MID WEST PORTS

Our approach

2021 MWPA MAINTENANCE DREDGE: BENEFICIAL USE ASSESSMENT

Prepared by

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Wavelength

Purpose

This document outlines the process that MWPA used to assess a range of opportunities to use dredged material from the 2021 Maintenance Dredge program for beneficial purposes. The document explains how the methodology used aligns with international agreements and commonwealth legislation designed to assess all alternatives to sea dumping and to recognise dredged materials as a valuable resource.

Importance

This document explains:

- how the dredged materials were characterised and assessed to determine their suitability for proposed beneficial uses;
- how potential nearshore placement areas were identified;
- MWPA's commitment to sustainable resource use; and
- how options were identified, assessed and evaluated to determine the option that best met MWPA objectives.

Report Links

The report was informed by:

- Benthic Habitat Assessment of Champion Bay & Surrounds, Benthic Habitat Mapping Report (AECOM); and
- Geraldton Port Baseline Sediment Characterisation & Assessment 2019 - SAP Implementation Report (O2 Marine).

This document helped to inform:

- Environmental Impact Assessments; and
- Dredge Environmental Management Plan.

Outcomes

The outcomes of the Beneficial Use Assessment was the selection of the following dredge material treatment options:

- placement of harbour sediments to the existing Berth 7 reclamation area for the purpose of land creation; and
- placement of channel sediments into a nearshore placement area for the purpose of retaining sediment within the natural system.

Resulting in 100% beneficial use of all dredged material from the 2021 Maintenance Dredge Program.

MID WEST PORTS

JANUARY 2021

2021 Maintenance Dredge:

Dredge Material Beneficial Use Assessment

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2 Introduction

Mid West Ports Authority (MWPA) is planning to undertake maintenance dredging to remove naturally accumulated sediments from within the commercial harbour and shipping channel at the Port of Geraldton. This is a necessary requirement to maintain the Port's operations. Consistent with international best practise and in alignment with the United Nations Sustainable Development Goals MWPA is committed to sustainable sediment management, whereby dredged sediments are considered a resource and not a waste product.

As part of the preparation for maintenance dredging this report was prepared to evaluate the potential beneficial re-use options for dredged sediments.

This report follows the following steps:

- Chapter 1: background, maintenance dredging strategy, coastal process
- Chapter 2: details on the assessment methodology
- Chapter 3: dredging requirements, volumes and sediment properties
- Chapter 4: beneficial use options
- Chapter 5: evaluation and ranking of options
- Chapter 6: recommendations

2.1 BACKGROUND

The Port of Geraldton is a critical part of the supply chain linking the Mid West Region to national and international trade markets. The Port is one of Australia's most diverse ports with bulk commodities imports and exports through the Port including Iron Ore, Mineral Sands, Metal Concentrates, Fertilisers, Grains, Livestock, Petroleum and General Cargo.

As a Port Authority MWPA responsibilities include:

- facilitation of trade;
- safe and efficient operations;
- maintenance of port assets; and
- protection of the environment.

At the Port of Geraldton the MWPA operates:

- seven (7) commercial berths, associated circuits and ship loading infrastructure, harbour basin and channel, and
- rail terminal, associated railway tracks and unloading infrastructure.

Uniquely, the MWPA also manage the Geraldton Fishing Boat Harbour, which supports the region's largest fishing industry.

Maintenance dredging is an essential part of managing critical marine assets, to ensure safe and efficient navigation within the harbour basin and approach channels. Through routine maintenance dredging MWPA supports national and global trade enabling national productivity, economic development, and continued connection to the global markets.

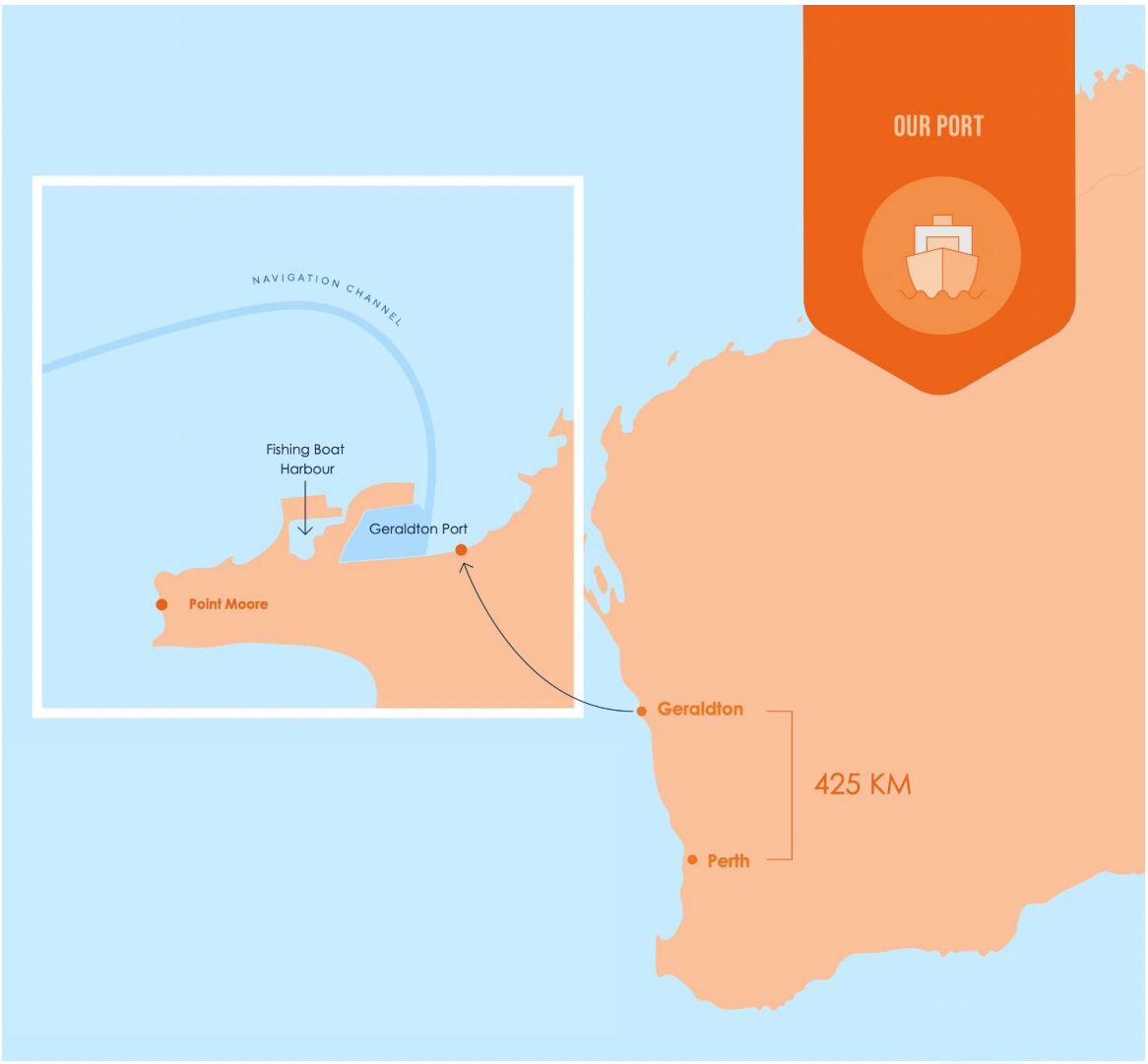


Figure 1. Port of Geraldton

2.2 MAINTENANCE DREDGING STRATIGY

Maintenance dredging is common practice in ports around the world and is essential to keeping our ports operating. It involves removing naturally accumulated sediment from within navigational channels, berths or other port areas to maintain design depths. If maintenance dredging does not occur, the declared depth continues to get shallower, ultimately reducing the capability of the port, resulting in significant flow-on effects to business and the local economy.

Maintenance dredging is typically undertaken using a trailer suction hopper dredge (TSHD). A dredge equipped with a suction pipe which ends in a drag head. The drag head is lowered to the seabed and then slowly moved along the channel removing accumulated sediments by suction. The mixture of sediments and seawater is pumped into the dredge's hopper. Once the hopper capacity is reached the dredge can sail to the designated placement site and either place sediment by opening doors on the underside of the vessel allowing sediment to fall to the seabed, or connecting to a pipeline and allow sediments to be pumped to the designated location.

MWPA has commenced work on a strategic approach to the management of marine sediments and to identify the optimal frequency for undertaking maintenance. In 2020, a long-term dredge strategy was developed for Geraldton Port (Wavelength, 2020), which included both short and long term dredging recommendations for the maintenance of the main channel, harbour basin and commercial fishing boat harbour.

This strategy recommended the development of a short-term maintenance dredging scope of works for the proposed 2021 maintenance dredge campaign to remove material which has accumulated within the navigational areas of the Geraldton Port (Wavelength, 2020). Recent hydrographic survey (June 2020) confirmed the need for maintenance dredging to occur within 2021 to return the harbour basin and main shipping channel to its design depth.

The strategy also reviewed the options for long term management of sediment accumulation in Geraldton Port, aiming to identify an appropriate dredging interval for future maintenance dredging campaigns. A longer term maintenance dredging target interval of approximately 5-6 years was recommend (Wavelength, 2020). This proposed maintenance dredging interval was based on several factors including estimated sediment siltation rates, vessel draft limitations, financial impacts of deferring dredging, costs of dredging, and dredge planning and environmental approval timeframes. MWPA undertakes routine hydrographic surveys to monitor sediment accumulation within navigational areas, these surveys will continue to inform future maintenance dredging requirements and influence dredging intervals

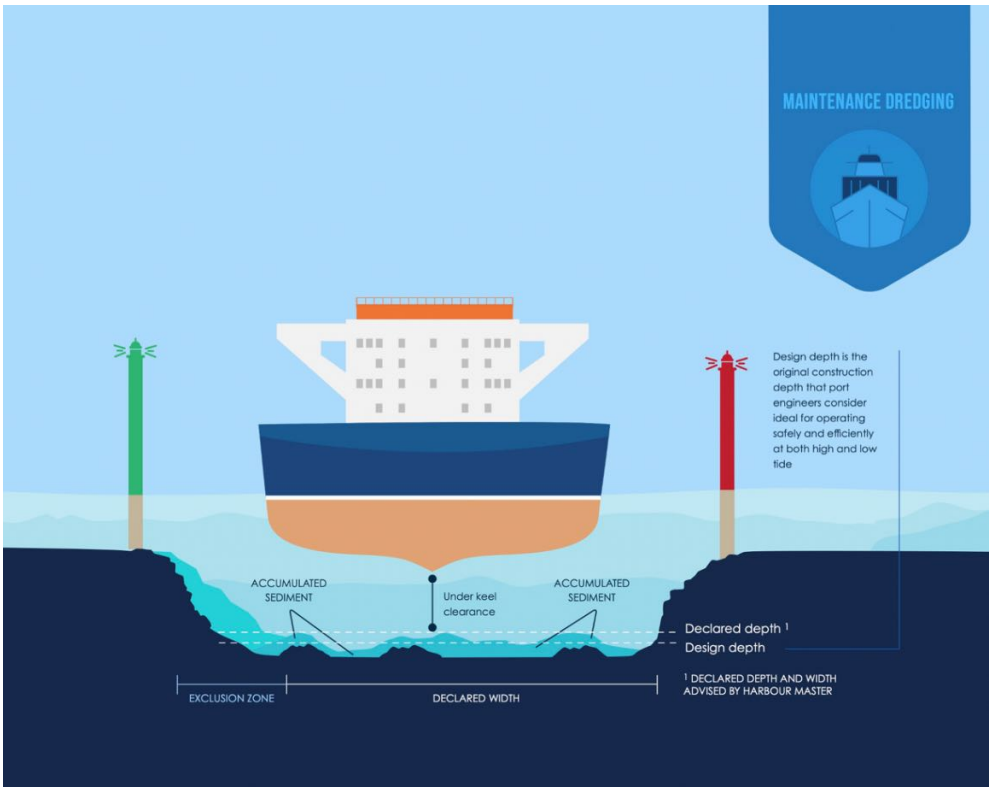


Figure 2. Sediment accumulation in navigation channels

2.3 SEDIMENT ACCUMULATION & COASTAL PROCESSES

The Geraldton coastline has two west-facing embayments which are separated by a prominent tombolo at Point Moore. A shallow (~10 m) coastal platform with discontinuous, north-south trending limestone ridges borders a sandy shoreline and coastal plain with only minor small rivers and low relief reef platforms (Curtin University, 2012). Historically, the coastline located north of Point Moore has been modified by changes to coastal infrastructure, including Geraldton Port, Fishing Boat Harbour, marinas, shoreline developments and coastal protection schemes.

The Geraldton coastal environment is complex, containing numerous natural and artificial sources and sinks for sediment which are strongly influenced by natural wave, swell, wind and weather conditions. The areas Coastal sediments tend to experience a net overall south to north transport pattern which is driven by the strong south-westerly swell waves and strong sea breezes (Curtin University, 2012).

Work by the Department of Transport (DoT, 2014) identified areas of the coast where sediment movement is interdependent and terrestrial landforms are likely to be connected through sediment exchange (i.e. the movement of sediment is connected to the land). These areas are called sediment cells, and in the vicinity of the Port the Secondary sediment cell spans between Point Moore and Glenfield, refer to Figure 3.

Further studies are being undertaken by MWPA to better understand the coastal processes influencing the Geraldton coastline between Greenough River and Oakajee, in particular the factors affecting sediment accretion and erosion which may be influenced by natural climatic conditions or historical changes to coastal infrastructure. The outcomes of this study will inform future opportunities for the beneficial use of dredge material for coastal stability programs.

MWPA assists the City of Geraldton with sand replenishment of northern beaches by transporting (via truck), approximately 12,500m3 of sand annually, which accumulates at Pages Beach for re-distribution on these beaches (GPA, 2006).

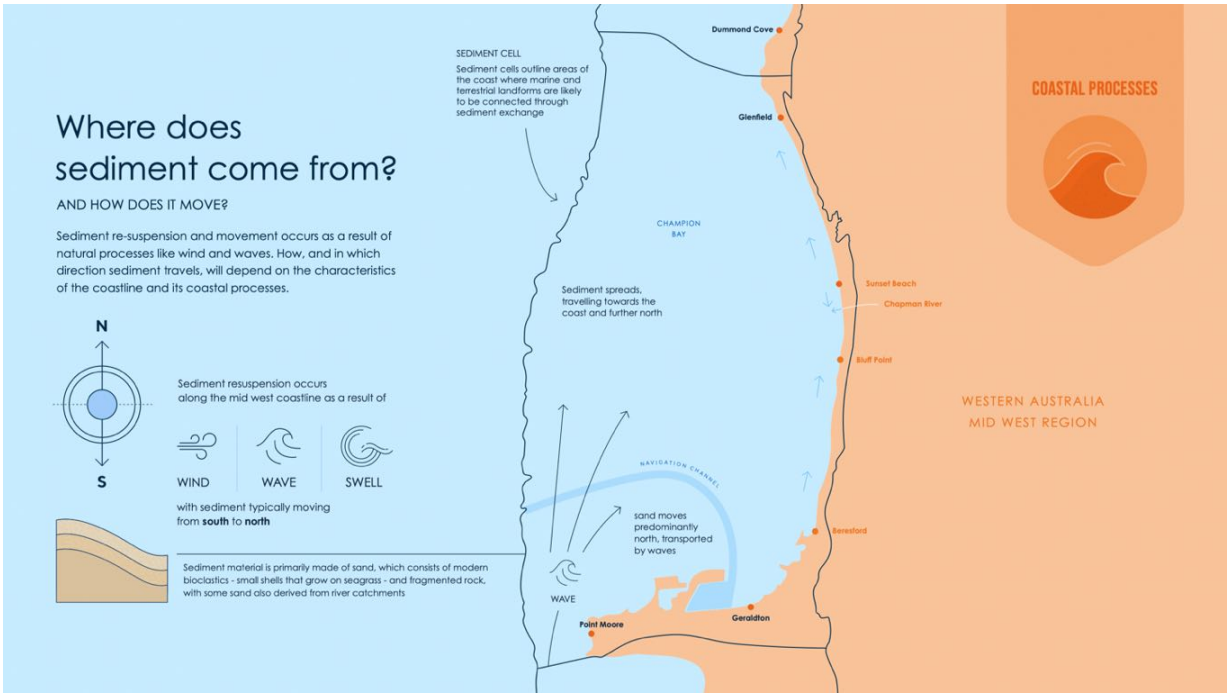


Figure 3. Sediment movement

3 Our Approach

3.1 METHODOLOGY

Australia is a signatory to the '*Convention on Prevention of Marine Pollution by Dumping of Wastes and Other Matter 1972*' (the 'London Convention') and the 2006 updated 'London Protocol' introduced to modernise and eventually replace the London Convention. The London Convention and Protocol provide an international standard to prevent the pollution of the oceans by dumping of waste.

Guidance on the application of the London Convention and Protocol to dredging is provided by the World Association for Waterborne Transport Infrastructure (PIANC) *Dredge Material As A Resource – Options and Constraints* (PIANC, 2009) and at a local level within the *National Assessment Guidelines for Dredging* (Department of the Environment, Water, Heritage and the Arts, 2009).

PIANC (2009) acknowledges that dredging is essential for the maintenance and development of ports. However, it encourages proponents to consider dredge material as a resource, not a waste, and to seek out beneficial options for the re-use of the dredged material.

The evaluation of disposal options for maintenance dredging has followed the following framework consistent with PIANC (2009) (refer also to Figure 4):

1. **Source** – define future dredging requirements
    a. identify the likely **volume** of future dredge material
    b. identify the likely **properties** of future dredge material
2. **Options** – identify the broad range of potential options for the re-use or disposal of dredge material
3. **Pre-screening** – rule out options unsuitable due to either:
    a. **environmental fatal flaws** – where, even after considering treatment options, the material properties preclude the option
    b. **engineering fatal flaws** – where either equipment or site constraints preclude the option
    c. **demand fatal flaws** – where there is no need or market for the option
4. **Multi-criteria assessment** – to rank options based on consideration of environmental/social, operational and economic impacts
5. **Option selection** – selection of the recommended option(s) which provided the greatest net benefit.

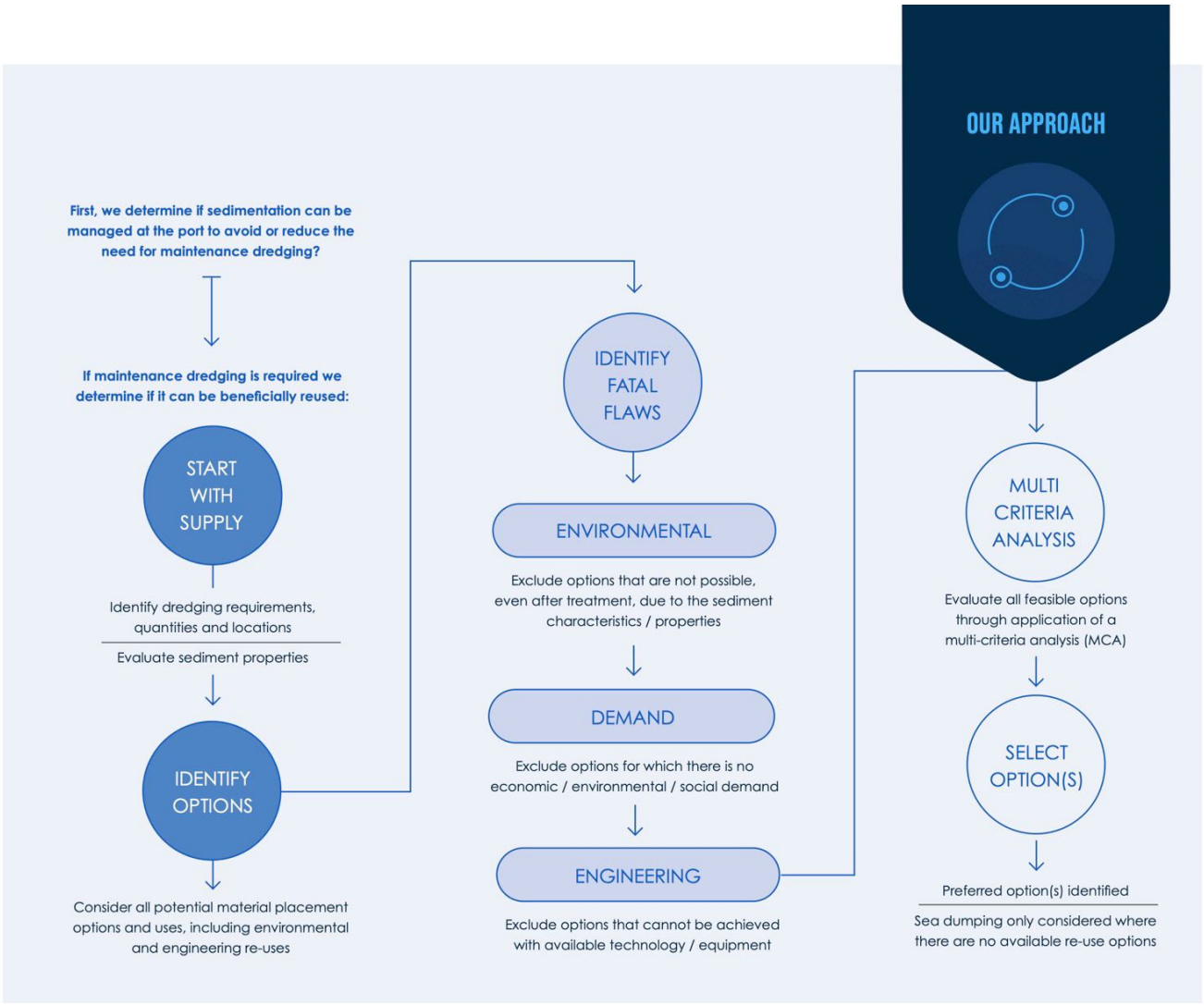


Figure 4. Our approach – methodology for selecting preferred re-use options

4 Maintenance Dredging Sediments

4.1 SILTATION PATTERNS

Review of monitoring hydrographic surveys indicates that sediment is primarily accumulating within the southern approach channel, on the western edge of the channel. This is as expected given the predominate movement of sediment is from south to north (refer to Section 2.3).

Figure 1 show a difference plot comparing the seabed levels in the recent June 2020 hydrographic survey to design levels.

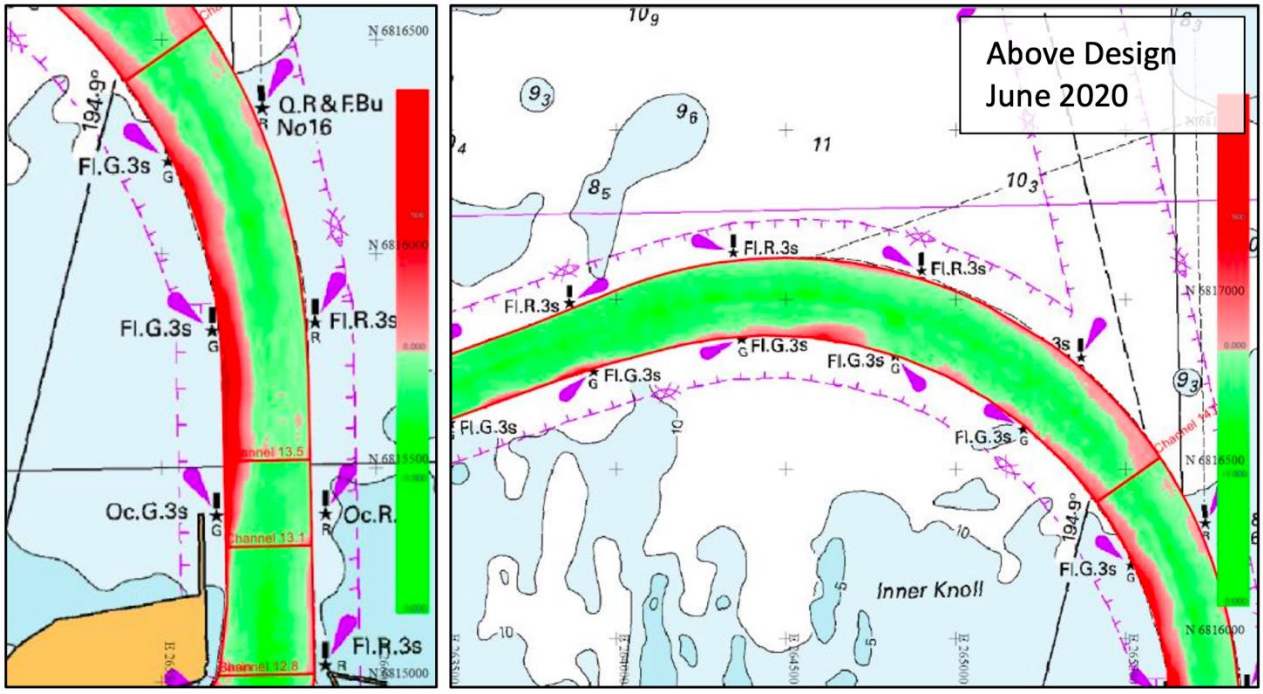


Figure 5. Monitoring hydrographic survey - difference plot (June 2020 to design) (PHS, 2020)

4.2 SEDIMENT VOLUMES

Dredging volume estimates were undertaken by Wavelength (2020) and based on the latest available hydrographic survey completed by Precision Hydrographic Service in May/June 2020. The total volume of sediment required to be removed was estimated to be between 171,000m^3 and 211,000m^3, comprising sediments from the harbour basin and the approach channel. The estimate allows for further siltation between the monitoring survey (June 2020) and the expected time of dredging (late 2021), based on average siltation rates calculated by Wavelength (2020).

An upper and best estimate was provided by Wavelength (2020) for dredging within the harbour basin based on review of the previous maintenance dredging undertaken in 2012. In 2012, due to the nature of

the material a larger dredging tolerance was required to achieve the required design depth, these dredging tolerances have been assumed in the upper volume estimate. If dredging is combined with seabed leveling with a support vessel, there may be an opportunity to reduce the volume of dredging required, as such a best estimate has also been included assuming this will be the case.

It is expected that the volume estimate will continue to be refined, particularly as further monitoring surveys are collected to allow a refinement of siltation rates and dredging equipment and methods are confirmed allowing a clear understanding of expected dredging tolerances.

The current estimated dredge volumes are presented in Table 1.

Table 1 - Dredging volume estimates

Zone	Total Volume Upper Estimate (m^3)	Total Volume Best Estimate (m^3)
Harbour Basin		
Berth Pockets	29,818	14,458
Turning Basin	33,579	13,292
Forecast Siltation	7,714	3,600
Total	71,111	31,350
Approach Channel		
Channel	N/A	131,410
Forecast Siltation	N/A	8,700
Total		140,110

4.3 SEDIMENT CHARATERISTICS

Sediment characterisation investigations were undertaken in June 2019 by O2 Marine. The purpose of these investigations was to assess the contaminant status and characterise the marine sediments which have accumulated within navigational areas of the Port to determine the suitability and acceptability of dredge material placement options.

Sediment investigations were carried out accordance with the *National Assessment Guidelines for Dredging* (Cmwlth of Aust, 2009) and the Sediment Baseline Characterisation Sampling & Analysis Plan developed for the project (O2 Marine, 2019a).

Overall, 31 sediment samples were collected for analysis from 28 sample locations, distributed across areas of accumulation within the harbour basin, berth pockets and shipping channel (O2 Marine, 2019), refer to Figure 6. A summary of the key findings of the investigation is outlined below.

- **Channel sediments** are quite consistent across the sites sampled, predominately comprising medium to fine sands of natural origins (eg. coastal silicate sands or marine carbonate sediments). These sediments contain very little organic matter, and are typically a yellow colour, becoming

progressively greyer with depth. Particle sizes for the channel sediments were dominated by medium to fine sands, with the proportion of gravel, clays and silt particles being low, typically 4%.

- **Inner harbour** sediments varied, depending on their location. Across most sample locations, sediment contained medium to fine silty sands, with finer silty sands present near the tug pen entrance and medium to fine beach sands present near the entrance channel. Sediments are typically grey in colour varying to brown or dark grey at some locations. Shell grit/fragments are quite common, though living biota was not observed. Organic matter, typically sea-wrack, is common throughout sediment samples. Particle sizes of the inner harbour sediments contain 47% silt, 41% medium to fine sands, 4-14% clay, with gravel found in very low proportions or not at all.

Figure 6. Sediment sampling locations (O2M, 2009a)

In review of the sediment sampling results, O2 Marine (2019) provided initial recommendation on the suitability of sediment for marine placement:

- beneficial re-use for marine or coastal placement – acceptable for channel sediments only
- beneficial re-use for placement within the Berth 7 reclamation – acceptable for all sediments (harbour and channel)
- non-beneficial re-use 'Sea Dumping' (offshore disposal of sediments to deep water) – likely to be acceptable for all sediments (harbour and channel), however recommendation provided for further sampling to be completed if this option was selected to confirm.

Although the primary purpose of sediment sampling was to identify the suitability of sediments for marine placement. The information collected can also be used to determine the environmental suitability for alternative terrestrial placement options.

5 Dredge Material Beneficial Use Options

5.1 OPTIONS IDENTIFICATION

A total of 24 beneficial re-use options were identified through consultation by the MWPA with its technical advisors and key stakeholders. The options identification process sought to find solutions which provided benefits to MWPA, the natural environment and the broader community.

Consistent with the PIANC (2009), dredge material placement options were divided into the following categories of environmental and engineering options:

Environmental enhancement

- **Agricultural** – use of sand for agricultural purposes
- **Sand replenishment (nearshore)** – placement of sand within the nearshore zone, inside the 'depth of closure' where sand can be actively transported to the shoreline by waves and currents
- **Sand replenishment (beach)** – placement of sand directly to the beach or within the surf-zone to enhance the beach; and
- **Artificial Reefs** – placement to support the creation of artificial reef systems.

Engineering

- **Reclamation (existing)** – placement within existing land reclamation to advance the Port's future development;
- **Reclamation (new)** – placement within new land reclamations as part of the Port's future development;
- **Export** – use of material for general construction, outside of reclamation. Includes the option of exporting the material; and
- **Other** – other engineering solutions, which may beneficially utilise sediments such as temporary storage of material for future uses/demands.

In addition, the option of offshore disposal was identified and included as part of the overall evaluation of options. Offshore disposal is not considered a beneficial re-use, however, was retained as an option 'of last resort' in the event that beneficial re-use is not viable for some of the dredged sediments.

The full list of options considered by the MWPA and its technical and environmental advisors are summarised in Appendix A.

5.2 OPTION PRE-SCREENING

Options were evaluated through a Multi-Criteria Assessment (MCA) taking into consideration a broad range of social, environmental and economic factors. Prior to the MCA, an initial pre-screening was undertaken to evaluate any fatal flaws which would prohibit an option being undertaken. This is consistent with PIANC (2009) which detail the need for a dredge material placement option to be both practical and functional.

The pre-screening was based on the evaluation of:

- **Environmental fatal flaw** – Sediment sampling and analysis undertaken by O2Marine (2019) identified the sediments within the harbour basin and berth pockets contain varying levels of contamination. As there are limited treatment options the presence of contaminants precludes the harbour sediments from several potential uses.
- **Engineering fatal flaw** – Where re-use cannot be achieved with the available equipment or where practical engineering constraints would preclude the consideration of this option.
- **Demand fatal flaw** – Where there is no identified demand for the option, the option may be feasible and practical, however is superficial to community or stakeholder needs.

Due to the different sediment properties the pre-screen was applied independently to the harbour basin sediments and the channel sediments. Where an option was rejected from further consideration no further evaluation of the option has been undertaken. A summary of the reasoning for the rejection of options is presented in Appendix A.

5.3 SHORTLISTED OPTIONS

Following the pre-screening, eight options were shortlisted for evaluation via MCA. These options are summarised in the following Table 2 and discussed in more detail below.

Table 2. Shortlisted options

#	Beneficial Use Category	Option name	Description	Harbour sediments	Channel sediments
1	PORT RECLAMATION	FILLING BERTH 7 RECLAMATION AREA (POND ONLY)	Dredge material placed to the existing contaminated site reclamation located within Berth 7, referred to as the 'Pond'. Minimal modifications to the existing contaminated site facility expected. Land filled to approximately existing levels to complete the reclamation	☑	☑
2		RAISING BERTH 7 RECLAMATION AREA RAISE LAND PROFILE 1M	Dredge spoil placed to the existing contaminated site reclamation located within Berth 7. Modifications to the existing	☑	☑

#	Beneficial Use Category	Option name	Description	Harbour sediments	Channel sediments
			reclamation required to raise the finish level by approximately 1m to provide a finish level ~5m AHD.		
3	SAND REPLENISHMENT - BEACH PLACEMENT	BEACH PLACEMENT BERESFORD FORESHORE	Dredge spoil from the channel placed to a temporary reclamation on Pages Beach before being screened and transported by trucks for placement on the beach at Beresford Foreshore.	☒	☑
4		BEACH PLACEMENT SUNSET BEACH	Dredge spoil from the channel placed to a temporary reclamation on Pages Beach before being screened and transported by trucks for placement on the beach at Sunset Foreshore.	☒	☑
5	SAND REPLENISHMENT – NEARSHORE PLACEMENT	NEARSHORE PLACEMENT - SUNSET BEACH (SITE A)	Dredge spoil from the channel transported by dredge and placed to a nearshore placement area to allow the continuation of the natural transport of sediments.	☒	☑
6		NEARSHORE PLACEMENT - SUNSET BEACH (SITE B)	Dredge spoil from the channel transported by dredge and placed to a nearshore placement area to allow the continuation of the natural transport of sediments.	☒	☑
7	OFFSHORE DISPOSAL	ROCK DISPOSAL (PREVIOUS NEARSHORE SPOIL GROUND)	Placement of rest loads of rock to a nearshore disposal location.	Rock rest loads	Rock rest loads
8		OFFSHORE DISPOSAL WITHIN 2.5KM OF WESTERN END OF SHIPPING CHANNEL	Offshore disposal of sediment to deep water in a similar location to offshore disposal sites used for the 2002-3 Port Enhancement Project.	☑	☑

5.4 PORT RECLAMATION – PLACEMENT TO BERTH 7 RECLAMATION AREA

Overview

The Berth 7 area is an existing reclamation, which has been previously constructed from the disposal of dredge material. The reclamation area is nearing capacity, with the section remaining to be filled is referred to as the 'Pond'. The reclamation was designed as a contaminated site facility and contains a liner assumed to extend to +3m AHD. The existing reclamation area is not a consistent level, originally constructed to approximately +3.5m AHD, northern and western portions have been progressively raised over the years.

The facility has some of the components of a weir box, comprising four connecting pipes with a structure previously used for installation of filter screens. The reclamation is protected by a rock armoured seawall. Photos of the reclamation area are presented in Figure 7.

View west from weir box

View south from northeast corner

View west of Pond from southeast corner

Eastern end of Pond

Northern side seawall wall

Weir box pipes (inside)

Figure 7. Photos of Berth 7 (15-Dec-2020)

Option Selection

Two options were considered for the placement of dredge material (Figure 8), these being:

- Option 1: Filling of Berth 7 reclamation area limited to the 'Pond' only, with final levels matching the existing level to complete the reclamation; and
- Option 2: Raising of the Berth 7 reclamation area, involving modification of the existing reclamation area to raise the finish level by approximately 1m to provide a finish level of ~5m AHD.

Option 1 can accommodate some 35,000m3 of dredge material, whilst Option 2 can accommodate ~138,000m3. The volumes estimate for raising the Berth 7 reclamation area to 5m AHD (Option 2) assumes the bunds will be constructed from material already contained within the reclamation or as dredged material is placed, i.e. they count as part of the potential volume capacity and no material will be imported. It was assumed the bunds would be inset 10m from the edge of the seawall or existing structures, to allow for access around the perimeter and allow the extension of the rock seawall to be undertaken in the future.

Option 1 – Berth 7 Placement (Pond Only)

Option 2 – Berth 7 Placement (Full Area)

Figure 8 - Berth 7 reclamation placement options

Sediment Suitability

Berth 7 reclamation area is suitable for both the harbour and channel sediments. The reclamation area does not have sufficient capacity to contain all the dredged material, with Option 1. Option 2 however, could accommodate all the harbour sediments and a proportion of the channel sediments, which could be utilised for capping the reclamation area.

Opportunity

The dredge material from the inner harbour is used as sub-grade fill with the channel sediments used as capping material for the completion of the reclamation area. This would enable expansion of the useable commercial area of Geraldton Port with resultant financial benefits to MWPA and the local economy. Option 2 provides the opportunity to raise the height of the reclamation area improving resilience to storm surge and future sea level rise.

Project Execution Considerations

Using a trailer suction hopper dredge (TSHD), material will be transported from the dredge via a floating pipeline to the Berth 7 reclamation area. Due to the small capacity of the reclamation area, dredging equipment would be limited to a small TSHD. Flow rates of dredge material into the containment area will be monitored and altered (as necessary) to ensure the environmental requirements for the discharge of water to the marine environment within the harbour are met.

For Option 1, the existing containment facility within Berth 7, will require some minor upgrades to the pipes and weir box located at the southern side of the seawall.

For Option 2, the raising of Berth 7 reclamation area would require construction of containment bunds to accommodate the additional 1 metre in height above the existing finishing level; possible raising of the containment liner; and potential upgrades to the weir box structure to accommodate the increased

containment height. The overall increase in height of Berth 7 reclamation area, would also require the future raising of the rock seawalls.

Environmental and Social Considerations

The key environmental and social considerations for these two placement options include:

- Berth 7 reclamation area has been constructed as a lined containment area, suitable for placement of contaminated dredge spoil material;
- Discharge waters from the reclamation site will need to be managed, with water quality monitoring undertaken to confirm compliance with water quality criteria; and
- Minor changes to amenity can be expected at Berth 7 resulting from earthworks associated with raising the level of the reclamation area by 1 metre.

Financial

Both options present relatively high cost solutions due to the costs associated with preparation and management of the reclamation area. The costs associated with Option 2 will be substantially greater than those for Option 1.

5.5 SAND REPLENISHMENT - BEACH PLACEMENT

Overview

Mid West Ports currently undertake sand replenishment activities, removing sand from Pages Beach and placing it on Beresford and St Georges beaches under MWPA's Northern Beaches Stabilisation Programme which is a commitment of Ministerial Statement 0600 approved by the Department of Water and Environmental Regulation (DWER) and supported by the City of Greater Geraldton via a Memorandum of Understanding. This option would involve beach nourishment in addition to the existing sand replenishment actives.

Sand replenishment by direct placement from the dredge onto beaches was a beneficial use option which was evaluated and rejected during the pre-screening process. Due to the shallow water depth at each of the eroding beaches, placement directly onto the beach would require the installation of a pipeline from deeper water. This option was considered either unfeasible (due to the nearshore reefs) or cost prohibitive at each of the locations (Appendix A). Concerns were also raised in the pre-screen regarding the potential for channel sediments to contain rock fragments or cobbles from the previous capital dredging, which would also be placed directly to the beach reducing the beach amenity. Nearshore reefs were recognised as important habitat and construction of a pipeline within this sensitive area was considered to potentially negate the benefits of the direct placement option.

Beach placement options outlined below are based on the placement of sand from the channel initially to Pages Beach, then screened and trucked to the selected beach.

Site Selection

Consultation with the City of Greater Geraldton identified four (4) potential locations for sand placement as beach nourishment, refer to Figure 9Figure 9:

- Beresford Foreshore;
- St Georges Beach;
- Bluff Point; and
- Sunset Beach.

Figure 9. Beach & Nearshore Placement Locations

Sediment suitability

Based on sediment analysis of the dredge material, the channel sediments are suitable for placement of material onto beaches for nourishment purposes.

Opportunity

Placement of material directly onto the beach aids in improving beach amenity and can act as a short-term strategy for coastal areas susceptible to beach erosion.

Operational and Project Execution Considerations

Dredge material will be pumped ashore via a floating pipeline to a temporary storage location on Pages Beach, where it will be screened to remove rock fragments prior to being transported by truck for placement on the Beach. Containment and dewatering facilities would need to be established at Pages Beach to manage return waters. Given that the channel dredge material has been classified as medium to fine beach sands, very little turbidity is expected and even then, only on an intermittent basis when material is pumped ashore.

Both Beresford Foreshore and St Georges Beach have existing access for placement by truck. Placement to both locations has similar constraints, for the purpose of the MCA only Beresford Foreshore has been evaluated, however this is considered indicative of both sites.

Whereas, Bluff Point and Sunset Beach have limited existing truck access and placement by truck is likely to require temporary access to be constructed. Placement to both locations has similar constraints. For the purpose of the MCA only Sunset Beach has been evaluated, however this is considered indicative of both sites.

Execution of these options have identified the following constraints:

- Beach area is not sufficient to absorb the full channel dredging volume of 140,000m3 without causing significant advancement of the shoreline;
- Retainment of dredge material on the beach may require containment structures (e.g. groynes);
- There is insufficient water depth nearshore for direct placement by dredge without the installation of a floating pipeline., Therefore will require temporary storage at Pages Beach and trucking to Sunset Beach;
- Risk of sediments stored at Pages Beach remobilising alongshore into the Fishing Boat Harbour channel;
- Dredge material requires screening to remove rock fragments prior to trucking material to respective beaches; and
- Access constraints for truck access to Bluff Point and Sunset beach, as no access currently exists.

Environmental and Social Considerations

The marine environments adjacent to Pages Beach are characterised by sand covered limestone pavement supporting low density seagrass communities and shallow reef platforms (AECOM, 2020).

Pages Beach is a well-known public space utilised by tourists and local residents for recreational skiing, swimming, boating, fishing and horse riding activities. Similarly, both Bluff Point and Sunset Beach are areas which are frequently accessed by local residents for recreational purposes.

Environmental and social considerations for these dredge material placement options include:

- Natural coastal processes transport material in a north easterly direction around Fishing Boat Harbour (FBH) reclamation, increasing the risk of sediment encroachment into the FBH navigational channel;
- Public access to pages beach will be restricted during the dredging program;
- Short term dust impacts to nearby FBH due to stockpiling of material, loading and trucking activities from Pages Beach; and
- Noise and traffic impacts expected due to significant truck movements (~11,000 truckloads) through Geraldton Port and residential areas.

Financial

These options were determined to be the highest cost solution, due to the added transport and traffic management costs associated with trucking the material to the northern beaches and the management of the material at Pages Beach.

5.6 SAND REPLENISHMENT – NEARSHORE PLACEMENT

Overview

An alternative option to beach replenishment is to place the dredge sediments within the nearshore littoral zone, shallow waters which are influenced by swell, longshore current and waves. The goal of nearshore placement to replenish and retain sediments within the sediment cell where natural oceanic swells and wind driven waves will continue to move the sediment both northwards and onshore, subsequently dispersing it naturally along the coastline.

PIANC (2009) identified alternatives to traditional methods of managing dredged material including '*In cases where sediment with no or low levels of contamination are involved, an alternative may be to maintain the sediment supply within the local transport system by means of recharge at rates that retain existing structure and function. Such practices have been defined as sustainable relocation or sediment cell maintenance.'*

Site selection

Two potential nearshore placement sites were identified, based on findings provided from the Champion Bay habitat mapping study undertaken in mid 2020 (AECOM, 2020). Figure 10 shows that both sites are located within marine habitat area described as containing sand covered sloping pavement substrate with low density (<50% cover) seagrasses, dominated by *Halophila* and *Amphibolis spp.* This section of the coastline experiences considerable wave and swell conditions, resulting in frequent resuspension of sand material. These natural conditions tend to limit the establishment of long term or high-density seagrass beds (AECOM 2020).

These two sites are shown in Figure 11 and 12 are identified and described as:

- Nearshore placement site A – located between 300m and 1.3 km from the shoreline, within 5-11m of water depth. The area covers approximately 1.7km2, with an average sailing distance from the shipping channel of approximately 5.5kms.
- Nearshore Placement Site B - located between 1km and 1.6km from the shoreline, within 10-11m water depth. The site is smaller than site A, with an area of 0.5km2, but located closer to the channel with an average sailing distance of 3.8km (refer to Figure 11).

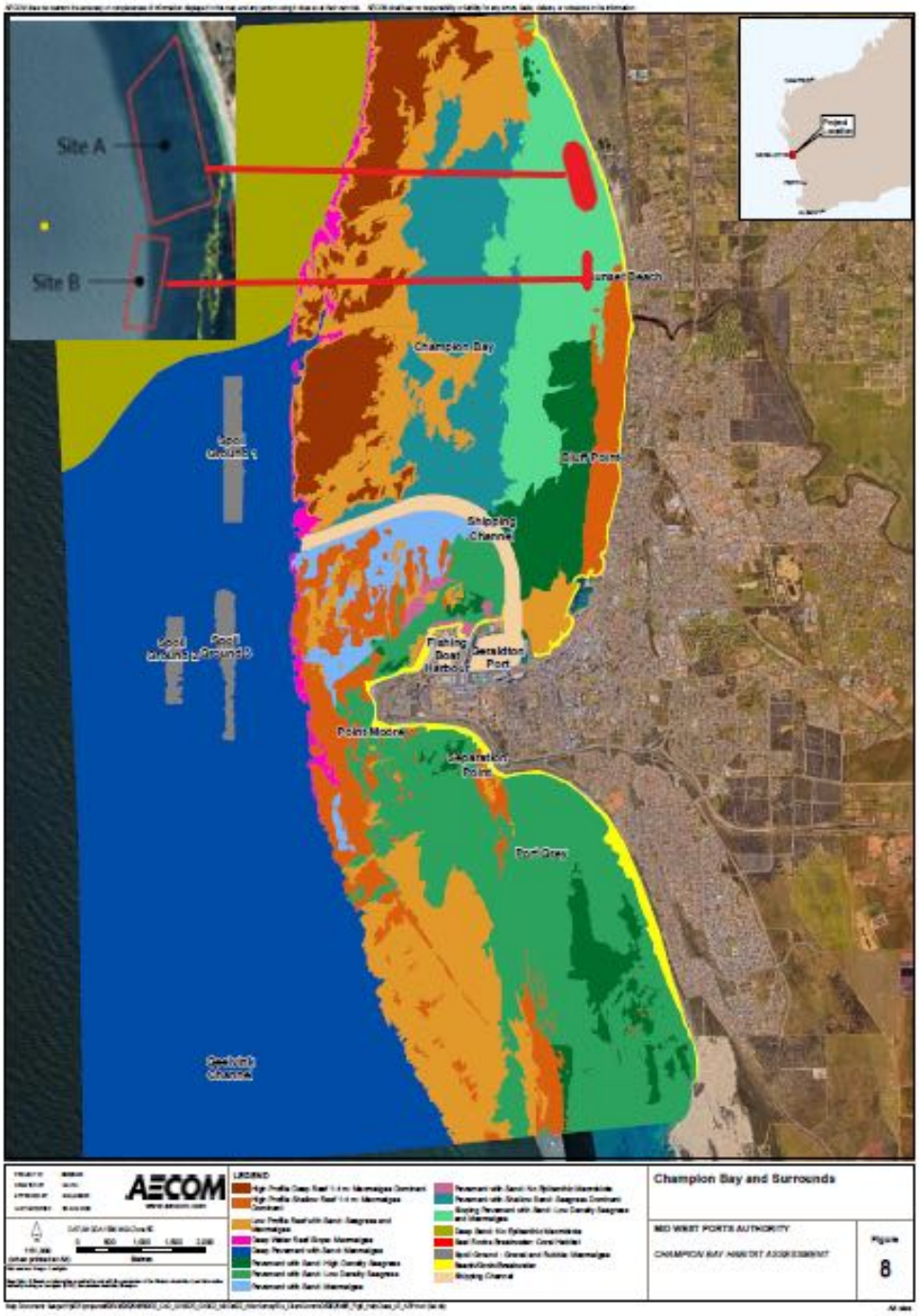


Figure 10 - Nearshore Placement Locations

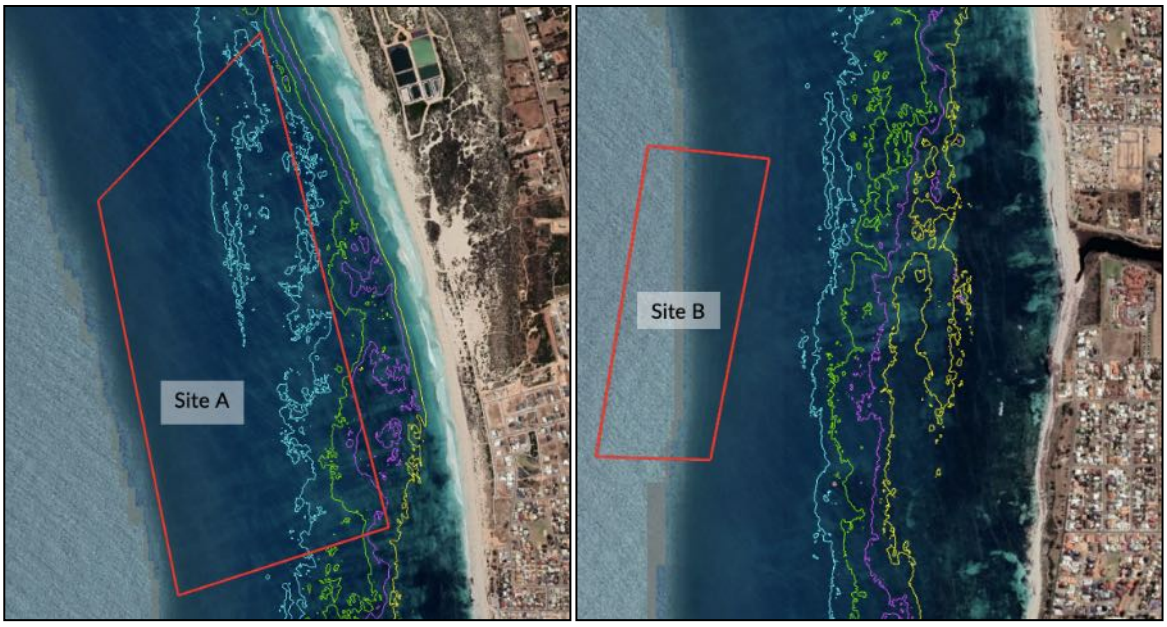


Figure 11. Nearshore Placement Sites

Sediment suitability

Based on sediment analysis of the dredge material (O2Marine, 2019), only the channel sediments are suitable for the nearshore placement of material for sediment cell nourishment purposes. Both sites have sufficient capacity for the entire volume of channel sediments. Both sites contain similar sediment particle sizes and origins to that of the dredged material.

Opportunity

The introduction of dredged material into the Champion Bay sediment cell to maintain and supplement sediment supply in order to sustain the natural processes. The nearshore placement keeps sediments within the natural system and allows natural coastal processes (waves and currents) to continue transporting sediments 'held-up' in the channel northwards and seasonally onshore, thereby nourishing the coastal system.

Operational and Project Execution Considerations

A TSHD will transport the material from the channel to the approved placement site. Access to proposed Site A is limited to a shallow draft dredge, while Site B can accommodate a small- medium sized dredge. Travel time to the nearshore placement areas is estimated at 4-6 hours return depending on which site is approved.

Material will be bottom dumped from the hopper onto the seabed. Bottom dumping of material, is an efficient method to place material on the seabed, reducing discharge time at the placement site. Material will be placed in wide, thin layers (approx. 0.35m above natural surface), parallel to the coast to enhance the prospect of its migration onshore via natural coastal processes.

Environmental and Social Considerations

These sites were chosen as they contained a predominantly sand covered pavement bottom which supports low density seagrass and macroalgae (Figure 10), and is located along a section of coastline which experiences considerable wave and swell conditions, resulting in frequent resuspension of sand material. Benthic communities inhabiting this section of the coastline are likely to be resilient to the natural high frequency wave and swell conditions (AECOM, 2020). These sites are located north of the high-density seagrass communities which inhabit a large portion of the more protected nearshore waters located to the south of Chapman River (Refer Figure 10).

The adjacent shorelines have been identified as a 'coastal erosion hotspot' in WA Dept of Transport's state-wide assessment of the extent and scale of coastal erosion. This assessment identified 55 locations along the WA coastline where coastal erosion is expected to have a significant impact on public and private property or infrastructure over the next 25 years. Further to this, the City of Greater Geraldton Coastal Hazard Assessment and Risk Management and Adaptation Planning Report, identify this portion of the coastline as an area susceptible to coastal erosion risk.

This section of the coastline is a well-known public space utilised by tourists and local residents for recreational surfing, wind surfing, boating, fishing, and recreational beach activities.

Environmental and social considerations for these dredge material placement options include:

- Short term, intermittent and minor reduction in water quality, due to increased turbidity levels and possible reduced light climate at the nearshore material placement area;
- Placement of material is likely to have short term impacts to the nearshore low density seagrass communities. Further studies are being undertaken to confirm the scale of potential impacts to benthic habitats;
- Minor changes to bathymetry, resulting from placement of material;
- Turbid marine waters may have minor, short term impacts to efficiency of commercial fishery programs, which can be largely avoided through project scheduling and the short-term nature of the dredge program; and
- Social impacts are minimal with no restriction on public access to the beach.

Further studies are underway to confirm that this option will in fact deliver beach nourishment outcomes and that impacts to adjacent marine habitats will be minor and acceptable.

Financial

The proposed method of nearshore placement of dredged material provides a substantially lower-cost alternative to expensive sand-mining and direct beach placement and delivers a beneficial use to an area that has been sediment deficient, thereby supplementing existing sand replenishment programs in a cost effective and sustainable manner.

5.6.1 Offshore Disposal

Overview

Dredge material is placed offshore in deep water when no suitable onshore or nearshore beneficial use option is feasible.

Where the selected option comprises only disposal by pumping, rock fragments are likely to accumulate in the hopper of the dredge. These fragments are small enough to be picked up by the drag head, but too large to be remobilised once in the hopper and pumped to the disposal site. This results in a small number of rest loads of rock fragments requiring disposal.

MWPA have three historical dredge material placement sites located in deep water, within 2.5km west of the shipping channel entrance (Refer Figure 12). Two sites are located to the south-west of the channel entrance, with one site located north-west of the channel entrance. Each of these areas cover an average of 0.5km^2. These locations have been used for the placement of capital dredge material from Geraldton Port during the Port Expansion Project completed in 2002 -2003.

5.6.1.1 Site Selection

- Two options were identified for this dredge program, these specifically being:
- Rock Disposal (Option 7) which is limited to the placement of rest loads of rock to an offshore disposal location via bottom dumping; and
- Offshore disposal of sediments to deep water within 2.5 km of the western end of the shipping channel (Option 8), at locations similar to previously used and approved offshore disposal sites.

Figure 12 - Offshore placement options

Sediment suitability

Based on sediment analysis of the dredge material, offshore disposal of sediments could be considered for both the harbour and channel sediments, providing the channels sediments are placed as a capping layer over the finer harbour sediments (O2Marine, 2019).

For option 7, volumes are expected to be very small, nominally 3-4 loads for the full campaign with no volume constraints expected. Similarly, for option 8, it is assumed there are no volume constraints and the full dredge volume could be placed to an offshore disposal site.

Opportunity

Offshore disposal of sediments provides a feasible low cost alternative when a suitable beneficial use for the dredge material cannot be determined.

Operational and Project Execution Considerations

- Once the TSHD hopper has reached capacity, the dredge would steam to the designated offshore material placement location and open its bottom hopper doors to release the dredge material. Travel time to offshore location would be similar to the nearshore placement area (approx. 4-6 hours return).
- Design characteristics for the offshore spoil ground are yet to be defined in detail. Considerations for project execution of this option include:
- Disposal site required to be located in sufficient water depth to allow access by selected dredge and not cause future impacts on navigation;
- Bottom dumping allows for a reduced discharge time; and
- Deep water location allows for the use of a larger dredge and potentially shorter dredging campaign.

Environmental and Social Considerations

Recent Benthic Habitat surveys (AECOM,2020) of these previously used dredge spoil grounds (3 in total) identify these areas as containing similar habitats. The substrate consisted of unconsolidated mixed masses of sand, gravel, pebbles and cobbles with a moderate gradual relief between 1-2m. Spoil ground 3 contained more sand and gravel than spoil ground 1 and 2 which consisted of larger material (i.e. pebbles and cobbles). Macroalgae communities, dominated by large red and brown algae with occasional *Ecklonia spp* were noted. Percentage cover varied between 10-70% cover, with cover greatest in areas with mixed sand and small to medium sized gravel. No corals, filter feeder or seagrass communities were observed at these locations, which is likely due to the unconsolidated material, water depth and strong water movement.

The seabed environment surrounding the historical spoil grounds contains limestone pavement with sand consisting of macroalgae species such as *Ecklonia spp*. and *Sargassum spp.,* along with red and brown algae. The area experiences substantial water movement due to the offshore currents and regular resuspension of sand patches. The natural oceanic conditions and water depth limit substantial seagrass

colonisation. This assessment is consistent with historical studies of this deep water area undertaken prior to the capital dredging project of 2002/03 (URS, 2000).

For Option 7 where only rest loads of rocks and cobbles will be dumped offshore, no significant environmental impacts are anticipated. If Option 8 proceeds, investigations to understand the extent, duration and impacts to sensitive marine receptors will be required. However, based on expert knowledge and the recent Habitat Survey (AECOM, 2020) and historical studies of the offshore spoil area and the surrounding areas (URS, 2000), the following environmental impacts are possible:

- Temporary loss/ reduction of macroalgal habitat due to placement of dredge material on seabed;
- Short term and intermittent reduction in water quality, including the release of nutrients and contaminants within suspended harbour sediments, increased turbidity levels and reduced light climate at the offshore material placement area;
- Minor changes to bathymetry, resulting from placement of material; and
- Minor, temporary impacts to whales and marine mammals, which can be largely avoided through project scheduling and the short-term nature of the dredge program.

Financial

The proposed dredging methods for direct placement of material offshore provide the lowest-cost solution, comparable to placing material within the nearshore disposal sites.

Offshore disposal treats the material as a waste and any opportunity for beneficial use of the material is lost.

6 Comparative Analysis

6.1 MULTI-CRITERIA ANALYSIS (MCA) – PROCESS OVERVIEW

A five-step MCA tool was adopted to facilitate and structure discussion and decision making around the maintenance dredge options. Initially, the proposed evaluation criteria are determined and then collectively reviewed. The review of the evaluation criteria is independent of any consideration of the options that will be evaluated.

Once the basis for evaluation criteria and the measurement criteria for each is agreed a 'forced' ranking comparison of the evaluation criteria is undertaken. This determines the 'weighting' or relative importance as a percentage for each evaluation criteria. The options under consideration are then ranked as a collective exercise on a five point scale (0 = fatal flaw to 5 = excellent) against each evaluation criteria.

Once agreed, the unweighted and weighted scores for each option are established and the option with highest individual score indicates the preferred option. If required, various sensitivity analysis scenarios area applied by varying the weighting factors to consider the impact on the scoring results.

GHD facilitated the MCA workshop with MWPA in Geraldton on 15 December 2020. This workshop included broad representation within the Geraldton and Perth based MWPA resource structures, supported by technical project advisers (GHD, 2020).

Figure 13. MCA Process (GHD, 2020)

6.2 OPTIONS EVALUATION CRITERIA

A total of six evaluation criteria were established for this MCA evaluation. This included criteria across sustainable resource opportunity, approvals and planning, operations, constructability, social and environmental aspects, and financial categories. The evaluation criteria seek to establish areas of differentiation between the options under consideration.

The evaluation criteria developed by MWPA and agreed with workshop participants are provided in Table 3.

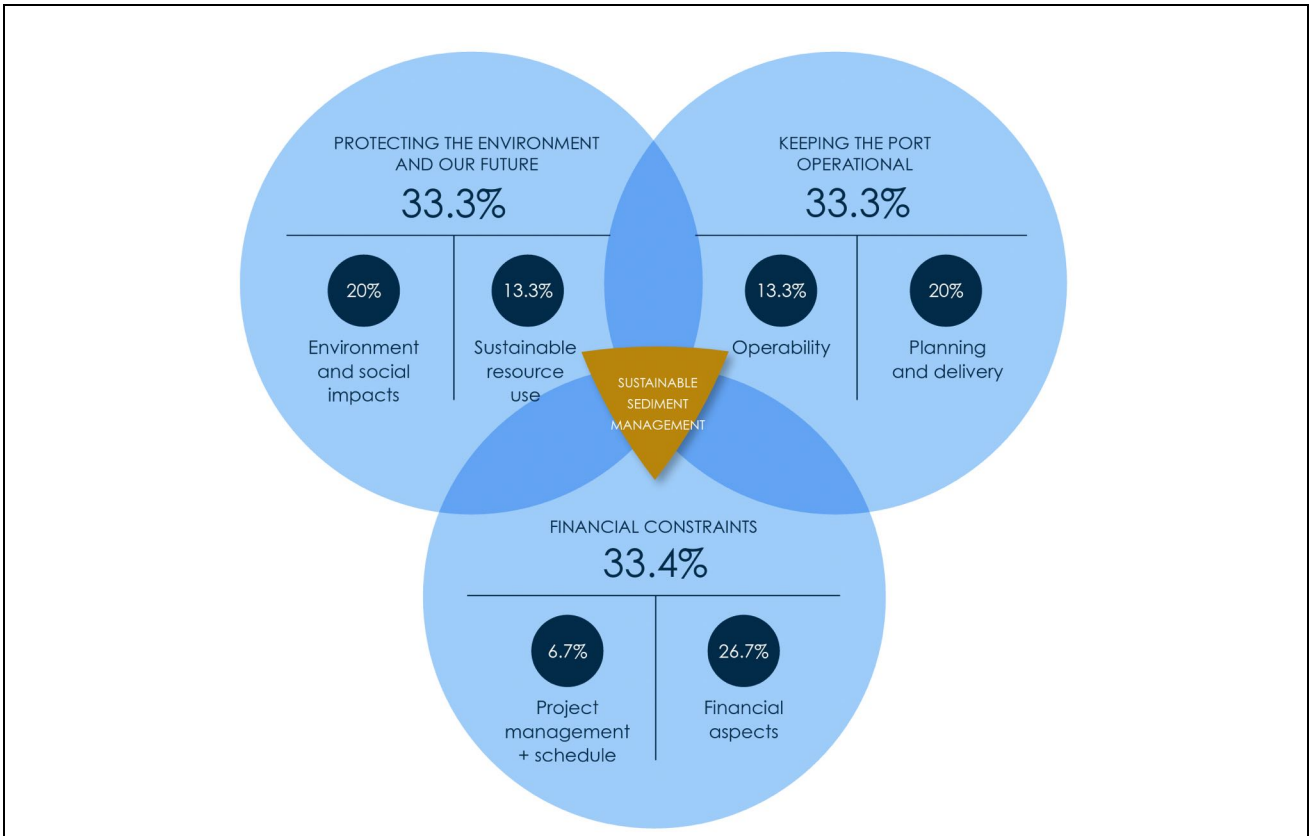
Table 3. MCA Evaluation Criteria (GHD, 2020)

Ref	Category	Criteria	Description (areas of differentiation)
1	Opportunity	Enabling use of resources through sustainable development / waste minimisation	- Alignment with port strategy and PMP / strategic land use intent - Avoids significant loss of future trade opportunities - Contributes to regional economy (e.g. local employment, trade growth, tourism, regional development/ research opportunities) - Protects critical (port + community) assets from future degradation (i.e. reduces coastal erosion/ inundation risks) - Scalable or provides long -term solution for beneficial use of dredge material - Waste minimisation
2	Approvals / Land Use	Planning & Delivery	- Timelines - Complexity of required approvals - Interactions with other existing operations and infrastructure - Development dependencies (linkages to other projects critical for success)
3	Operation	Operability	- Short term / intermittant impacts to navigation - dredge & commercial vessels - Accessibility from land and/ or water - Extent of disruption to port operations - Safety - vessel interactions, dewatering operations, traffic impacts
4	Constructability	Construction fronts/schedule	- Constructability issues - Complexity (including interactions with existing materials handling infrastructure) - Number of construction fronts - Period to construct - Stageability - Impact on existing operations
5	Social / Environmental Aspects	Social impacts and Impacts on the Environment & Public Health	- Amenity and public health (noise, dust, noise, odours) impacts - distance to sensitive receptors - Scale of disturbance to marine habitat, water quality vulnerable/ protected species (e.g. Sea Lions) - Scale of disruption to commercial fisheries - Scale and duration of disturbance to community areas/ activities - Recreational fishing impacts e.g. rock lobster
6	Financial	Financial aspects	- Capex & Opex costs - Scale of investment and return on investment - Costs provide economic value to user - Potential for external investment e,g, investment from CGG, limk to capital dredge program, share mobilisation cost

6.3 EVALUATION CRITERIA WEIGHTING

Based on the discussions at the MCA workshop the evaluation criteria ranking, and weighting set out in Figure 14 was established.

The weighting profile as result of the forced ranking is considered ‘balanced’ with a larger weighting on social / environmental impacts, financial aspects and planning and delivery components. Shorter term aspects such as construction complexity and operation impacts have attracted a lesser weighting proportion. This is considered representative of MWPA’s long-term goal of sustainable sediment management.



Evaluation Criteria

Criteria A

Criteria B	1 Enabling use of resources through sustainable development	2 Planning & Delivery	3 Operability	4 Construction fronts/schedule	5 Social impacts and Impacts on t	6 Financial aspects	Count
1 Enabling use of resources through sustainable development / waste minimisation							0
2 Planning & Delivery	B						1
3 Operability	A	A					0
4 Construction fronts/schedule	B	A	A				1
5 Social impacts and Impacts on the Environment & Public Health	A	B	A	B			2
6 Financial aspects	B	B	B	B	A		4
Count	2	2	2	0	1	0	

Results	Weighting (/100)
Enabling use of resources through sustainable development / waste minimisation	13.30
Planning & Delivery	20.00
Operability	13.30
Construction fronts/schedule	6.70
Social impacts and Impacts on the Environment & Public Health	20.00
Financial aspects	26.70
	100

Figure 14 - Evaluation Criteria Forced Ranking Outcomes (GHD, 2020)

6.4 OPTIONS REVIEW & RANKING

In order to consider a whole of project solution, as many shortlisted options were not able to accommodate the maximum potential dredge volume (~211,000m3), a combination of options was considered for evaluation. The following combined option constraints were identified:

- A combination of Option 1 and Option 2 need to be considered to accommodate as a minimum the full maximum volume of the harbour basin dredge material (~70,000m3), as the only beneficial re-use option for these sediments.
- Options 3, 4, 5 and 6 (which can only accommodate channel sediments) would require a combination with either Option 1/2 hybrid or Option 8 to accommodate both harbour and channel sediments; and
- Option 3 and 4 (pumping only options) would additionally require combination with Option 7 to accommodate the removal of larger rock pieces retained within the dredge hopper.

Based on the above option combinations the following 2-step approach was undertaken for the MCA option ranking:

- Step 1: Compare Options 3, 4, 5 & 8 to establish a preferred option for the channel sediments; and
- Step 2: Compare step 1 preferred option + Option 1/2 hybrid against Option 8 to establish a preferred option for the entire dredge material handling options.

MCA Ranking - Option 3, 4, 5 and 6

Based on the performance of each option (unweighted and weighted MCA comparison) Options 5 and 6 for nearshore placement for sand replenishment scored significantly higher than Options 3 and 4 which involved temporary storage at Pages beach and trucking materials to the northern beaches. Key areas of negative differentiation with regards to Option 3 and 4 are:

- high levels of material double handling due to temporary placement at Pages beach and then rehandling the material to transport it to northern beaches;
- requirement to include Option 7 to allow for rock disposal;
- transport of material via trucks through residential areas;
- difficult and constrained construction requirements;
- increased social (dust, noise) and environmental (sediment back into environment) impacts; and
- highest financial costs.

The relative unweighted and weighted scores for Options 3, 4, 5 and 6 are set out in Figure 15. Option 5 is preferred and considered marginally better than Option 6 due to the location of material placement for

Option 6 being closer to reef systems and high-density seagrass communities, however, this is subject to further detailed impact modelling.

Non Weighted Ranking

Evaluation Criteria	Option 3	Option 4	Option 5	Option 6
Enabling use of resources through sustainable development / waste minimisation	3	5	4	4
Planning & Delivery	3	3	4	4
Operability	2	2	4	4
Construction fronts/schedule	2	2	4	4
Social impacts and Impacts on the Environment & Public Health	1	1	4	3
Financial aspects	1	1	4	4
UNWEIGHTED SUM	12	14	24	23
UNWEIGHTED RANK	4	3	1	2

Weight Score Table

Weighting	Evaluation Criteria	Option 3	Option 4	Option 5	Option 6
13	Enabling use of resources through sustainable development / waste minimisation	39.90	66.50	53.20	53.20
20	Planning & Delivery	60.00	60.00	80.00	80.00
13	Operability	26.60	26.60	53.20	53.20
7	Construction fronts/schedule	13.40	13.40	26.80	26.80
20	Social impacts and Impacts on the Environment & Public Health	20.00	20.00	80.00	60.00
27	Financial aspects	26.70	26.70	106.80	106.80
	UNWEIGHTED SUM	12	14	24	23
	UNWEIGHTED RANK	4	3	1	2
	WEIGHTED SUM	186.60	213.20	400.00	380.00
	WEIGHTED RANK	4	3	1	2

Figure 15 - Comparative Analysis - Channel Sediments

MCA Ranking (Option 5 + Option 1/2) and Option 8

A combination of Option 5 (Nearshore placement of channel sediments at Site A) and Option 1/2 (Placement of sediment into the Berth 7 reclamation) was compared against Option 8 (offshore disposal). Based on the unweighted and weighted MCA comparison, the combination of Option 5 + Option 1/2 marginally exceeds Option 8 (Figure 16).

Option 5 + Option 1/2 provides beneficial use opportunities for MWPA and the local community. It is also anticipated that this option presents a simple environmental approvals pathway, as initial advice from DAWE confirms sea dumping permits are not required for projects which demonstrate a beneficial use of the material. Further studies are being undertaken to confirm the benefits of sediment transport from the placement site. This option does however increase the operational (Berth 7 interface) and construction complexity and will incur a greater cost. However once completed, the land reclamation will provide financial benefit to the Port and the local economy.

Option 8 provides the cheapest and simplest option from a financial, construction and operational impact perspective. However, this option provides no beneficial use of material; will require a sea dumping permit to be obtained from the Commonwealth; and is likely to incur more negative public perception due to the offshore disposal of useable materials suitable for nourishment of eroding beaches.

Non Weighted Ranking

Evaluation Criteria	Option 1/2 (all contam) + Op 5 (prefered)	Option 8 (all contam + all channel)
Enabling use of resources through sustainable development / waste minimisation	5	1
Planning & Delivery	4	1
Operability	3	5
Construction fronts/schedule	2	4
Social impacts and Impacts on the Environment & Public Health	4	4
Financial aspects	3	5
UNWEIGHTED SUM	21	20
UNWEIGHTED RANK	1	2

Weight Score Table

Weighting	Evaluation Criteria	Option 1/2 (all contam) + Op 5 (prefered)	Option 8 (all contam + all channel)
13	Enabling use of resources through sustainable development / waste minimisation	66.50	13.30
20	Planning & Delivery	80.00	20.00
13	Operability	39.90	66.50
7	Construction fronts/schedule	13.40	26.80
20	Social impacts and Impacts on the Environment & Public Health	80.00	80.00
27	Financial aspects	80.10	133.50
	UNWEIGHTED SUM	21	20
	UNWEIGHTED RANK	1	2
	WEIGHTED SUM	359.90	340.10
	WEIGHTED RANK	1	2

Figure 16 - Comparative Analysis - Dredge Material Placement Solution

7 Recommendation

While there are several options which can be considered, there are a discrete number of feasible options which have the potential for beneficial use of dredge material. In line with PIANC (2009) the suitability of and demand for dredge material are critical aspects which need to be assessed.

The analysis of the eight short listed options for reuse or disposal of dredge material identified the following:

- a combination of options needs to be considered as part of the overall solution (i.e. no single option alone is suitable); and
- 100% beneficial use of material can be achieved for the 2021 maintenance dredging project.

7.1 PREFERRED SOLUTION

Based on the detailed comparative analysis, the preferred options providing the greatest net benefit were found to be a combination of the following:

- placement of harbour sediments to the existing Berth 7 reclamation area for the purpose of land creation (Option 1/2); and
- placement of channel sediments into a nearshore placement area for the purpose of retaining sediment within the natural system (Option 5/6).

This combination performed the strongest, ranking high for sustainable resource use, planning and delivery, and environmental/ social impacts. Whilst it ranked lower for finance, construction and operability, due to costs and preparation works required for Berth 7 reclamation area, it enables the MWPA to achieve its goal of 100% beneficial use of the material.

The filling and completion of for Berth 7 reclamation area provides MWPA with a valuable asset to support trade growth and future operations at Geraldton Port.

In line with PIANC (2009) 'Sustainable Relocation' principles nearshore placement has the potential to provide a long-term solution for future use of the channel material which will enable marine sediments to continue their natural migration along the coastline.

Further studies are recommended to confirm expected seasonal migration patterns of the sediment once placed to the nearshore placement sites. In addition, MWPA have initiated further habitat characterisation studies in the vicinity of both material placement sites to confirm that seagrass density is low and provide background information for impact assessment studies. This information should be taken into consideration in the selection and refinement of the optimum nearshore placement area and to confirm the viability of this option.

8 Conclusion

MWPA aims to establish a long-term 'Sustainable Sediment Management Plan' to support the planning and delivery of efficient maintenance dredging. It is envisaged that a similar Beneficial Use Assessment process will be applied prior to each dredge campaign to identify new and possible beneficial uses. The nearshore placement of material as an alternative to offshore placement will remain a key option for consideration based on and informed by the outcomes of the 2021 Maintenance Dredge Program.

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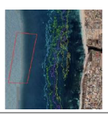
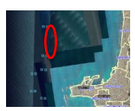
10 Appendix A – Beneficial Use Options Pre-Screening

			Pre-Screening - Suitability/Feasibility		
Beneficial Use Category	**Name**	**Description**	**Harbour Basin Sediments**	**Channel Sediments**	**Comments (Where Option Is Rejected)**
Engineering - Export	Construction / Fill sands (export)	Suitable sand may be exported to oversees or east coast locations dependent on demand. Sand is currently exported from Geraldton Port to Singapore.	Unsuitable due to contaminants. No treatment available.	Unsuitable due salt content and rock fragments. Treatment of washing /screen prevents demand.	Limited by salt content and quality assurance requirements. Cost prohibitive (possible) due to need to screen out unsuitable rocks / cobble material.
Engineering - Other	Spending Beach Batavia Coast Marina	The Batavia Coast Marina is located approx. 1.2km north of the Port. It is understood that the entrance to the marina was originally designed to accommodate a spending beach, a beach that reduces wave reflections in the entrance channel. Suitable material could potentially be used to create this beach.	Unsuitable due to contaminants. No treatment available.	No demand	Not a project currently earmarked by DoT. Engineering concerns over the suitability of the sediment. Sediment is relatively fine and likely to require structures to retain and prevent impacting on navigation. Accessibility and water depth constraints. Relatively small volume capacity.
Engineering - Other	Pages Beach - Temporary Storage	Temporary storage of dredged material at Pages Beach. Material stored above high water line to reduce risking migration of material into Lives Beach. Suitable material could be used in future beach restoration projects or as fill material for future Port reclamations.	Unsuitable due to contaminants. No treatment available.	No demand	No immediate 1-2 year defined use scoped. High volume of sand placed to Pages Beach has potential impacts to environment and human health. A failure of containment would result in fine sediments creating a plume / smothering of nearshore benthic habitats. Long term storage has dust and sand drift impacts to FBH users. There is a high risk of sediments being remobilised and transported to the FBH causing the ended for additional dredging.
Engineering - Reclamation (Existing)	Berth 7 - Pond only	The Pond (Berth 7 reclamation area) is an approved contaminated disposal site. The PMP aims to reclaim this area in the coming 0-5 years. Suitable material could be placed within the reclamation area, providing a usable area of land for Port operations and future Port expansion.	Recommended for inclusion in MCA	Recommended for inclusion in MCA	
Engineering - Reclamation (Existing)	Fishing Boat Harbour Reclamation - raising land profile	Inundation studies indicate that the existing reclamation areas could benefit from being raised and further protected from storm surge and sea level rise. Additional material may be placed as a stockpile for use in future Port expansions.	Unsuitable due to contaminants. No treatment available.	Timing unsuitable and commercial / trade impacts	FBH designated in PMP for aquaculture. Trade may have immediate commitments for the land (commercial opportunities and limited flexibility). Infrastructure impacts due to split level in height reclamation. Timing for use of land does not align with dredge project. Alternatives to use pages Beach sand for reclamation height increases.
Engineering - Reclamation (Existing)	Berth 7 - raising land profile	Inundation studies indicate that the existing reclamation areas could benefit from being raised and further protected from storm surge and sea level rise. Additional material may be placed as a stockpile for use in future Port expansions.	Recommended for inclusion in MCA	Recommended for inclusion in MCA	
Engineering - Reclamation (New)	Port Masterplan Reclamation -Berth 8	The PMP flags Berth 8, including associated reclamation area, for development in the coming 0-5 years. The details of potential reclamation capacity and associated dredging volumes are currently unknown. Suitable material could be placed within the reclamation area, providing a usable area of land for future Port expansion.	No demand & timing unsuitable	No demand & timing unsuitable	Timing for project development and environmental approvals to construct Berth 8 (2-3 years) does not align with timeframes for maintenance dredge project (12-18mths).
Engineering - Reclamation (New)	Port Masterplan Reclamation -Berth 9	The PMP flags Berth 9, including associated reclamation area, for development in the coming 5-10 years. The details of potential reclamation capacity and associated dredging volumes are currently unknown. Suitable material could be placed within the reclamation area, providing a usable area of land for future Port expansion.	No demand & timing unsuitable	No demand & timing unsuitable	Construction of Berth 9 requires the relocation of the Tug Harbour to the northern side of Berth 7 reclamation (as identified in the PMP). Timing for project development and environmental approvals to construct Berth 9 (3-5 years) does not align with timeframes for maintenance dredge project (12-18mths).
Engineering - Reclamation (New)	FBH Potential Reclaim (southern end of South Pens) - PMP 22	Potential reclaim on the southern end of the harbour as per PMP.	No demand & timing unsuitable	No demand & timing unsuitable	Timing for project development and environmental approvals does not align with timeframes for maintenance dredge project (12-18mths).
Engineering - Reclamation (New)	Berth 1/2 Upgrades (Sheet Pile and Backfill)	Berth 1/2 require significant upgrades to facilitate future trade. The desire is to move trade currently on Berth 6 to Berths 1/2. There are two options being considered in PMP. Sheet Pile and backfill B1/2 Or the creation of a Super Berth which is a variation of Berth 8.	No demand & timing unsuitable	No demand & timing unsuitable	Feasibility of sheet piling needs to be confirmed. Scope of works for redevelopment of Berth 1/2 yet to be defined.
Engineering - Reclamation (New)	Super berth (Tug pen reclamation)	To facilitate the creation of a Super Berth or Berth 8/9 the existing Tug pen will be reclaimed. Material could potentially be stockpiled on the existing reclaim area north of the current Tug Pen.	No demand & timing unsuitable	No demand & timing unsuitable	Timing for project development and environmental approvals does not align with timeframes for maintenance dredge project (12-18mths).
Engineering - Reclamation (New)	New Tug Pen	To facilitate the creation of a Super Berth or Berth 8/9 a new Tug pen will be required. PMP nominates an area north of the Berth 7 Reclaim. It is unclear of the design and dredging requirements probably a small amount of fill material is required. This could be stockpiled on the Berth 7 Reclamation area	No demand & timing unsuitable	No demand & timing unsuitable	Timing for project development and environmental approvals does not align with timeframes for maintenance dredge project (12-18mths).

			Pre-Screening - Suitability/Feasibility		
Beneficial Use Category	**Name**	**Description**	**Harbour Basin Sediments**	**Channel Sediments**	**Comments (Where Option Is Rejected)**
Engineering - Reclamation (New)	Reclamation to Support Aquaculture -PMDP 8	Extension of FBH Northern reclaim - see item 8 of the PMP Mud Map. This reclamation will facilitate the expansion of fishing related industries. There is potential to replicate a lined facility (Pond) to facilitate future dredging requirements including capital projects associated with the commercial harbour.	No demand & timing unsuitable	No demand & timing unsuitable	Timing for project development and environmental approvals does not align with timeframes for maintenance dredge project (12-18mths).
Engineering - Reclamation (New)	Pages Beach - Connell Road widening (PMP 19)	PMDP identifies roads as a major pinch point for trade growth. PMP already identified an increase of the width of Connell Road. PMDP options discussion included developing a new road west of Connel Road to develop a separate FBH light vehicle entrance	No demand	No demand	Timing for project development and environmental approvals does not align with timeframes for maintenance dredge project (12-18mths). Could use pages beach as source of fill.
Engineering - Reclamation (New)	Connell Road Widening - North West (Pens) FBH reclamation (PMP 20)	Reclamation of the North west corner of the Fishing Boat Harbour is likely to be a sheet pile structure and in fill. This will facilitate the widening of Connel Road.	No demand	No demand	Timing for project development and environmental approvals does not align with timeframes for maintenance dredge project (12-18mths). Could use pages beach as source of fill.
Engineering - Reclamation (New)	The Southern Transport Corridor protection and coastal road. (PMP 23)	The Southern Transport corridor is at risk of being impacted by coastal erosion. All coastal hazard studies identify the coast line south of the Port as eroding. To protect this corridor the PMP identifies the development of a coastal road and protection structure to ensure the ports supply chain is not compromised and to separate light vehicle and heavy vehicle traffic.	Timing unsuitable	Timing unsuitable	Timing for project development and environmental approvals does not align with timeframes for maintenance dredge project (12-18mths).
Environmental Enhancement - Agricultural	Lime Sands	Lime sands are used by farmers to increase pH levels of soils for agricultural purposes. Mid West Sand Supplies collect approx. 100,000m3/yr sand from South Gate Dunes to the south of Geraldton (MRA, 2017). Suitable material could potentially be used for this purpose.	Unsuitable due to contaminants. No treatment available.	Unsuitable due salt content and rock fragments. Treatment of washing /screen prevents demand	Consultation with Mid West Sand Supplies identified existing abundance of suitable alternative sand sources. Dredging material would not be suitable without washing and screening. Additional handling/ washing/ screening requirements considered to prevent demand.
Environmental Enhancement - Artificial Reef	Environmental Mahomet's Multi Purpose Reef	Mahomet's Multi Purpose Reef (MPR) is a proposed reef to be constructed at Mahomet's or Back Beach approx. 2km south of the Port (coast, 2019). This beneficial use project was identified through discussions with the Mid West Development Commission (Wavelength 2019). The reef aims to provide surfable waves, with flow-on effects to the local economy from increased tourism, as well environmental and coastal protection benefits. Suitable material could be placed within the Reef project.	Unsuitable due to contaminants. No treatment available.	Material Unsuitable	Current design is based on the use of rock. Water depths will preclude a dredge accessing the location to place sand.
Environmental Enhancement - Artificial Reef	Offshore disposal - Geelink Channel	Placement of rock and large rubble material which is unsuitable for onshore disposal and cannot be pumped ashore. This material could add value to the existing offshore artificial reefs located to the north of the channel entrance.	Recommended for inclusion in MCA	Recommended for inclusion in MCA	Only suitable for rest loads of primarily rock.
Environmental Enhancement - Sand Replenishment (Beach)	Beach Placement - Beresford Foreshore	Beresford Foreshore is approx. 3km north of the Port and has a history of erosion. Beresford was identified as a Coastal Erosion Hotspot by Department of Transport (DoT) (DoT, 2019) and flagged as a potential location by CoGG (Wavelength 2019). Suitable material could be used as beach nourishment in this area.	Unsuitable due to contaminants. No treatment available.	Recommended for inclusion in MCA	Sediment sampling by O2Marine (2019) precludes used of harbour sediments due to sediment contamination. Pages Beach material used for beach nourishment - fine material. Rock material within the dredge sediments may cause community concerns.
Environmental Enhancement - Sand Replenishment (Beach)	Beach Placement - Sunset Beach	Sunset Beach is approx. 12km north of the Port and has a history of erosion. Sunset Beach was identified as a Coastal Erosion Hotspot by DoT (2019) and flagged as a potential location by CoGG (Wavelength 2019). Suitable material could be used as beach nourishment in this area.	Unsuitable due to contaminants. No treatment available.	Recommended for inclusion in MCA	Sediment sampling by O2Marine (2019) precludes used of harbour sediments due to sediment contamination. Need to de-water material prior to transport to beach nourishment.
Environmental Enhancement - Sand Replenishment (Beach)	Direct placement by pipeline to Beresford Foreshore or Sunset Beach	To reduce the doublehanding of material. Sediment would be pumped ashore via a pipeline from deep water and placed to the beach to help reduce erosion.	Unsuitable due to contaminants. No treatment available.	Not considered practical. Volume exceeds demand. Cost prohibitive.	Beaches do not have sufficient capacity to receive all sediment without a significant advancement of the shoreline, which is not considered consistent with the CoGG long-term coastal management strategy identified through their recent CHRMAP. Sand would contain rock fragment. There are significant risks and increased cost with the installation and operation of a pipeline across the seabed floor. At Beresford this is not considered practical due to the rocky platform.
Environmental Enhancement - Sand Replenishment (Nearshore)	Nearshore Placement - Option A (Sunset/Glenfield)	Nearshore placement within the depth of closure, with the aim of increasing onshore sediment feed to the coastline to help reduce erosion.	Unsuitable due to contaminants. No treatment available.	Recommended for inclusion in MCA	Sediment sampling by O2Marine (2019) precludes used of harbour sediments due to sediment contamination.
Environmental Enhancement - Sand Replenishment (Nearshore)	Nearshore Placement - Option B (Beresford/Sunset)	Nearshore placement within the depth of closure, with the aim of increasing onshore sediment feed to the coastline to help reduce erosion.	Unsuitable due to contaminants. No treatment available.	Recommended for inclusion in MCA	Sediment sampling by O2Marine (2019) precludes used of harbour sediments due to sediment contamination.
Non-Beneficial Use	Off-shore disposal	Disposal to off-shore spoil ground located in deep water to the north of the channel. Either to existing spoil grounds or to new.	Recommended for inclusion in MCA	Recommended for inclusion in MCA	Suitable for potentially contaminated material. Consider trade off between nearshore placement vs offshore placement of material.

11 Appendix B – Short-listed Options Comparison

										
		Option Description	The Duck Pond (Berth 7 reclamation area) is an approved contaminated disposal site. The Draft Port Master Plan (MWPA, 2019) aims to reclaim this area in the coming 0-5 years. Suitable material could be placed within the reclamation area, providing a usable area of land for Port operations and future Port expansion.	Inundation studies indicate that the existing reclamation areas could benefit from being raised and further protected from storm surge and sea level rise. Additional material may be placed as a stockpile for use in future Port expansions.	Beresford Foreshore is approx. 3km north of the Port and has a history of erosion. Beresford was identified as a Coastal Erosion Hotspot by Department of Transport (DoT) (DoT, 2019) and flagged as a potential location by CoGG (Pers. Comm. Mike Dufour CoGG, 23/9/19). Suitable material could be used as beach nourishment in this area.	Sunset Beach is approx. 12km north of the Port and has a history of erosion. Sunset Beach was identified as a Coastal Erosion Hotspot by DoT (2019) and flagged as a potential location by CoGG (Pers. Comm. Mike Dufour CoGG, 23/9/19). Suitable material could be used as beach nourishment in this area.	Nearshore placement within the depth of closure, with the aim of increasing onshore sediment feed to the coastline to help reduce erosion.	Nearshore placement within the depth of closure, with the aim of increasing onshore sediment feed to the coastline to help reduce erosion.	Placement of rock and large rubble material which is unsuitable for onshore disposal and cannot be pumped ashore. This material could add value to the existing offshore artificial reefs located to the north of the channel entrance.	Disposal to off-shore spoil ground located in deep water to the north of the channel. Either to existing spoil grounds or to new.
Ref	**Criteria**	**Description (areas of differentiation)**	**Option 1 - Filling Berth 7 Reclamation Area (Duck Pond Only)**	**Option 2 - Raising Berth 7 Reclamation Area Land profile to 5m AHD**	**Option 3 - Beach Placement Beresford Foreshore**	**Option 4 - Beach Placement Sunset Beach**	**Option 5 - Nearshore Placement - Sunset Beach (NS Option A)**	**Option 6 - Nearshore Placement - Sunset Beach (NS Option B)**	**Option 7 - Offshore disposal (Previous Spoil Ground)**	**Option 8 - Offshore disposal within 2.5km of western end of shipping channel**
1	Enabling use of resources through sustainable development / waste minimisation	- Alignment with port strategy and PMP / strategic land use intent - Avoids significant loss of future trade opportunities - Contributes to regional economy (e.g. local employment, trade growth, tourism, regional development/ research opportunities) - Protects critical assets from future degradation (i.e. reduces coastal erosion/ inundation risks) - scalable or provides long -term solution for beneficial use of dredge material - Waste minimisation	Enables future port development / land use efficiency of Berth 7 reclamation; Promotes regional economy through local employment, trade growth; Access restrictions to berth during dredging limits short term trade opportunities; Contains contam spoil; Short haul distance; Cannot accommodate total dredge volume (~35,000m3) Not scalable beyond limited dredge volumes - short term option Restricts future disposal of contaminated waste water and materials from port loading/handling operations (lined facility will be filled and capped);	Protects critical port asset and allows land increase in port area; Short term access restrictions to Berth 7 during dredging operations may limit short term trade opportunities; Promotes regional economy through local employment, trade growth; Contains contam spoil; Short haul distance; Cannot contain all dredge spoil (140,000m3); Not scalable beyond limited dredge volumes - short term option;	Contributes to existing beach nourishment program being undertaken at Beresford foreshore; Local employment generated for trucking campaigns; scalable beyond dredge volumes - provides longer term option; Cannot accommodate contaminated spoil;	Contributes to beach nourishment of priority coastal erosion hotspot as identified in report - Assessment of coastal erosion hotspots in WA ; Local employment generated for trucking campaigns; scalable beyond dredge volumes - provides longer term option Cannot accommodate contaminated spoil	Restores the natural coastal sediment processes of Champion Bay; Provides a long term solution for beneficial use of clean channel sediments; Scalable beyond dredge volumes - provides longer term option Cannot accommodate contaminated spoil	Aids to replenish eroding northern beaches of Champion Bay; Provides a long term solution for beneficial use of clean channel sediments; Saleable beyond dredge volumes - provides longer term option; Cannot accommodate contaminated spoil;	Suitable for large rock fragments which were caught in dredge hold during 2012 campaign; Provides a contingency for efficient port operations; Scalable beyond dredge volumes - provides longer term option; Can accommodate contaminated spoil;	No beneficial use - only suitable for sediment where no other suitable option feasible; Provides a contingency for efficient port operations; Scalable beyond dredge volumes - provides longer term option for sediments Risk of valuable material which is suitable for re-use being disposed at sea - lost opportunity; Can accommodate contaminated spoil;
2	Planning & Delivery	- Timelines - complexity of required approvals - Interactions with other existing operations and infrastructure - development dependencies (linkages to other projects critical for success)	Some modification required to Berth 7 in preparations (relocation of bulk waste materials storage area, establish dewatering infrastructure); Require access to part of Karara Lease area; This option only accommodates a portion of total dredge spoil - approvals, timelines, impact to operations are dependant on other options considered;	Some modification required to Berth 7 in preparations (relocation of bulk waste materials storage area, establish dewatering infrastructure); Require access to part of Karara Lease area; Management of return waters into inner harbour; This option only accommodates a portion of total dredge spoil - approvals, timelines, impact to operations are dependant on other options considered;	Dredge spoil material slightly different to Pages beach- clean white sand, but likely to contain cobbles; Pages Beach to be used as dewatering/ staging area - limited public access to portion of pages beach; Impacts to FBH - pipeline and dewatering site - noise, traffic, water quality and access issues; Beach access available for trucks at Beresford; Negative public feedback possible - sand contains cobbles - safety / aesthetic issue; Traffic mgt req - large number of trucks travelling through residential area;	Negotiation with DWER and CoGG - Sunset identified as priority location for beach stabilisation and agreement; Dredge spoil material slightly different to Pages beach- clean white sand, but likely to contain cobbles; Pages Beach to be used as dewatering/ staging area - limited public access to portion of pages beach; Impacts to FBH - pipeline and dewatering site - noise, traffic, water quality and access issues; Negative public feedback possible - sand contains cobbles - safety / aesthetic issue; Traffic mgt req - large number of trucks travelling through residential area; Truck access to Sunset beach is limited - additional road works required;	May require environmental approvals from DWER; Sea dumping permits not required from DAWE if demonstrate its placement of material for a purpose; Increased turbidity during pumped placement Impact on coastal process / equilibrium	May require environmental approvals from DWER (if unable to demonstrate no significant impact); Sea dumping permits not required from DAWE if demonstrate its placement of material for a purpose; Increased turbidity during pumped placement Impact on coastal process / equilibrium	Sea dumping permit required - approx. 4 months for approval;	Sea dumping permit required - approx. 4 months for approval; Duck pond previously approved for contam soils. Sea dumping permit unlikely to be approved for sediments suitable for placement in Berth 7 reclamation;
3	Operability	- Impacts to navigation - accessibility from land and/ or water - extent of disruption to port operations - safety - vessel interactions, dewatering operations, traffic impacts	Floating pipeline connection and discharge point required within the harbour; Disruption to marine operations limited to 2- 4 wks; Minor traffic impacts - machinery and equipment to build containment bunds; Impacts to neighbouring leases - relocation of laydown area; Impacts to Port operations - laydown areas and material stockpiles to be relocated;	Floating pipeline connection and discharge point required within the harbour; Disruption to marine operations limited to 4 -6 wks; Traffic impacts - machinery and equipment required to construct containment bunds and raise liner; Impacts to neighbouring leases - relocation of laydown area; Impacts to Port operations - laydown areas and material stockpiles to be relocated; Requires future extension of rock wall;	Installation of floating pipeline to pump dredge material to Pages beach; Access and traffic impacts to Fishing boat harbour Requires dedicated area to be secured for de-watering and drying of material at Pages Beach; Traffic management issues as large number trucks travelling through residential and public use areas;	Installation of floating pipeline to pump dredge material to Pages beach; Access and traffic impacts to Fishing boat harbour Requires dedicated area to be secured for de-watering and drying of material at Pages Beach; Traffic management issues as large number trucks travelling through residential and public use areas;	Proposed location is suitable for small dredge; distance to location from NE edge of channel is approx. 3.7-5.5km; Longer dredge timeframe likely due to distances required for placement of material - potential to impact Port operations;	Proposed location is suitable for small dredge; distance to location from NE edge of channel is approx. 2.2-3.5km; Longer dredge timeframe likely due to distances required for placement of material - potential to impact Port operations;	Distance to location from dredge area is approx. 1-3.3 km from end of shipping channel; Longer dredge timeframe likely due to distances required for placement of material - potential to impact Port operations;	Distance to location is approx. 2.5km from end of shipping channel; Longer dredge timeframe likely due to distances required for placement of material - potential to impact Port operations;
4	Construction fronts/schedule	- Constructability issues - Complexity (including interactions with existing materials handling infrastructure) - Number of construction fronts - Period to construct - Stageability - Impact on existing operations	Access to Berth 7 required 1 mth prior to dredge program; Construction impacts to neighbouring lease areas (e.g. Karara); Relocation of Berth 7 laydown areas and material stockpiles required; Can be staged to allow settlement and dewatering of dredge material; Capacity limited to unlikely to be insufficient room for all harbour sediments; Limited to the use of a "small" dredge due to small reclamation capacity; Management of return waters required, minor upgrade to pipes & weir box likely; No additional bunds/liner required to be constructed;	Construction impacts to neighbouring lease areas (e.g. Karara); Access to Berth 7 required 6 weeks prior to dredge program; Relocation of Berth 7 laydown areas and material stockpiles required; Capacity sufficient for all harbour sediments plus a capping layer of channel sediments Limited to the use of a "small" dredge due to small reclamation capacity Management of return waters required, upgrade to weir box likely; Requires construction of containment bunds and possible raising of liner; Requires future extension of Berth 7 rock wall;	Insufficient water depth for direct placement by dredge without the installation of a pipeline, assumes temporary storage at Pages Beach and trucking; Requires management of return waters; Risk of sediments remobilising into the Fishing Boat Harbour; Requires screening to remove rock fragments; Operational challenges with rock blockages to pipeline;	Insufficient water depth for direct placement by dredge, requires temporary storage at Pages Beach and trucking; Requires management of return waters; Risk of sediments remobilising into the Fishing Boat Harbour; Requires screening to remove rock fragments; Truck access constraints at Sunset Beach - no existing beach truck access;	Suitable for small dredge; Options for split campaign; Dewatering not required for clean channel sediments; Dredge can access offshore environment (6-10m depth); Acceptable location for cobble material, leaving it in marine environment, allowing sand to migrate via natural processes; Bottom dumping allowing a reduced discharge time; Restricted to a shallow draft dredge;	Suitable for small dredge; Options for split campaign; Dewatering not required for clean channel sediments; Bottom dumping allowing a reduced discharge time; Restricted to a small/medium size dredge;	Bottom dumping allowing a reduced discharge time; Allows the use of a larger dredge;	Bottom dumping allowing a reduced discharge time; Allows the use of a larger dredge;
5	Social impacts and Impacts on the Environment & Public Health	- Amenity and public health (noise, dust, visual, odours) impacts - distance to sensitive receptors - Scale of disturbance to marine habitat, water quality vulnerable/ protected species (e.g. Sea Lions) - Scale of disruption to commercial fisheries - Scale and duration of disturbance to community areas/ activities	Minor dust and visual impacts to vessels and port operations; Management of sediments containing ASS; Management of sediments containing elevated metals; minor, short term disturbances to Sea Lions - berth 7 used as haul out site; short term turbidity and water quality impacts to inner harbour from dewatering activities; Activities confined to Port Area - impact to community negligible Berth 7 lined facility suitable for harbour sediments	Minor dust and visual impacts to vessels and port operations; Management of sediments containing ASS; Management of sediments containing elevated metals; minor, short term disturbances to Sea Lions - Berth 7 used as haul out site; Minimal impacts to commercial fisheries; short term water quality and turbidity impacts to inner harbour and shipping channel;	turbidity and sedimentation issues from de-watering and drying of material; dust and noise impacts from drying of material and trucking campaigns (dewatering location and Beresford residential area); Requires large number of trucks moving through residential areas; If screening of material required - additional dust and noise impacts; Minimal impacts to commercial fisheries; Limited public access to Beresford foreshore during trucking campaigns; Only suitable for clean channel sediments; Beach aesthetic impacts - sediments may contain cobbles and rock fragments, which is different to fine sediments previously used from Pages Beach.	turbidity and sedimentation issues from de-watering and drying of material; dust and noise impacts from drying of material and trucking campaigns (dewatering location and sunset residential area); Large number of trucks interacting with local traffic/ residential area; If screening of material required - additional dust and noise impacts; Minimal impacts to commercial fisheries; Limited public access to Sunset beach during trucking campaigns; Only suitable for channel sediments; Beach aesthetic impacts - sediments may contain cobbles and rock fragments, which is different to fine sediments previously used from Pages Beach.	Water quality impacts - turbidity in shallow waters; Potential smothering of small areas of low density seagrasses; Light impacts to seagrasses from turbidity; Minor changes to seabed due to placement of materials (sand with minor cobbles); Consider timing of placement - impacts to crayfish habitat/migration periods and seagrasses; Natural screening of rock fragments; Only suitable for channel sediments; ASS risk low as material is not exposed to air;	Water quality impacts - turbidity in shallow waters; Potential smothering of small areas of low density seagrasses; Minor changes to seabed due to placement of materials (sand with minor cobbles); Consider timing of placement - impacts to crayfish habitat/migration periods and seagrasses; Natural screening of rock fragments; Only suitable for channel sediments;	water quality impacts - short term turbidity plumes; Commercial fisheries beneficial outcomes (PEP project evidence); Changes to seabed/navigational depths from placement of material; Consider timing of placement - impacts to crayfish habitat/migration periods, seagrasses;	water quality impacts - short term turbidity plumes; Commercial fisheries beneficial outcomes (PEP project evidence) Changes to seabed/navigational depths from placement of material; Consider timing of placement - impacts to crayfish habitat/migration periods, seagrasses;
6	Financial aspects	- Capex & Opex costs - Scale of investment and return on investment - costs provide economic value to user - potential for external investment	Total cost = $6.6 mill (Inc. Mob / demob) or $1.8 mill (exc. mob/demob); Relatively high unit cost ($53/m3); limited to small dredge due to small reclamation capacity; Only accommodates 35,000m3 material; No additional bunds or liners required; Minor upgrades to pipes and weir box likely; Incorporated into long term groundwater monitoring program - leachate monitoring; Increases ports future revenue potential = more land + development space outside inundation zone Requires to be combined with other option to accommodate all spoil volume = more expensive	Total cost = $12.8 mill or $5.6 mill (exc. mob/demob); Relatively high unit cost ($41/m3); Requires additional expenditure to raise sea walls; Limited to small dredge due to small reclamation; Additional liners and upgrades to dewatering infrastructure required; Increases ports future revenue potential = more land + development space outside inundation zone Protects port structures; Requires to be combined with other option to accommodate all spoil volume = more expensive	Total cost = $8.7 mill or $4.4 million (exc. mob/demob); Highest unit placement cost due to added trucking cost ($64/m3); No port land benefit; Impacts on ports current obligation to transfer sand from Pages Beach; Requires to be combined with other option to accommodate all contaminated spoil volume = more expensive	Total cost = $9.2 mill or $4.8 million (exc. mob/demob); Highest unit placement cost due to added trucking cost ($69/m3); No port land benefit; Requires to be combined with other option to accommodate all contaminated spoil volume = more expensive	Total cost = $5.9 mill or $1.8 million (exc. mob/demob); Lowest unit placement cost; Long term monitoring of sediments and seagrasses; Only suitable for channel sediments; Requires to be combined with other option to accommodate contaminated spoil volume = more expensive	Total cost = $5.9 mill or $1.8 million (exc. mob/demob); Lowest unit placement cost; Long term monitoring of sediments and seagrasses; Requires to be combined with other option to accommodate contaminated spoil volume = more expensive	Total cost = $645,000 (assume 4 rest loads); No benefit to land reclaim or coastal protection - sunk cost; accommodates only cobble and rock rest loads; Requires to be combined with other option to accommodate contaminated spoil volume = more expensive	Total cost = $5.9 mill or $1.8 million (exc. mob/demob); Low unit placement costs; Long term monitoring of sediments and seagrasses; No benefit to land reclaim or coastal protection - sunk cost; Single site dredge operation that accommodates both total contaminated and clean dredge spoil volumes = less expensive