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Geraldton Fishing Boat Harbour

2022 Maintenance Dredging – Post-dredge Benthic Communities and Habitats

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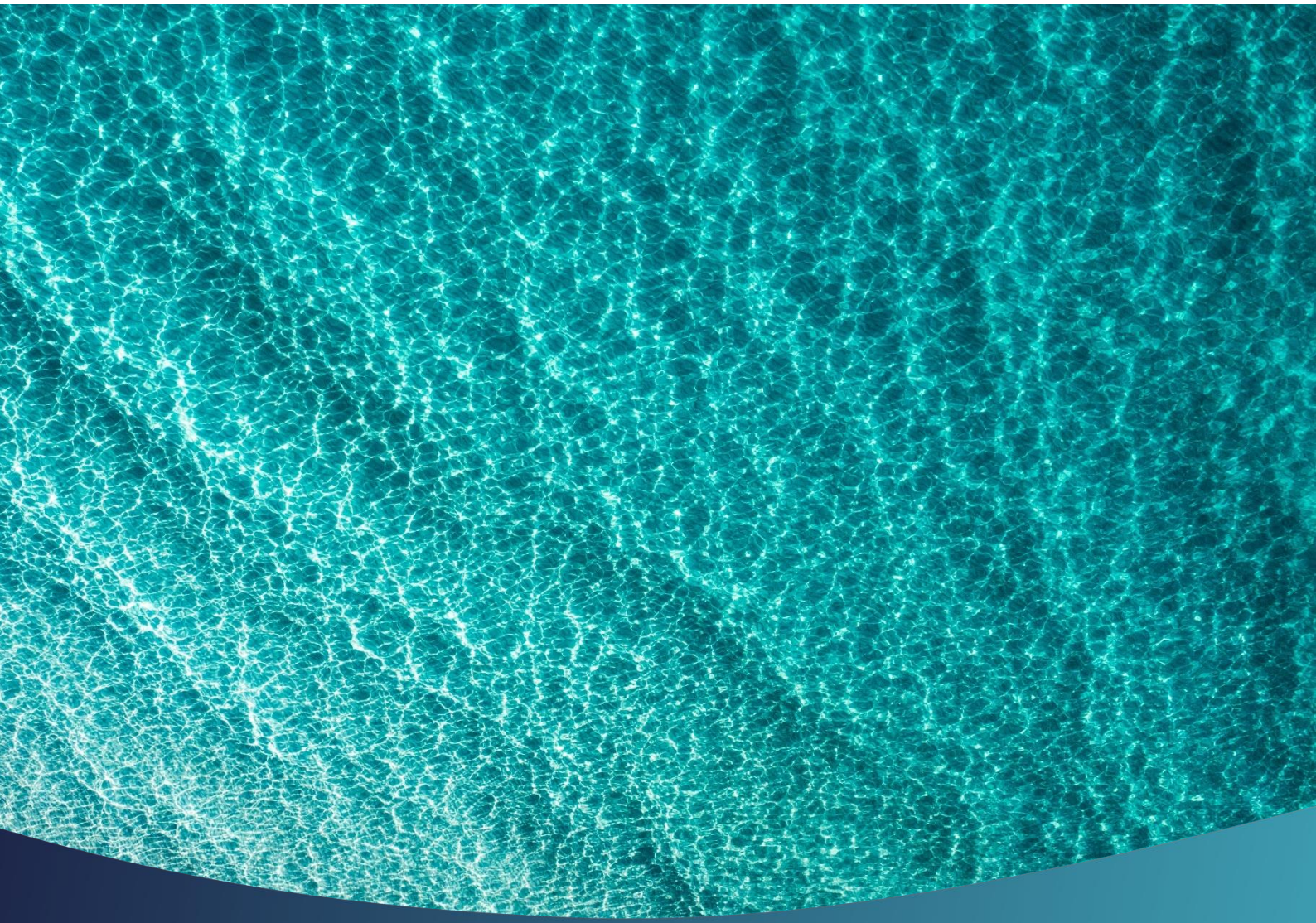

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Executive Summary

In 2022, the Midwest Ports Authority (MWPA) completed a maintenance dredging campaign which was required to reinstate design depths to the entrance channel and commercial harbour due to sedimentation which had reduced draft depths and channel width since the previous campaign in 2012. Maintenance dredging was conducted by Cooper Group of Companies Dredging Contractors between the 10th of September and the 7th of December 2022. Dredging was undertaken by the cutter suction dredge (CSD) Mudlark 1 which completed the following dredging and material placement activities:

- Removal of 22,291.29 m^3 sediments from an area of 28,793.04 m^2 via cutter suction.
- Placement of 22,291.29 m^3 of dredge material from the inner harbour via pipeline into existing land reclamation area of 21,833 m^2 north of Berth 7.

To ensure that potential project impacts are adequately managed, a project specific Dredging Environmental Management Plan (DEMP) (O2 Marine 2022a) was developed and implemented throughout the maintenance dredging campaign. The key purpose of the DEMP was to outline the Environmental Protection Outcomes (EPOs) and Management Targets (MTs) associated with the dredging and dredge material placement and outline key management and monitoring requirements to ensure the defined EPOs are achieved.

One of the requirements of the DEMP was to implement a Benthic Communities and Habitat (BCH) Monitoring Program, which comprised pre- and post-dredging surveys to assess potential impacts and validate marine environmental impact predictions to confirm EPOs have been met.

The results from the pre- and post-dredge surveys identified the following key observations:

- A total cover increase in the dominant BCH at two survey locations
- A total cover decrease in dominant BCH at three survey locations, and
- Similar pre- and post-dredge BCH total cover at the remaining seven survey locations.

No significant changes to BCH composition and total cover were observed at the majority of survey sites. Where differences were observed, it is likely that shifts were attributable to seasonal variability. More favourable growing conditions experienced within the summer months are likely to explain the two sites featuring greater cover of seagrass and macroalgal assemblages during the post-dredge survey, a result of warmer and clearer water. A change in three sites near the entrance of the harbour from sparse-low cover seagrass to become dominated by macroalgae and sea wrack is thought to be linked to seasonal current variation.

Seagrass cover at sites nearest the dredge area either maintained high cover, or in one case, increased from medium to high cover. In light of the survey results, it appears that there is no evidence to indicate that the dredging operation and placement of clean sandy sediments within Berth 7 had an adverse impact on the seagrass beds in proximity of the Dredge Material Placement Area (DMPA). As such, it is considered that the defined EPOs and MTs established for BCH were considered to have been met for this dredge operation.

Acronyms and Abbreviations

Acronyms/Abbreviation	Description
BCH	Benthic Communities and Habitats
DEMP	Dredge Environmental Management Plan
DMPA	Dredge Material Placement Area
EIA	Environmental Impact Assessment
EPA	Environmental Protection Authority
EPO	Environmental Protection Outcome
MT	Management Target
MWPA	Mid-West Ports Authority
ROV	Remote Operated Vehicle

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1. Introduction

1.1. Background

The Port of Geraldton is located approximately 430 km north of Perth in the Mid-West region of Western Australia (Figure 1). The Port is administered by the Midwest Ports Authority (MWPA) and presently consists of an entrance channel, a seven berth Commercial Harbour, a large fishing boat harbour, a tug pen and associated land-based infrastructure.

The Midwest Ports Authority (MWPA) are responsible for the ongoing management and environmental performance of the Fishing Boat Harbour (FBH), adjacent Port and Port Waters. MWPA carried out maintenance dredging between 10th of September and the 4th of December 2022, where 22,291.29 m^3 of accumulated sediments were removed within the FBH entrance and adjacent Lives Beach. Sediments were considered of natural origins and free from contamination and were relocated to the existing Berth 7 dredge material placement area (DMPA).

Environmental management requirements for the dredging operation were set out in a Dredge Environmental Management Plan (DEMP) (O2 Marine 2022a), which defined environmental quality trigger levels to facilitate assessment of project Management Targets (MTs) and Environmental Protection Outcomes (EPOs). Included in the DEMP is the requirement to undertake monitoring of benthic communities and habitat (BCH) prior to and post-completion of the dredging operation, which is the focus of this report.

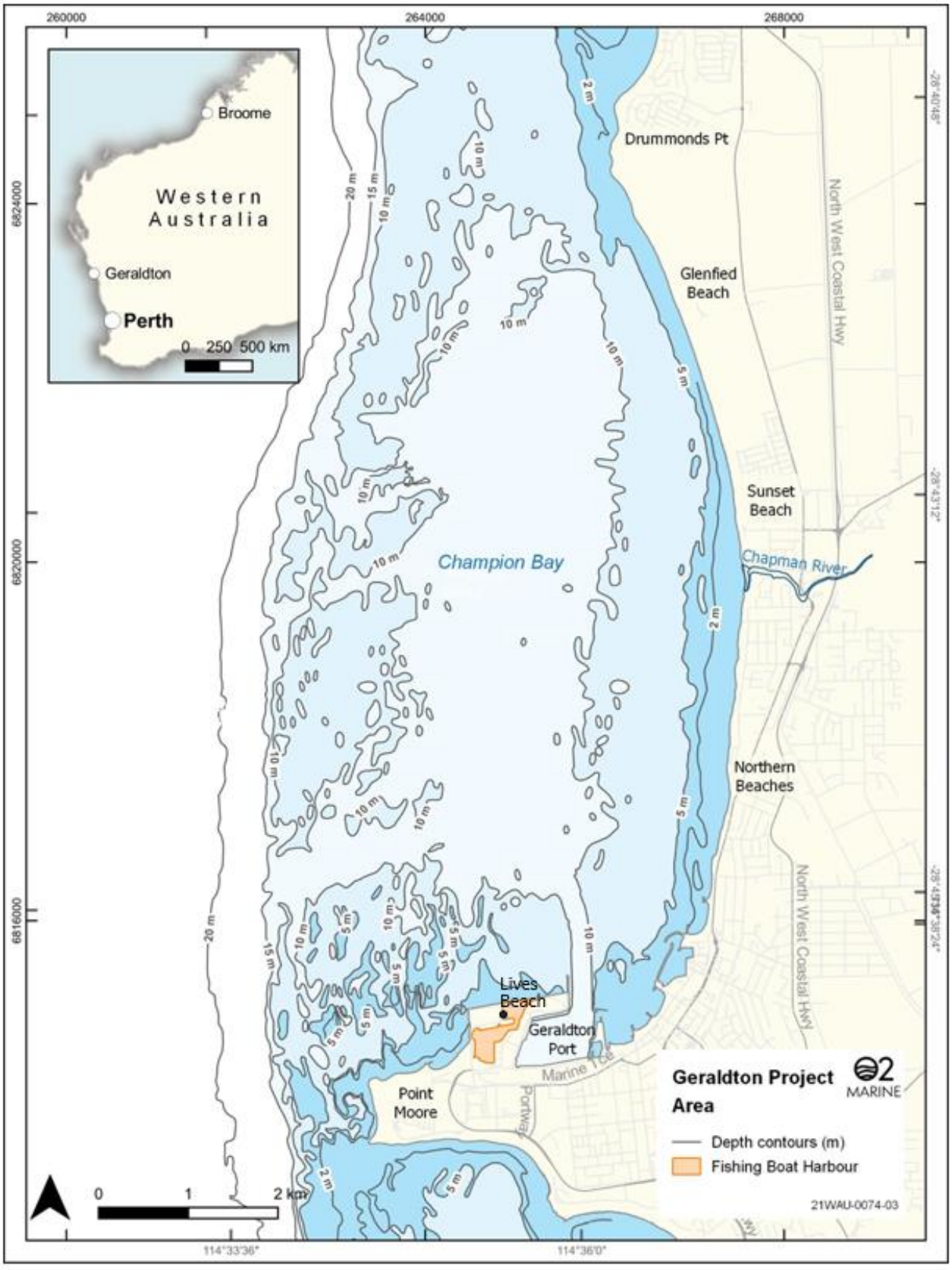


Figure 1 Geraldton Port location map

1.2. Project Description

A summary of project and operational activities are presented in Table 1 and Table 2, while the locations of activities are presented in Figure 5.

Table 1 Summary of the Project

Project Title	Geraldton Fishing Boat Harbour 2022 Maintenance Dredging Project
Proponent Name	Midwest Ports Authority
Short Description	Maintenance dredging of accumulated sediments within the FBH entrance and adjacent Lives Beach removed a volume of 22,291.29 m^3. Sediments are considered of natural origins and free from contamination and were relocated to the existing Berth 7 DMPA.

Maintenance dredging was conducted by CGC Dredging between 10th of September 2022 and 7th of December 2022. A cutter suction dredge (CSD Mudlark 1; Figure 2) was used to remove 22,291.29 m^3 of sediments from a dredge footprint area of 28,793.04 m^2. Dredge material was placed into the existing land reclamation cell north of Berth 7 (Figure 5).

CSDs are typically non-propelled barges equipped with a hydraulic cutterhead, suction pipe and pumps. During dredging, the cutterhead is lowered to the seabed, rotating and disturbing the material to be dredged. The cut material together with water is drawn into the suction mouth. A slurry mixture is then transported by the dredge pump through the discharge pipeline to the designated discharge site.

While operating, the CSD is considered stationary, with spud and anchor systems used for positioning the dredge within the dredging area. During the dredging works, a spud is lowered in the seabed to secure the vessel. Winches and anchors are used to swing the dredge from side to side allowing the cutterhead to removes material from the seabed.

The CSD used (Mudlark 1) had the following specifications:

- Displacement: 48 tonnes
- Hull Length: 18 m
- Breadth: 5 m
- Pump: Warman 250mm high head dredge pump.
- Draft: 900mm

Figure 2 CSD used in dredging program – Mudlark 1

In common with the 2002/2003 capital dredge, and the 2012 and 2021 maintenance dredge projects, dredged material was relocated to the existing Berth 7 DMPA (Figure 5). The reclamation area is double lined with a layer of geotextile cloth and plastic membrane on the northern, eastern and western sides (Figure 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. 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 discharge pipeline within the DMPA was varied over the duration of the dredging to allow for the even placement of sediments within the area (Figure 4). Excess water ('tailwater') returned to the northwest corner of the harbour via existing return water outlet pipes located in the south-western corner of the reclamation area (Figure 4 and Figure 5). A geotextile silt curtain will be installed within the reclamation area prior to the outlet pipes to minimise fine sediment release to the Harbour.

Table 2 Location and extent of operational dredging and material placement activities

Element	Location	Proposed Extent
Maintenance dredging of accumulated FBH entrance and Lives Beach sediments	Figure 5	Removal of 22,291.29 m^3 of sediments from a dredge footprint area of 28,793.04 m^2 via cutter suction dredge.
Land reclamation within existing Berth 7 DMPA	Figure 5	Placement of 22,291.29 m^3 of dredge material into existing land reclamation cell north of Berth 7.

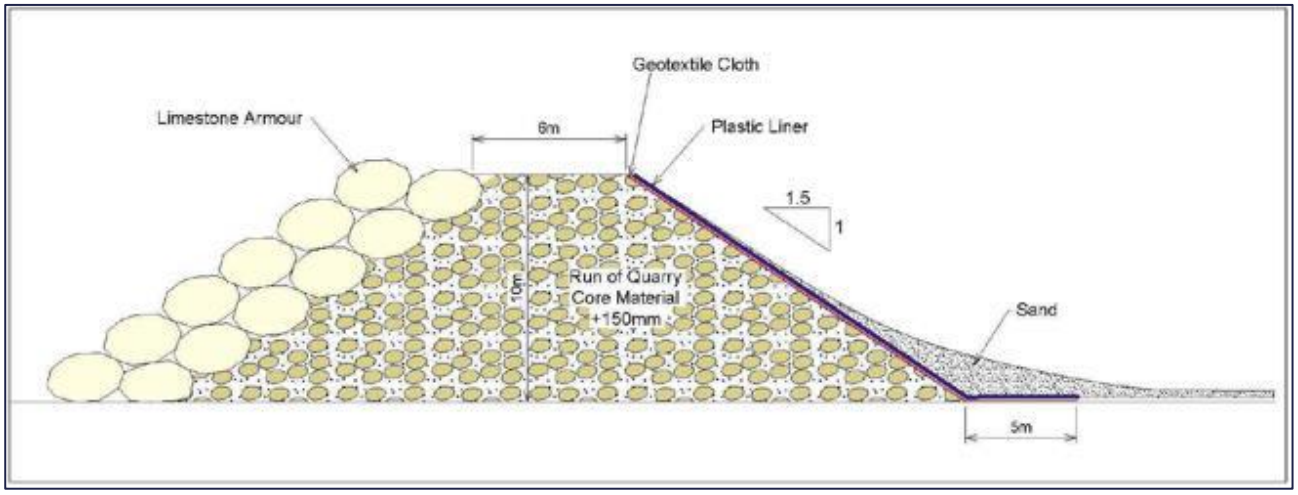


Figure 3 Bund wall cross section

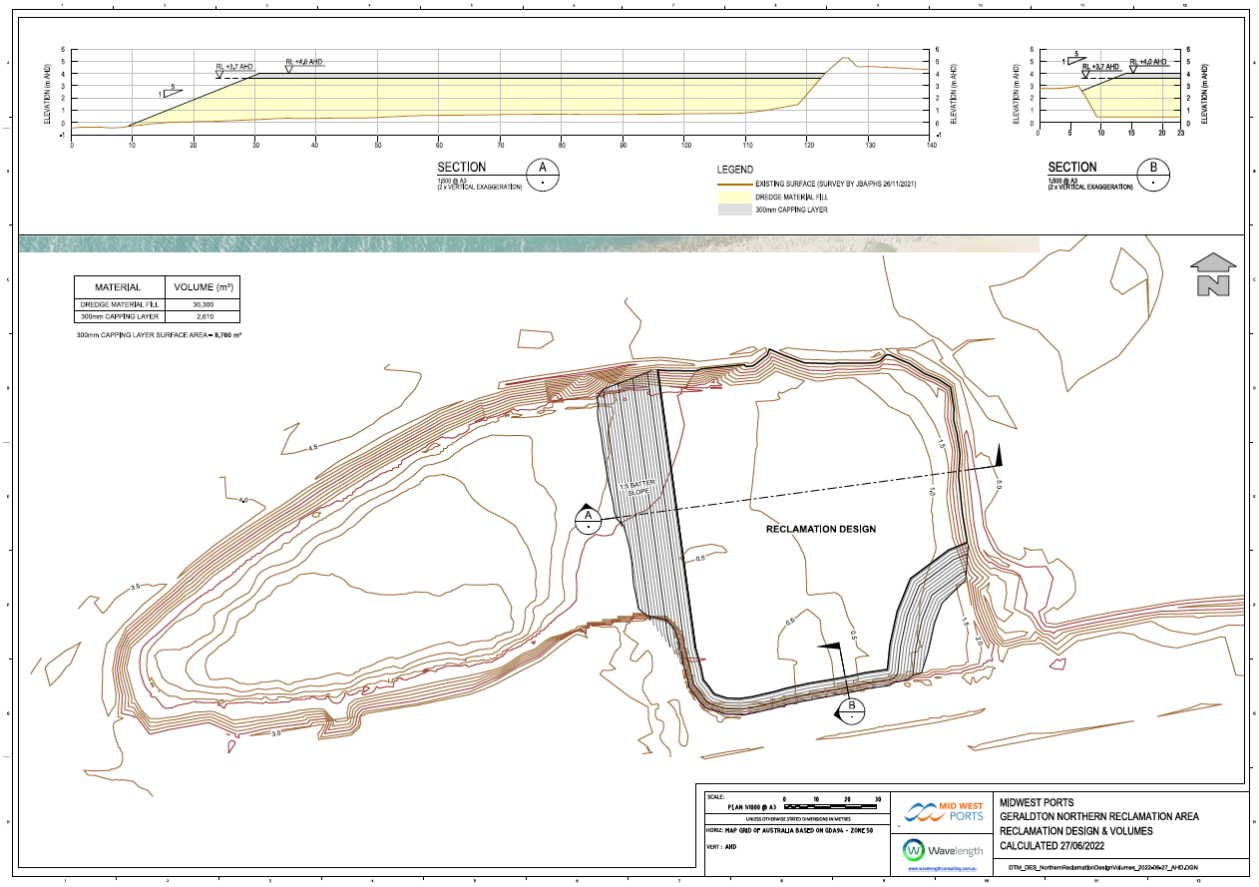


Figure 4 Berth 7 Dredge Material Placement Area and Tailwater Return Pipes

1.2.1. Dredge Program

Dredging works were completed over 84 days, commencing 10th of September 2022 to completion on 7th of December 2022. Dredging works were typically undertaken 6 days per week (Monday to Saturday). Several significant delays to dredging occurred due to breakdowns and damage to the dredging equipment. A summary of the programme is shown in Table 3.

The following significant delays (>2 days) occurred during the dredging works:

- 12 September - 15 September (2.5 days): combined sea state delay and repairs (crack in the auxiliary spud carriage)
- 22 September - 11 October (19 days):
- Snapped spud wires, awaiting divers to retrieve (5 days).
- While awaiting divers, both the main and auxiliary spuds were stuck in the seabed without the ability to lift either spud, causing significant damage to the auxiliary spud and spud carriage. In attempting to release the spuds, the auxiliary spud was snapped off with the top 6m retrieved and the remaining 4m left below the seabed. Dredge retrieved to hardstand, various repairs and maintenance undertaken. Dredge modified to operate on a single (main) spud only (14 days).
- 29 October – 1 November (3 days): standby due to poor sea state.

Table 3 2022 Dredging program

Date	Item
8-12 August 2022	Early works to prepare the Berth 7 reclamation
24-27 August 2022	Pre-dredge survey, including setup and calibration
22 August 2022	Mobilisation commenced
10 September 2022	Dredging commenced
7 December 2022	Dredging complete
14 December 2022	Demobilisation of dredging equipment complete
7-9 December 2022	Post-dredge survey, including setup and calibration

Figure 5 Dredging and dredge material placement area footprints.

1.3. This Report

The report presents a summary of the findings of BCH monitoring requirements within the DEMP to ascertain whether the project MTs and EPOs have been achieved. The post-dredge BCH survey results are assessed against the Performance Assessment Criteria outlined in the DEMP.

2. Dredge Environmental Management Plan

2.1. Overview

During planning for the maintenance dredging works MWPA commissioned an Environmental Impact Assessment (EIA) to ensure that potential project impacts were adequately identified and assessed (O2 Marine, 2022b). The EIA identified potential impacts and their proposed management which were subsequently incorporated into a project specific DEMP. The key purpose of the DEMP was to outline the EPOs and MTs associated with the dredging and placement of dredge material. Detailed management actions and monitoring programs were included to ensure that the project EPOs were achieved.

A BCH monitoring program was implemented to validate the following predicted outcomes (undertaken as part of the EIA):

- No irreversible loss, or serious damage to benthic communities outside the dredge footprint.
- No detectible reduction from the baseline state of benthic communities outside the dredge footprint.

In accordance with the DEMP, the BCH monitoring program was conducted pre- and post-dredging to assess potential impacts to confirm if EPOs have been achieved.

2.2. Environmental Protection Outcomes and Management Targets

The specific EPOs and MTs for the protection of BCH were outlined in the DEMP and are summarised in Table 4.

Table 4 Environmental Protection Outcomes, Management Targets and potential environmental impact pathways

Environmental Factor	EPA Objective	Potential Environmental Impact Pathway	Environmental Protection Outcome (EPO)	Management Target (MT)
Benthic communities and Habitat (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 direct impacts or irreversible loss of BCH outside of the dredge footprint as spatially defined in Figure 5.	Dredging operations do not occur outside the dredge footprint as spatially defined in Figure 5.
		Indirect impacts to BCH due to reduction in available light caused by increase in suspended sediments released into the water column during dredging.	No indirect or irreversible loss of BCH from baseline conditions outside the dredge footprint as spatially defined in Figure 5.	No detectable reduction in baseline condition of BCH outside of the dredge footprint as spatially defined in Figure 5.

2.3. Benthic Communities and Habitat Performance Assessment Criteria

To determine if the project defined EPOs and MTs have been met, Performance Assessment Criteria were defined within the DEMP under the BCH monitoring program. Performance Assessment Criteria applied to the dredge project are summarised in Table 5 below.

Performance Assessment Criteria were developed to ensure impacts from dredge plumes associated with dredging, onshore placement and smothering from sediment transport are not outside the limits acceptable to achieve the Project EPOs and MTs. Where unacceptable impacts are identified, ongoing monitoring is required to assess the rate of recovery and ensure BCH returns to pre-dredge condition and extent.

Table 5 Performance Assessment Criteria applied for the 2021 maintenance dredging project.

Monitoring Locations as per Figure 6	
Performance Measure: Early warning for no negative change from baseline state in BCH	Performance Assessment Criteria 1
	Visible dredge plume from dredge activities extends over nearest sensitive receptor.
Management Target: No detectible reduction from the baseline state of BCH	Performance Assessment Criteria 2
	Visible dredge plume from dredge activities extends over nearest sensitive receptor for six consecutive days and/or Significant community shift related to dredging observed between pre- and post-dredge monitoring
Environmental Protection Outcome: No detectible reduction from the baseline state of BCH	Performance Assessment Criteria 3
	Annual BCH monitoring identifies recovery from observed impacts within less than 5 years

The post-dredge BCH survey results will present an assessment against the Performance Assessment Criteria presented within Table 5. If Performance Assessment Criteria 2 is achieved, then the EPO is considered met and no further monitoring is required.

If Performance Assessment Criteria 2 is not achieved, 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.

3. Survey Methods

The BCH study area and survey effort for the pre- and post-dredge surveys is presented in Figure 6. The pre-dredge BCH survey took place between the 18th-20th of July 2022, and the post-dredge BCH survey on the 7th of February 2023. The surveys were undertaken using drop camera deployments using a Remotely Operated Vehicle (ROV) to provide visual records of BCH. Monitoring locations were chosen as locations that were identified as being at greatest risk from the maintenance dredging project. Figure 6 shows locations of monitoring locations relative to BCH distribution. Exact coordinates of monitoring locations are presented in Table 6.

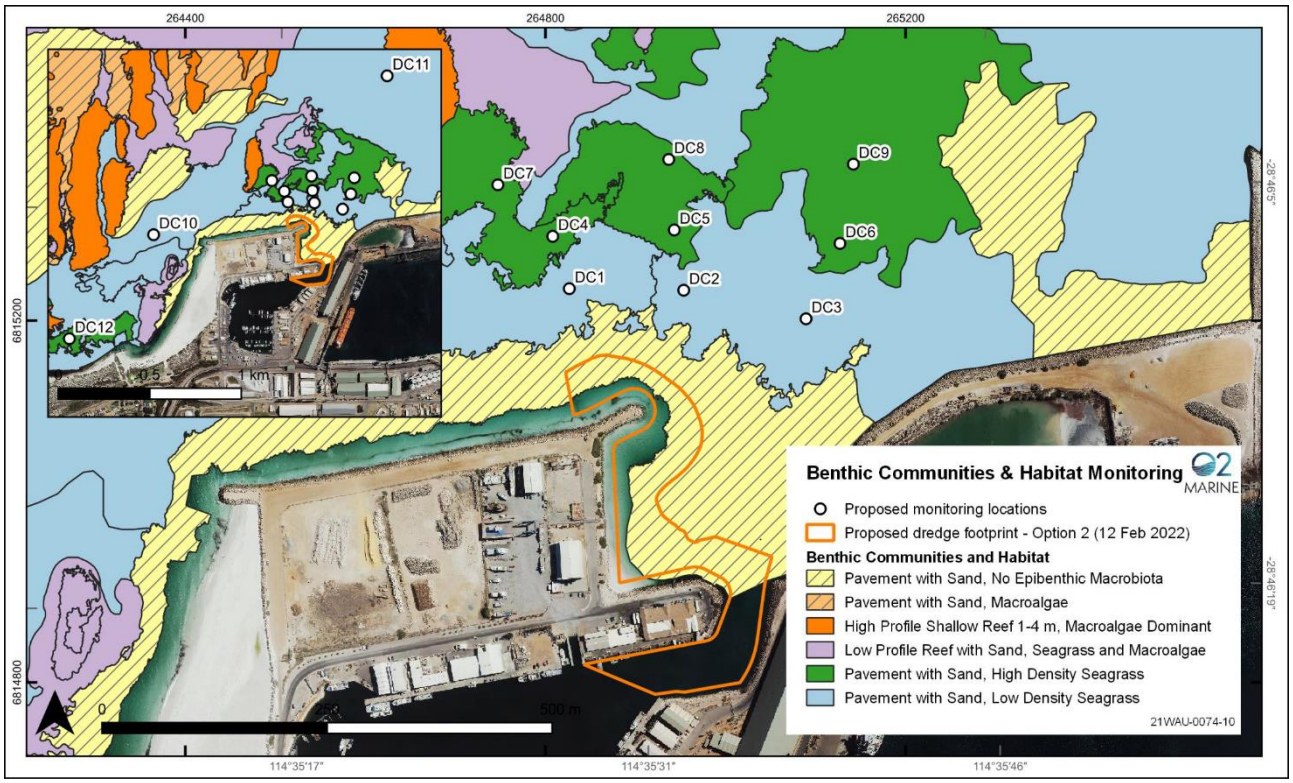


Figure 6 Pre- and post-dredge BCH survey effort and study locations

Table 6 Monitoring location coordinates (GDA94 MGA50)

Site ID	Easting	Northing
DC1	264826	6815234
DC2	264953	6815232
DC3	265089	6815200
DC4	264807	6815292
DC5	264942	6815299
DC6	265126	6815284
DC7	264774	6815368
DC8	264936	6815377
DC9	265141	6815371
DC10	264185	6815044
DC11	265288	6815927
DC12	263792	6814472

3.1. Survey Methodology

Targeted ground-truth benthic videography was conducted at each of the monitoring locations (Table 6). O2 Marine's FiFish V6 ROV was used to collect video transects at each site. At each site, the ROV was positioned laterally (i.e., camera view directly down) approximately 2-3 m from the seafloor and a haphazard transect was recorded based upon the surge vector. Approximately 30-40 seconds of footage was analysed visually in the field via the topside control viewfinder, enabling approximately 20 m of seafloor imagery to be captured per transect.

3.2. Data Analysis

3.2.1. Ground-truth Video Classification

Footage from all underwater ROV videos were classified according to benthic habitat type. Habitat and substrate classification was made in accordance with the Collaborative and Automated Tools for Analysis of Marine Imagery (CATAMI) standard classification scheme for scoring marine biota and physical characteristics from underwater imagery which includes:

- relief
- substrate
- bedforms
- visual estimate of cover of benthic flora and fauna, and
- the dominant and sub-dominant taxa.

For classification purposes, an estimate average per transect was applied (e.g., a small patch of high-cover seagrass next to a patch of bare sand was classified as medium-cover seagrass.).

An overview of the classification system based on CATAMI and as applied to each survey is presented within Table 7.

Table 7 BCH Classification system for video analysis

Relief		Substrate Type		Bedform		Total Cover		BCH			
F	Flat	S	Sand	N	None	B	Bare (<1%)			Ph	Mixed Phaeophyceae
L	Low (<1m)	LP	Limestone Pavement	2DW	Waves (>10cm Parallel)	S	Sparse (1-3%)	Ma	Macroalgae	Rh	Mixed Rhodophyta
		LPS	Limestone Pavement With Sand Veneer	3DR	Ripples (<10cm Uneven)	L	Low (3-10%)			Ha	Halimeda spp.
		R-LP	Rock – Low Profile	3DW	Waves (>10cm Uneven)	M	Medium (10-25%)			Sa	Sargassum spp.
						H	High (25-75%)			Ec	Ecklonia spp.
										TA	Unidentified turf algae
								S	Seagrass	Ms	Mixed Seagrass
										Am	Amphibolis spp.
										Po	Posidonia spp.
										Th	Thalassodendron spp.
										Ha	Halophila spp.
										Sy	Syringodium spp.

4. Results

4.1. Performance Assessment

Dredging occurred intermittently between 10th of September and 7th of December 2022 due to equipment break down and weather (Table 3). Dredging operations only occurred during daylight hours. Therefore, the opportunity to reach the assigned criteria for action was limited, as plumes dissipated quickly each time the dredge stop operations.

4.1.1. Performance Criteria 1 - Visible Plumes

Criteria was not reached. Plume sketches and aerial images confirm this. See below examples of aerial imagery (Figure 7, Figure 8, Figure 9) and plume sketch (Figure 10) captured during a period of continuous daily dredging during December 2022. Figure 8 is a zoomed image of Figure 7b, revealing the minimal spatial extent of the dredge plume relative to nearby sensitive receptors. Site visits and visual inspections by MWPA during the project also validated that Performance Assessment Criteria 1 was not triggered.

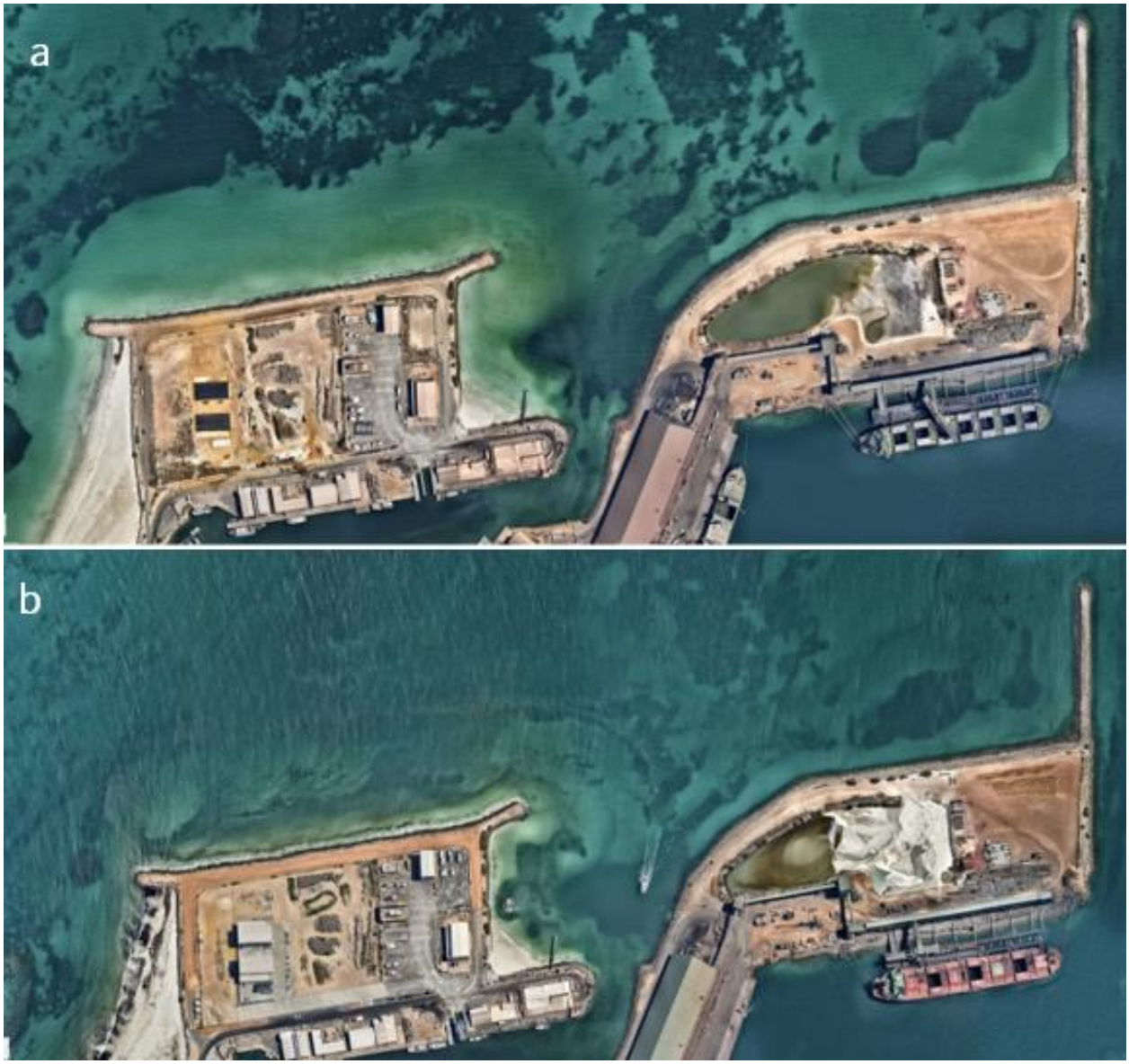


Figure 7 a) Pre dredge (February 2022), b) During dredging (December 2022)

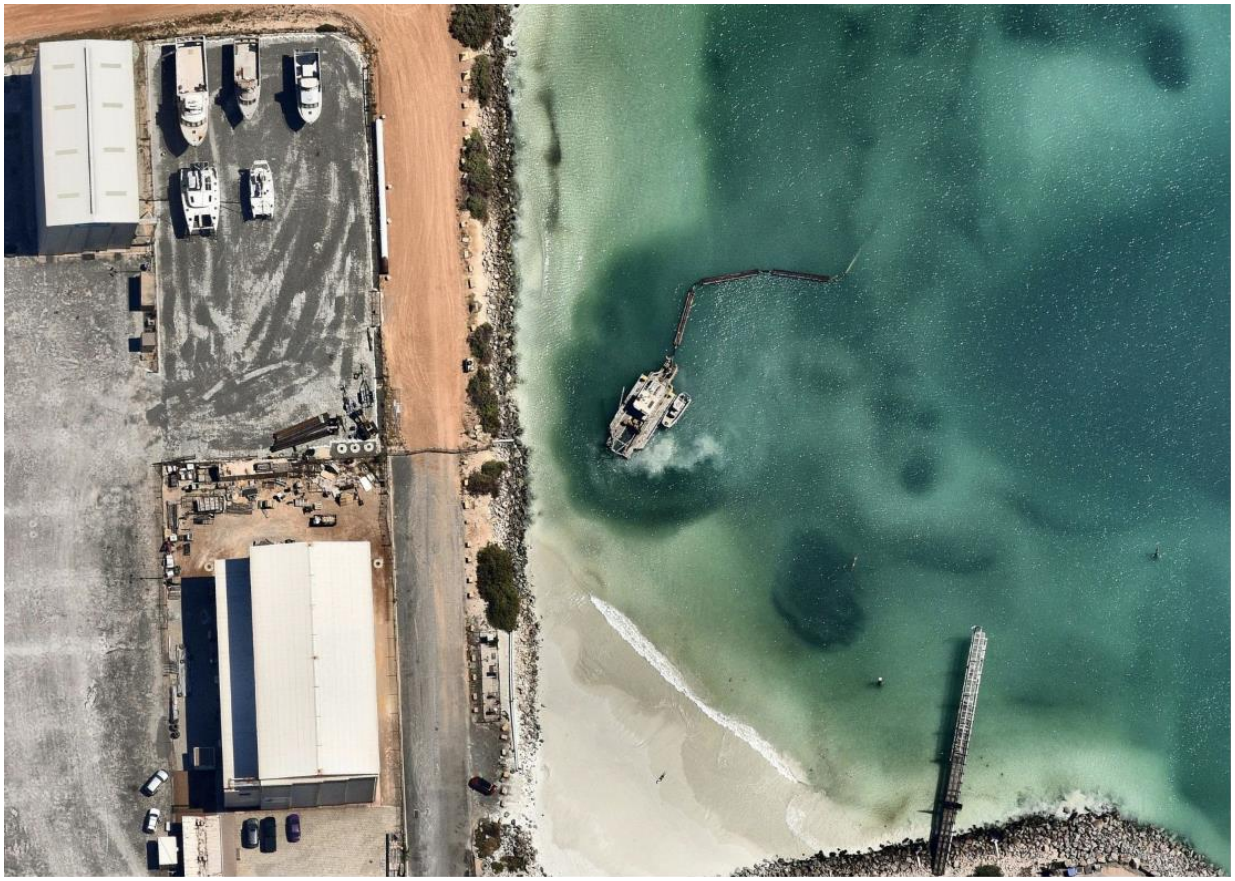


Figure 8 Typical dredge plume - 7th of December 2022

Figure 9 Aerial imagery of Berth 7 at various stages of the dredging program: Before (May), During (September, December), After (May 2023).

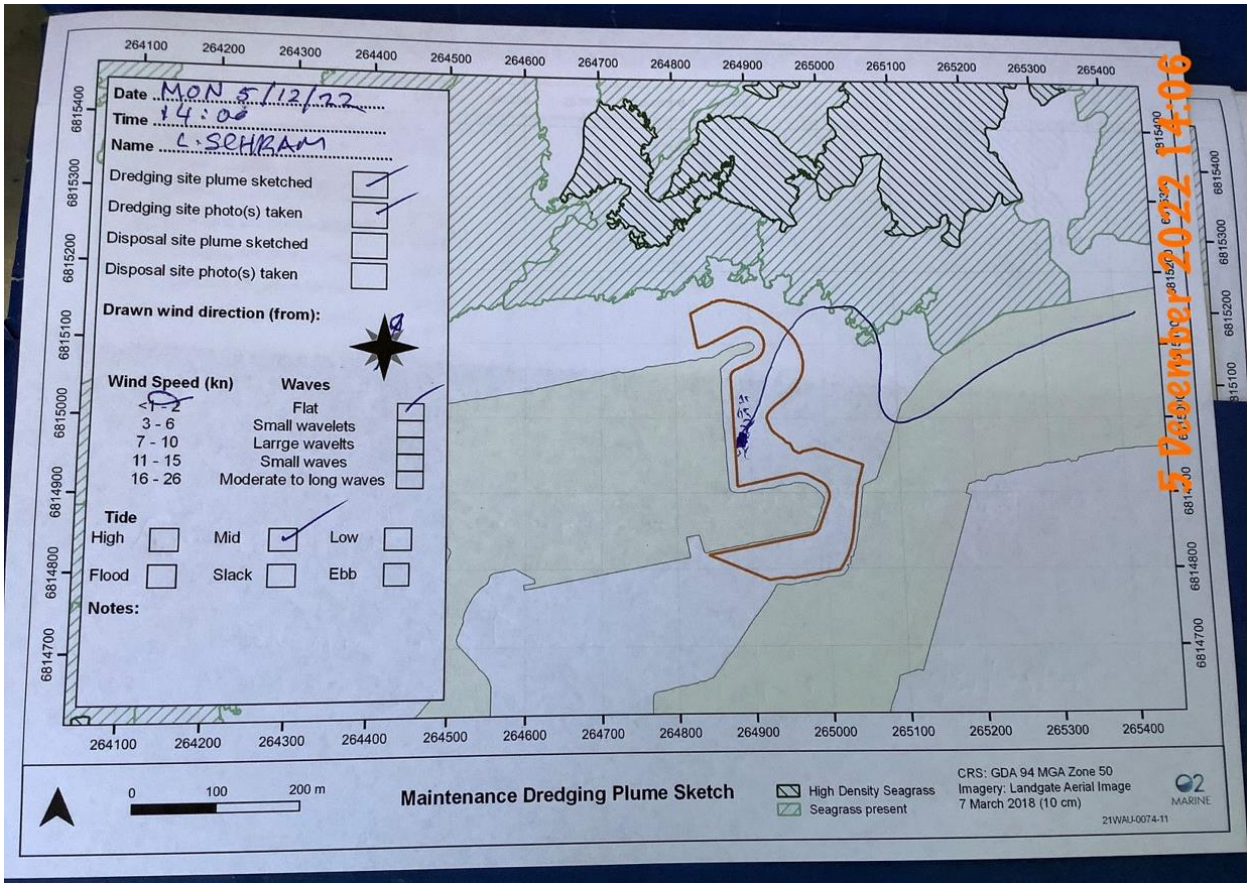


Figure 10 Plume Sketch example

4.1.2. Performance Criteria 2 – Visible Plumes

No visible plumes extended over the nearest sensitive receptors. This was validated by plume sketches and site inspections. Dredging was carried out intermittently, with the longest continuous period of dredging being 6 days. The post-dredge BCH survey did not identify any significant shift in benthic communities as discussed further in the following section of this report.

4.1.3. Performance Criteria 2 – Post Dredge BCH Assessment

4.1.3.1. BCH Classification from Analysis of Ground Truth Video Data

Table 8 presents the results from the targeted ROV videography sites, which provides a comparison of pre-dredge and post-dredge classification. Where the dominant BCH cover increased, green font has been applied to the post-dredge survey results. Alternatively, where the dominant BCH cover decreased, red font has been applied to the post-dredge results. If similar results were obtained, then no colour has been applied to the post-dredge survey results. Additionally, Figure 11 illustrates the spatial distribution of significant BCH total cover changes. Overall, the post-dredge survey results indicated:

- total cover increase in the dominant BCH at one survey location
- total cover decrease in dominant BCH at three survey locations, and
- similar pre- and post-dredge BCH total coverage at the remaining eight survey locations.

Further detail for each of the targeted survey areas is presented below. Representative video stills from the pre- and post-dredge surveys for each survey location are presented in Table 9.

4.1.3.2. Pre-dredge Survey

BCH type was variable across the survey sites, with a diversity of biotic assemblages across the entire area, while sand was the dominant substrate type and was observed at all sites. Where exposed sandy substrate was observed, it often occurred in uneven ripples < 10 cm high (DC1, DC2, DC11) or in wave patterns > 10 cm high (DC3, DC10). At DC9, sand was mixed with high quantities of shell fragments. Unvegetated sand was recorded at sites DC10 and DC11. These sites were located west and north-east of the FBH respectively (Figure 11).

Seagrass of varying densities and assemblage type was recorded at 10 out of 12 sites. High cover seagrass was recorded at six sites (DC4, DC5, DC7, DC8, DC9, DC12), medium cover seagrass recorded at one site (DC6) and sparse to low cover seagrasses observed at three sites (DC1, DC2 and DC3). The latter three sites were located in closest proximity to the harbour entrance (Figure 11). Seagrass at sites DC1 and DC2 had comparatively high levels of epithetic algal growth on the seagrass assemblages (relative to seagrass at other sites).

Posidonia spp. was consistently recorded as the dominant taxa across all seagrass-hosting sites. The most common assemblage of seagrass was a mix of *Posidonia spp.* and *Halophila ovalis*. This mix occurred at seven sites (DC1, DC4, DC5, DC6, DC7, DC8, DC9). Two sites (DC2, DC12) exclusively featured *Posidonia spp.*.

4.1.3.3. Post-dredge Survey

As with the pre-dredge survey, BCH was variable across the survey sites, with a diversity of biotic assemblages across the entire area. Several sites recorded patches of bare sand directly adjacent to high cover seagrass and then a mixed community of seagrass and macroalgae. As with the pre-dredge survey, only the dominant substrate or BCH type was recorded for each site.

Sandy substrate was the dominant habitat type being recorded at all 12 sites. Areas of bare sand were observed at D2, D3 and DC11. The former two sites had varying densities of mobile benthic sea wrack, whereas DC11 was characterised as completely bare sand with uneven ripples < 10 cm high. Sites where seagrass was absent were mostly characterised by varying densities of benthic sea wrack (DC2, DC3). Drop camera footage

from DC1 revealed a similar appearance to the former two sites, however the high cover of macroalgal matter made it impossible to verify if it the materials was attached to the substrate, or if it was a high cover of sea wrack. These sites were located closest to the fishing boat harbour entrance (Figure 11).

Seagrass of varying types were recorded at eight out of 12 sites. All sites where seagrass was present were characterised as high total cover. Six sites (DC4, DC5, DC6, DC7, DC8, DC9) featured mixed assemblages where *Posidonia spp.* was the dominant taxa and *Halophila ovalis* was the subdominant taxa. Two of these sites (DC6, DC7) additionally hosted subdominant taxa of *Syringodium spp.*. One site (DC12) featured only *Posidonia spp.* and no other seagrass species.

Subdominant macroalgal assemblages existed at three sites (DC4, DC9, DC10), with the former two sites characterised by low and sparse cover of *Ecklonia spp.* DC10 featured a medium cover subdominant assemblage of turf algae, existing around the base of *Halophila ovalis.*

Table 8 ROV Video BCH Classifications – Pre- and Post-Dredge Surveys

Site ID	Date	Relief	Substrate Type	Bedforms	Dominant BCH (Cover)	Subdominant BCH (Cover)	Dominant Taxa	Subdominant Taxa	Comments
DC1	July 22	L	S	3DR	S (L)	-	Po	Ha	Area of low-cover Posidonia spp. with epithetic algal growth covering. Some H. ovalis present.
	February 23	L	S	N	-	-	-	-	Macroalgal assemblage (Ecklonia radiata, Sargassum spp., Amphibolos spp.) Difficult to determine if attached to substrate
DC2	July 22	L	S	3DR	S (S)	-	Po	-	Sparse instances of Posidonia spp. Fine benthic sea wrack and epithetic algal growth on seagrass.
	February 23	L	S	3DR	-	-	-	-	Bare sand and sparse benthic sea wrack
DC3	July 22	L	S	3DW	S (L)	-	-	-	Sparse Posidonia spp. Fine benthic sea wrack
	February 23	L	S	N	-	-	-	-	Bare sand and low benthic sea wrack
DC4	July 22	L	S	N	S (H)	-	Po	Ha	Posidonia spp. interspersed with H. ovalis
	February 23	L	S	N	S (H)	Ma (L)	Po	Ha, Ec	Posidonia spp. interspersed with H. ovalis patches. Instances of macroalgae throughout (Ecklonia). Hard to verify if attached.
DC5	July 22	L	S	N	S (H)	Ma (S)	Po	Ha, Ec	Posidonia spp. interspersed with H. ovalis patches. Instances of macroalgae throughout (Ecklonia). Hard to verify if attached.
	February 23	L	S	N	S (H)	-	Po,	Ha	Posidonia spp. interspersed with H. ovalis patches. Instances of macroalgae throughout (Ecklonia). Hard to verify if attached.

Site ID	Date	Relief	Substrate Type	Bedforms	Dominant BCH (Cover)	Subdominant BCH (Cover)	Dominant Taxa	Subdominant Taxa	Comments
DC6	July 22	L	S	N	S (M)	-	Po	Ha	Patchy areas of Posidonia spp. and H. ovalis, exposed sand and shell fragments.
	February 23	L	S	N	S (H)	-	Po	Ha, Sy	Posidonia spp. interspersed with H. ovalis and Syringodium spp.
DC7	July 22	L	S	N	S (H)	-	Po	Ha	Posidonia spp. with some H. ovalis. Some patches of bare sand.
	February 23	L	S	N	S (H)	-	Po	Ha, Sy	Posidonia spp. H. ovalis and Syringodium spp.
DC8	July 22	L	S	N	S (H)	-	Po	Ha	Posidonia spp., meadow interspersed with H. ovalis.
	February 23	L	S	N	S (H)	-	Po	Ha	Posidonia spp. meadow interspersed with H. ovalis.
DC9	July 22	L	S	N	S (H)	-	Po	Ha	Patchy areas of Posidonia spp. and H. ovalis, exposed sand and shell fragments.
	February 23	L	S	N	S (H)	Ma (S)	Po	Ha, Ec	Posidonia spp. meadow interspersed with H. ovalis and macroalgae.
DC10	July 22	L	S	3DW	-	-	-	-	Bare sediment with 3D waves.
	February 23	L	S	N	S (H)	Ma (M)	Ha	Ta	H. ovalis with turf algae.
DC11	July 22	L	S	3DR	-	-	-	-	Bare sand with 3D ripples
	February 23	L	S	3DR	-	-	-	-	Bare sand with 3D ripples
DC12	July 22	L	S	N	S (H)		Po		High cover Posidonia spp. meadow
	February 23	L	S	N	S (H)	-	Po	-	High cover Posidonia spp. meadow

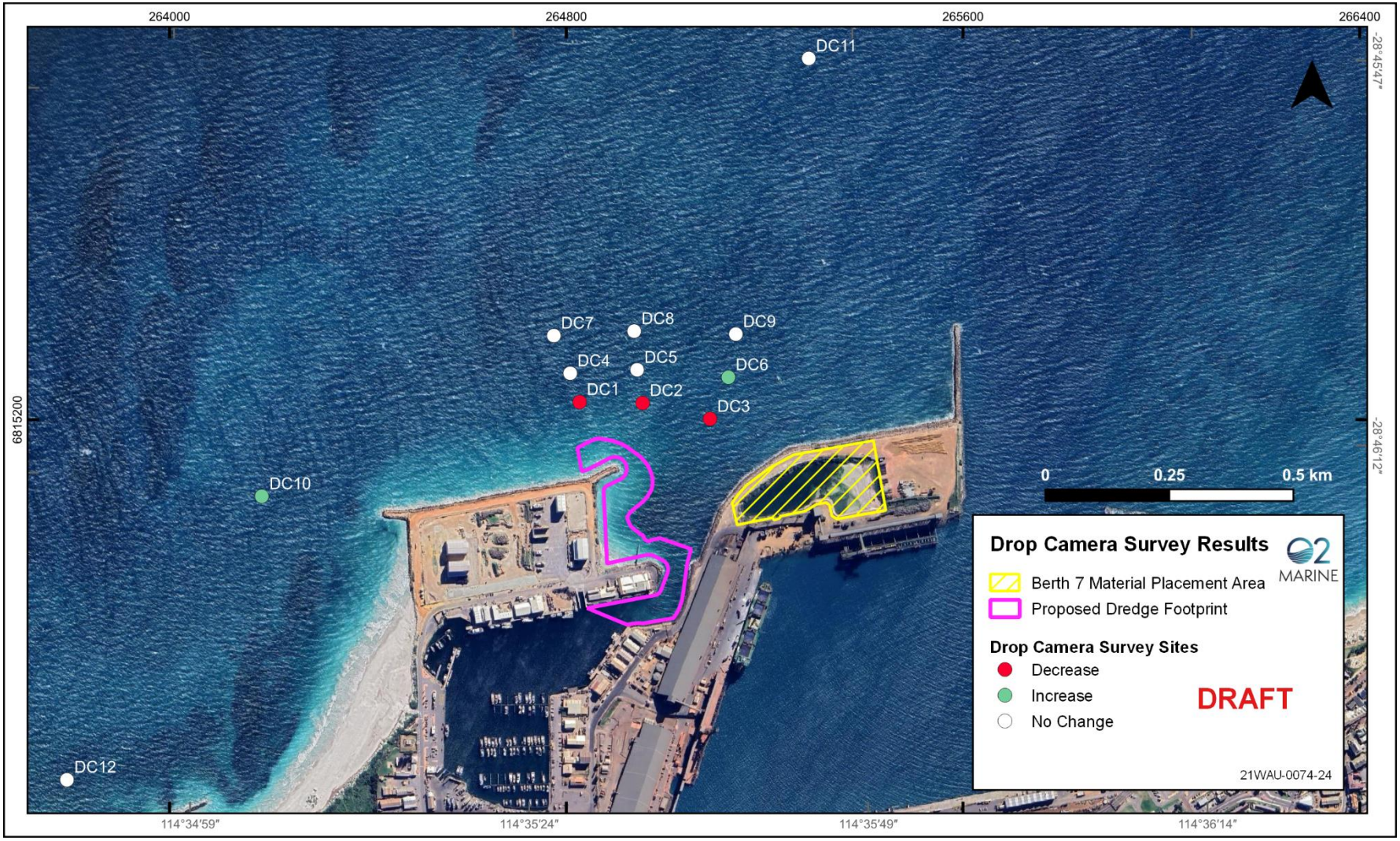
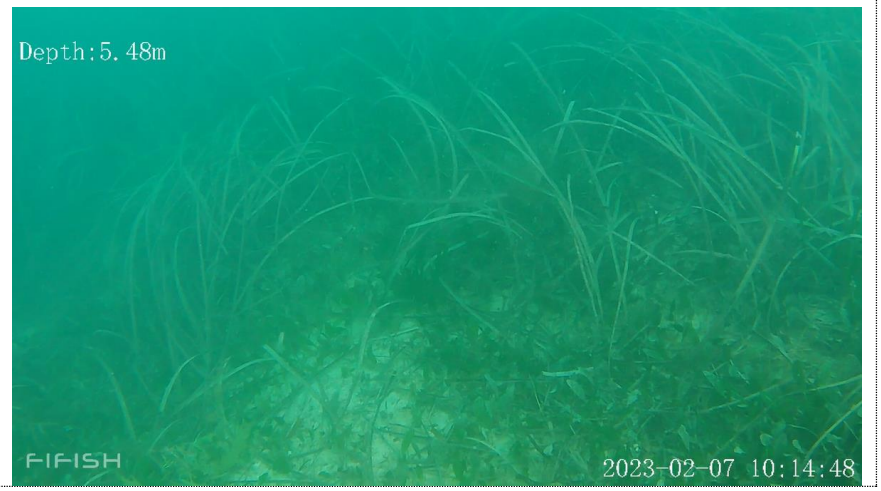


Figure 11 Results of BCH drop camera survey. Change in BCH total cover from pre-dredge survey to post-dredge survey.

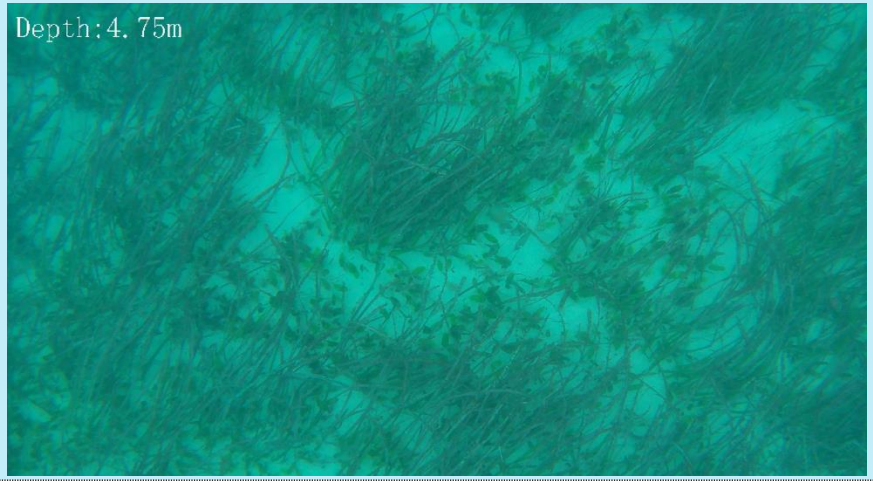
Table 9 Pre- and Post-dredge BCH Drop Camera Stills

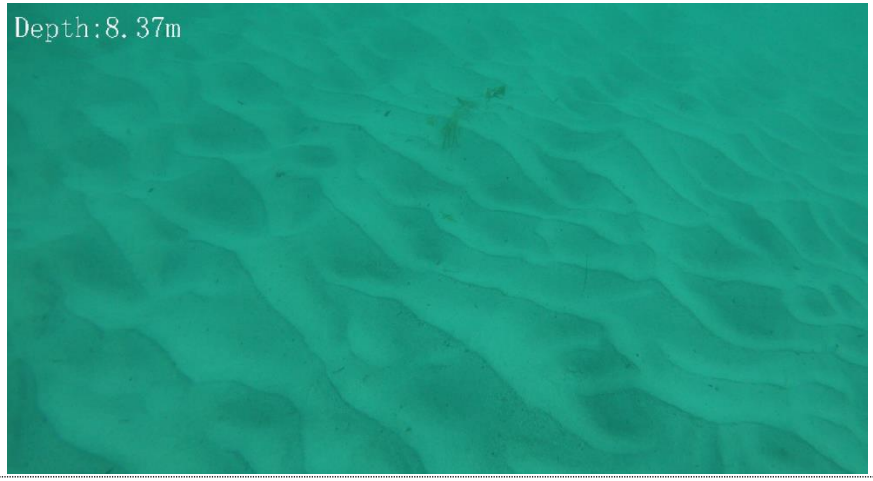
Pre- and Post-dredge BCH Drop Camera Stills. Left; Pre-Dredge – July 2022; Right; Post-dredge – February 2023		
Survey Area		
DC1		

DC2	 Depth:5.29m	 Depth:4.65m FIFISH 2023-02-07 10:11:22
DC3	 Depth:5.27m	 Depth:4.67m FIFISH 2023-02-07 10:07:43

DC4	 Depth:4.51m	 Depth:5.44m FIFISH 2023-02-07 10:27:44
DC5	 Depth:5.85m	 Depth:5.48m FIFISH 2023-02-07 10:14:48

DC6	 Depth:5.49m	 Depth:5.10m FIFISH 2023-02-07 10:04:12
DC7	 Depth:5.34m	 Depth:4.95m FIFISH 2023-02-07 10:24:06

DC8	 Depth:4.75m	 Depth:5.62m FIFISH 2023-02-07 10:19:08
DC9	 Depth:5.91m	 Depth:5.45m FIFISH 2023-02-07 09:59:35

DC10	 Depth:6.73m	 Depth:5.85m FIFISH 2023-02-07 09:23:53
DC11	 Depth:8.37m	 Depth:8.44m FIFISH 2023-02-07 09:53:33

DC12		

5. Discussion and Conclusion

MWPA recently completed a maintenance dredging campaign which was required to reinstate design depths to the harbour entrance channel and adjacent beach due to sand accretion. Maintenance dredging was conducted by CGC Dredging between 10th of September 2022 and 7th of December 2022.

To ensure that potential project impacts were adequately managed, a project specific DEMP (O2 Marine 2022) was developed and implemented throughout the maintenance dredging campaign. The key purpose of the DEMP was to outline the EPOs and MTs associated with the dredging and dredge material placement, and outline management and monitoring requirements to ensure the defined EPOs are achieved.

One of the requirements of the DEMP was to implement a BCH Monitoring Program which comprised pre- and post-dredging surveys to assess potential impacts and validate marine environmental impact predictions to determine if EPOs have been achieved.

A summary of key results from the two surveys is presented below.

- Drop camera survey:
  - A total cover increase in the dominant BCH at two survey locations;
  - A total cover decrease in dominant BCH at three survey locations; and
  - Similar pre- and post-dredge BCH total coverage at the remaining seven survey locations.

The greatest observable reduction in BCH cover occurred at DC1, DC2 and DC3, sites located in closest proximity to the harbour entrance, and which were observed with varying levels of unattached wrack. The accumulation of wrack is likely attributed to natural processes. BCH mapping data in Figure 6 reveals an abundance of shallow reefs southwest-west of the FBH, which may act as significant sources of macroalgal sea wrack under the dominant summer wind and sea conditions. During summer, SSW winds dominate this region, often reaching 46 km/h (Tecchiato et al., 2015). This wind drives north-eastward currents which may transport sea wrack, losing momentum as they reach the sheltered northern side of the FBH, where wrack can sink to the seabed. As a result, sea wrack may accumulate here during the summer months. This movement is evidenced in aerial imagery of the site collected in December (Figure 7b), where seagrass wrack can be observed along FBH reclamation area and on Pages beach. The accumulation of sea wrack can smother the remaining seagrass and facilitate a loss of sunlight possibly explaining the decline of seagrass cover at these sites.

Analysis of the post and pre-dredge BCH survey results revealed seagrass cover increases at two sites. Seven survey locations maintained high cover seagrass assemblages, including the addition of another seagrass taxa, *Syringodium spp.*, at two sites. Results showed increased macroalgae presence in three sites. Observed increases in seagrass cover and species richness are likely driven by seasonal variability, owing to the timings of the survey dates. During the pre-dredge survey (July), BCH productivity would have been low, a result of cooler water temperatures, more aggressive swell driven currents and increased turbidity which reduce the ability for BCH to grow (Masini & Manning 1997, Lavery et al 2009). The post-dredge survey (February) took place during the summer months, which typically features warmer waters, less aggressive currents and lower

turbidity provide more suitable conditions for BCH to thrive. As a result, seagrass assemblages can reach higher cover, and seasonal coloniser species (e.g., H. ovalis) can establish.

Whilst there were observed differences in BCH coverage between the two surveys, as well as some slight shifts in dominant types, this investigation does not present any evidence to suggest that maintenance dredging at the harbour entrance and Lives Beach has resulted in any assemblage shifts or BCH impacts. The negative changes observed at three sites are insignificant, involving losses of low to sparse cover seagrass, and can be attributed to seasonal circulation effects influencing sea wrack coverage. Aside from these areas, seagrass assemblages have been observed to increase or remain consistent, indicating no direct impacts from dredging operations.

The findings from this investigation support the predicted project impacts as presented within the project EIA (O2Marine, 2022b) that the placement of marine sediments within Berth 7 from channel dredging would not result in significant impacts to adjacent BCH types.

Based on visual assessment, monitoring, and the results of this survey, the assigned Performance Assessment Criteria were not considered to be met or exceeded, and no management or mitigation actions were required during the dredging program. Therefore, the Environmental Protection Outcomes and Management Targets are considered to have been met as presented in Table 10.

Table 10 Assessment of Environmental Protection Outcome

Environmental Factor	EPA Objective	Environmental Protection Outcome (EPO)	Management Target (MT)	EPO Achieved (Y/N)
Benthic communities and Habitat (BCH)	To protect BCH so that biological diversity and ecological integrity are maintained.	No direct impacts or irreversible loss of BCH outside of the dredge footprint as spatially defined in Figure 5.	Dredging operations do not occur outside the dredge footprint as spatially defined in Figure 5.	Yes
		No indirect or irreversible loss of BCH from baseline conditions outside the dredge footprint as spatially defined in Figure 5.	No detectable reduction in baseline condition of BCH outside of the dredge footprint as spatially defined in Figure 5.	Yes

6. Reference List

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