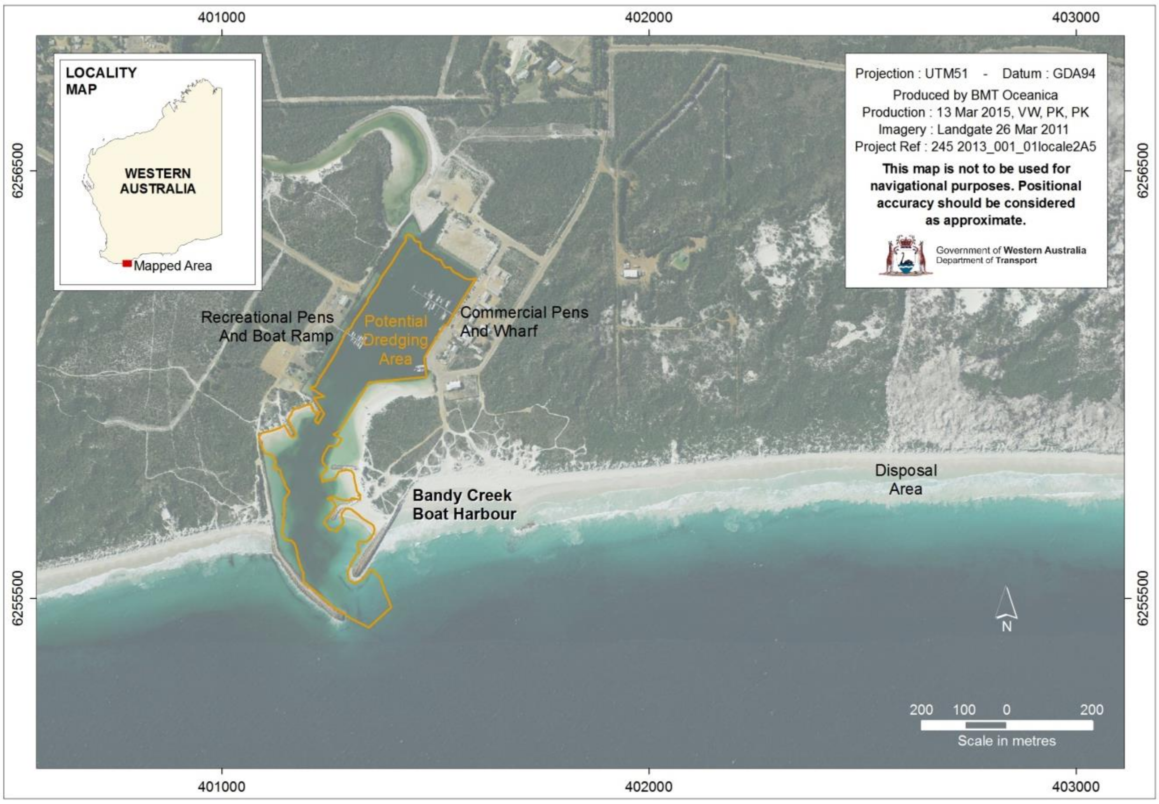

Figure 4-1: Department of Transport Bandy Creek Boat Harbour maintenance dredging and disposal area

Table 4-1: Potential environmental impacts associated with Castletown Beach nourishment

Environmental factor[1]	Potential impact
Benthic communities and habitat	Direct or indirect damage/loss to marine benthic habitats from burial
Marine and terrestrial environmental quality	Release of contaminants to marine water
	Hydrocarbon spills and waste generation
Flora and vegetation	Vegetation/Disturbance removal from equipment lay down/access tracks
Social surroundings	Public safety, visual amenity and beach access
	Navigational hazards
	Noise generation
	Dredging and/or disposal disturbance/damage to Aboriginal and European Heritage

(1) The environmental factors and objectives are structured in accordance with EPA (2016)

4.1.2 Anticipated secondary approvals:

While formal referral and primary approval under Part IV of the EP Act are likely not required; secondary approvals may be required under various legislation to assess and approve potential impacts upon flora and fauna and social surroundings (Table 4-1).

Any vegetation disturbance or removal for equipment access and/or lay down areas requires approval of a Native Vegetation Clearing Permit under Part V of the *Environmental Protection Act 1986*.

The proposed dredging and disposal areas are within the Native Title Determination Area registered under the Esperance Nyungar Indigenous Land Use Agreements held by body cooperate Esperance Tjaltjraak Native Title Aboriginal Corporation. Consultation with the Native Title Group is required to determine heritage requirements under the *Aboriginal Heritage Act 1972.*

It is understood the dredging will occur within internal waters and dredged material will be disposed via pipeline above the high water mark and there is no requirement for a sea dumping permit under the *Sea Dumping Act 1981.*

Ongoing consultation with relevant Decision Making Authorities is recommended to ensure potential concerns are addressed prior to and during the nourishment works.

4.1.3 Anticipated environmental management

Following the selection of final design for nourishment, an Environmental Management Plan (EMP) is recommended to outline appropriate monitoring and management of the nourishment works. Anticipated environmental management to minimise and avoid environmental impacts may include:

- Adherence to relevant approval conditions
- Monitoring of the turbid plume generated from dredging and disposal and appropriate contingency
- Public safety, beach access and amenity
- Navigational hazards
- Noise
- Ongoing stakeholder consultation

4.2 Indicative timings for approvals

4.2.1 Heritage

As outlined in section 4.1, it is recommended to firstly consult with the local Native Title Group to discuss whether the proposed disposal area is within Native Title determined area. The Shire may have already had some interaction with the Native Title Group from past nourishment campaigns.

Should the local group advise the Project may potentially impact Heritage, an activity notice (or equivalent) may be requested to be completed and submitted to the Native Title Group for review and advice. Once submitted, the anticipated turnaround may be in the order of 1 month.

If the outcome of the activity notice is that a Heritage survey is required, it is likely the local group will engage their preferred Heritage consultant to complete the survey. Approximately 2-3 months timing is anticipated for this depending on consultant availability and scope.

If the outcome of the Heritage Survey is that the disposal is likely to impact on Heritage, a Section 18 may be required to obtain consent from the relevant Minister the project can still occur, or what conditions may be imposed. This process is lengthy and might take 6-12 months for consent.

4.2.2 Environmental

As recommended in section 4.1, a detailed environmental impact assessment to assess potential environmental risk posed by the dredging and disposal is recommended to demonstrate environmental impacts have been considered and mitigated.

If there are any approvals required, such as a native vegetation clearing permit for vegetation clearing/destruction. The timeframe for this is in the order of 2-3 months. If the project is referred as the outcome of the impact assessment is that the Project likely to cause a significant environmental impact, the timeframe for this is the order of 2-3 months to achieve a decision from EPA, however; it is not anticipated a project of this scale will require formal EIA.

5 CONSULTATION WITH THE DEPARTMENT OF TRANSPORT

The preferred option (Option 3 - Coordinated BCBH dredging & sand back-passing) constitutes a potential “Win-Win” scenario for the Shire of Esperance and the Department of Transport. One of the key benefit of this proposal is to give them the opportunity to realize technical synergies between the coastal erosion management at Castletown Beach and the siltation management downstream at the Bandy Creek Boat Harbour (using a familiar technology in a familiar environment within long-established operating procedures) while optimizing the limited state funding available for coastal management projects.

The resulting high degree of coordination necessary between the Shire of Esperance and the Department of Transport for the implementation of the proposed strategy, however necessitates early engagement to identify potential risks, determine the level of support and consolidate early requirements from the Department of Transport.

A consultation meeting was held on the Thursday 3rd May 2018, at the Department of Transport Marine House to discuss the topic of *Coordination of Bandy Creek Boat Harbour dredging & sand back-passing at Castletown Beach.*

5.1 Meeting participants

The meeting participants included:

- Peter Wilkins: Manager Asset Management | Department of Transport
- Demont Hansen (app. Fangjun Li): Manager Coastal Management | Department of Transport
- Clark Irwin: Regional Facilities Coordinator | Department of Transport
- Karim Ghaly: Maintenance Dredging Program Manager | Department of Transport / BMT
- Frederic Saint-Cast: Project Manager | BMT / Shire of Esperance

The Objective(s) and benefit(s) of the meeting were to:

- Inform – raise awareness and clarify understanding
- Consult – Identify show stoppers, determine level of support, and consolidate recommended actions/conditions

5.2 Meeting agenda

The agenda was as follow:

- Introduction (9:00)
  - Topic
  - Participants
  - Objective(s) and benefit(s) of the meeting
- Background Information (9:05)
  - Issue, objective, constraints
  - Management options

- Multi-criteria appraisal
- Preferred Option
- Summary of Win-Win option

- Consultation – workshop (9:15)
  - Identify show stoppers
  - Determine level of support
  - Consolidate recommended actions/conditions
- Conclusion (9:55)

5.3 Meeting outcomes

The meeting was well received by the participants and achieved the following:

- Raised awareness of erosion problem and management solutions at Castletown Beach
- Clarified the preferred approach following screening and MCA, i.e. Cooperation Option 3
- Summarised WIN-WIN scenario
- Investigated the option SWOT profile from the Department of Transport standpoint:
  - No show stoppers identified at this stage
- Determined inclination of the Department of Transport to further the Cooperation Option 3:
  - The Department of Transport is supportive of the proposal in principle, subject to several considerations (to be expected at this stage of the process)
- Noted recommended actions/conditions by the Department of Transport
  - Need of each organisation to follow due process
  - Need appropriate design
  - Need to plan a trial and monitoring
  - The next dredging campaign is in winter 2019, so the execution timing of such project should also be a consideration

For more details, the meeting power point presentation, including the 3 additional slides (p12, p13 & p14) summarising the findings and outcomes of the consultation meeting/workshop is included in appendices.

6 CONCULSION AND RECOMMENDATIONS

Considering our findings, the cost of managing the erosion issue at Castletown Beach over the long term, within the problem constraints, could reasonably be expected to be reduced by more than 50% compared to the current practice (status-quo).

6.1 Preferred solution

Coordinated BCBH dredging & sand back-passing

Significant economic improvement could be achieved by seeking to implement beach nourishment at Castletown Beach in collaboration with the Department of Transport during their two-yearly maintenance dredging of Bandy Creek Boat Harbour. This “soft” solution, referred to as “Option 3” in the report, is expected to hydraulically deliver sufficient quality and quantity of sand to rebuild the eroded foreshore by having a more natural beach profile shifted seaward with an appropriate berm width to accommodate storm erosion events until the next dredging campaign (two years). This approach offers savings potential immediately and in the future for all time frames, due to the absence of upfront capital expenditures and a lower and less frequent cost of operations. Note that the favourable economics of this approach can only be made possible as part of a coordinated dredging and disposal operation with the Shire and the DoT working collaboratively. This approach is robust across a range of criteria other than the economics, including social, technical and environmental.

6.2 Alternative strategies

A number of other approaches consisting of installing various arrangements of rock protection structures could be considered.

Seawall

Rock protection along the beach, in the form of a seawall extending approximately 700m downstream of the existing groynes field is a primary strategy already used for the Esperance Foreshore enhancement Works. This “hard” solution is expected to provide sound erosion protection. Although, this approach also offers some savings potential in the long term beyond the 40 years horizon, it is not competitive in the medium term versus the status-quo due to the elevated capital expenditure required for construction.

Groyne(s)

Alternatively, the use of 1 large L-groyne or 4 small groynes solution can achieve better cost reduction than the seawall. This solution includes an initial beach nourishment, which is recommended to establish a more appropriate sand buffer to accommodate the impact of large storms. This solution is expected to reduce the littoral drift and retain sand within the groyne shadow area. Although, this solution offers potential economic benefits in the medium term beyond the 20 years horizon, it is remains more capital intensive in the short term than the status-quo. Also, the cost of implementing large T-groynes solution would be prohibitive compared to other solutions, so it is not recommended.

Staged implementation of short groyne field

A staged implementation of the 4 short groynes field solution could offer some benefit by spreading the capital spending over time. However, extending the existing groyne field with one "new" short groyne alone would fail to address the stated objective and constraints of this study, and a suitable strategy would need be developed in addition to adequately mitigate the elevated risk of erosion in the lee of this "new" terminal groyne.

Geotextile bags

Note that the implementation of the 4 small groynes field using geotextile bags is marginally cheaper at the beginning but operational cost rapidly increases due to the shorter life of the material requiring more frequent maintenance that generally requires replacement of the outer bag layers.

6.3 Practical implications to improve management practices

As a result of our rational option appraisal, the preferred solution (i.e. "Option 3 - Coordinated BCBH dredging & sand back-passing") was selected.

Following this primary filter, the preferred option was subjected to further scrutiny, including environmental approval consideration and early engagement with the Department of Transport, to detect potential implementation risks and constraints.

No fatal flaws were identified at this stage.

The routine ongoing two-yearly dredging and beach disposal activities that are taking place at BCBH encourage DoT to support "in principle" the proposal subject to a range of consideration typical for such proposal.

Accordingly, it is recommended for the Shire to:

- Develop a design appropriate for the site and the proposed strategy (as outlined in section 2.5 and 3.2.3)
- Address the social, environmental and heritage requirements (as outlined in section 4)
- Note the next dredging campaign is scheduled for the Winter 2019 quarter

This would ensure that all necessary conditions are timely met, thus satisfying the primary and secondary stakeholders needs and their organisational requirements.

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APPENDIX A:
DOT CONSULTATION MEETING PRESENTATION AND OUTCOMES