Maintenance dredging

2021 MAINTENANCE DREDGING PROJECT, DREDGE ENVIRONMENTAL MANAGEMENT PLAN (DEMP)

Prepared by O2 MARINE

Purpose

The DEMP describes the Maintenance Dredge Program and outlines the environmental protection objectives, management measures and targets for the project.

For each activity, MWPA has identified the potential environmental impact and set management targets and actions. The project's environmental performance is monitored and validated through a detail management and monitoring program. The monitoring program is focused on maintaining water quality and protecting the benthic communities and habitats within Champion Bay.

Importance

- Outlines MWPA environmental performance measures and targets for the successful execution of the dredge program;
- Informs the dredging contractor's management plans and procedures;
- Defines the monitoring methods, frequency, sampling locations and triggers for action;
- Outlines how the GEMMS dredge plume and sediment fate model will be validated; and
- Defines MWPA stakeholder and performance reporting requirements.

MONITOR & MANAGE

- ✓ **Marine fauna observers on board vessel**
- ✓ Aerial surveillance to monitor turbidity
- ✓ **Nearshore placement site hydrographic surveys**
- ✓ Regular monitoring of water quality and light levels
- ✓ **Beach profiles**
- ✓ Seagrass health surveys
- ✓ **Wind, waves, currents**

Outcomes

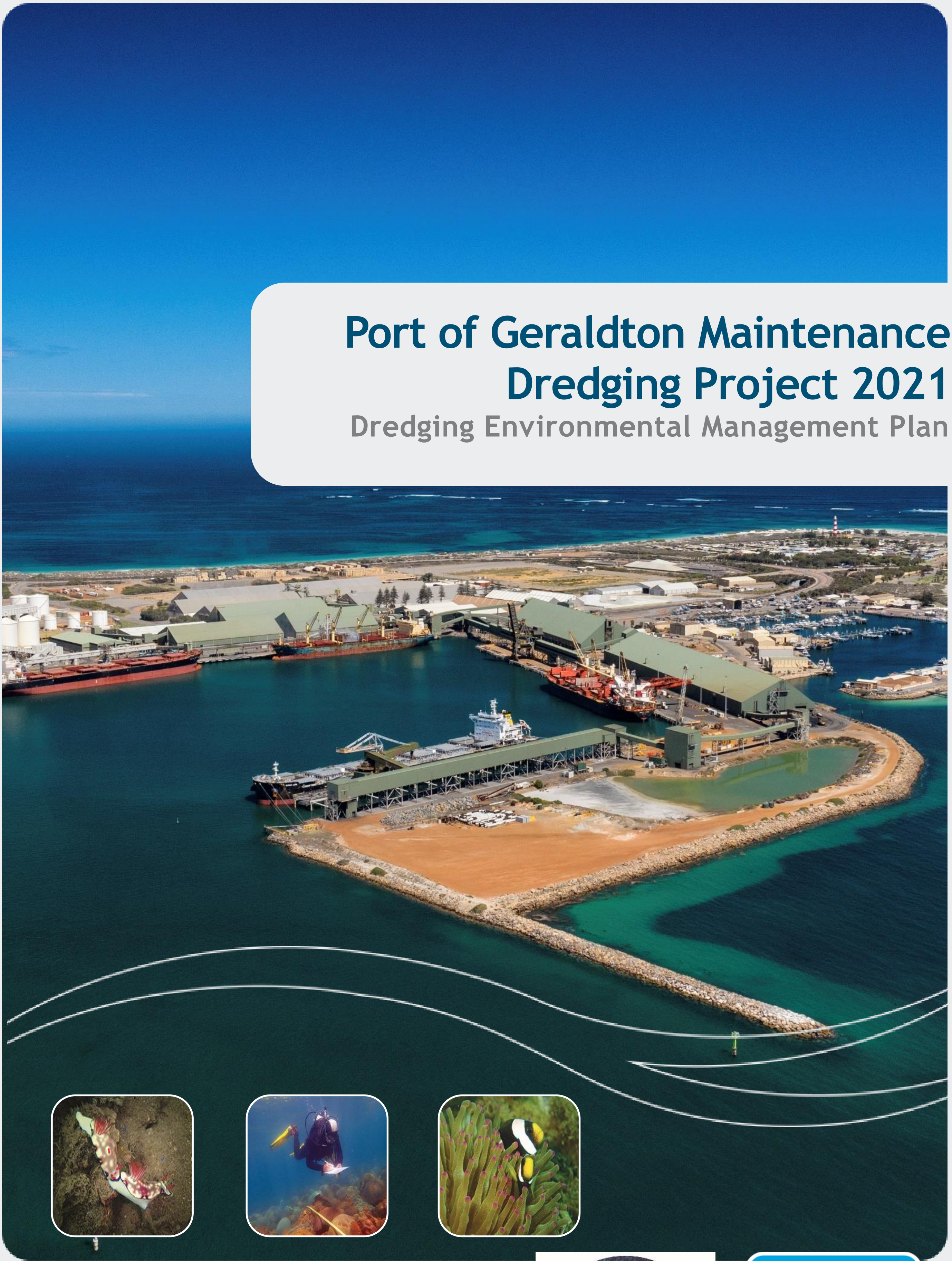
The Dredge Environmental Management Plan is designed to manage the dredge program to protect and maintain the ecological values of Champion Bay.

Public Input

Input from a public two week consultation period held in July 2021, have been incorporated into this plan.

Port of Geraldton Maintenance Dredging Project 2021

Dredging Environmental Management Plan



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Version Register

Version	Status	Author	Reviewer	Change from Previous Version	Authorised for Release (signed and dated)	
Rev A	Draft	R Stevens	G Motherwell			
Rev B	Draft	R Stevens	K Reynolds I Le Provost	Internal review comments addressed	R Stevens	29 June 2021
Rev C	Draft	R Stevens	Public Review	Client review comments incorporated	R Stevens	9 July 2021
Rev 0	Final	R Stevens		Update for contractor's equipment	R Stevens	19 August 2021

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Acronyms and Abbreviations

Acronyms/Abbreviation	Description
ASS	Acid Sulfate Soil
ASSMP	Acid Sulfate Soil Management Plan
BCH	Benthic Communities And Habitat
DEMP	Dredge Management and Monitoring Plan
DMPA	Dredge Material Placement Area
EIA	Environmental Impact Assessment
EPO	Environmental Protection Outcomes
HEPA	High Ecological Protection Area
LEPA	Low Ecological Protection Area
MEPA	Moderate Ecological Protection Area
MFO	Marine Fauna Observer
MT	Management Target
MWPA	Mid West Ports Authority
MWQM	Marine Water Quality Monitoring
MEQMP	Marine Environmental Quality Monitoring Program
NATA	National Association of Testing Authorities
PAR	Photosynthetic Active Radiation
SPL	Species Protection Levels
TRM	Tailwater Return Monitoring
TSHD	Trailer Suction Hopper Dredge
TSS	Total Suspended Solids
ZoHI	Zone of High Impact
ZoI	Zone of Influence
ZoMI	Zone of Moderate Impact

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1. Introduction

1.1. Project Summary

The Mid West Ports Authority (MWPA) is proposing to undertake maintenance dredging within the inner harbour and navigation channel using a trailing suction hopper dredge at the Port of Geraldton, Western Australia. The Project will require dredging of approximately 235,000 m^3 of dredging material with disposal of approximately 45,000 m^3 of inner harbour dredge material into the Northern Reclamation Dredge Material Placement Area (DMPA) and approximately 190,000 m^3 of accumulated sediment in the entrance channel being relocated to a designated Nearshore DMPA.

1.2. Purpose of this Plan

The purpose of this Dredging Environmental Management Plan (DEMP) is to outline the Environmental Protection Outcomes (EPOs) and Management Targets (MTs) associated with the dredging and dredge material disposal to be undertaken for the maintenance dredging project. Detailed management and monitoring actions are included to ensure that the project EPOs are achieved.

1.3. Proponent Details

The proponent for the project is the Midwest Ports Authority (MWPA). Proponent details are provided in **Table 1-1**.

Table 1-1 Proponent Details

Entity Name:	Midwest Ports Authority
Australian Business Number (ABN):	73 384 989 178
Address:	298 Marine Terrace, Geraldton Western Australia 6530
Key Contact (Role):	Damian Tully – A/CEO
Key Contact Email:	mail@midwestports.com.au

1.4. Legislation, Regulation and Guidelines

1.4.1. Commonwealth Environment Protection and Biodiversity Conservation Act 1999

The *Environmental Protection and Biodiversity Conservation Act* (1999) (EPBC Act) establishes a process for the assessment and approval of proposed actions that are likely to have a significant impact on matters of national environmental significance or on Commonwealth land.

1.4.2. Other Commonwealth legislation, regulation and guidelines

Other applicable Commonwealth legislation and guidelines include, but are not limited to, the following Acts, Regulations (and relevant amendments):

- *Protection of the Seas (Prevention of Pollution from Ships) Act* 1983;
- Australian Ballast Water Management Requirements Version 7 2017;
- *Biosecurity Act* 2015;
- *Biosecurity Regulations* (2016); and
- National Water Quality Management Strategy (Commonwealth Government of Australia 1992).

1.4.3. State legislation, regulation and guidelines

The key Western Australian legislation, regulation and guidelines relevant to dredging at the Port of Geraldton include:

- *Biodiversity Conservation Act* 2016;
- *Port Authorities Act* 1999;
- *Navigable Waters Regulations* 1958;
- *Shipping and Pilotage (Port and Harbour) Regulations* 1967
- *Western Australian Marine Act* 1982;
- *Pollution of Waters by Oil and Noxious Substances Act* 1987;
- *Marine and Harbours Act* 1981;
- *Environmental Protection Act* 1986;
- *Environmental Protection Regulations* 1987;
- *Fisheries Resource Management Act* 1994 (the State Act addressing Introduced Marine Pests);
- Western Australia Environmental Protection Authority Technical Guidance - Assessment Guidelines of Marine Dredging Proposals (WA EPA, 2016a);
- Western Australia Environmental Protection Authority Technical Guidance - Protecting the Quality of Western Australia's Marine Environment (WA EPA, 2016b); and
- Western Australia Environmental Protection Authority Technical Guidance – Protection of Benthic Communities and Habitats (WA EPA, 2016c).

1.5. Project Description

Table 1-2 Summary of the Proposal

Project Title	Geraldton Port 2021 Maintenance Dredging Project
Proponent Name	Midwest Ports Authority
Short Description	Conduct maintenance dredging of accumulated sediments within the inner harbour (~45,000m^3) and entrance channel (~190,000m^3). Inner harbour sediments have been identified as mildly contaminated and will be placed into the existing land reclamation area north of Berth 7 with tailwater discharge returning to the north-western corner of the inner harbour. Entrance Channel sediments are considered of natural origins and free from contamination and will be sustainably relocated into the natural system at a designated 530,000 m^2 nearshore DMPA.

Table 1-3 Location and proposed extent of operational elements

Element	Location	Proposed Extent
Maintenance dredging of accumulated inner harbour sediments	**Figure 1-1**	Removal of up to ~45,000 m^3 sediments from an area of 334,869 m^2 via trailing suction hopper dredge.
Landside reclamation at existing Northern Reclamation DMPA	**Figure 1-1**	Placement of up to ~45,000 m^3 of dredge material from the inner harbour via pipeline into an existing land reclamation area of 21,833 m^2 north of Berth 7.
Tailwater return from the Northern Reclamation DMPA	**Figure 1-1**	Managed tailwater return from land reclamation into the north-western corner of the inner harbour into a temporary Low Ecological Protection Area.
Maintenance dredging of accumulated entrance channel sediments	**Figure 1-1**	Removal of up to ~190,000 m^3 sediments from an area of 851,948 m^2 via trailing suction hopper dredge.
Nearshore placement of dredge material from entrance channel at designated Nearshore DMPA	**Figure 1-1**	Placement of up to ~190,000 m^3 of dredge material from the entrance channel directly at a 529,140 m^2 Nearshore DMPA from dredge hopper.

Figure 1-1 Proposed dredging and relocation footprints and associated development envelope

2. Dredging Program

2.1. Schedule

The detailed schedule of works is yet to be confirmed, however it is confirmed that the dredging and material placement activities will be undertaken using a trailer suction hopper dredge (TSHD). Under the current project schedule, activities are planned to commence in early September and be completed by late October – early November. Dredging and material placement from the inner harbour is anticipated be completed within less that month and the entire program within less than two months.

2.2. Proposed Operational Elements

2.2.1. Dredging Equipment

Dredging will be completed by the TSHD Modi R (**Figure 2-1**), the dredge will be equipped with a suction pipe which ends in a drag head (**Figure 2-2**). 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 will be pumped into the dredge's hopper, as the hopper starts to fill excess waters will be overflowed until the hopper reaches capacity. Once the hopper capacity is reached the dredge will sail to the designated DMPA.

The dredge size and specification is slightly smaller than the the previous 2012 maintenance dredging, the TSHD Modi R has the following specification:

- Hopper capacity: 1,393m3
- Length: 67.05m
- Breadth: 12.8m
- Draught loaded: 3.8m

Based on monitoring data collected during the 2012 maintenance dredging it is expected the hopper net capacity will be ~20% (~300m3) prior to overflowing and ~70% (~1,000m3) at full capacity following overflowing. Similarly, based on monitoring data collected during the 2012 maintenance dredging it is expected that an operational efficiency of 85% will be achieved, which allows for operational constrains such as weather and shipping. The average production rate over the duration of the project is expected to be ~200m3/hr.

Figure 2-1 TSHD Modi R

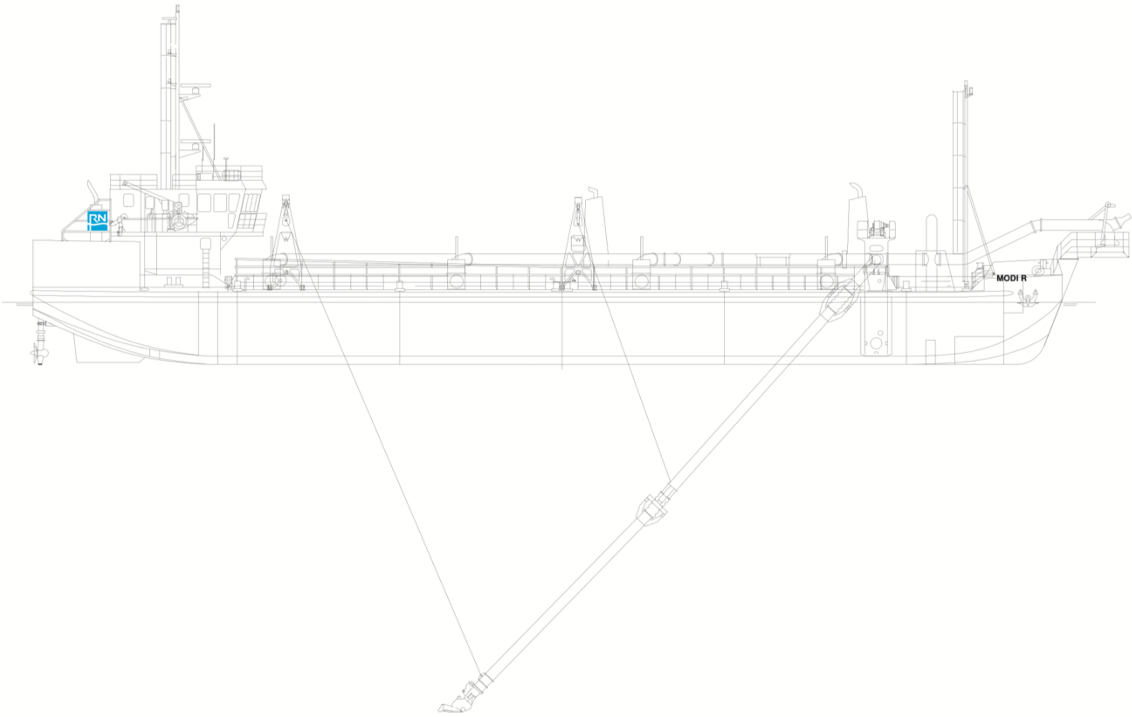

Figure 2-2 **TSHD Modi R**

2.2.2. Inner Harbour Dredging

Sediments totalling ~45,000 m3 will be removed within the Inner Harbour basin and berth shipping pockets as presented in **Figure 2-5**. Dredged sediments from these locations will be transported to the Northern Reclamation DMPA and pumped from the dredge hopper to the DMPA via a pipeline.

Inner Harbour and Channel dredging will be undertaken concurrently. The time available for Inner Harbour dredging will be limited by shipping movements and berth availability. It is expected that on average there will only be one to two hopper loads from within the inner harbour in a 24hr period. This may increase during periods of low shipping. This extended time between loads will allow settlement of sediments within the reclamation and management of return waters.

Sediments from within this dredge area are known to contain contaminants, however O2 Marine (2021a) concluded that these sediments are typically fit for offshore disposal as the bioavailability and elutriate tests identify most contaminants, with the exception of some elutriate zinc and TBTs, at concentrations below the respective assessment guidelines. However, beneficial re-use of these sediments for engineering purposes was determined as a more suitable option therefore they will be relocated from the inner harbour and pumped into the Northern Reclamation DMPA (see below).

2.2.3. Northern Reclamation DMPA

In common with the 2002/2003 capital dredge and 2012 maintenance dredge projects, dredged inner harbour material (described above) will be placed within the existing reclamation area (Northern Reclamation DMPA). The reclamation area was constructed during 2001 and 2002 as part of the MWPA’s (formerly the Geraldton Port Authority) Port Enhancement Project. The reclamation area is double-lined with a layer of geotextile cloth and plastic membrane on the northern, eastern and western sides (**Figure 2-3**). The geotextile was used to ensure the containment of silts, while the plastic membrane was used to reduce the permeability of the bund wall (URS 2001). The southern wall (i.e. harbour side) of the reclamation area was considered impermeable to sediments and was intentionally left unlined so that any water would preferentially flow back toward the harbour (i.e. away from open waters and the intakes of the lobster processing plants).

The location of the dredge hopper discharge pipeline within the Northern DMPA will be varied over the duration of the dredging to allow for the even placement of sediments within the area (**Figure 2-4**). Excess water (‘tailwater’) will return to the northwest corner of the harbour via existing return water outlet pipes located in the south-western corner of the reclamation area (**Figure 1-1** and **Figure 2-4**). A geotextile silt curtain will be installed within the reclamation area prior to the outlet pipes to minimise fine sediment release to the Harbour.

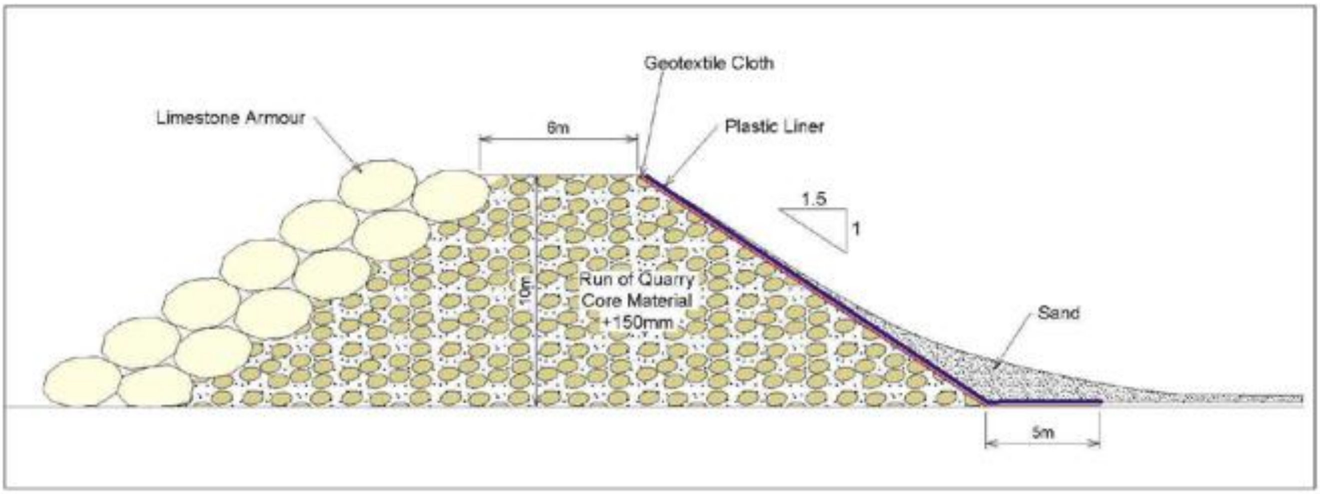

Figure 2-3 Bund wall cross section

To allow for placement capacity within the reclamation and management of the tailwaters, bunds may be built around the edge of the reclamation area to allow the height of the reclamation to be increased. The most recent survey of the reclamation area indicates a capacity of approximately 145,000 m3 remains within this area (**Figure 2-4**). The total dredge material anticipated to be generated by the harbour dredging (~45,000 m^3) will not exceed this capacity.

At the completion of dredging and once dredged sediments have sufficiently consolidated to allow for trafficable access, placed material will be capped with 300mm of clean material (refer to Acid Sulfate Soils Management Plan (ASSMP)).

2.2.4. Entrance Channel Dredging

As with inner harbour dredging, entrance channel sediments will be removed via trailing suction hopper dredge (TSHD) (**Figure 2-1**).

Sediments totalling ~190,000 m^3 will be removed from high spots occurring within the entrance channel as presented in **Figure 2-6**. Dredged sediments from the entrance channel will be transported to the Nearshore DMPA.

Dredging of the channel will occur concurrently with the inner harbour, until the inner harbour dredging is completed. It is assumed that on average three in every four dredge loads will be from the channel, while the inner harbour is being completed then all loads will be from the channel. This will equate to 3-4 loads and then 4-5 loads in a 24-hour period.

Sediments from within this dredge area are characterised as medium to fine grained, yellow to grey sands of natural origins such as coastal silicate sands transported to the entrance channel via localised northern longshore drift, or marine carbonate sediments transported via oceanic currents and swell (O2 Marine 2021a). No contaminants of potential concern were identified for entrance channel sediments, therefore they are considered to be clean. Therefore, beneficial use of these sediments from the entrance channel and harbour entrance via hopper discharge to the Nearshore DMPA is proposed (see below).

2.2.5. Nearshore DMPA

Material dredged from the entrance channel (~190,000m^3) will be relocated within the dredge hopper to the Nearshore DMPA (**Figure 1-1**). The Nearshore DMPA as presented is the largest maximum size allowed for sediment disposal and will be reviewed prior to the activities commencing with the dredging contractor. Once the dredge reaches the Nearshore DMPA the sediments will be released from the hopper by opening doors on the underside of the vessel and allowing the sediments to fall to the ocean floor. Each time the dredge will place material to a different location within the DMPA to allow for the even placement of material across the whole area.

Upon award of contract, MWPA, in consultation with the contractor, will determine an appropriate buffer between the actual DMPA boundary and adjacent benthic communities and habitat (BCH) (typically the high-density seagrass to the east). This will be based upon discussion with the contractor as to their sediment placement methodologies and accuracy to ensure no impacts occur to adjacent BCH.

Hydrographic surveys will be used during the placement to ensure the material is not being deposited in favour of one location rather than being evenly deposited which could result in high spots. A final hydrographic survey will take place, and areas greater than one metre in height from pre-existing levels will be levelled using an underwater drag plough or similar to ensure uniform distribution, and minimum height of material at the Nearshore DMPA. At the completion of the dredging, the placed material is not anticipated to be greater than one metre in height above the natural seabed levels and have an average placement height of ~0.5m.

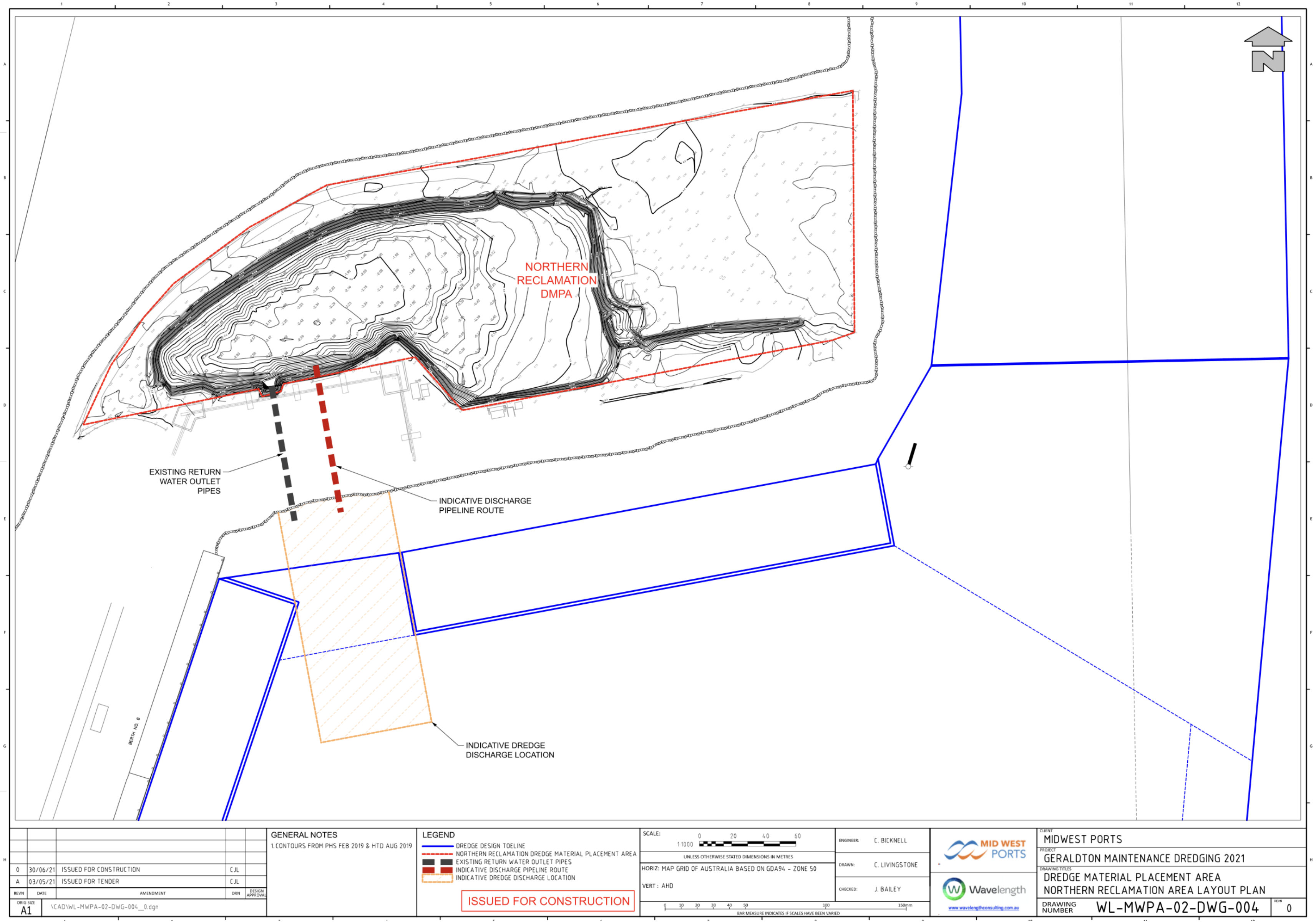

Figure 2-4 August 2019 survey of the existing Northern Reclamation DMPA

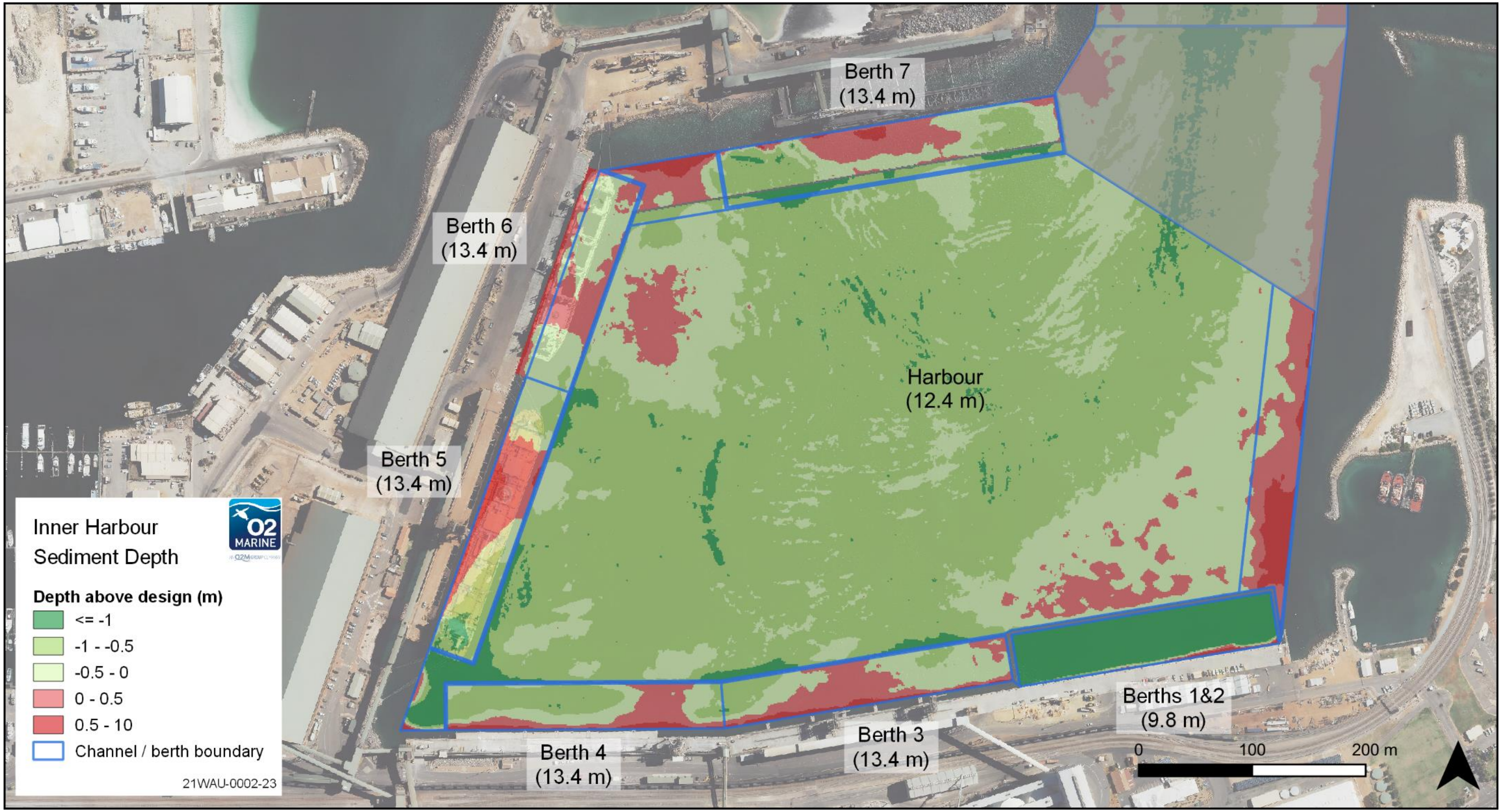

Figure 2-5 Inner Harbour sediment height above design depth

Figure 2-6 Entrance Channel sediments above design depth

2.2.6. Potential Acid Sulfate Soils

The Sediment Quality Assessment (O2 Marine 2021a) identified a small presence of potential Acid Sulfate Soils (ASS) within the proposed dredge areas. However, the natural acid neutralising capacity of the sediments was found to provide sufficient buffering for any acid-generating processes and the material was considered unlikely to require treatment (i.e. lime dosing) during onshore placement within the Northern Reclamation DMPA.

However, to ensure there are no contamination issues arising from soil acidification which then have the potential to mobilise contaminants with tailwater release into the marine environment, an ASSMP has been developed for the project. The ASSMP specifically addresses concerns with onshore placement and identifies monitoring and controls additional to those outlined within this management document.

3. Roles and Responsibilities

The roles and responsibilities for the implementation of the DEMP are summarised in **Table 3-1**.

Table 3-1 Roles and responsibilities of key personnel

Position	Responsibility
Proponent (Mid West Ports Authority)	• Overall responsibility for implementation of this DEMP • Overall responsibility for complying with relevant legislation, standards and guidelines • Ensures dredging activities are conducted in an environment safe for both site personnel and the public • Reports on environmental performance for the project to key stakeholders • Responsible for environmental compliance reporting • Responsible for reporting all environmental non-compliance incidents
Proponent's Representative (Wavelength Consulting)	• Complies with the requirements of this DEMP • Provides advice on dredging and dredge material environmental issues • Oversee implementation of environmental controls, monitoring programs, inspections, audits and management actions in this DEMP • Completes compliance reporting requirements • Responsible for the implementation of the environmental monitoring program and inspections • Prepares environmental monitoring reports • Provides advice with respect to environmental issues as required
Dredging Contractor (RN Dredging)	• Undertakes dredging and placement works • Prepares and implements an environmental management plan in accordance with the requirements of this DEMP • Conducts tailwater return water monitoring in accordance with **Section 6.1.1**. • Implements the management actions of this DEMP • Ensures all staff are adequately trained for their area of responsibility • Ensures all equipment is adequately maintained and correctly operated • Responsible for reporting all environmental incidents to the Proponent within 24 hours in accordance with MWPA incident reporting procedures
All persons involved in the project	• Comply with the requirements of this DEMP • Comply with all legal requirements under the approvals documents and relevant Acts • Exercise a Duty of Care to the environment at all times • Report all environmental incidents

4. Environmental Factors and Objectives

The key environmental factors and objectives to be managed under this DEMP have been derived from the Statement of Environmental Principles, Factors and Objectives (EPA 2016), which outlines objectives aimed at protecting all environments (Themes) including: Sea, Land, Water, Air and People. The project specific Environmental Protection Outcomes (EPOs) and Management Targets (MTs) for each of the key environmental factors (benthic communities and habitats marine environmental quality and coastal processes) and are outlined in **Table 4-1**.

Table 4-1 Key environmental factors, potential environmental impact pathways and management outcomes

Environmental Factor	EPA Objective	Potential Environmental Impact Pathway	Environmental Protection Outcome (EPO)	Management Target (MT)	Management Measures
THEME: SEA					
Benthic Communities and Habitats (BCH)	To protect BCH so that biological diversity and ecological integrity are maintained.	Direct impacts to BCH due to removal within the dredge footprint	No irreversible loss, or serious damage to BCH outside of the dredge footprint and Nearshore DMPA as spatially defined in **Figure 1-1.**	Dredging operations do not occur outside the dredge footprint and nearshore placement does not occur outside the Nearshore DMPA as spatially defined in **Figure 1-1**	**Table 5-1**
		Direct impacts to BCH due to burial within the Nearshore DMPA.			
		Indirect impacts to benthic communities and habitats due to reduction in available light caused by increase in suspended sediments released into the water column during dredging and nearshore placement.	No detectible reduction from the baseline state of benthic communities outside of the dredge footprint and Nearshore DMPA within the Zone of Moderate Impact as spatially defined in **Figure 4-2.**	No detectible reduction from the baseline state of benthic communities within the Zone of Moderate Impact as spatially defined in **Figure 4-2.**	
		Indirect impacts to benthic communities and habitats due to sediment deposition and burial caused by increase in suspended sediments released into the water column during dredging and nearshore placement.			
		Turbidity impacts to BCH arising from return water discharge	A 'Low Level of Ecological Protection' shall be maintained at point of dredge return water discharge as spatially defined in	Marine environmental quality outside the inner harbour during dredging and nearshore placement shall be	

			Figure 4-1 and will return to a 'Moderate Level of Ecological Protection' within one month following cessation of discharge.	maintained as far as practicable to a 'High Level of Ecological Protection' as spatially defined in **Figure 4-1**	
Marine Environmental Quality	To maintain the quality of water, sediment and biota so that environmental values are protected	Disturbance of contaminants in sediments during dredging and return water discharge has the potential to deteriorate water quality and contaminate marine organisms	A 'Low Level of Ecological Protection' shall be maintained at point of dredge return water discharge as spatially defined in **Figure 4-1** and will return to a 'Moderate Level of Ecological Protection' within one month following cessation of discharge.	Marine environmental quality outside the inner harbour during dredging and nearshore placement shall be maintained as far as practicable to a 'High Level of Ecological Protection' as spatially defined in **Figure 4-1**	**Table 5-2**
		Changes to the physico-chemical properties of the water column as a result of dredging and nearshore placement.	A temporary, localised reduction in marine environmental quality during dredging in the immediate vicinity of the dredge footprint and Nearshore DMPA .	Marine environmental quality maintained to a 'Moderate Level of Ecological Protection' inside the harbour and to a 'High Level of Ecological Protection' outside the harbour as spatially defined in **Figure 4-1** during dredging and nearshore placement far as practicable.	
		Hydrocarbon release into the marine environment from a vessel spill and or bunkering operations	Manage vessel bunkering, chemical storage and spill response to ensure no adverse impacts to the marine environment.		
Coastal Processes	To maintain the geophysical processes that shape coastal morphology so that the environmental values of the coast are protected.'	Relocation of sediment within the Point Moore to Glenfield secondary sediment cell impacting natural transport mechanisms.	No residual impact on coastal processes as a result of the Project and Project activities.	Localised minor impacts upon sediment transport and currents immediately surrounding the Nearshore DMPA.	**Table 5-4**
		Sustainable relocation of dredge material resulting in localised alteration of the morphology of the coastal zone potentially resulting in changes to erosion/deposition patterns.		Potential environmental benefits for coastal resilience to coastal erosion of northern beaches.	
		Sustainable relocation of dredge material resulting in localised alteration of the morphology of the coastal zone potentially impacting Chapman River hydrology with secondary impacts to the TEC – Coastal Salt Marshes			

		Alterations to the existing physical characteristics of the designated Nearshore DMPA.			
		Alteration of the structure of adjacent marine communities through placement of material.			

Figure 4-1 Proposed levels of ecological protection for the Port of Geraldton and surrounding water

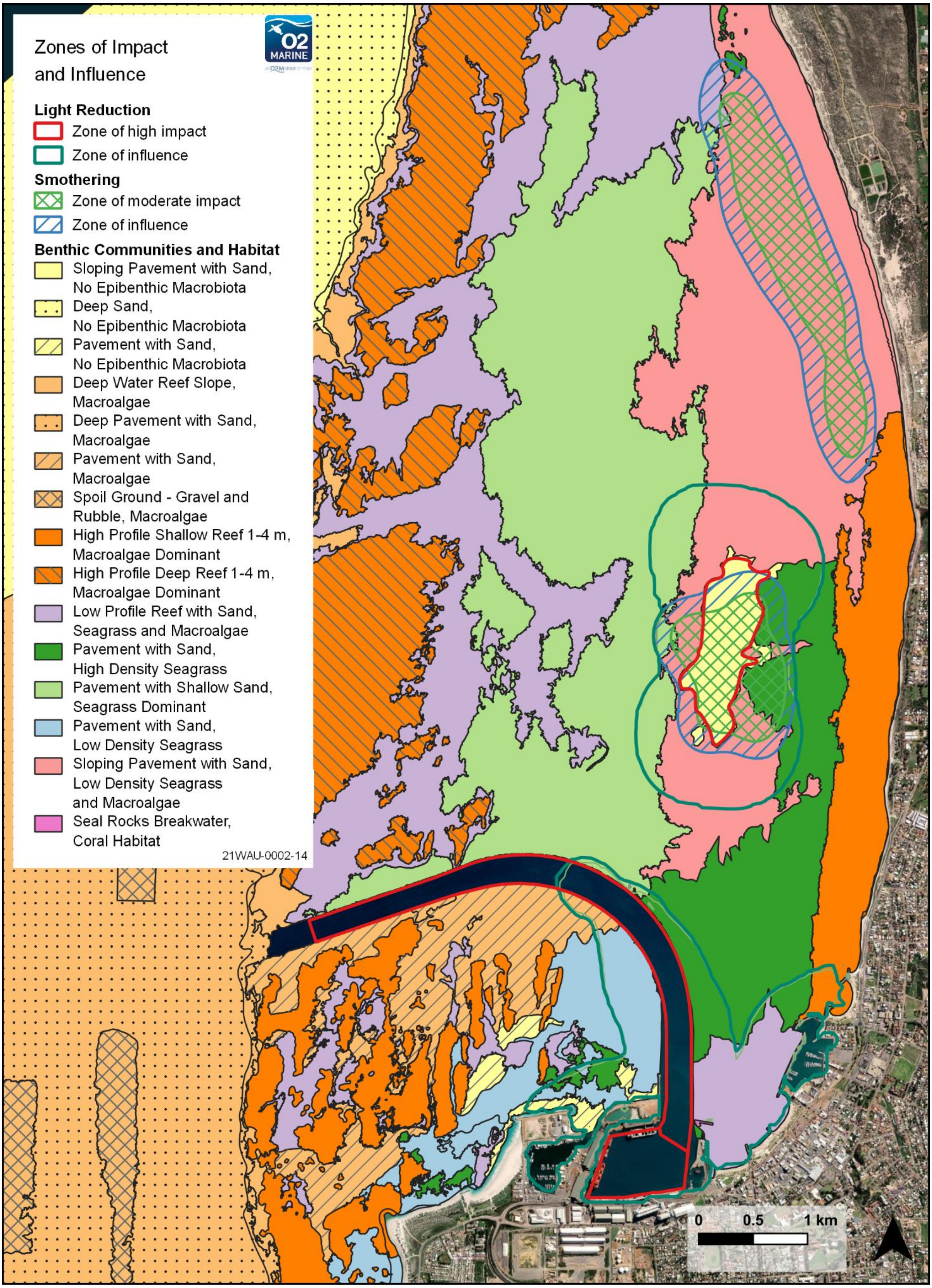

Figure 4-2 Predicted Seagrass impact zones from smothering and light reduction

5. Management

The potential environmental impacts (**Table 4-1**), have been assigned monitoring and management actions to measure compliance against the EPOs[1] and MTs. Management actions have been separated into Tier 1 (which specifically address the three identified key environmental factors, benthic communities and habitat, marine environmental quality, and marine fauna); and Tier 2 (which relate to the overall works and can be managed through standard operational procedures (including introduced marine pests, hydrocarbons and waste).

A description of the existing environment is presented within **Appendix A.** This provides context for the environmental monitoring program detailed below with regards to the identified receptors that occur within the project area. This existing environment also formed the basis of the Project Environmental Impact Assessment (O2 Marine 2021b) which identified potential impacts which this plan aims to manage and monitor to ensure the EPOs and MTs are met during implementation of the Project.

[1] EPOs identified in **Table 4-1** are not presented in the following tables as it is assumed that if the MT is achieved then the corresponding EPO will also be achieved.

5.1. Benthic Communities and Habitat

The (Tier 1) management actions to minimise potential impacts on the environmental factor 'Benthic Communities and Habitat' are presented in **Table 5-1**.

Table 5-1 Management actions to minimise impacts on Benthic Communities and Habitats

<table>
<tr><th>Environmental Factor</th><th colspan="6">Benthic Communities and Habitats</th></tr>
<tr><td>Activity</td><td colspan="6">Dredging and return water discharge</td></tr>
<tr><td>Potential Impacts</td><td colspan="6">• Direct loss of benthic communities and habitats due to dredging activities
• Indirect impacts of benthic communities and habitats due to reduction in available light caused by increase in suspended sediments released into the water column during dredging and discharge of dredge return water
• Turbidity impacts on BCH arising from return water discharge</td></tr>
<tr><th rowspan="2">Management Targets</th><th colspan="2">Management Actions</th><th colspan="4">Environmental Performance</th></tr>
<tr><th>Item</th><th>Actions</th><th>Responsibility</th><th>Reporting/Evidence</th><th>Timing</th><th>Contingency</th></tr>
<tr><td>Marine environmental quality outside the inner harbour during dredging and nearshore placement shall be maintained as far as practicable to a 'High Level of Ecological Protection' as spatially defined in Figure 4-1.</td><td>1.1</td><td>Implement the Marine Environmental Quality Monitoring Program (MEQMP) described in Section 6.1.</td><td>Proponent and Contractor</td><td>• Weekly and final reports</td><td>Tailwater return monitoring:
• Monthly data logging pre-dredge; and
• Daily assessment pH data during tailwater discharge.
Marine Water Quality Monitoring:
• Water sampling every second week for four weeks pre-dredge;
• Weekly water quality sampling during dredging and tailwater release; and
• Weekly water quality sampling for either two weeks post dredging or until trigger achieved.</td><td>Tailwater return monitoring:
• Implement tiered management framework as described in Figure 6-1; and
• Manage water quality to targets presented in Table 6-2.
Marine Environmental quality monitoring:
• Implement tiered management framework as described in Figure 6-3; and
• Manage water quality to targets presented in Table 6-4.

Consider requirement for additional BCH monitoring.</td></tr>
</table>

	1.2	Inspect and maintain discharge pipeline to minimise leakage	Contractor	• Pre-mobilisation equipment checklist • Equipment maintenance schedule/documentation	• Prior to commencement of dredging and daily during dredging	• Cease dredge operations and repair leakage
No detectible reduction from the baseline state of benthic communities within the Zone of Moderate Impact as spatially defined in **Figure 4-2**.	1.3	Implement the BCH Monitoring Program described in **Section 6.2.**	Proponent	• Pre-dredging BCH survey report • Post-dredging BCH survey report	• Pre-dredging survey at least one month prior to commencement of dredging (complete) • Post-dredging survey conducted in same season as pre-dredge survey during 2022	• If dredging and material placement activities have resulted in detectable sublethal impacts on BCH within the ZoMI and ZoI then annual surveys are required to satisfy the triggers presented within **Table 6-7**. • If seagrass has not shown evidence of recovery after 5 years then an investigation is required to determine the severity and extent of impacts and identify any management actions to increase recovery.
Dredging operations do not occur outside the dredge footprint and nearshore placement does not occur outside the Nearshore DMPA as spatially defined in **Figure 1-1.**	1.4	Employ high-resolution positioning system to control dredge operations	Contractor	• Inspection and calibration of vessel positioning system. • Dredge reports submitted throughout works period	• Calibration prior to commencement of dredging • Position reporting daily throughout dredging	• Cessation of dredging and relocation of dredge; and • Servicing and calibration of positioning system

5.2. Marine Environmental Quality

The (Tier 1) management actions proposed to minimise potential impacts on the environmental factor 'Marine Environmental Quality' are described in **Table 5-2**.

Table 5-2 Management actions to minimise impacts on Marine Environmental Quality

Environmental Factor	**Marine Environmental Quality**					
Activity	Dredging and return water discharge					
Potential Impacts	• Disturbance of contaminants in sediments during dredging and return water discharge has the potential to deteriorate water quality and contaminate marine organisms • Changes to the physico-chemical properties of the water column as a result of dredging and return water discharge					
Management Targets	**Management Actions**		**Environmental Performance**			
	Item	**Actions**	**Responsibility**	**Reporting/Evidence**	**Timing**	**Contingency**
Marine environmental quality maintained to a 'Moderate Level of Ecological Protection' inside the harbour and to a 'High Level of Ecological Protection' outside the harbour as spatially defined in **Figure 4-1** during dredging and nearshore placement far as practicable.	2.1	Implement the Marine Environmental Quality Monitoring Program (MEQMP) described in **Section 6.1**.	Proponent and Contractor	• Weekly and final reports	Tailwater return monitoring: • Monthly data logging pre-dredge; and • Daily assessment pH data during tailwater discharge. Marine Water Quality Monitoring: • Water sampling every second week for four weeks pre-dredge; • Weekly water quality sampling during dredging and tailwater release; and • Weekly water quality sampling for either two weeks post dredging or until trigger achieved.	Tailwater return monitoring: • Implement tiered management framework as described in **Figure 6-1**; and • Manage water quality to targets presented in **Table 6-2**. Marine Environmental quality monitoring: • Implement tiered management framework as described in **Figure 6-3**; and • Manage water quality to targets presented in **Table 6-4.** Consider requirement for additional BCH monitoring.
	2.2	Inspections of all dredge equipment and pipelines to check for leaks or damage	Contractor	• Vessel and Site Environment Safety and Health inspection checklist	• Prior to the commencement of dredging • Daily throughout dredging	• Cease works if significant spillage or damage observed • Activate spill response actions (control drainage, clean up) as required; and • Undertake incident investigation and implement recommendations • Continue MWQMP

	2.3	Deploy and maintain silt curtain around tailwater outfall pipes	Contractor	• Daily dredge logs	• Prior to and post tailwater discharge	• Alter deployment location • Alter the deployment method • Alter the silt curtain mesh size • Continue to implement the MEQNP

5.3. Marine Fauna

The (Tier 1) Management actions proposed to minimise potential impacts on the environmental factor 'Marine Fauna' are described in **Table 5-3**.

Table 5-3 Management actions to minimise impacts on marine fauna.

Environmental Factor	**Marine Fauna**					
Activity	Dredging operations					
Potential Impacts	• Injury or death of marine fauna as a result of dredge operations • Injury or death of marine fauna due to vessel movement (strike) • Disturbance to juvenile rock lobster and or whale migration • Water quality impacts on marine fauna					
Management Targets	**Management Actions**		**Environmental Performance**			
	Item	**Actions**	**Responsibility**	**Reporting/Evidence**	**Timing**	**Contingency**
No reported incidences of marine fauna injury or death as a result of water quality impacts.	3.1	Implement the Marine Environmental Quality Monitoring Program (MEQMP) described in **Section 6.1**.	Proponent and Contractor	• Weekly and final reports	Tailwater return monitoring: • Monthly data logging pre-dredge; and • Daily assessment pH data during tailwater discharge. Marine Water Quality Monitoring: • Water sampling every second week for four weeks pre-dredge; • Weekly water quality sampling during dredging and tailwater release; and • Weekly water quality sampling for either two weeks post dredging or until trigger achieved.	Tailwater return monitoring: • Implement tiered management framework as described in **Figure 6-1**; and • Manage water quality to targets presented in **Table 6-2**. Marine Environmental quality monitoring: • Implement tiered management framework as described in **Figure 6-3**; and • Manage water quality to targets presented in **Table 6-4.**
No reported incidences of marine fauna injury	3.2	Implement a soft start procedure prior to commencing operations.	Contractor	• Daily dredge logs.	• Each occasion, prior to activating TSHD head.	• Dredge operations not to commence unless a soft start procedure has been implemented.

or death as a result of dredge operations	3.3	All project vessels are to have at least one crew member trained as a Marine Fauna Observer (MFO) on board at all times.	Contractor	• Training certificate.	• Prior to commencement of dredging.	• Dredge operations not to commence unless at least one crew member is a trained MFO.
	3.4	MFO logs to be complete during all dredge operations.	Contractor	• MFO logs.	• Daily whilst dredge operations are occurring.	• Investigate quality of MFO logs, or why logs were not complete, and ensure adequate staff and resources are in place to fulfil requirement.
	3.5	Dredge operations are to cease if: • Whales are observed within 100 m of the dredge vessel and at risk of collision • Dolphins, sealions or turtles are observed and at risk within 50 m of the dredge vessel.	Contractor	• MFO logs, • Daily dredge logs.	• For the duration of dredging.	• Investigate why dredge operations were not ceased and apply required correction actions.
	3.6	Incident report to be complete if any marine mega fauna (whale, turtle, dolphin, sealion etc) remains are observed within the dredge hopper or placement site.	Contractor	• Site ES&H inspection checklist.	• As required.	• Investigate fauna death and apply required corrective actions and or modifications to dredge operations.
No reported incidences of marine fauna injury or death as a result of vessel strike	3.7	All project vessels are to have at least one crew member trained as a MFO on board at all times.	Contractor	• Training certificate.	• Prior to commencement of dredging.	• Dredge operations not to commence unless at least one crew member is a trained MFO.
	3.8	All construction vessels to operate at a speed under 10 knots at all times during the project.	Contractor	• Vessel GPS monitoring system • MWPA harbour master management and monitoring.	• Continuous throughout vessel operations.	• Investigate why vessel was recorded in excess for the defined speed limit and amend vessel operations and activities as appropriate.

5.4. Coastal Processes

The (Tier 2) Management actions proposed to minimise potential coastal processes impacts from beneficial re-use of clean sediments to maintain northward natural input of sediments into Champion Bay that have been trapped by shipping channel are described in **Table 5-4**.

Table 5-4 Management actions to minimise the risk to Coastal Processes.

Environmental Factor	Coastal Processes					
Activity	Material Placement at Nearshore DMPA					
Potential Impacts	• Localised alteration of the morphology of the coastal zone causing coastal erosion. • Localised alteration of the morphology potentially impacting Chapman River hydrology • Alteration of the structure of adjacent marine communities through placement of material.					
Management Targets	**Management Actions**		**Environmental Performance**			
	Item	**Actions**	**Responsibility**	**Reporting/Evidence**	**Timing**	**Contingency**
Localised minor impacts upon sediment transport and currents immediately surrounding the Nearshore DMPA.	4.1	Placement of material at Nearshore DMPA must be <1 m height above existing seabed compared with pre-dredge hydrographic survey	Contractor	• During and post dredging hydrographic survey	• Daily hydrographic survey during dredging • Final post-dredge hydrographic survey	• Seabed leveling of any high spots
	4.2	Employ high-resolution positioning system to control dredge operations	Contractor	• Calibrate and inspect positioning and vessel monitoring system • Dredge reports submitted throughout works period	• Calibration prior to dredge operations • Reporting daily during dredging	• Cessation of dredging and relocation of dredge; and • Services of positioning system
Potential environmental benefits for coastal resilience to coastal erosion of northern beaches.	4.3	Continuation of coastal beach profiling in accordance with the Northern Beaches Stabilisation Program	Proponent	• Annul beach survey report	• Annually	• To be investigated with City of Greater Geraldton and Department of Transport if impacts are identified

5.5. Introduced Marine Pests

The (Tier 2) Management actions proposed to minimise potential impacts associated with introduced marine pests are described in **Table 5-5**.

Table 5-5 Management actions to minimise the risk of introduced marine pests

Environmental Factor	**Marine Fauna**					
Activity	Vessel mobilisation to site					
Potential Impacts	• Translocation of introduced marine pests to the environment adjacent to the project area					
Management Targets	**Management Actions**		**Environmental Performance**			
	Item	**Actions**	**Responsibility**	**Reporting/Evidence**	**Timing**	**Contingency**
Manage vessel activities to prevent the introduction of introduced marine pests into and within State waters.	4.1	All interstate and overseas vessels that mobilise to the project site are required to complete the Department of Primary Industry and Regional Development (DPIRDs) Vessel Check 2.0 assessment.	Contractor	A copy of the Vessel Check 2.0 report is to be submitted to MWPA for assessment along with any supporting documentation including antifoul certificates and inspection reports.	Prior to dredge entering Western Australian Waters from overseas or interstate.	Vessel not to enter Western Australia without approved Introduced Marine Pest documentation
	4.2	Adhere with MWPA's Marine Pest Management procedure (HSE-PR0-022).	Contractor	A copy of the Vessel Check 2.0 report is to be submitted to MWPA for assessment along with any supporting documentation including antifoul certificates and inspection reports.	Prior to dredge vessels entering Australian waters or mobilising to the Port of Geraldton until all dredging operations have ceased.	Implementation of contingency measures as required by MWPA and Department of Fisheries quarantine requirements.
	4.3	Continue to implement the MWPA marine pest monitoring program	Proponent	Annual report	Biannual	Implementation of contingency measures as required by MWPA and Department of Fisheries quarantine requirements.

5.6. Hydrocarbon Management

The (Tier 2) Management actions proposed to minimise potential impacts associated with hydrocarbon pollution are described in **Table 5-6**.

Table 5-6 Management actions to minimise the risk of hydrocarbon pollution

Environmental Factor	**Marine Environmental Quality**					
Activity	Dredging operations					
Potential Impacts	• Hydrocarbon release into the marine environment from a vessel spill and or bunkering operations					
Management Targets	**Management Actions**		**Environmental Performance**			
	Item	**Actions**	**Responsibility**	**Reporting/Evidence**	**Timing**	**Contingency**
Manage vessel bunkering, chemical storage and spill response to ensure no adverse impacts to the marine environment.	5.1	Implement the Marine Water Quality Monitoring component of Marine Environmental Quality Monitoring Program (MEQMP) described in **Section 6.1**.	Proponent and Contractor	Weekly and final reports	Marine Water Quality Monitoring: • Weekly water quality sampling during dredging and tailwater release; and Weekly water quality sampling for either two weeks post dredging or until trigger achieved.	Marine Environmental quality monitoring: • Implement tiered management framework as described in **Figure 6-3**; and • Manage water quality to targets presented in **Table 6-4.**

	5.2	Comply with MWPA's vessel bunkering procedure and permit system during operations	Contractor	Vessel management procedures The proponent is to be notified immediately in the event of a hydrocarbon spill of any volume to water	Prior to commencement of dredging	Dredge operations not to commence prior to development and approval of vessel management procedures. Investigate spill event and review management actions and responses
	5.3	Document vessel bunkering management, including appropriately licensed bunkering facilities	Contractor	Vessel management procedures	Prior to commencement of dredging	Dredge operations not to commence prior to development and proponent approval of vessel bunkering management procedure
	5.4	Undertake vessel maintenance and bunkering in accordance with dredging contractors approved vessel bunkering management systems/plans/procedures	Contractor	Vessel management procedures	For the duration of dredging	Vessel bunkering management systems to be reviewed and refined (if required) in the event of an identified procedural breach or hydrocarbon spill
	5.5	Implement industry standard hydrocarbon management practices (chemical handling, storage, segregation and spill response)	Contractor	Vessel management procedures The proponent is to be notified immediately in the event of a hydrocarbon spill of any volume to water	Prior to commencement of dredging	Dredge operations not to commence prior to development and approval of all required operational procedures. Investigate spill event and review management actions and responses
	5.6	Undertake an environmental inspection of dredging vessel	Contractor	Vessel management procedures	Prior to the commencement of dredging	Dredge operations not to commence prior to development and approval of environmental inspection checklist

5.7. Waste Management

The (Tier 2) Management actions proposed to minimise potential impacts that waste management may have on the environment are listed in **Table 5-7**.

Table 5-7 Management actions to manage waste

Environmental Factor	Marine Environmental Quality					
Activity	Incorrect or accidental disposal of liquid or solid waste from a vessel					
Potential Impacts	• Impacts on the marine environmental quality (both sediment and water) due presence of foreign materials • Decrease in viability of flora and fauna at species and population levels due to excess waste in water column					
Management Targets	**Management Actions**		**Environmental Performance**			
	Item	**Actions**	**Responsibility**	**Reporting/Evidence**	**Timing**	**Contingency**
Manage disposal systems in compliance with requirements for MWPA and in accordance with MARPOL 73/78 Convention Annex IV (sewage) and Annex V (garbage).	6.1	Dredging contractor to establish a sewage and garbage disposal plan in accordance with MWPA and MARPOL 73/78	Contractor	Within 12 hours of a reportable incidence	Duration of dredging operations	Contingency measures as required by MWPA
Manage the correct onshore disposal and	6.2	Biosecurity Controlled Wastes (e.g. Garbage) from international commercial vessels must be managed in	Contractor	Consent from appropriate avenues needs to be obtain	Duration of	Contingency measures as required by MWPA

reporting systems		accordance with the Australian *Biosecurity Regulation* 2016 and MWPA procedures.		before correct disposal of waste	dredging operations	
	6.3	Only a licenced Controlled Waste Carrier to be used for any controlled waste discharged ashore	Contractor	Controlled waste tracking forms to be completed as soon as possible	Duration of dredging operations	Contingency measures as required by MWPA
	6.4	All forms of waste need to be stored in appropriately labelled drums or tanks and be correctly disposed of and not discharged to the environment	Contractor	Approval certification and tracking forms to be completed as soon as possible	Duration of dredging operations	Contingency measures as required by MWPA
	6.5	Reporting of any type of spillage within the marine environment directly to the MWPA Harbour Master	Contractor	Within 12 hours of reportable	During the duration of dredging operations	Contingency measures as required by MWPA

6. Monitoring

To ensure that proposed management requirements outlined in **Section 5** are adequate to minimise and reduce the potential environmental impacts, MWPA have designed a comprehensive marine environmental monitoring program. The monitoring is broken down into three discrete programs as presented in

1. Marine Environmental Quality Monitoring Program;
2. Benthic Communities and Habitat Monitoring Program; and
3. Model Validation Monitoring Program.

A summary and overview of the three programs is presented in **Table 6-1** and a detailed description of each in the following sections.

Table 6-1 Monitoring Program Overview

Element	Management Target	Frequency	Duration	Parameters	Methods	Sample Locations	Trigger for management action
Marine Environmental Quality Monitoring Program							
Tailwater Return Monitoring	During dredging and nearshore placement marine environmental quality is maintained to a 'Moderate Level of Ecological Protection' inside the harbour and to a 'High Level of Ecological Protection' outside the harbour as spatially defined in **Figure 4-1**.	Daily water column profiles	For entire duration of inner harbour dredging and tailwater discharge activities	pH Dissolved Oxygen.	Handheld water quality meter	WQD1 at LEPA/MEPA boundary (**Figure 6-2**)	Refer **Table 6-2**
Water Quality Monitoring		Pre-dredge – every second week. During Harbour dredging – weekly. Post harbour dredging – weekly until target achieved.	Water sampling will commence four weeks prior to dredging and continue post dredging until target is achieved.	Water sample analysis: i. Dissolved metals to include Al, As, Cd, Cr, Cu, Pb, Mn, Ni, Zn, Hg ii. Sulphate ii. Chloride v. Nutrients (Total N, TKN, NH3, NOx-N) v. TRH vi. TBT Water column profiles: i. pH ii. DO ii. NTU v. Temp v. Conductivity	Water sampling through water column Physicochemical profiling with handheld water quality meter	WQD1, WQ2, WQL3 & WQ4 (**Figure 6-2**)	Refer **Table 6-4**

Element	Management Target	Frequency	Duration	Parameters	Methods	Sample Locations	Trigger for management action
		Hourly in-situ measurements	Commencement one month prior to tailwater release. Completion one month post tailwater discharge (weir box closure).	pH Dissolved Oxygen.	In-situ data logger	WQD1 at LEPA/MEPA boundary (**Figure 6-2**)	Refer **Table 6-4**
Benthic Communities and Habitat Monitoring Program							
Seagrass Monitoring	No detectible reduction from the baseline state of benthic communities within the Zone of Moderate Impact as spatially defined in **Figure 4-2.**	Annually	Pre-dredge survey – Completed Jan/Feb 2021 Post-Dredge Survey planned Jan/Mar 2022	Seagrass health metrics i. Seagrass shoot density and height ii. Species composition ii. Presence of epiphyte and epifauna v. Habitat type v. Percent coverage	Diver based surveys in accordance with BMT (2021a)	12 locations within Champion Bay (**Figure 6-4**)	Refer **Table 6-7.**
BCH Monitoring			Pre-dredge survey – Planned August 2021 Post-Dredge Survey planned Jan-Mar 2022	i. Percent coverage ii. Species composition ii. Habitat type v. Habitat extent	Drop down camera survey in accordance with BMT (2021b) combined with side scan sonar of study area.	36 drop camera locations and side scan sonar survey area as presented in **Figure 6-4** and **Figure 6-5**	
Model Validation Program							

Element	Management Target	Frequency	Duration	Parameters	Methods	Sample Locations	Trigger for management action
TSS	To validate predicted dredge plume TSS from hydrodynamic modelling.	TSS – collected in accordance with MWQ program	Commencement – immediately prior to dredging Completion – immediately post dredging	TSS	Water sample collection for TSS	TSS Random – two locations at dredging operation area Fixed – MWQMMP locations	Refer **Table 6-7**
Sediment transport	To validate volume loss as predicted by sediment transport modelling	Six monthly surveys	2 years post dredging	Hydrographic multibeam bathymetry data	Multibeam bathymetry survey	Nearshore DMPA footprint	Refer **Table 6-8**
Aerial Dredge Plume Monitoring	The visible dredge plume remains within the predicted ZoI	Fortnightly	Throughout Dredging program	Aerial photo and video	Drone or chartered flight	Set flight path Target dredge vessel activity and visible plume locations	Excessive dredge plumes observed

6.1. Marine Environmental Quality Monitoring Program (MEQMP)

6.1.1. Tailwater Return Monitoring (TRM)

Rationale

Monitoring of the return water will be undertaken to ensure that the EPOs and MTs for protection of marine environmental quality are achieved and potential acidification in the Northern Reclamation DMPA is managed. The monitoring approach is based on daily monitoring of the return water quality. The EPOs, MTs and associated trigger levels were adopted assuming the potential for a temporary, localised reduction in marine environmental quality in the immediate vicinity of the return water discharge. This is spatially presented as the Low Ecological Protection Area (LEPA) in **Figure 4-1**. Management actions have also been developed for the management of potential acidification in the Northern Reclamation DMPA (Refer to the ASSMP).

Monitoring Locations & Frequency

Return water will be monitored at site WQD1 located on the LEPA/MEPA boundary daily (**Table 6-3** and **Figure 6-2**). Return water shall be discharged directly to the north-eastern corner of the inner harbour. Sampling will commence immediately as dredge material is placed onshore and will continue until no further return water is discharged to the marine environment.

Combined with daily monitoring, physicochemical profiles are included as part of the weekly water sampling program at four locations as well as continuous data logging on the LEPA/MEPA boundary for the duration of the water sampling program (**Section 6.1.2**).

Environmental Protection Outcomes, Management Targets and Trigger Levels

The EPOs, MTs and trigger levels to be applied for protection of marine environmental quality are presented in **Table 5-2**. A tiered management approach has been developed based on monitoring and reporting against these trigger levels to ensure EPOs and MTs for protection of marine environmental quality (**Figure 6-1**). Weekly reports and a final report shall be prepared to document the return water quality monitoring program as described in **Table 7-1**.

Table 6-2 Impact management targets for tailwater return water monitoring.

Monitoring Location: WQD1 on LEPA/MEPA Boundary (Figure 6-2)	
Early warning: High Level of Ecological Protection	**Trigger Level 1 – Instantaneous**
	pH: >80th or <20th percentile of baseline marine water quality data OR Dissolved Oxygen = <70% Saturation
Management Target: Moderate Level of Ecological Protection	**Trigger Level 2 – Instantaneous**
	Physico-chemical pH: >95th or <5th percentile of baseline marine water quality data OR Dissolved Oxygen = <60% Saturation
Management Target: Moderate Level of Ecological Protection	**Trigger Level 3 – two consecutive sample events**
	Physico-chemical pH: >95th or <5th percentile of baseline marine water quality data OR Dissolved Oxygen = <60% Saturation

Note: Trigger is exceeded if any one of the factors are exceeded

Parameters and Procedures

pH and DO will be collected daily at site WQD1 using a handheld multiparameter sonde. Measurements are required to be undertaken at two separate locations within 10 m of the provided site coordinate for WQD1 at the following measurement levels:

> 0.5 m below surface
> 5 m below surface and
> 8 m below surface.

An average value is to be calculated from the six measurements for comparison against the established trigger levels.

The sonde is required to be calibrated and serviced in accordance with the manufacturer's standards throughout the duration of the project to ensure data collected are accurate.

Corrective Actions

Tailwater return water monitoring data shall be reviewed daily against the Trigger Levels (**Table 5-2**). If Trigger Level 1 is exceeded the proponent shall be notified and monitoring shall continue. If Trigger Level 1 or 2 are exceeded the dredge program will be reviewed and may be modified if appropriate. In addition, the following modifications to the return water may also be considered:

- Cease discharge from the onshore management area to either stop release of water or reduce the proportion of fine sediments released;
- Modify the dredge plan to relocate dredge to another site to reduce frequency of inner harbour dredging; and/or

> Other tailwater response management as directed within the ASSMP.

Management of return water from Northern Reclamation DMPA shall continue until the Trigger Levels are no longer exceeded.

Discharge from Northern Reclamation DMPA will cease immediately if the Trigger Level 3 is exceeded for two consecutive days (‘continued exceedance’). In this instance direction for tailwater and reclaim sediment acidity management will be completed in accordance with the ASSMP. Recommencing tailwater discharge will occur only when actions under the ASSMP are completed and return water is of suitable quality for discharge.

In addition, detailed investigations on the likely causes of the exceedance and the recommended changes to the dredge program or Northern Reclamation DMPA is required within 7 days of any Trigger Level 3 exceedance. Results from Marine Water Quality Monitoring should be reviewed in light of the investigation.

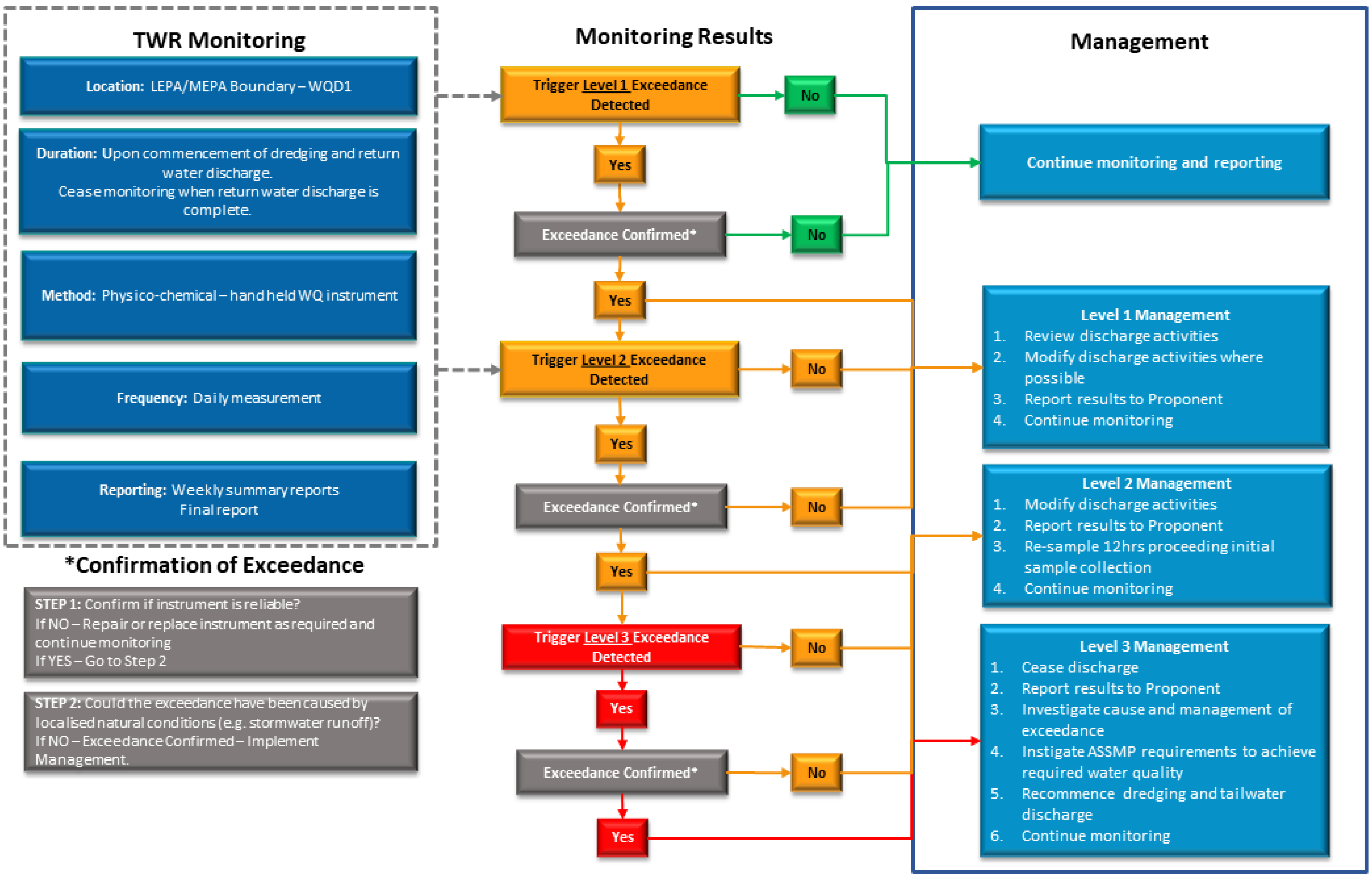

Figure 6-1 Tiered management response for tailwater return monitoring.

6.1.2. Marine Water Quality Monitoring (MWQM)

Rationale

MWQM has been included to validate the impact assessment and sediment characterisation conclusions that the removal and land reclamation of harbour sediments have a low potential for risk to marine environmental quality. Samples are required to be freighted to Perth and require laboratory analysis, therefore, a delay of up to five days is required for laboratory reporting of contaminant concentrations. Therefore, the key reactive aspect for marine environmental quality is provided within the TRM as the low risk of ASS, which has the potential to digest contaminants from sediments and mobile them into the marine environment.

Monitoring of the marine water quality will be undertaken to ensure that the EPOs and MTs for protection of marine environmental quality are achieved and the potential for contaminants to be released from dredge sediments or return water are adequately assessed. The monitoring approach is based on weekly monitoring of marine water quality at the LEPA/MEPA and MEPA/HEPA boundaries and within the HEPA as spatially defined in **Figure 4-1**. The EPOs, MTs and associated management actions were adopted assuming the potential for a temporary, localised reduction in marine environmental quality in the immediate vicinity of the return water discharge. This is spatially presented as the LEPA in **Figure 4-1**. As there are no contamination concerns related to the dredging of channel sediments, this water quality program is specific only to inner harbour dredging.

Results from MWQM will be used to validate the TRM reactive management program, whilst also introducing a second layer of management based upon the triggers presented within **Table 6-4**.

Monitoring Locations & Frequency

Marine water quality will be monitored at four locations as presented within **Table 6-3** and **Figure 6-2**. Sites represent the LEPA/MEPA (WQD1) and MEPA/HEPA (WQ2) boundaries and the HEPA (WQL3 and WQ4). In-situ data logging will occur at WQD1 only.

Marine water quality will be sampled according to the following frequency:

- Pre-dredge - every second week for one month;
- During dredging – Weekly for duration of inner harbour dredging; and
- Post dredging – weekly until target met.

In-situ data logging will occur over the same duration as water sampling with the exception of hourly data recording.

Table 6-3 Marine Water Quality Sample Location Coordinates (GDA94 MGA50)

Site ID	Easting	Northing
WQD1	265265	6814854
WQ2	265808	6815192
WQL3	263823	6814599
WQ4	264389	6818655

Environmental Protection Outcomes, Management Targets and Trigger Levels

The EPOs, MTs and trigger levels to be applied for protection of marine environmental quality are presented in **Table 6-4**. A tiered management approach has been developed based on monitoring and reporting against these trigger levels to ensure EPOs and MTs for protection of marine environmental quality (**Figure 6-3**).

Weekly reports and a final report shall be prepared to document the return water quality monitoring program as described in **Table 7-1**.

Table 6-4 Impact management targets for marine water quality monitoring

Monitoring Location: WQD1, WQ2, WQL3 and WQ4 (Figure 6-2)	
Early warning: Moderate and High Level of Ecological Protection	**Trigger Level 1 – One sampling round** WQD1 - Contaminant concentrations exceed the ANZG (2018) 90% Species Protection Levels or WQ2, WQL3 &WQ4 - Contaminant concentrations exceed the ANZG (2018) 99% Species Protection Levels
Management Target: Moderate and High Level of Ecological Protection	**Trigger Level 2 – Two consecutive sampling rounds** WQD1 - Contaminant concentrations exceed the ANZG (2018) 90% Species Protection Levels or WQ2, WQL3 &WQ4 - Contaminant concentrations exceed the ANZG (2018) 99% Species Protection Levels
Environmental Protection Outcome: Moderate Level of Ecological Protection	**Trigger Level 3 – One month after cessation of harbour dredging and tailwater return** WQD1 - Contaminant concentrations exceed the ANZG (2018) 90% Species Protection Levels

Parameters and Procedures

Water Sample Collection – Contaminants

Water samples will be collected at all four sampling locations identified in **Table 6-3**. Water samples are collected using a depth-integrated water sampler[2] to pump the required volume of water evenly from the water column between 0.5 m below the surface to 0.5 m above the seabed.

The water sampler should be rinsed with Decon solution (or equivalent) between samples to ensure no cross contamination. Water samples will be collected into suitable (laboratory supplied) bottles and immediately stored on ice for transport to a National Association of Testing Authorities (NATA) accredited laboratory for analysis.

[2] If a depth-integrated water sampler is not available, a pole sampler or niskin bottle (or equivalent) may be used to sample at a depth of 0.5m below the surface. Near-surface sampling is generally considered to be representative of water quality at the sample sites as waters in Geraldton Port experience a moderate degree of mixing.

All sample containers will be marked with a unique identifier, the date/time and the sampler's name and clarification that the samples are marine water using a waterproof permanent maker. All samples

- Dissolved metals to include Al, As, Cd, Cr, Cu, Pb, Mn, Ni, Zn, Hg
- Sulphate
- Chloride
- Nutrients (Total N, TKN, NH3, NOx-N)
- TRH
- TBT

Water Column Profiling

A pre-calibrated, Water Quality Sonde (i.e. YSI ProDSS or equivalent) will be used to collect physico-chemical water quality profiles at all four sampling locations identified in **Table 6-3**. As a minimum, the following parameters should be measured at 0.5 metre (m) intervals throughout the water column (i.e. 0.5 m below surface to 0.5 m above seafloor):

- Depth (m);
- Water temperature (°C);
- pH;
- Salinity (ppt);
- Electrical Conductivity (mS/cm);
- Turbidity (NTU); and
- Dissolved oxygen (% saturation & mg/L).

All recorded measurements will be stored on the sonde hand-held unit and downloaded to a secure server within 24 hours. The data should be immediately assessed to ensure validity and, any erroneous data should be removed from the analysis as appropriate.

The sonde is required to be calibrated and serviced in accordance with the manufacturer's standards throughout the duration of the project to ensure data collected are accurate.

In-situ Data Logging

A pre-calibrated water quality data logger will be used to collect physico-chemical water quality data at site WQD1 identified in **Table 6-3**. The data logger will record pH and DO as a minimum, hourly throughout the duration of the sampling period.

The data logger is required to be calibrated and serviced in accordance with the manufacturer's standards throughout the duration of the project to ensure data collected are accurate.

Corrective Actions

MWQM data shall be immediately reviewed upon receipt of laboratory results against the Trigger Levels (**Table 6-4**). If Trigger Level 1 is exceeded the proponent shall be notified and monitoring shall continue. If Trigger Level 1 or 2 are exceeded the dredge program will be reviewed and may be modified if appropriate. In addition, the following modifications to the dredging operations or return water may also be considered:

- Cease discharge from the onshore management area to either stop release of water or reduce the proportion of fine sediments released;
- Modify the dredge plan to relocate dredge to another site to reduce frequency of inner harbour dredging; and/or
- Other tailwater response management as directed within the ASSMP.

Management of dredging and return water from the Northern Reclamation DMPA shall continue until the Trigger Levels are no longer exceeded.

In addition, detailed investigations on the likely causes of the exceedance and the recommended changes to the dredge program or Northern Reclamation DMPA is required within 7 days of any Trigger Level 3 exceedance. Results from the TWR program should be reviewed in light of the investigation.

Trigger level 3 has been included to assess the rate of return of water quality post dredging to MEPA (90% SPLs) within the inner harbour which has a MT assigned to return to the moderate protection level within one month post completion of inner harbour dredging and tailwater release. Trigger level 3 is breached if the 90% SPLs are not achieved within the first month of sampling. The target is considered met once two consecutive monitoring events meet the 90% SPL criteria and monitoring can cease.

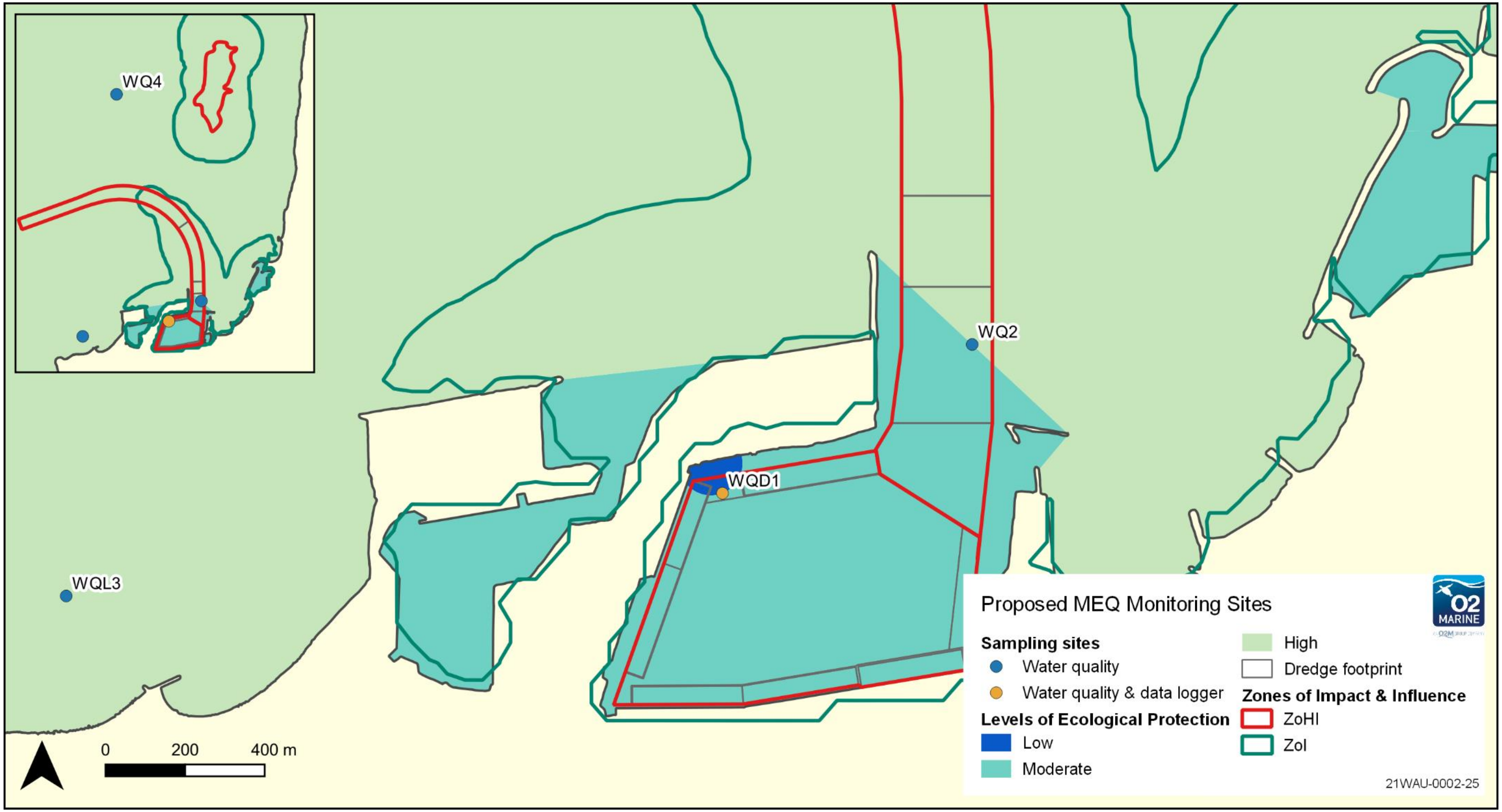

Figure 6-2 Proposed Water quality monitoring locations

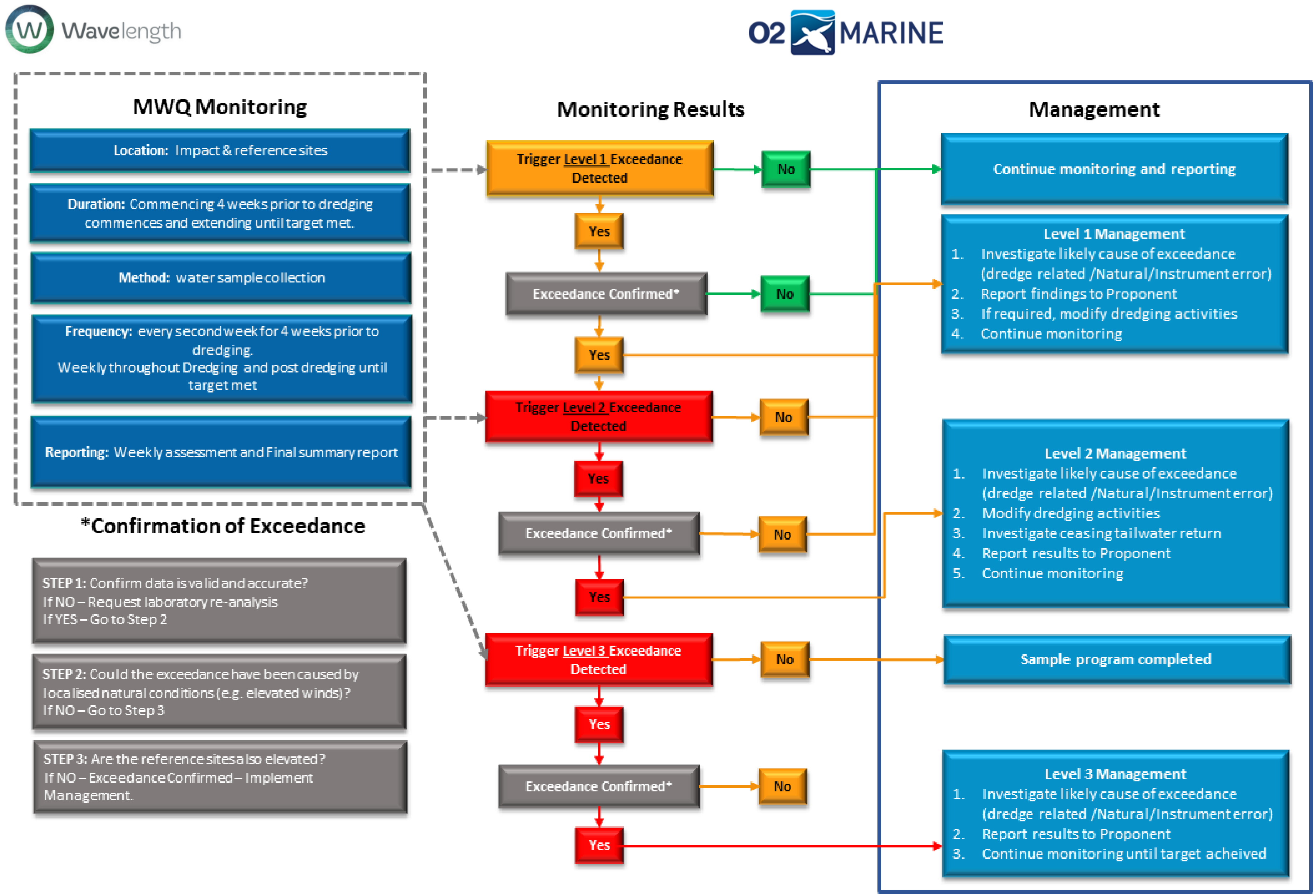

Figure 6-3 Tiered management response for marine water quality monitoring

6.2. Benthic Communities and Habitat Monitoring

6.2.1. Rationale

A validated hydrodynamic and sediment transport model was used to assess the fate of sediment plumes associated with dredging and sediment transport from the Nearshore DMPA (GEMS 2021). Modelling works were conducted based upon a total dredge volume of approximately 235,000 m3, with approximately 190,000 m3 dredged from the entrance channel and identified for beneficial re-use via relocation to the Nearshore DMPA. Based upon dredge plume light reduction investigations and sediment smothering thresholds applied for the Oakajee project (Oceanica 2010) and sediment smothering investigations by Coupland (1997) a series of impact zones for BCH impacts, predominantly focused on *Amphibolis griffithii,* were predicted as per the below:

1. ZoHI – This is considered to represent the direct footprint of the dredge area and boundary of the Nearshore DMPA.
2. ZoMI:
    a. Sedimentation/smothering - *A. griffithii* experience smothering >15 cm for a duration >eight weeks.
3. ZoI:
    a. Shading – *A. griffithii* experience a reduction of >71 hours of saturating irradiance, measured as photosynthetic active radiation (PAR) from ambient during dredging.
    b. Sedimentation/smothering - *A. griffithii* experience smothering >4 cm for a duration >six weeks.

The predicted impact zones are presented in **Figure 4-2** and described in further detail within the Environmental Impact Assessment (O2 Marine 2021b).

As there are no predicted '*irreversible loss*' and '*recoverable impacts'* (as defined by EPA 2016) are described as highly conservative (O2 Marine 2021b), along with a short project duration, no reactive BCH sampling program is included for this project. Rather, a post dredge BCH health assessment designed to provide qualitative data to validate model predictions and assess any '*recoverable impacts'* associated with the project was determined commensurate with predicted impacts.

Monitoring of BCH health post-dredging will be undertaken to ensure that the EPOs for protection of BCH are achieved and the potential for smothering and light reduction from dredging and material placement are adequately assessed. The monitoring approach is based on completing a post dredge seagrass assessment at representative sites surveyed pre-dredge during January February and March 2021 (BMT 2021a and BMT 2021b). Sites selected are suitably located within the ZoMI, on the ZoMI boundary as spatially defined in **Figure 4-2**, and within no impact zones to allow a static and temporal assessment of potential impacts. The EPOs were adopted assuming the potential for a '*recoverable impact*' of BCH located within the ZoMI.

6.2.2. Monitoring Locations & Frequency

Seagrass Monitoring

Seagrass monitoring will be conducted at 12 locations as presented within **Table 6-5** and **Figure 6-4**. Sites represent the ZoMI (D75, D90, D114 and S2), ZoMI boundary (D68, D4 and D102) and no impact areas (D84, GF1, TL1, TL11, S1 and PAGES).

Seagrass monitoring will be conducted according to the following:

- Pre-dredge – Jan-Mar 2021; and
- Post-dredge – Jan-Mar 2022 and annually until EPOs achieved.

Table 6-5 Seagrass sampling location coordinates (GDA94 MGA50)

Site ID	Easting	Northing
D102	266866	6816290
D114	266033	6815331
D4	264742	6815405
D68	266098	6822134
D75	266367	6818968
D84	265300	6818845
D90	266257	6817825
GF1	265086	6822887
Pages	263814	6814517
S1	265735	6816486
TL1	265490	6820334
TL11	265962	6817095

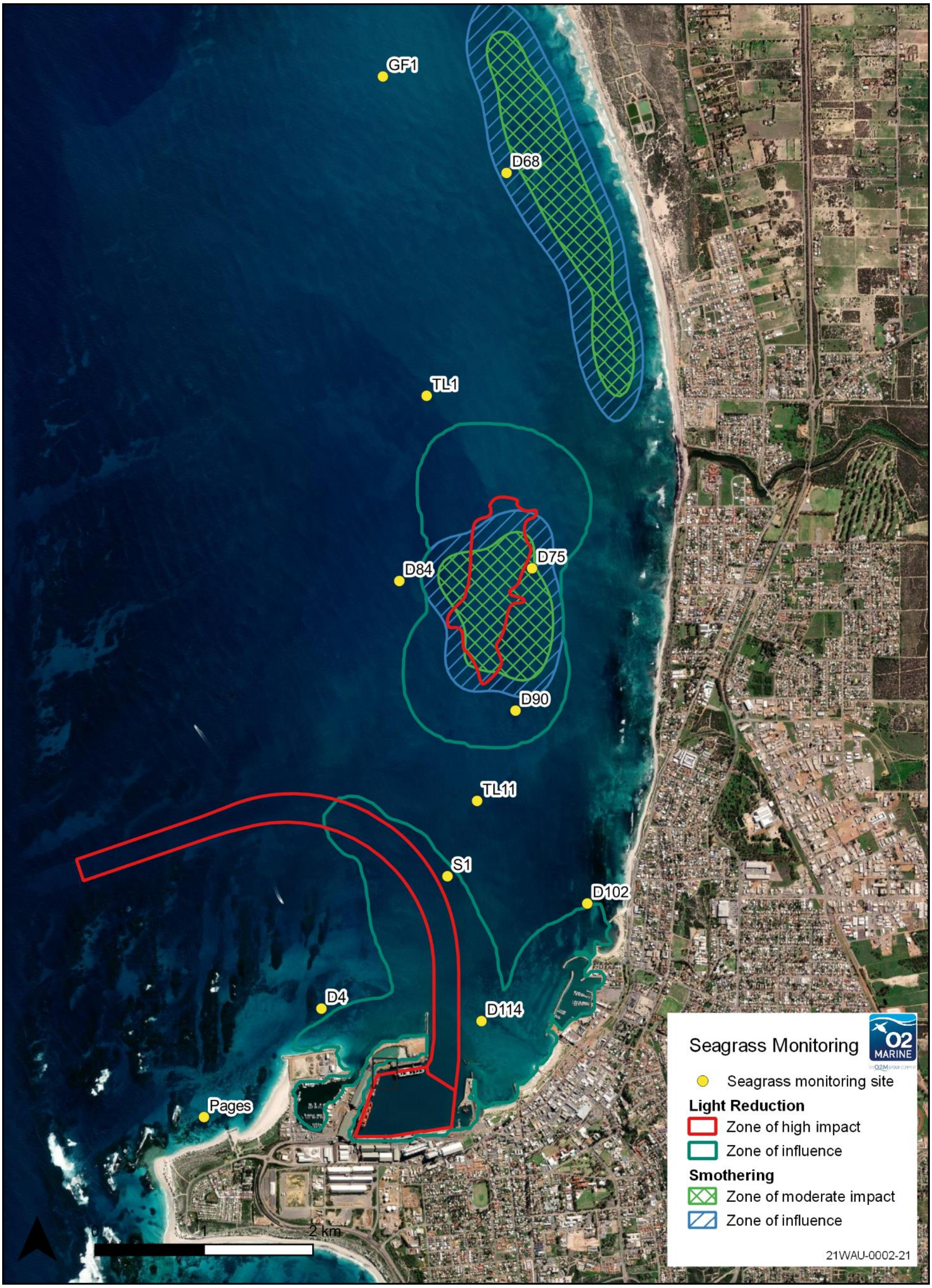

Figure 6-4 Proposed post-dredge seagrass survey locations

BCH Monitoring

BCH monitoring will be conducted at all 36 locations as presented within **Table 6-5** and **Table 6-6**, whilst side scan sonar data will be collected within the study area as displayed within **Figure 6-5**. BCH monitoring will be conducted as follows:

- Pre-dredge – July / August 2021; and
- Post-dredge – March / April 2022 and annually until EPOs achieved.

Side scan sonar sampling should avoid the Nearshore DMPA footprint where possible as this habitat type is known and will be monitored by ongoing hydrographic surveys in accordance with **Section 6.3**.

Table 6-6 BCH sampling location coordinates (GDA94 MGA50)

Site ID	Easting	Northing
DC1	265846	6819011
DC2	265728	6818780
DC3	265647	6818646
DC4	265632	6818309
DC5	265597	6818034
DC6	266129	6817898
DC7	266383	6818058
DC8	266700	6818030
DC9	266214	6818376
DC10	266279	6818617
DC11	266712	6818719
DC12	266335	6818769
DC13	266360	6818997
DC14	266363	6819182
DC15	266651	6819354
DC16	266602	6819670
DC17	266231	6819606
DC18	266215	6819978
DC19	265900	6819863
DC20	265881	6819327
SH1	267122	6820507
TA1	266425	6821980
TA4	266304	6822308
TA6	266720	6821586

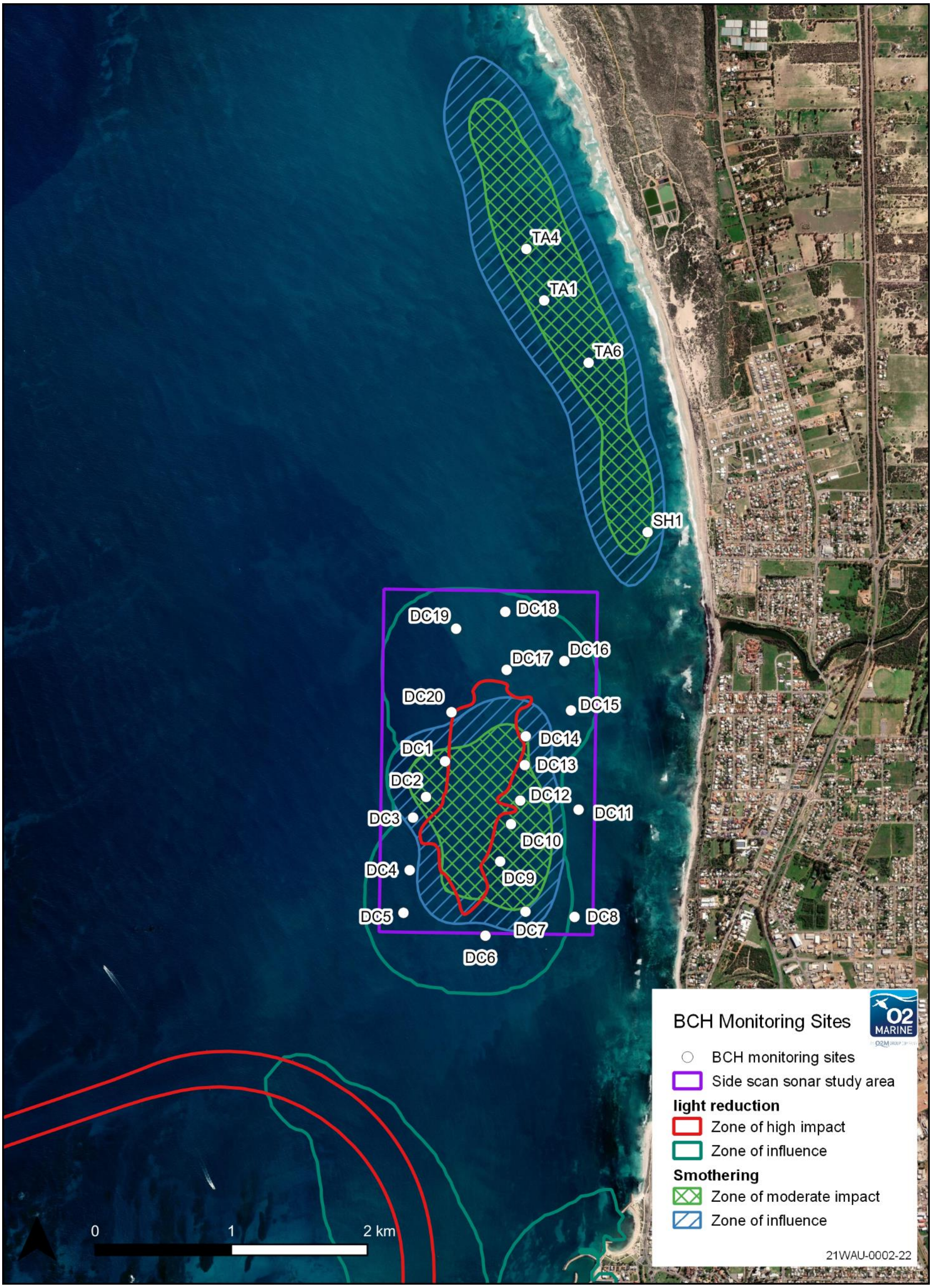

Figure 6-5 Proposed post-dredge BCH survey locations.

Environmental Protection Outcomes, and Performance Assessment Criteria

The EPOs and performance assessment criteria to be applied for protection of BCH are presented in **Table 6-7**. As this program occurs pre- and post-dredging there is no reactive dredge management actions, only actions to ensure the EPO is achieved.

An annual report and a final report (if trigger exceeded) shall be prepared to document the BCH monitoring program as described in **Table 7-1**.

Table 6-7 Impact management targets for BCH monitoring programs

Monitoring Locations as per Figure 6-4 and Figure 6-5	
Performance Measure: Early warning for no negative change from baseline state on BCH	**Performance Assessment Criteria 1** Annual seagrass health assessment indicates sub-lethal impacts, decreased extent or significant community shift related to dredging and material placement or Annual BCH monitoring decreased habitat extent or significant community shift related to dredging and material placement
Environmental Protection Outcome: No negative change from baseline state on BCH	**Performance Assessment Criteria 2** Annul seagrass health assessment identifies recovery from observed impacts > 5 years or Annual BCH monitoring identifies recovery from observed impacts > 5 years

6.2.3. Parameters and Procedures

Seagrass Monitoring

For the purposes of conducting pre- and post-dredge seagrass health assessment at each of the sampling locations presented within **Table 6-5** and **Figure 6-4** the following minimum parameters may be recorded in-situ or post-hoc:

1. Seagrass shoot density and height
2. Species composition
3. Presence of epiphyte and epifauna
4. Habitat type
5. Percent coverage

Procedures for the sampling of parameters 1-4 remain consistent with BMT (2021a) with the following exceptions:

1. Seagrass shoot density and height may be counted in-situ rather than removal and laboratory analysis:
2. Parameters previously collected such as aboveground biomass, leaves per cluster and presence of dead rhizome mat are not required for assessment of dredging related impacts.

Parameter 5 will be sampled in accordance with the methods described in BMT (2021a).

BCH Monitoring

BCH monitoring will be completed using a combination of side scan sonar and drop-down cameras at the study area and sampling locations presented within **Table 6-5**, **Table 6-6** and **Figure 6-5.** Parameters and procedures for BCH monitoring using drop-down cameras will be in accordance with or to the same standard as the methods described by BMT (2021b) and AECOM (2020).

Side scan sonar will be used to collect data within the defined study area in accordance with procedures associated with the equipment used. This typically requires associated equipment such as the sonar unit and data capture laptop operated by trained marine scientists, DGPS and survey vessel. Transects will be defined prior to commencing survey operations with corresponding georeferenced paths uploaded to the survey vessel navigation equipment to determine the best method for data capture across the entire study area.

6.2.4. Data Analysis

Seagrass Monitoring

Data collected from the seagrass monitoring program will be analysed using suitable statistical methods to determine the following null hypothesis:

1. Measured seagrass health metrics at ZoMI locations are statistically similar with health metrics at reference sites thus no dredge related impacts are measured; and
2. Measured seagrass health metrics are statistically similar to pre-dredge survey results as presented in BMT (2021a).

Annual reports and a final report shall be prepared to document the findings from seagrass surveys.

BCH Monitoring

Field data collected from side scan sonar and drop-down cameras will be analysed post-hoc with specialised software to determine habitat type and extent. The most recent habitat map (O2 Marine 2021b) will be used as a base layer upon which revised data will be interpolated to create a pre-dredge habitat map for the Nearshore DMPA and adjacent area. A similar approach will be used for post-dredge data capture to provide the ability to undertake a pre- and post-dredge habitat type and extent interrogation using GIS or similar suitable software.

Data collected from the BCH monitoring program will be analysed using suitable statistical methods to determine the following null hypothesis:

1. Observed BCH habitat classes are statistically similar for pre- and post-dredge datasets; and
2. Measured BCH habitat extents are statistically similar for pre- and post-dredge datasets.

In addition, habitat type and extent data collected from the pre-dredge BCH survey will be used to define appropriate buffers for material placement within the Nearshore DMPA prior to commencing placement activities.

A pre dredge summary report, annual reports and a final report shall be prepared to document the findings from BCH surveys.

6.2.5. Corrective Actions

Annual reporting shall be reviewed against the performance assessment criteria presented within **Table 6-7**. If performance assessment criteria 1 is not exceeded (i.e. no impacts are identified within the ZoMI from dredging and placement of material) then the EPO is considered met and no further monitoring is required.

If performance assessment criteria 1 is exceeded, then annual monitoring should continue until recovery to pre-dredging baseline conditions are observed. If recovery has not been observed within five years the EPO is not considered achieved.

If the EPO is not met, an investigation is required to determine the severity and extent of related impacts and management actions identified to ensure no future impacts from dredging and material placement arise.

If the dredge project is identified as having significant environmental impacts, MWPA may consider consultation with the EPA branch within DWER to consider future corrective actions.

6.3. Model Validation Monitoring Program

6.3.1. Rationale

To predict impacts upon BCH from light reduction and smothering, hydrodynamic and sediment transport modelling was conducted (GEMS 2021). The impact assessment concluded that minimal impacts to BCH were predicted from project activities, typically due to the short duration of the project and the site selection for the Nearshore DMPA (O2 Marine 2021b).

However, MWPA are committed to continual improvement, and as such have developed a sampling program which aims to collect actual data during dredging and nearshore placement with the aim of validating the model and ensuring the impact assessment predictions are commensurate with any actual impacts.

This monitoring program is aimed at collecting data on the dredge plume and sediment transport as a mechanism to validate hydrodynamic and sediment transport modelling. The first aspect aims to collect suspended sediments and use results from aerial photography as a means to validate plume outputs and light loss predictions used to establish the ZoI. The second aims to quantify the volume of material lost from the Nearshore DMPA over the dredge model duration (two years) to validate the sediment transport model.

Results will also provide a feedback loop to assist interpretation of BCH monitoring results if any impacts are identified.

6.3.2. Monitoring Locations & Frequency

Dredge Plume Validation

Total Suspended Sediments

Total suspended sediments (TSS) will be collected at all six locations presented in **Table 6-3** and **Figure 6-2** in conjunction with weekly MWQM. In addition to these sites, two targeted sites will be sampled during each weekly event which target the actual dredge plume as it is occurring at the time from either channel dredging or nearshore material placement activities.

TSS will be collected during all MWQM events pre-dredge and during dredge (channel and inner harbour).

Aerial Photography

Aerial photography will be collected along a pre-determined flight path across project area, including channel and harbour dredging and material placement activities at the Nearshore DMPA. Monitoring will be conducted at least fortnightly during throughout dredging and material placement activities.

Sediment Transport Validation

Upon completion of the material placement within the Nearshore DMPA the contractor is required to complete a hydrographic survey. The survey extent for the post placement survey will be completed on a six-monthly basis for a period of two years. The Nearshore DMPA footprint is presented in **Figure 1-1**.

6.3.3. Environmental Protection Outcomes and Performance Assessment Criteria

The EPOs and performance assessment criteria to be applied for model validation are presented in **Table 6-8**.

The dredge plume validation program shall have a final close out report presented to MWPA. Six monthly reports and a final report shall be prepared to document the sediment transport program. These are described in **Table 7-1**.

Table 6-8 Impact management targets for model validation

<table>
<tr><th colspan="2">Dredge Plume Validation- Monitoring Location:
PAR - LL1, LL2 & WQL3 (Figure 6-2)
TSS - LL1, LL2 , WQD1, WQ2, WQL3 and WQ4 (Figure 6-2) plus random dredging plume locations</th></tr>
<tr><td rowspan="2"><u>Performance Measure:</u>
PAR/TSS exceed model prediction for ZoMI and indicate potential ZoHI</td><td>Performance assessment criteria 1</td></tr>
<tr><td>Actual dredge TSS levels recorded are >25% lower over the dredge project than model predictions
or
Predicted dredge plume visible extent is 50% greater than model predictions</td></tr>
<tr><th colspan="2">Sediment Transport Validation – Monitoring Location – Nearshore DMPA</th></tr>
<tr><td rowspan="2"><u>Performance Measure:</u>
Sediment volumes naturally transported from the Nearshore DMPA exceed model predictions for ZoMI and indicate potential ZoHI</td><td>Performance assessment criteria 2</td></tr>
<tr><td>Actual sediment volumes mobilised from the Nearshore DMPA are >25% higher for each sampling period than model predictions.</td></tr>
</table>

6.3.4. Parameters and Procedures

Dredge Plume Validation

Suspended Sediments

SSC samples will be conducted concurrently with the MWQM sampling program. SSC samples will be collected as per the methods described for contaminants, however three subsamples will be collected per site. At each site subsamples will be collected from:

> 0.5 m below surface;
> Centre of water column; and
> 0.5 m above seafloor.

Whilst this program is concurrently implemented with the MWQM program, TSS samples are required to be collected for number of dredge scenarios to adequately verify the hydrodynamic modelling. Therefore, when scheduling weekly water sampling events, liaison with the dredge contractor should be included to ensure data is obtained across a range of channel dredging and nearshore placement activities.

Aerial Photography

Oblique aerial photography will be captured using either a drone set to a pre-determined flight path, or via commercial light aircraft. Photographs will be targeted at locations where the dredge vessel is actively dredging or placing material. Turbidity plumes developed from natural events, such as wind or swell, will also be targeted during the same flight to provide context to observed dredging and placement plumes. GPS coordinates of photographs should be recorded where possible.

Sediment Transport Validation

Post dredging channel and Nearshore DMPA bathymetric surveys will be conducted every six months concurrently with the Ports Draft Under Keel Clearance surveys. Ongoing surveys will be completed using the same methodology and using similar equipment as the final survey collected upon completion of the dredging project.

6.3.5. Data assessment

Data obtained through this program will be fed back into modelling to determine the level of accuracy of the predicted outputs (dredge plume and sediment transport).

Dredge plume aerial photography will be compared to dredging model outputs provided by GEMMS (2021) to determine the accuracy of predicted visible plumes. An assessment of naturally occurring turbidity collected at sites not impacted from dredging and material placement activities will also be considered in the interpretation. Photographs may be used by MWPA on the website for stakeholder engagement during dredging activities.

Sediment transport data analysis can be completed by conducting a simple loss calculation to determine the volume moved through natural sediment relocation mechanisms during each sampling period. This value will then be compared to the model predictions for each period to determine the accuracy of predicted sediment transport.

Any significant weather events (i.e. cyclone activity, large storm or swell events, flushing from Chapman River mouth etc.) are to be considered when evaluating results as these will likely alter the accuracy of modelled predictions. When considering this aspect, a reference to the modelled parameters should be considered (i.e. what weather scenarios were included in the dredging period) Benthic PAR will also need to be evaluated against the reference location to determine if any measured light reduction was a natural occurrence (swell induced turbidity or cloud cover) or related to dredge plumes.

6.3.6. Corrective Actions

Where performance criteria for TSS, visible dredge plume extent or sediment transport are not achieved MWPA will undertake an investigation to determine further actions. This may consider, but not be limited to:

- Consider additional BCH or seagrass sampling;
- Evaluate the and refine the model to ensure future predictions are more accurate;
- Identify and collect additional data to support future dredge plume and sediment transport modelling outputs;
- Consult stakeholders to evaluate potential impacts to adjacent operations.

7. Reporting

A summary of the reporting requirements for the project are provided in **Table 7-1**.

Table 7-1 Project reporting requirements

Report	Content	Timeframe	Recipient
Non-compliance Summary Report	• Identify which Environmental Protection Outcome has not been achieved • Detail the monitoring results that identified the Environmental Protection Outcome was not being achieved • Describe the investigation being undertaken into the cause of the Environmental Protection Outcome not being achieved • Identify any corrective or contingency management actions proposed to be implemented or being implemented	Within 7 days of determining that an Environmental Protection Outcome has not been achieved	Proponent
Site and vessel inspection checklists/logs	• Site Environment, Safety & Health inspection – (e.g. dredge pipe integrity, erosion, bund integrity, dust, drainage). • Vessel Environment, Safety & Health inspection – (e.g. equipment inspection, navigation equipment systems, speed, MFO personnel, bunkering log). • Dredge operation log – (e.g. operations times, types of operations, GPS positioning, dredge volumes). • Marine fauna observation Logs – (e.g. dredge operation time, name of observer, fauna species, distance/direction from vessel, management response)	Daily during Construction	Proponent
Non-compliance Investigation Report	• Identify which Environmental Protection Outcome has not been achieved • Detail the findings of the investigations undertaken into the cause of the Environmental Protection Outcome not being achieved	Within 30 days of determining that any Environmental Protection Outcome has not been achieved	Proponent
Dredging Close-out Report	• Statement of compliance with the relevant Environmental Protection Outcomes • Comparison of the actual and predicted dredge-related pressures and resultant environmental impacts and effects	Within 3 months following the completion of dredging.	Proponent

A summary of the additional reports that are expected to inform and demonstrate that the Management Targets have been met are listed in **Table 7-2**.

Table 7-2 Reporting requirements for environmental monitoring programs to determine if MTs are met

Topic	Content	Timeframe	Responsibility
Benthic habitat pre-dredge survey	Results, including updated habitat map of study area, and discussion of pre-dredge benthic habitat survey	Prior to commencement of dredging	Proponent
Benthic habitat post-dredging survey	Results, including updated habitat map of study area, and discussion of post-dredge benthic habitat survey including ZoMI	Within eight-months following completion of dredging	Proponent
Seagrass monitoring post-dredging survey	Results and discussion of post-dredge seagrass survey including statistical comparison of ZoMI and non ZoMI sites and pre- and post-dredge health metrics.	Within eight-months following completion of dredging	Proponent
Marine water quality monitoring	Summary of water quality health relative to the Environmental Protection Outcomes and Management Targets	Weekly Monthly Final report within one-month following cessation of dredging	Proponent
Tailwater return monitoring	Summary of water quality health relative to the Environmental Protection Outcomes and Management Targets	Weekly Monthly Final report within one-month following cessation of tailwater discharge	Proponent
Dredge plume Validation	Results from benthic light and TSS will be compared against model outputs and the associated management targets.	Final report within two months from completion of data capture	Proponent
Sediment transport validation	Results from sediment transport will be compared against model outputs and the associated management targets.	Biannual summary reports Final close out report at two years	Proponent
Dredging and Nearshore Placement Close-out Report	Evaluation of all environmental monitoring programs including: • Statement of compliance with the relevant Environmental Protection Outcomes • Comparison of the actual and predicted dredge-related pressures and resultant environmental impacts and effects • Summarise the effectiveness of nearshore placement as a future strategy for dredge material management • Summarise the effectiveness of management and monitoring programs • Provide recommendation for future improvements to dredge planning, impact assessment, management and monitoring.	Within 3 months following the completion of environmental monitoring programs.	Proponent

A summary of the external reporting requirements for the project are provided in **Table 7-3**.

Table 7-3 External reporting requirements

Report	Content	Timeframe	Recipient
Biosecurity Incident	Reporting potential, suspected or known marine pest incursion.	Within 24 hours of potential identification of marine pest incursion	DPIRD – FishWatch – 1800 815 507
Major hydrocarbon spillage	Complete a POLREP - https://www.transport.wa.gov.au/imarine/reporting-marine-oil-pollution.asp	Immediately	DoT – MEER (08) 6480 9924
Major pollution incident	Details regarding the incident such as time, place, pollution type, severity, extent etc.	Immediately	DWER – 1300 784 782
Significant Impact arising from project	There is no formal process for reporting significant environmental impacts. A report detailing the significant impact, technical investigations undertaken to support conclusions and all associated incident investigations and actions implemented to reduce the impact should be compiled for consultation.	Liaison should commence immediately upon identification of impacts. Reports to be submitted upon completion.	Consultation with the EPA branch of DWER

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Appendix A Existing Environment

A.1 Coastal processes

A.1.1 Regional Setting

Geraldton is located within the Midwest region on the west coast of Western Australia, approximately 400 km north of Perth. The Port is located on the northern side of the Point Moore peninsula with the Port and city centre facing north into Champion Bay. Champion Bay is a semi-sheltered embayment protected from raw ocean swell conditions by a series of shallow subtidal reef systems extending off Point Moore and a deeper parallel limestone ridge which runs north towards Drummond Cove. East of the limestone ridge, water depths up to approximately 11 m occur within two kilometres of the coast. To the west of the limestone ridge, water depths rapidly increase to 20-30 m, and then gradually deepen to 50 m before shallowing again at the Houtman Abrolhos Islands located some 50 km offshore.

To the north and south of Point Moore, the coast is comprised primarily of sandy beaches generally overlying beach rock. Occasional areas of shallow beach rock and limestone platform are exposed at locations such as at Drummond Cove, Bluff Point, Point Moore and adjacent to the mouth of the Greenough River. Two main rivers, the Greenough River (~10 km south of Point Moore), and Chapman River (~5 km north of Point Moore), periodically discharge into coastal waters in the Geraldton area. These rivers are typically closed at the river mouth discharging only after significant rain falls within the two catchments.

A.1.2 Climate and Oceanography

Offshore coastal waters, west of Champion Bay and Point Moore, experience moderate to high wave-energy. O2 Metocean (2021) undertook a metocean measurement programme on behalf of the City of Greater Geraldton in 2020. Waves, water levels, currents, and water temperature measurements collected at two sites distanced 1,100 m from each other, both approximately 500 m west of Sunset Beach foreshore in 10m water depth, were collected to improve the understanding of the metocean conditions contributing to beach change at Sunset Beach. Anticipating that most severe beach erosion would occur in winter, the measurement campaign commenced in March 2020 and extended to October 2020. Summer conditions were later added to the programme, with the summer measurement campaign lasting six (6) weeks from late November 2020 to early January 2021.

The significant wave height (Hs, total) at the measurement sites (10m depth) peaked at Hs~2.6m during a late May 2020 (winter) storm. The data revealed that Hs>2m is a relatively common occurrence during winter, where Hs>1.4m occurs approximately 30% of the time between June and October. Long period swells with peak spectral wave periods (Tp) longer than 20s were very rarely observed (<2%), however winter swells presented a peak period of 10<Tp<20s. Substantially more benign conditions were recorded in summer, with Hs>1.4m less than 1% of the time and Hs<1m 83% of the time.

The currents are tidally driven and predominantly parallel to the coast, rotating from northward to southward (and vice versa) with the tidal cycle. Depth averaged peak current speeds typically range from 0.10 to 0.20m/s in winter and rarely exceed 0.10m/s in summer. Only once during the measurement campaign the current exceeded 0.25m/s (May 2020 storm). Geraldton experiences diurnal tides with a small range (~0.9m spring).

Geraldton experiences a seasonal wind pattern on which is superimposed a diurnal land-sea breeze system. During winter, night and morning winds are generally moderate (6–30km/hr) and prevail from the north-east, then swing through north-west to south in the afternoon (URS 2001). Summer morning winds are moderate (11–30km/hr) and generally originate from the east to south-east. In the afternoon the winds shift to moderate to strong (generally 21–40km/hr) through south to south-west (URS 2001). Typically, December is the windiest month and July the least windy. Extreme winds occur mainly in summer and generally are isolated events associated with thunderstorms and tropical cyclones (ATA 1994).

A.1.3 Geomorphology

The Central West Coast Region is an area where the continental shelf is relatively narrow and there is a diversity of moderate energy coastal landforms developed. The coast is formed over the Perth Sedimentary basin. Through the Pleistocene (10,000 to 2,000,000 years ago) there was a succession of transgressions and regressions of the sea over the Swan Coastal Plain. As sea level fell during each regression it left behind a coastal dune field, the oldest of which have consolidated to form North-South aligned ridges of aeolianite limestones (URS 2001). Ridges that occur above present-day sea level usually bear a mantle of Holocene dunes. Those below sea level form sublittoral reefs, often undercut and cavernous on the seaward side. Small islands, representing high points of flooded ridges, are a relatively common feature within a few kilometres of the shore.

Semi-sheltered lagoonal habitats are developed behind offshore limestone reefs in many localities. The degree of shelter is variable, depending on the depth and continuity of the offshore reefs and islands. The shore is commonly comprised of long sandy beaches with occasional rocky cliffs and headlands where the limestone outcrops. Notched intertidal rock platforms are a feature of this coast.

The sediments of the littoral and shallow water zone of Champion Bay are primarily seagrass derived (i.e. mainly composed of microscopic shells of seagrass-associated organisms), with secondary riverine quartz sediment input and dune related carbonate sediment input (Tecchiato *et al* 2012). There is an overall south to north transport pattern driven by south-westerly swell waves and strong sea breeze wave fields, however, temporary reversal can occur during powerful north-west swells potentially associated with tropical storms or large winter storms (Tecchiato *et al* 2012, Stull *et al* 2014).

Champion Bay is one of many partially protected embayments that occur along the coast within the Central West Coast Region. While the Bay has extensive reef along its western side, this generally rises to only 8 to 10 m below sea level and there are no offshore islands to provide protection from wave energy. Swell height at the coast is attenuated by coastal limestone ridges; however wave heights and periods are sufficient to initiate bottom sediment particle movement over the entire Geraldton inshore platform (Tecchiato *et al* 2012). The limited protection of Champion Bay is evidenced by the relatively narrow, high energy beaches found along most of its length and the relatively small amount of sediment which is present on the floor of the Bay. Only the south-eastern corner of the Bay has a level of protection sufficient to allow the development of extensive seagrass beds on thick sand veneers overlying the limestone basement.

A.2 Marine Environmental Quality

A.2.1 Water Quality

Water clarity in Champion Bay is variable during the year as a result of wind driven current strengths and wave energy, as well as intermittent rainfall runoff in the catchments of the rivers, such as the Greenough and Chapman Rivers that drain the hinterland. Typically, the season of lowest water clarity is winter as a higher energy swells mobilising bottom sediments and due to this being the main time during which the intermittent discharge to the Bay of alluvial sediments from river discharge. In wet years, the Bay remains turbid for many months and salinity of nearshore waters slightly decreases as a result of river inflow. Strong winds in summer create waves that also cause an increase in suspended particulate matter which can also reduce water clarity. The period of greatest water clarity is usually in late summer to autumn (February to May) and occurs in response to reduced wind strengths and wave energy and absence of riverine sediment input.

Turbidity within Champion Bay typically increases closer to shore, mostly as a consequence of wave action that lifts sands and silt-sized particles into the water column (URS 2001). During spring and summer there is often a marked diurnal effect, with the increased wave action generated by the strong mid-morning to evening sea breezes increasing coastal turbidity compared to the early morning and dawn calms. During autumn and winter, turbidity and cloudiness (discolouration) is also often elevated in the inner half of Champion Bay, a period when fine organic material from the nearshore and shoreline wracks of decaying seaweed and seagrass is suspended and dispersed through the nearshore water column. Apart from the natural sources and cycles of turbidity, propeller wash from ship and tug movements along the inner sector of the entrance channel also contributes to turbidity. Marked variations in turbidity therefore occur within hourly, daily, weather-system and seasonal time cycles, as well as with depth.

MWPA have implemented a passive water quality monitoring program targeting key metal contaminants since November 2012. This involves the collection of time weighted average samples at three locations within the Inner harbour (Berths 4, 5 and 6) and one reference site within Champion Bay north of the entrance channel. Analytes collected during this period include cadmium, cobalt, copper, lead, nickel and zinc as these are known elements occurring withing exported metal concentrate ores. A summary of the water quality sampling results are provided below.

- General:
    - No exceedances of the 90% species protection level (SPL) (typically applied to Ports) or the 95% SPL have occurred within the inner harbour throughout the monitoring program.
    - Water quality within the inner harbour is considered to be of a very high quality with slight elevations from natural conditions occurring for copper, lead and zinc.
    - Two exceedances of the copper 99% SPL were reported from the reference sites however detections to the ultra-trace for copper may result in handling or laboratory errors.
- Cadmium:
    - Cadmium concentrations at impact sites are typically very low, ranging from below the laboratory detection levels to 0.046 µg/L. The 90% SPL typically applied to a Port environment is 14.0 µg/L.

- Inner harbour and reference sites typically have comparable concentrations.

- Cobalt:
  - Cobalt concentrations at impact sites are typically very low, ranging from below the laboratory detection levels to 0.031 µg/L. The 90% SPL typically applied to a Port environment is 14.0 µg/L.
  - Inner harbour and reference sites typically have comparable concentrations.
- Copper:
  - Copper concentrations at impact sites are typically low, ranging from low level detections of 0.24 µg/L to 2.65 µg/L. The 90% SPL typically applied to a Port environment is 3.0 µg/L.
  - Whilst there have been no exceedances of the 90% SPL, copper concentrations are generally elevated within the inner harbour compared to reference sites which range from below the laboratory detection level to 1.46 µg/L.
- Lead:
  - Lead concentrations at impact sites are typically very low, ranging from low level detections of 0.05 µg/L to 0.89 µg/L. The 90% SPL typically applied to a Port environment is 6.6 µg/L.
  - Whilst there have been no exceedances of the 90% SPL, lead concentrations are generally elevated within the inner harbour compared to reference sites which range from below the laboratory detection level to 0.43 µg/L.
- Nickel:
  - Nickel concentrations at impact sites are typically very low, ranging from low level detections of 0.10 µg/L to 0.32 µg/L. The 90% SPL typically applied to a Port environment is 200 µg/L.
  - Inner harbour and reference sites typically have comparable concentrations.
- Zinc:
  - Zinc concentrations at impact sites are typically low, ranging from 2.0 µg/L to 11.3 µg/L. The 90% SPL typically applied to a Port environment is 23 µg/L.
  - Whilst there have been no exceedances of the 90% SPL, zinc concentrations are generally elevated within the inner harbour than reference sites which range from 0.3 µg/L to 6.2 µg/L.

A water quality monitoring program was also implemented by MWPA (2013) as part of the environmental management program developed for the 2012 maintenance dredging program. The program was typically identified to determine the water quality within the moderate ecological protection area (i.e. the inner harbour) and the high ecological protection area (i.e. Champion Bay).

It should be noted that during this program no low ecological protection area (LEPA) was established and it is likely that several monitoring sites may have been located within a defined LEPA. As the LEPA has a lower SPL assigned within, several exceedances reported in MWPA (2013) may be overestimated.

The sampling program incorporated collection and laboratory analysis of dissolved metals, tributyltin (TBT) and polycyclic aromatic hydrocarbons. TBT and PAHs were dismissed during post dredging as no detection occurred in pre dredge or during dredge monitoring.

Sampling events included one round pre-dredging, two rounds during dredging and seven events post dredging.

A summary of the key sampling results is provided below.

> Pre-dredging:
  - No results exceeded the 90% SPL within the MEPA;
  - Copper exceeded the 99% SPL at six of seven sites in the HEPA;
  - PAH and TBT concentrations were all below the LoRs.
> During Dredging:
  - Zinc exceeded the 90% SPL on both sampling events at one location within the MEPA;
  - Lead exceeded the 90% SPL on one occasion at one site within the MEPA;
  - Copper and zinc exceeded the 99% SPL within the HEPA at several sites on both sampling rounds;
  - Silver (two sites) and nickel (one site) exceeded the 99% SPL on the second sample round only:
  - PAH and TBT concentrations were all below the LoRs.
> Post Dredging
  - TBT and PAH were not samples based upon no detection during or pre dredging;
  - No concentrations exceeded the 90% SPL within any sample round for MEPA sites;
  - Zinc and copper exceeded the 99% SPL at some sites during the first two rounds;
  - Silver exceeded the 99% SPL at one site during round two;
  - No exceedances occurred at MEPA or HEPA sites during rounds three to seven.

Limited data is available for the wider Champion Bay marine environment, though there are limited activities which are likely to result in any marine environmental impacts. Identified activities and their potential, temporary impacts may include:

1. Aquaculture fish farming within Champion Bay may have a localised impact over short duration on water quality, such as minor nutrient loading.
2. Shipping and tug movement within the entrance channel result in localised, short duration turbidity plumes on a regular basis.
3. Commercial and recreation vessel activities may have minor, highly localised impacts on water quality from hydrocarbon spillages, rubbish or vessel anode deterioration.

During periods of warmer water, when swell and wind conditions result in very calm sea surface condition, temporary blooms of Trichodesmium, a filamentous cyanobacteria, may occur within Champion Bay. These blooms typically dissipate quickly when wind or sea state become more unsettled and are considered natural events, however they may have short duration impacts upon water quality during periods of extended blooms.

A.2.2 Sediment Quality

O2 Marine developed a Sediment Characterisation Sampling and Analysis Plan (2021c) and conducted SAP Implementation sampling and reporting (2021b) to determine the quality of the material to be dredged and disposed of within the two proposed DMPA's. The assessment included both preliminary and detailed site investigations in accordance with the DER (2014) guidelines for the *Assessment and Management of Contaminated Sites*.

Preliminary Site Investigation

The preliminary site investigation reviewed historical sediment investigations and sources of contaminants. The desktop assessment identified that existing contaminants occur within the inner with current extent typically limited to the Berth 3, 4 and 5 shipping pockets, whilst the central and eastern sediments had limited information and entrance channel sediments were likely to clean and free from contamination. Assessment of the accumulated sediments was divided into three categories in accordance with the NAGD (2009) to include:

1. 'Probably Clean' channel sediments;
2. 'Probably Contaminated' harbour sediments associated with the Berths 3, 4 and 5 pockets; and
3. 'Suspect' sediments within the remaining harbour sediments.

Within the berth 3, 4 and 5 pockets copper, zinc lead and tributyltin (TBT) have historically exceeded the respective guideline values. Historical sampling has also identified potential acid sulphide soils (PASS) within sediments.

Outcomes of the preliminary site investigation provided a basis for determining the scope of the detailed site investigation, including defining the contaminants of potential concern (CoPC) and identifying the number, depth and location of required sampling (O2 Marine 2021c).

Detailed Site Investigation

Detailed site investigations to characterise sediments were undertaken during June 2019, February 2020 and March 2021 (O2 Marine 2021a). A total of 31 surface and subsurface samples were collected and analysed from 28 sediment sampling locations during the field survey. Sediment samples were collected using SCUBA divers and push cores. Observations and photos were taken prior to sediments being homogenised and packed into laboratory containers. Collected sediment samples were sent to a NATA-accredited laboratory for testing of:

> Physical Sediment Characteristics: Particle size analysis (PSA), total organic carbon (TOC), moisture content;
> Inorganic Compounds: Metals and Metalloids (Al, Ag, As, Cd, Cr, Cu, Fe, Pb, Hg, Ni and Zn);
> Nutrients (Sediments: TKN & TP; Porewater NH4, NO2+NO3, FRP);
> Organotins (TBT, DBT and MBT); and
> Acid sulfate soils (SCr).

Additional sediment samples were also collected and analysed for SPOCAS to inform the Acid Sulphate Management Plan (Coffey 2021).

'Probably Clean' sediments were characterised by fine grained, yellow to grey sands of natural origins such as coastal silicate sands transported to the entrance channel via localised northern longshore drift, or marine carbonate sediments transported via oceanic currents and swell. No contaminants of potential concern (COPC) were identified for probably clean sediments, which is consistent with previous assessments of entrance channel sediments.

Sediments at the proposed Nearshore DMPA were characterised by fine grained, yellow to light brown sands of natural origins such as coastal silicate sands and marine carbonate sediments. No contaminants of potential concern (COPC) were identified at any of the five sites assessed.

'Suspect' and 'Probably Contaminated' sediments occurring within the harbour were typically comprised of consistently finer material than channel sediments with the exception of sites near the channel entrance which were physically similar to those within the channel. The sediments occurring in Berths 3-7 were comprised of slightly coarser material, described as medium/fine silty sands, than the south-eastern corner of the harbour characterised by fine silty sands. Appearance ranged from grey to dark grey and brown throughout the berth pockets and the south-eastern corner.

Total copper, zinc and mercury at 'Suspect' sediment sites were detected above DGV levels, with the 95% UCL of the mean for copper and zinc exceeding the DGV. Total cadmium, copper, lead and zinc in 'Probably Contaminated' sediment sites were detected above the DGV screening levels, with the 95% UCL of the mean for copper and zinc exceeding the DGV. Terrestrial based ecological and health-based investigation levels were also referenced within this report with the aim of providing a generalised comparison with soil guidelines to consider an option for onshore disposal of dredge spoils. The terrestrial investigation levels indicate contaminants would not exceed soil Environmental Investigation Levels (EILs).

Comparison of total metals to ambient background was undertaken through normalising raw results using aluminum as a normalising element to represent differences in metal concentrations based on particle size between samples for total metals cadmium, copper, lead, iron, manganese, mercury, vanadium and zinc. All metals display a strong linear correlation with aluminum. Normalised 'Suspect' sediments indicated 'Minor' to 'Moderate' enrichment for copper, 'Moderately Severe' to 'Severe' enrichment for zinc and 'No Enrichment' for mercury. Metals manganese, iron and vanadium, with no screening guideline values, recorded 'No Enrichment' to 'Minor'. Normalised 'Probably Contaminated' sediments indicated 'Minor' to 'Moderately Severe' enrichment for cadmium, copper and lead, with 'Severe' to 'Extremely Severe' zinc enrichment. Metals manganese, iron and vanadium, with no screening guideline values, recorded 'No Enrichment' to 'Minor'.

Except for mercury, all samples of total metals that exceeded DGV screening levels were tested using elutriate (dissolved metals) and bioavailable (dilute acid extraction) techniques. Dissolved metal concentrations from 'Suspect' sediments for copper were below the laboratory limit of reporting (LoR) and zinc concentrations from two samples exceed the 90% ecosystem protection guideline. Dissolved metal concentrations from 'Probably Contaminated' sediments for cadmium, copper and lead were below the LoR, with zinc concentrations exceeding the 95% ecosystem protection guideline at one site and 90% at two sites. The dilute acid extraction (DAE) assessment returned results below the LoR for all cadmium and lead samples, whilst copper was only detected at two sites. Zinc ranged between 2-8 mg/kg for all sites within the harbour. All DAE test results were below DGV levels and recorded levels considered acceptable for ocean disposal or onshore placement/reuse.

Tributyltin (TBT) was assessed for all 'Suspect' sites and three 'Probably Contaminated' sites. TBTs normalised to 1% total organic carbon are below the SQG of 9.0 µgSn/kg at all 'Suspect' sites, while the 95% UCL of the means and two sites from the 'Probably Contaminated' sites exceed this level.

Subsequent assessment undertaken on three samples from the 'Probably Contaminated' sites CH4, CH5 and CH6 were analysed for elutriate TBTs. All results were reported below the laboratory LoR and the 95% recommended for moderately disturbed ecosystems (ANZG 2018).

Acid Sulfate Soil (ASS) Action level criteria were exceeded at all inner harbour sites and at one 'Probably Clean' site. Acid based accounting results indicate that the potential acidity of these sediments are effectively buffered from the acid neutralising capacity (ANC), and therefore there would be a negative net acidity following disturbance of these sediments. However, as the DER (2015) action criteria was exceeded an Acid Sulfate Soils Management Plan will need to be developed to manage all potential impacts associated with ASS.

Nutrients in sediments and porewaters were assessed from 'Probably Contaminated' soils. Results identified typically consistent results for total nitrogen and total phosphorous ranging between 870 mg/kg to 2,300 mg/kg and 370 mg/kg to 710 mg/kg, respectively. Total nitrogen was typically of 100% organic origins, as nitrate/nitrite results for all sites were below the laboratory detection levels. Nutrients in porewater were considered very low in comparison with nitrate and nitrate are typically very low, with only one real detection at CH2. Ammonia was quite variable with results ranging from 0.06 mg/L (CH7) to 29 mg/L (CH1). FRP results are all very low ranging between 0.03 mg/L (CH7) to 0.94 mg/L (CH1). Interestingly, ammonia and FRP results for CH1 and CH2 show a high level of variability, considering they are sampled from the same shipping pocket at Berth 3.

A.3 Benthic Communities and Habitats (BCH)

A.3.1 Characteristics, Distribution and Condition of BCH

Broadscale Habitat Mapping – Champion Bay

Habitat mapping undertaken by AECOM (2020) identified that the benthic habitats of Champion Bay and the surrounding area can be broken down into a range of habitats, with the key feature of the Bay the limestone substrate which underlies most of the bay and surrounds. Limestone reef presence, relief or reef profile, and the depth of sand overlaying reef, are key factors which influence the epibenthic communities in the bay and surrounding areas. Exposure from prevailing south westerly swell and seas is also a key factor as they play a pivotal role in the movement and dispersal of sand within the bay. Deposition, erosion or frequent resuspension of sand due to wave and tidal water movement greatly influences what type of epibenthic communities colonise certain areas in the bay. Key distinctions can be seen in habitats with similar depths, topography and substrate slope but with varying levels of protection from swell and waves. AECOM described the following natural habitat types, and associated communities:

1. Deep water sand, No epibenthic macrobiota;
2. Deep water pavement with sand, Macroalgae dominant;
3. Deep water reef slope, Macroalgae;
4. High profile deep reef 1-4 m, Macroalgae dominant;
5. Sloping pavement with sand, Low density macroalgae and seagrass;
6. Pavement with sand, No macrobiota;
7. Pavement with sand, Low density seagrass;
8. Pavement with sand, High density seagrass;

9. Pavement with shallow sand, Seagrass dominant;
10. Pavement with sand, Macroalgae
11. Low profile reef with sand, Macroalgae and seagrass codominant;
12. Low profile reef with deep sand, Low density seagrass and macroalgae;
13. Low profile reef with sand, seagrass and macroalgae; and
14. High profile shallow reef 1-4 m, Macroalgae dominant.

A summary of the habitat mapping is described below. Please refer to AECOM (2019) for further details.

Deep Water Communities and Habitat (1-4)

The deep-water habitats typically occur west of a series of north south orientated limestone reef systems which run from Point Moore to the north of Champion Bay and continue on past Drummonds Point. These habitats occur where the low-profile reef with sand become the high profile reef line which forms the western edge of Champion Bay and the deep water offshore habitats of Geelvink Channel. The habitat is highly variable as it transitions from high profile macroalgae dominated reef in relatively shallow waters (8–12 m) to the deeper (>20 m) sand and sand covered pavement offshore habitats. The area is characterised by very high profile (> 4 m) reef walls and overhangs which give way to sloping pavement into deeper water. Epibenthic biota were also highly variable.

Benthic communities associated with low and high relief reef are macroalgal with common species such as red and brown algae (*Sargassum* and *Ecklonia*) with a conspicuous understory of *Amphibolis* and *Thalassodendron* seagrass. Interspersed amongst these floral assemblages are substantial patches of completely bare, heavily rippled deep sand. The deep-water reef slope benthic communities are highly variable with small red and brown algae, brown lobed algae, crustose coralline algae, and sporadic sponges and solitary hard corals including *Turbinaria*, *Faviids* and small *Acropora* species. Deep water pavement and sand habitats typically comprised no benthic communities or were dominated by *Sargassum* and *Ecklonia* some patches of low cover *Amphibolis* and *Thalassodendron*.

Limestone Pavement and Sand Communities and Habitats (5-10)

Limestone pavement, with overlying sand of varying depth which receives regular resuspension from swell waves and currents, comprise most of the habitat type in the eastern side of Champion Bay. It's characterised by gradually sloping sand veneered pavement and supports a mosaic of mixed assemblages of macroalgae and seagrass interspersed with equal areas of bare sand. The south-eastern corner of Champion Bay and directly north of the fishing boat harbour entrance is characterised by areas of stable sand generally overlaying pavement. The area receives some protection from swell waves and consequently supports large high-density seagrass meadows, typically dominated by *Halophila, Syringodium* and *Posidonia* with up to 90% coverage mapped.

The seabed in the central part of Champion Bay is the deepest continuous area in the bay forming a natural basin between the eastern nearshore area and the high-profile western reefs. The topography is relatively flat with no sloping in either direction. The area is predominantly sand covered substrate with seagrass meadows of mostly moderate to dense (up to 70% cover) *Amphibolis* with *Halophila* and *Syringodium*. Low densities of small red and brown algae, *Ecklonia* and *Sargassum* also occur.

Several areas in shallow water fringing the fishing boat harbour, and north of the Northern Reclamation DMPA, consisted of deeper sand on pavement which supported little to no benthic communities. The area is often characterised by loose seagrass and macroalgal wrack. Two areas further seaward also featured sand across large areas with very little benthic communities.

Low density seagrass meadows on sand veneered pavement account for a large area directly north of the fishing boat harbour up to the start of the shipping channel. The 10 m isobath appeared to be the depth limit for seagrass dominance in this habitat. West of the fishing boat harbour a band of low density meadows stretching from the 4 m isobath seaward to the start of the low profile reef areas gradually curving south towards Point Moore. Substrate in the area was characterised by moderately deeper sand veneers on pavement with seagrass density ranging from 5% to 50% and dominated by *Halophila*. Smaller patches of low cover *Posidonia* and *Syringodium* were also observed.

Shallow Reef Communities and Habitats (11-14)

Running along the south-eastern shoreline of the Bay from Sunset Beach southwards to just north of the marina, and extending out ~400 m from shore, is an area of dissected limestone shoreline platform with high relief at the offshore end. The habitat contains numerous holes and depressions and supports predominantly large *Ecklonia* and *Sargassum*, with occasional patches of high density *Amphibolis* and *Thalassodendron* seagrass.

North of the shipping channel, low profile reef with sand encompasses the transition between the central basin and the high-profile western reefs. Topographically, the area is predominantly moderate profile (0-1 m) with a gradual rise of approximately 2-4 m from the border of the central basin to the base of the high-profile western reefs. Macroalgae dominate the higher relief areas, while seagrass dominate the lower relief areas which also feature sand. Both biota groups were recorded at up to 50% cover with *Amphibolis* dominating the seagrass taxa and *Sargassum* with *Ecklonia* dominating the macroalgae.

The south-eastern corner of the Bay is characterised by a shallow nearshore area of low-profile reef consisting of rocks, cobbles and low-profile limestone outcrops, surrounded by areas of mostly bare sand. As the seabed becomes shallower towards the shoreline, progressively less limestone is exposed, and deep sand becomes more prominent. Reef areas support low density small algae, with areas of sand supporting low density *Posidonia* and *Halophila* seagrasses. The area also comprised areas of dense seagrass wrack on bare sand.

South of the shipping channel areas of undulating substrate comprising a mix of low-profile limestone rises interpreted with sandy patches and higher relief reef occur. Low-profile limestone predominantly comprises macroalgae, whilst sand inundated pockets support seagrass such as *Halophila* and *Posidonia*. Sections of higher relief support dense communities of small red and brown algae, *Ecklonia* and *Sargassum.* Notably, *Posidonia* is distinct to the southern areas as the northern low profile reef areas are dominated by *Amphibolis*.

Finescale Habitat Mapping – Nearshore DMPA

To support the final spatial location of the Nearshore DMPA, BMT (2021b) undertook further habitat investigations at a much finer scale. These fine scale investigations targeted three proposed placement areas. A brief description if the findings are summarised below.

Nearshore Placement Area A

Nearshore Placement area A was dominated by patches of bare sand and low relief reef (<1 m) with a mixed seagrass and macroalgal community. The seagrasses on low relief reefs included *Amphibolis antarctica*, *A. griffithii*, *Thalassodendron pachyrhizum*, sparse patches of *Halophila* spp. and *Syringodium isoetifolium*, with occasional *Posidonia australis* and *P. sinuosa*. The macroalgae growing on low relief reefs were *Sargassum* spp., *Ecklonia* spp., *Padina* spp. and other brown algae. Small patches to relatively large extensive meadows (ranging from 5–50 m) of *A. antarctica* and *A. griffithii* were recorded in some sections, along with sparse meadows of *S. isoetifolium* and *Halophila* spp. The sections of bare sand observed were either flat (no profile) or contained small ripples with undulations 1–10 cm arranged in a westerly to south-westerly direction.

Nearshore Placement Area B

Nearshore Placement Area B was dominated by large sections of bare sand with small ripples (1–10 cm undulations) aligned in a south-westerly direction and floating wrack comprised of primarily *Sargassum* spp., *Ecklonia* spp., other brown algae and some *Amphibolis* spp. leaves. The southern end comprised the largest section of bare sand. Low relief reefs (<1 m) were observed throughout the area with a mixed community of seagrass including *A. antarctica*, *A. griffithii*, *Halophila* spp., *T. pachyrhizum*, and *S. isoetifolium,* and macroalgae (*Sargassum* spp., *Ecklonia* spp. and filamentous red algae). Dense and sparse patches of *A. antarctica* were also observed throughout the area.

Nearshore Placement Area C

Nearshore Placement Area C comprised unconsolidated sediments with few areas of low relief reef (<1 m). Benthic communities were largely dominated by mixed seagrasses and macroalgae. Seagrasses included *Posidonia sinuosa, Amphibolis antarctica, A. griffithii, Halophila spp*. and *Syringodium isoetifolium*. The macroalgae growing on low relief reefs were *Sargassum spp., Ecklonia spp., Padina spp.* and other brown and red algae. The sections of bare sand observed throughout Disposal Site C were either flat (no profile) or contained small ripples with undulations 1–10 cm.

A.3.3 Champion Bay Habitat Map

Based on data from AECOM (2020) and BMT (2021b), O2 Marine (2021b) created a consolidated habit map for the Project area. The consolidated habitat map is presented in **Figure A - 1**.

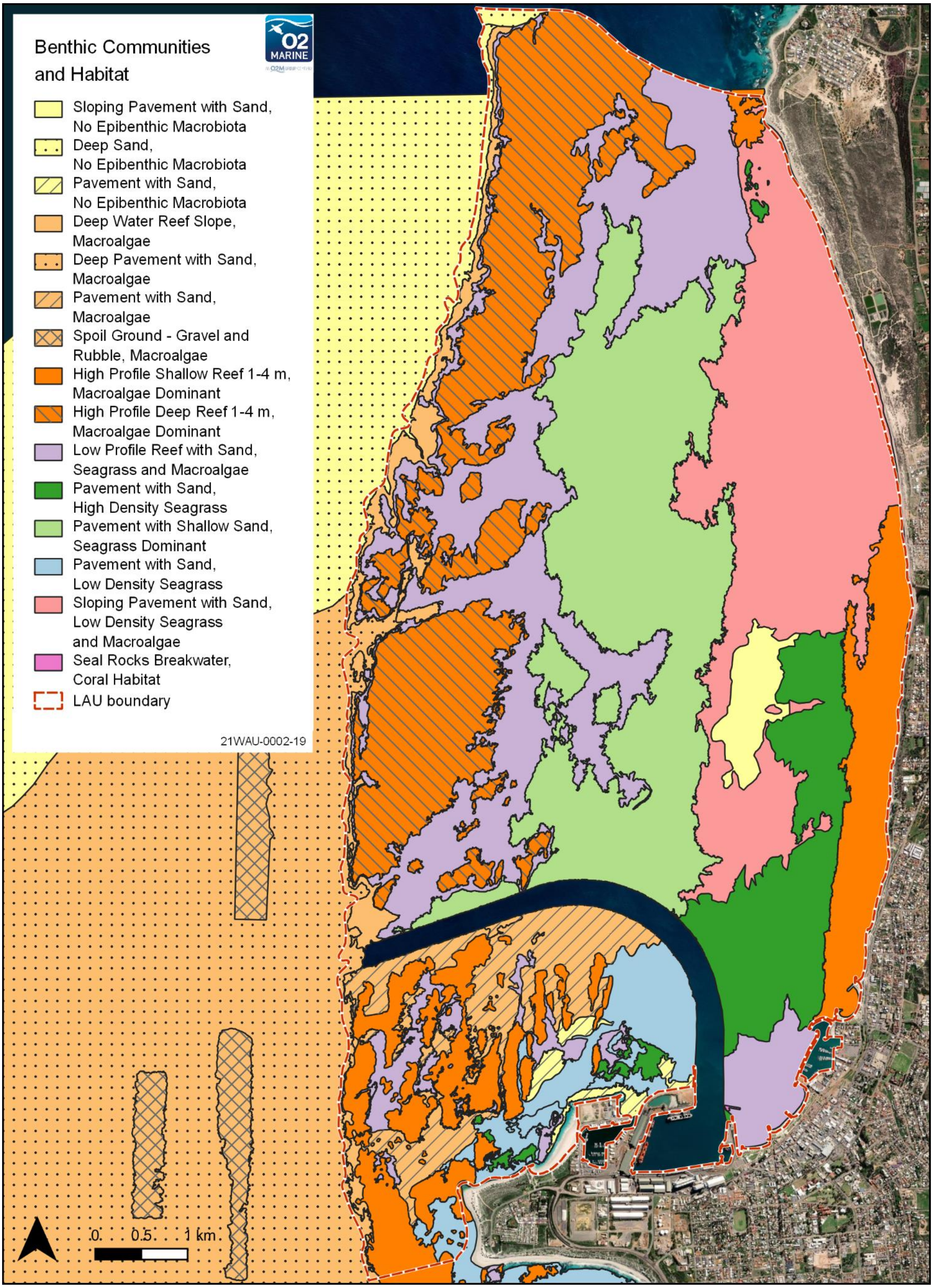

Figure A - 1 Champion Bay Benthic Communities and Habitat Map

A.3.4 Seagrass Condition

To determine the current baseline, or pre-dredging, seagrass health and condition, BMT (2021a) undertook a health investigation at key locations previously incorporated into Geraldton Port dredging programs (2002/2003 and 2012). BMT (2021a) collected data on six key seagrass health indicators across 14 sites within Champion Bay, along with sites at Greenough, Dongara and Jurien Bay to provide regional context. As many of these sites have historical data a comparison with previous data to provide statistical assessment on the current health was completed.

Overall BMT (2021) summarised that seagrass indicators, such as shoot density, shoot height, leaves per shoot/cluster and aboveground biomass measured at *A. antarctica* and *P. sinuosa* sites showed a relative increase compared to the historical dataset. BMT (2021a) also identified fluctuations within community composition and health over the years. It was identified that this had also occurred within the wider monitoring program and also worldwide. BMT (2021a) surmised that the dynamic nature of Champion Bay (strong waves and currents) are continuously responsible for redistributing sand within the Bay, which is responsible for both creating new, and destroying old BCH communities. It is also possible that global water rise, and the marine heatwave from 2011 may have been responsible for community shifts observed during 2021. It is therefore reasonable to assume that a high level of natural variability occurs within Champion Bay BCH habitats, particularly seagrasses.

A.4 Marine Fauna

O2 Marine (2021d) completed a desktop assessment search of the online EPBC Act Protected Matters Search Tool. The desktop assessment revealed that a number of threatened or migratory marine species may occur within the vicinity of the Geraldton Port channel. The main species identified include:

- Australian sea lion (Neophoca cinerea);
- Humpback whale (Megaptera novaeangliae);
- Indo-Pacific bottlenose dolphin (Tursiops aduncus); and
- Western rock lobster (Panulirus cygnus).

Geraldton is home to a small, non-breeding (male) colony of Australian sea lions (*Neophoca cinerea*). Approximately 17 to 20 mainly sub-adult males and the occasional female are known to use the breakwaters of the Port as haul-out sites (URS 2001a). The sea lion is native to Western Australia and is listed in Schedule 4 of the WA Wildlife Conservation (Specially Protected Fauna) Notice 1998.

Humpback whales (*Megaptera novaeangliae*) are found in the Geraldton area between late-May to early-December with the peak of the southern migration occurring in September to November (DEH 2005). The humpback whale is a listed threatened migratory species (Vulnerable) under the Environmental Protection and Biodiversity Conservation (EPBC) Act 1999 and is listed as rare or likely to become extinct under the Wildlife Conservation Act 1950.

Western rock lobsters (*Panulirus cygnus*) occur widely along the mid-west coastline. Juveniles are observed closer along the shoreline and within the protection of bays, such as Champion Bay and use seagrass area and shallow rocky reef areas for foraging and protection. The Geraldton region supports one of the largest commercial and recreation rock lobster fisheries in Australia, although the range is wide and extends far greater than Champion Bay.

The Indo-Pacific bottlenose dolphin (*Tursiops aduncus*) is likely to occur in the area though is considered a key species. It has a low conservation status level and is not listed under the EPBC or BC Act. However, it is listed as near threatened according to the IUCN Red List. They occur over a very wide region and are regularly seen within Champion Bay and surrounding waters.