Pilbara Ports Authority (**PPA**) is the proponent for the Dampier Cargo Wharf Extension and Landside Redevelopment Project at the Port of Dampier, WA (**Project**).

PPA is planning to construct and operate a southern wharf extension to the Dampier Cargo Wharf. The Project incorporates the development of a new (adjoining) southern section of wharf and associated mooring dolphin, wharf connecting structure, dredged berth pocket and vessel manoeuvring area.

As part of PPA's referral of the Project to the Commonwealth Department of Climate Change, Energy, the Environment and Water under the *Environmental Protection and Biodiversity Conservation Act 1999* (Cth), PPA welcomes public comment on the preliminary documentation for the Project.

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Dampier Cargo Wharf Extension and Landside Redevelopment Project

Benthic Communities and Habitat Cumulative Loss Assessment

ENVIRONMENT
An O2Marine company

CLIENT: Pilbara Ports Authority

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Acronyms and Abbreviations

Acronyms/Abbreviation	Description
ALOF	Alternative Load-Out Facility
BSC	Burrup Services Corridor
Burrup SIA	Burrup Strategic Industrial Area
CD	Chart Datum
DBLB	Dampier Bulk Liquids Berth
DCW	Dampier Cargo Wharf
DLI	Daily Light Integral
DMSF	Dampier Marine Services Facility
DPA	Dampier Port Authority
EIA	Environmental Impact Assessment
EPA	Environmental Protection Authority
Ha	Hectares
HLOF	Heavy Load Out Facility
LAU	Local Assessment Unit
LNG	Liquid Natural Gas
m	Metres
PPA	Pilbara Ports Authority
SSC	Suspended Sediment Concentration
TSS	Total suspended solids
ZoHI	Zone of High Impact
ZoI	Zone of Influence
ZoMI	Zone of Moderate Impact

Table of Contents

Figures

Tables

1. Introduction

1.1. Project Description

Pilbara Ports Authority (**PPA**) is the proponent for the Dampier Cargo Wharf Extension and Landside Redevelopment Project (**the Project**). PPA is proposing to construct and operate a land-backed wharf extension to the Dampier Cargo Wharf (**DCW)** at the Port of Dampier (**the Port**). The ultimate scope of the Project incorporates the development of a new (adjoining) southern section of wharf and associated mooring dolphin, wharf connecting structure, dredged berth pocket and vessel manoeuvring area (

Figure 1). The design of the wharf structure is yet to be finalised; however, key construction elements of the Project may include pile driving works, stabilisation of the shoreline via construction of rock revetment or a retaining wall and construction of a concrete deck.

Up to 380,000 m^3 of capital dredging will be undertaken to establish a new berth pocket and associated manoeuvring basin to design depths of -13.2 m (Chart Datum (**CD**)) and -11.0 m (CD) respectively (note that up to 1m of over-dredging may be required to achieve these depths). This volume includes an estimated 100,000m^3 of underlying and surface granophyre rock at the south-east end of the dredging footprint. To undertake dredging of this material it must be broken up first using drilling and blasting techniques. Dredging will be undertaken using either a cutter suction or backactor dredge. Material dredged as part of the Project is proposed to be placed within the three established spoil grounds within the Port depending on the type of material to be disposed. These spoil grounds are named East Lewis Island Spoil Ground (**ELI**), Spoil Ground A/B and Spoil Ground 2B (locations displayed in Figure 2). Suitable rock material may be beneficially reused for other approved Port projects and/or be placed within established Spoil Grounds within the Port. Where possible, PPA will seek to place rock material in such a way within ELI Spoil Ground that it can be colonised by corals.

The Dredging Footprint includes highly modified seabed environments the majority of which has undergone previous capital dredging (Figure 6) and are subject to ongoing maintenance dredging in accordance with PPA's Commonwealth 5-year Sea Dumping Permit (**SDP**) (SD2019/3962) and approved Long-Term Dredge Management Plan. The Development Envelope and Project Footprint (Figure 1) also include developed and operational port infrastructure, including laydown areas, coastal revetments, an existing mooring dolphin associated with the DCW and two wharf facilities: the Heavy Load Out Facility (**HLOF**) and Alternative Load-Out Facility (**ALOF**).

A summary of the Project is provided in Table 1. The physical, construction and operational elements of the Project are provided in Table 2. The final design and construction details of the Project at this stage are not known. The construction elements detailed within this report represent the "worst case" proposed design. The number of piles and volumes of blasting may decrease (but will not increase) when finalising the Project design and construction details. The proposed Development Envelope and Project Footprint are presented in

Figure 1.

Table 1 General Project description

Project title	Dampier Cargo Wharf Extension and Landside Redevelopment Project
Proponent name	Pilbara Ports Authority

Short description	The Project is for the construction and operation of a land-backed wharf extension to the DCW at the Port. The Project incorporates the development of a new (adjoining) southern section of wharf, dredged berth pocket and vessel manoeuvring area. The Project will enable larger vessels (up to Panamax class) to access the terminal and facilitate new trades and products being handled at the Port.

Table 2 Proposal content elements

Proposal element	Location / description	Maximum extent, capacity or range
Physical elements		
Land-backed wharf Extension	Figure 1	325 m wharf face with a wharf connecting structure.
Berth pocket and vessel manoeuvring area	Figure 1	• Total dredge footprint of 8.4 hectares (ha). • Berth pocket to design depth of -13.2 m CD. • Vessel manoeuvring area to design depth of -11 m CD. (*Note that up to 1m of over-dredge may be required to achieve these design depths)*
Construction elements		
Construction of the Project	Figure 1	• Pile driving works (approx.) 470 steel piles of up to 1800 mm diameter and potential installation of a suspended wharf deck. • Construction of rock revetment and installation to form the wharf deck and associated mooring dolphin.
Capital Dredging	Figure 6	• Up to 380,000 m^3 (including up to 1m of over-dredge) of capital dredging will be undertaken using a backactor or cutter suction dredge.
Drilling and blasting	Figure 6	• Approximately 100,000 m^3 of granophyre rock material to the south and east of the Dredging Footprint will be broken up using drilling and blasting techniques.
Disposal of material	Figure 2	• Dredge spoil, including blasted rock material to be placed at established spoil grounds located in Port waters including Spoil Ground 2B, Spoil Ground A/B and East Lewis Island Spoil Ground (ELI Spoil Ground). Suitable rock material may be beneficially reused for other approved Port projects and / or within established Spoil Grounds within the Port. Where possible, PPA will seek to place rock material in such a way within ELI Spoil Ground that it can be colonised by corals.
Operational elements		
Vessels and wharf	Figure 1	• Enable larger vessels (Panamax class) to access the terminal and facilitate new trades and products being handled at the Port.

Ongoing maintenance dredging	Figure 1	• In accordance with PPA's 5-year SDP for maintenance dredging (SD2019/3962) or subsequent revisions.

1.2. Location

The Port is located approximately 1,540 kilometres (by road) north of Perth, WA and 260 kilometres (by road) west of Port Hedland. The Port is located on the western side of Murujuga on the Pilbara coastline (Figure 2), approximately 20 km west of Karratha.

The Port extends out into Mermaid Sound and the Indian Ocean beyond the limits of State Waters (3 nautical miles) and incorporates the waters surrounding Murujuga and some waters of the Dampier Archipelago.

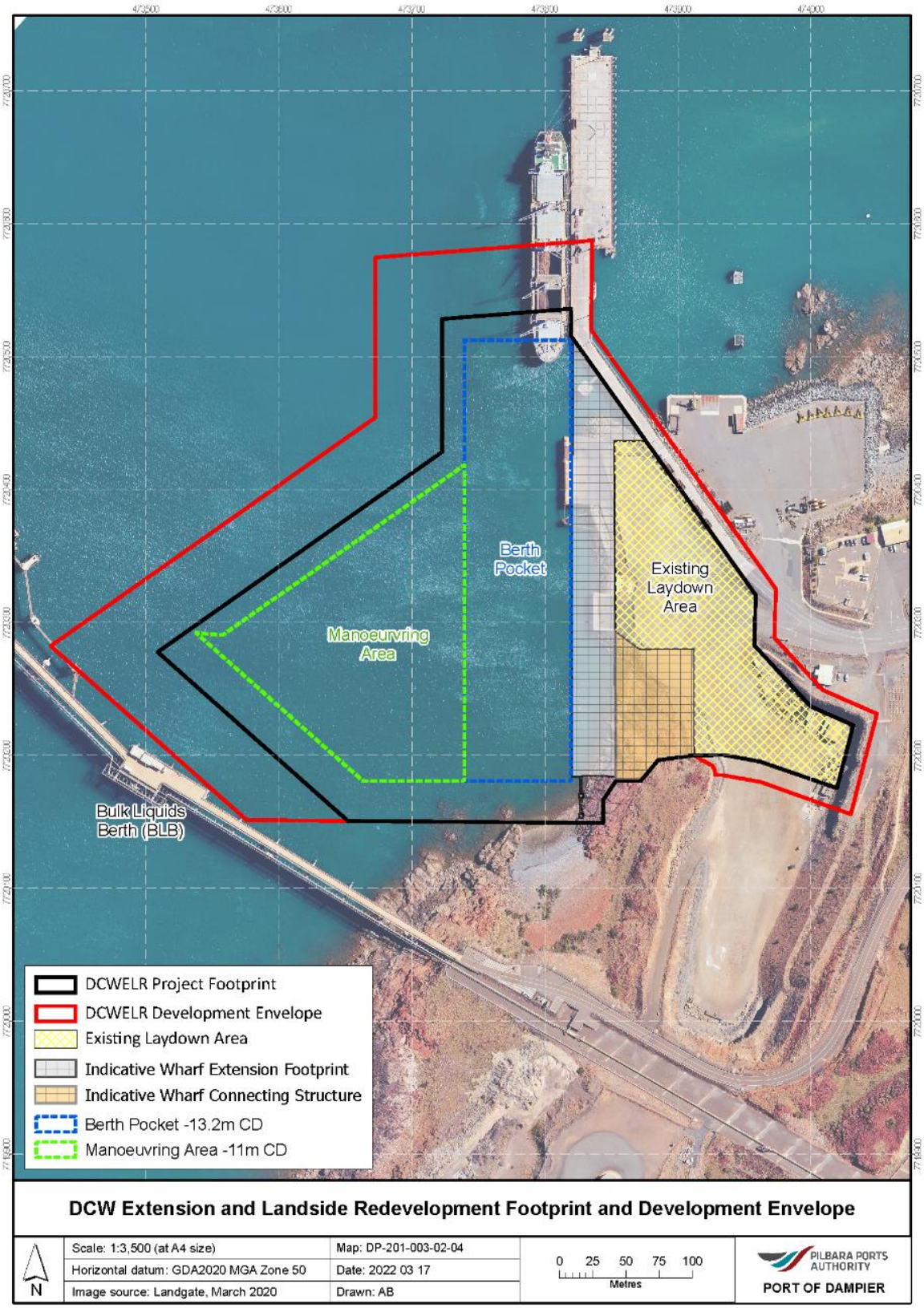

Figure 1 Project Footprint and Development Envelope

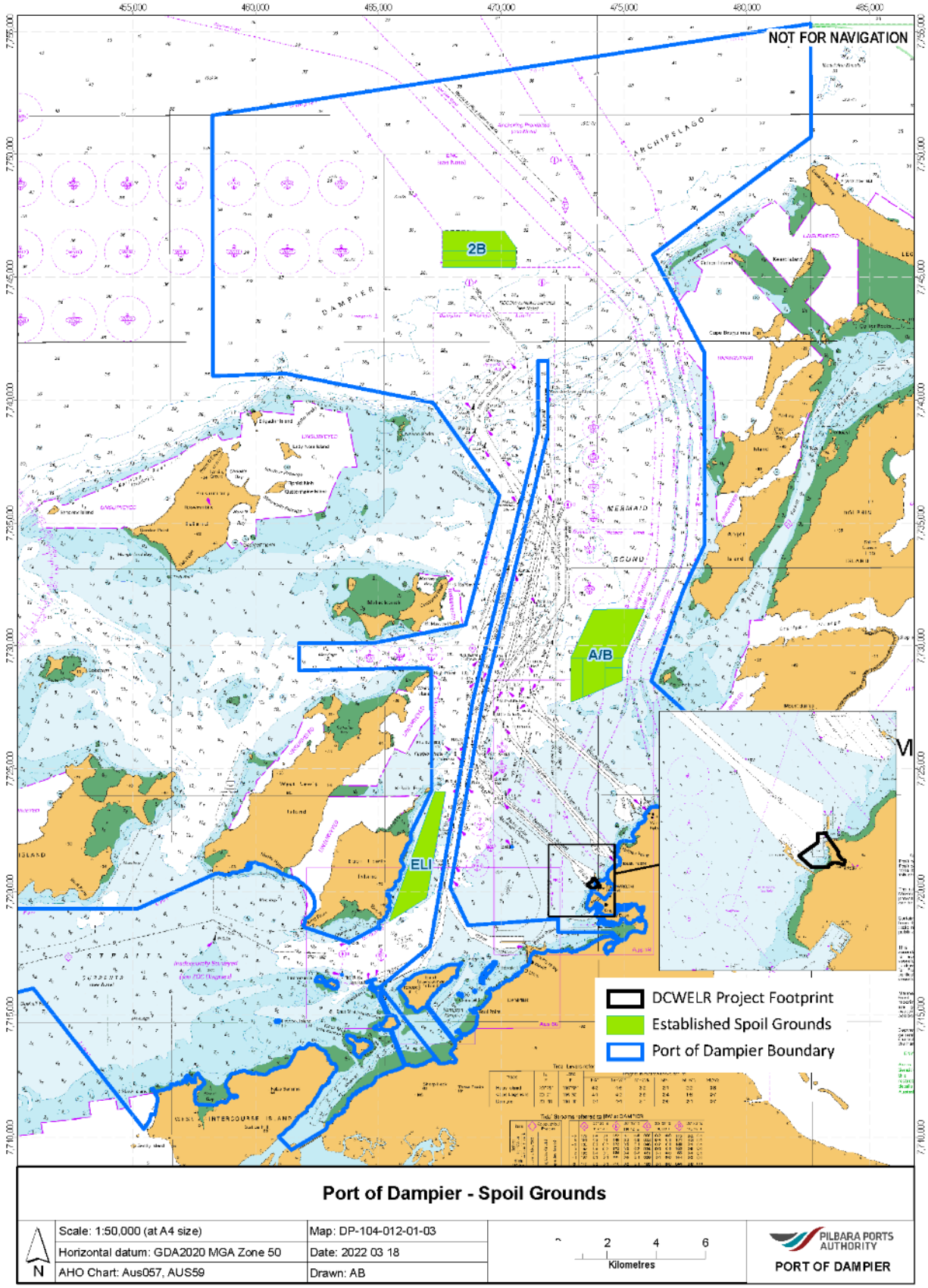

Figure 2 Location of Project and Port of Dampier Spoil Grounds

1.3. Purpose of this Document

On 10 November 2021, an Environmental Issues Identification workshop (**ENVID**) was held to identify and then evaluate the potential environmental risks associated with the Project.).

From this workshop it was identified that a Benthic Communities and Habitat (**BCH**) Cumulative Loss Assessment was required to inform the Environmental Protection Authority's (**EPA**'s) environmental impact assessment (**EIA**) of the Project for the key environmental factor of BCH.

The objectives of this document are to:

- Provide an overview of existing BCH within the Port.
- Characterise the existing BCH that is predicted to be impacted by the Project and describe the extent, severity and duration of those impacts.
- Provide a cumulative loss assessment of BCH in line with the EPA's Technical Guidance - Benthic Communities and Habitats. The purpose of this is to determine whether the Project, in combination with other historical and approved losses, will significantly impact benthic communities and/or their habitat, and any consequent impacts to ecological integrity and biodiversity.

2. Benthic Communities and Habitat Mapping

2.1. Port of Dampier BCH Overview

PPA has developed a benthic habitat map using publicly available reports and papers on the Dampier Archipelago including the Port (MScience 2018). The key BCH of the Dampier Archipelago, including the Port, are discussed in this Section and are shown in Figure 3.

The Port includes inshore, relatively calm and turbid environments that are sheltered by the 42 islands of the Dampier Archipelago and Murujuga. Offshore areas of the Port are influenced by clearer oceanic waters and rougher seas. The Port is bounded by the western coastline of the Burrup Peninsula to the east and Dampier Archipelago to the west. The marine waters between these boundaries are shallow in bathymetry, with depths ranging from 5-20 m below lowest astronomical tide. The channel between these two boundaries is known as Mermaid Sound. The area is described as a drowned coastal embayment which is interspersed by a number of small islands often fringed by limestone rock platforms. The seabed generally comprises silt/sand sediments of mixed terrestrial and marine origin, with occasional limestone reef outcrops (Stoddart and Anstee, 2005). These sediments become coarser with increasing wave exposure and are typically relatively fine in the southern region of Mermaid Sound adjacent to the Project.

The Port supports a wide range of marine benthic communities and habitats including coral, limited seagrass, macroalgae, mangrove and mixed communities (unconsolidated sediment with filter feeder and infauna communities). The fringing and subtidal coral communities provide habitat for a range of species including diverse corals, fish and invertebrates. Intertidal areas generally feature mudflats, sand/gravel beaches and rocky shores.

There are five key types of BCH categorised and found within the Port (PPA 2021). These habitats include:

- Coral
- Seagrass

- Macroalgae
- Mangroves (and Saltmarsh)
- Mixed Community.

The dominant habitat (by area) on the seabed within the Port is soft sediment largely composed of sand and silt (Bancroft and Sheridan 2000). This habitat is typically bare however in patches there may occur seasonal macroalgae and seagrass as well as filter feeder and infauna communities (WorleyParsons 2009; MScience 2014). The silty subtidal habitats of the Dampier Archipelago are in more sheltered areas around the shorelines of the island and mainland coast of Murujuga, and it is in these locations that the seagrasses and corals generally occur.

2.1.1. Coral

It is widely recognised that coral communities provide high ecological value to the marine environment. Thus, coral communities within the Dampier Archipelago have been researched to identify community ecological structure and manage impacts associated with port development and other anthropogenic impacts. Historically, taxonomic surveys and ecological research have concentrated on the outer Archipelago (Griffith, 2004), while studies associated with monitoring potential impacts on coral from industrial development and port expansion have focused on nearshore areas (Blakeway & Radford 2005).

The waters in and around the Port and Dampier Archipelago support more than 120 species of scleractinian coral from 43 genera. These corals generally occur in narrow linear features fringing the shorelines of islands and Murujuga typically between -2 m and -10 m CD (Blakeway and Radford 2005; Jones 2004). Habitat mapping for Mermaid Sound shows that coral communities below -10 m and 12 m CD are extremely rare and that most of the corals fringing Murujuga and Angel and Gidley Islands are above that depth limit (Woodside 2019). The fringing reefs establish and grow on existing hard substrata (Jones, 2004; WorleyParsons 2009) and are not true coral reefs where the structure and substratum is formed by successive layers of dead coral. Instead, these fringing reefs are rock and boulders with a veneer of living coral. Although some of the colonies may be over 100 years old and over a metre across, the corals have not yet provided a true reef structure. The reefs are narrow and fall quickly to a sand/mud substratum only a few metres below low tide level.

The distribution of coral communities shows a strong gradient in which nearshore or inner harbour reefs are dominated by sediment tolerant species that shift to wave tolerant clear water species further offshore in the outer port (Moustaka et al. 2019; Simpson 1988). A detailed study of the Ports' inner harbour area found that of the 229 known Dampier coral species, 120 species from 40 genera occur in the inner harbour (Blakeway and Radford 2005). These inner harbour communities are typically dominated by faviids, Turbinaria and Pavona (Blakeway and Radford 2005; WorleyParsons 2009a) while outer harbour communities shift towards Acropora and Pocillopora dominated communities (Blakeway and Radford 2005; MScience 2007).

2.1.2. Seagrass

Seagrasses in the Dampier Archipelago are generally sparse, occurring in low abundance on shallow sandy sediments in sheltered areas and interspersed with other benthic communities and habitats (CALM, 2005; Jones, 2004; MScience, 2014). Surveys and studies of the region have identified nine species: *Cymodocea angustata, Enhalus acoroides, Halophila decipiens, Halophila minor, Halophila ovalis, Halophila spinulosa, Halodule uninervis, Thalassia hemprichii* and *Syringodium isoetifolium* (McMahon et al., 2017; Woodside, 2006). However, Halophila is

the predominant genus and Halophila species are typically restricted to above the 6 m (CD) depth contour (MScience, 2014).

There are no established seagrass beds within or adjacent to the Project or established spoil grounds. The only mapped area of seagrass (Figure 3) close to the Project is from surveys conducted off the southern side of East Lewis Island and between the causeways connecting East Intercourse Island and Mistaken/East Middle Intercourse Islands (MScience, 2014). This area is not expected to be impacted from the Project. Sparse patches of seagrass have also been recorded throughout Mermaid Strait and in the nearshore environments of the bordering islands (MScience, 2014; Huisman and Borowitzka, 2003; Waycott et al., 2004).

Recorded occurrences of Halophila species in the Dampier Archipelago fluctuate depending on a variety of factors such as salinity, success of seed set and colonisation, temperature and grazing by dugongs (Woodside, 2006). Furthermore, this fluctuation may indicate the presence of transitory communities, which are annual meadows that develop from the seed bank, grow flower, set seed and die back each year (McMahon et al., 2017).

2.1.3. Macroalgae

Macroalgae are normally found on hard substrata as they need something to attach to. Macroalgal assemblages in the Pilbara tend to be ephemeral and not present year-round (Jones, 2004). Macroalgae in the vicinity of the Port largely occurs in shallow waters on rocky substrata. The soft sediments that characterise most of the habitat in Mermaid Sound, including the established spoil grounds, do not generally support macroalgae.

2.1.4. Mangroves and Salt Marsh

Mangroves and salt marsh communities occur in intertidal areas and are generally located away from the area where dredging and spoil disposal is proposed. The nearest mangrove communities to the Project are at King Bay, directly to the south of the proposed dredging. There is no direct environmental impact pathway envisaged from the proposed dredging activities on these or any other mangrove communities.

2.1.5. Mixed Community

MScience (2018) grouped sponges, soft corals and other such biota occurring together, classifying them as 'Mixed Communities'. The distribution of mapped mixed communities in Dampier Archipelago is shown in Figure 3. Most of the sea floor within the bounds of the Port and adjacent Dampier Archipelago is soft sediment (WorleyParsons 2009). This habitat type (which makes up almost all of the seabed in the established spoil grounds) can support areas of 'mixed communities' and infauna such as polychaetes, crustaceans and molluscs. The invertebrates tend to be short lived and able to adjust to disturbance of the benthic environment.

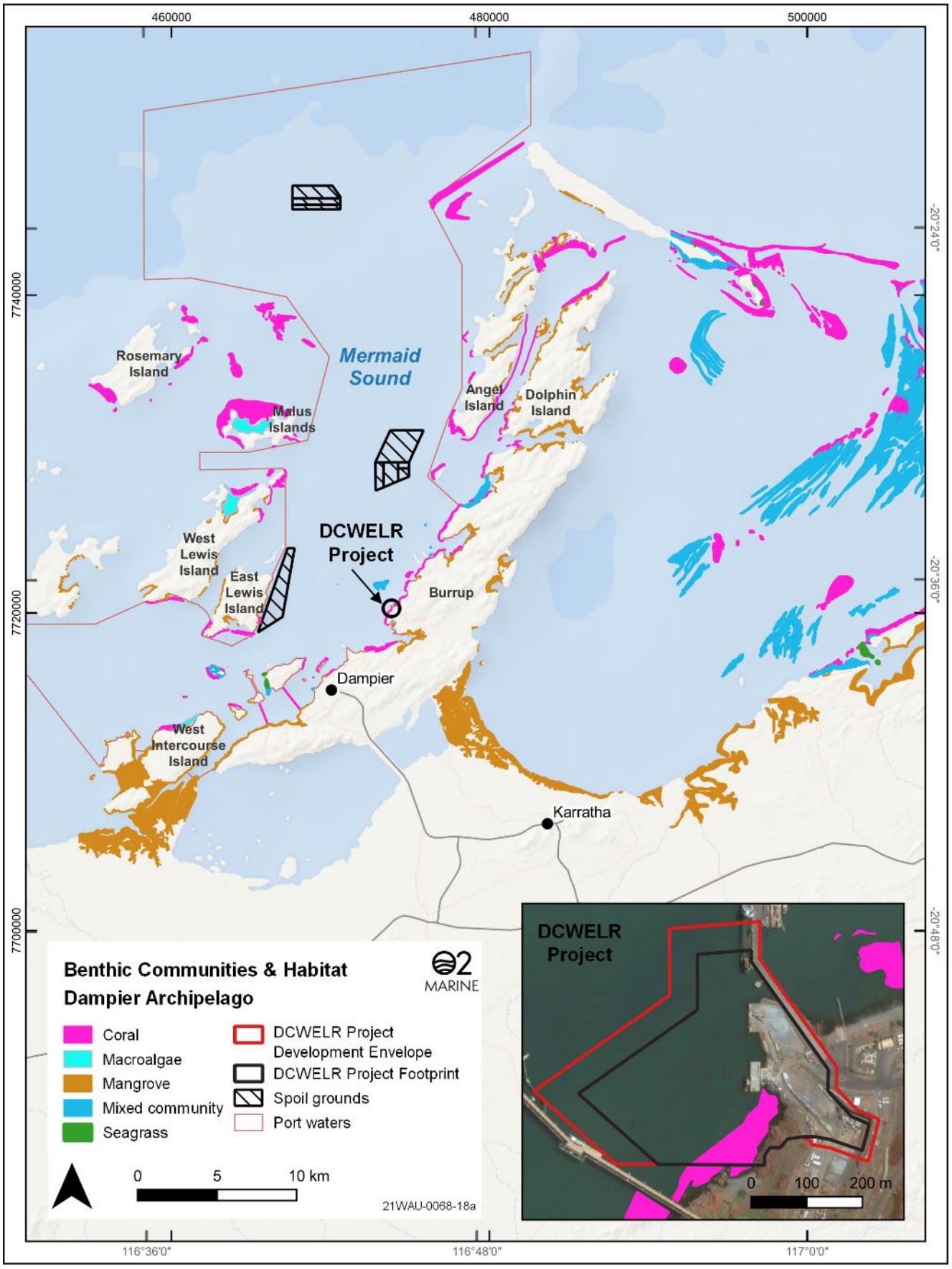

Figure 3 Significant BCH of the Dampier Archipelago (source: MScience 2018)

2.2. BCH Validation Mapping

2.2.1. Project Footprint

It was identified at the ENVID workshop for the Project that in order to undertake a robust BCH Cumulative Loss Assessment, a contemporary investigation of the BCH within and adjacent to the Project footprint was required to validate existing BCH mapping. This information would then support the contemporary BCH Cumulative Loss Assessment. The BCH which occurs within or adjacent to the Project Footprint was previously mapped (WorleyParsons, 2009) for the Dampier Marine Service Facility (DMSF) Project (Ministerial Statement 868). These BCH data sets are contained in PPA's consolidated map of Significant BCH of the Damper Archipelago (Figure 3).

O2 Marine undertook the BCH Validation Survey over 3 days from 31 January to the 2 February 2022 using Underwater Tow Camera and Side Scan Sonar. The findings from the validation survey are provided in the BCH Validation Survey Report (Attachment 1).

The results of the BCH Validation Survey indicate that the extent of the coral habitat is very similar to when it was last surveyed for the DMSF Project in 2009 (Worley Parsons 2009). In some areas the coral habitat area has increased although this may be due to the recent O2 marine BCH survey including all potential coral habitat (i.e. rubble and rocky substratum) as well as coral. Regardless, the results of the O2 Marine survey demonstrates that the coral habitat was not irreversibly impacted from previous capital dredging undertaken in the area or if it was previously indirectly impacted it has recovered well. Note: for consistency with PPA's historical BCH loss calculations in the Port, the PPA's mapped extent of coral (validated by O2 Marine 2022) is used for this cumulative loss assessment.

The BCH within and adjacent to the Project Footprint is mostly bare sediment with an intertidal and shallow subtidal rocky shore containing high to moderate profile reef colonised by coral communities (with some macroalgal and filter feeder communities). This coral/rocky reef habitat is categorised and mapped simply as 'coral' in the consolidated benthic habitat map of significant marine habitats of the Dampier Archipelago (Figure 3). The coral habitat extends from approximately -1 m to -6 m CD, seawards of the rocky shoreline areas. Coral cover is generally sparse to moderate, ranging from under 10% to more than 20% with limited areas of dense cover (>50%). This coral habitat occurs as a veneer of living coral growing on a substratum of bedrock outcrop and large boulders and is typically restricted to a band <100 m from shore before the habitat transitions to unconsolidated fine sediment which is unsuitable habitat for coral.

These reefs appear quite healthy with many large and long-lived coral colonies, although some signs of stress and damage was observed with sediment sitting on the surface of some coral colonies, a few partially bleached corals and some partially or completely dead corals. Coral genera in the area are predominantly faviids with *Turbinaria* species and a mix of other genera making up the remaining cover. There was evidence of new coral recruitment at some locations, with small colonies between 2-10 cm across being relatively common on suitable dead coral substratum, and many fish species were observed on these reefs, both indicative of a healthy reef community.

The unconsolidated benthic substrate beyond this coral habitat typically comprises fine sediments typical of the south of Mermaid Sound.

A nearshore BCH map for the Project comparing the 2009 and 2022 BCH surveys is shown in Figure 4.

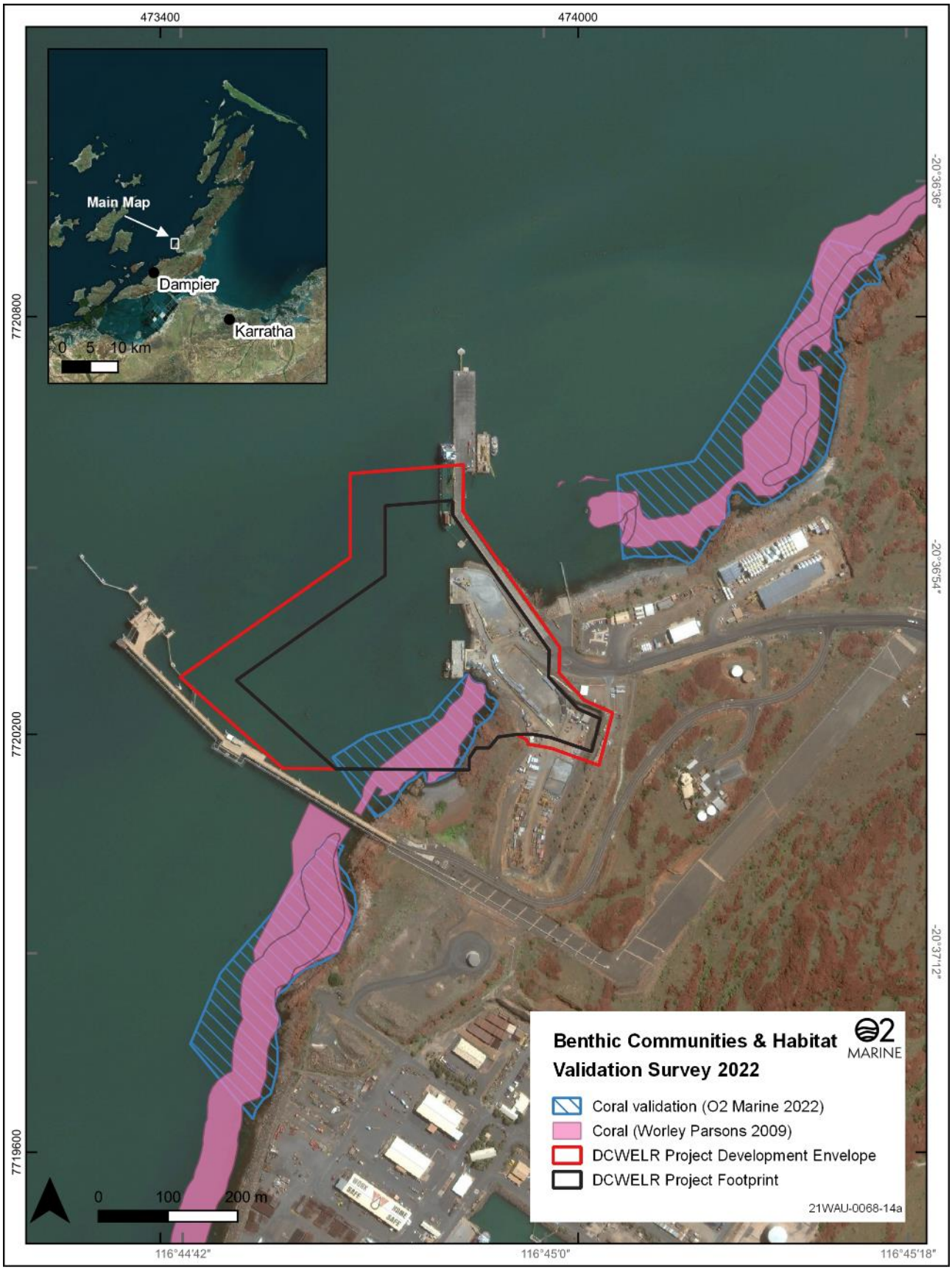

Figure 4 BCH Map for the area within and adjacent to Project Footprint

2.2.2. Established Spoil Grounds

Part of the BCH validation Survey was to undertake a high-level survey of the BCH within and adjacent to the three established spoil grounds in the Port (shown in Figure 2). The findings of the spoil ground surveys are provided in Attachment 1.

Material dredged as part of PPA's capital dredging program will be placed within the three established spoil grounds within the Port. The quantities of spoil allocated to the respective spoil grounds will depend on the characteristics of the excavated material that, in turn, is dependent on the method of dredging to be used. These spoil grounds are named East Lewis Island Spoil Ground, Spoil Ground A/B and Spoil Ground 2B (location displayed in Figure 2). A brief overview of each spoil ground is provided below. Management and allocation of the location that material can be placed within the established spoil grounds is the responsibility of PPA.

East Lewis Island Spoil Ground

Dredged material has been placed within the East Lewis Island Spoil Ground since the establishment of the Port of Dampier as an Iron Ore Port in the 1960s. Due to its shallow depths, it is often not possible / practical for a larger Trailer Suction Hopper Dredge (TSHD) to utilise this spoil ground for dredged materials placement. PPA currently maintains an agreed upper 'ceiling' depth of -6m CD. Based on the most recent hydrographic survey data available for this area, there is approximately 6.7 Mm3 of capacity remaining within this spoil ground so there is ample capacity to receive the expected volume of dredge spoil from the Project.

Spoil Ground A/B

Spoil Ground A/B was originally established in 1986 by Woodside for the disposal of dredged material from several capital and subsequent maintenance dredging programs. It has been used extensively by Rio Tinto, Woodside and PPA since that time. Following its use in 2017, PPA has determined that Spoil Ground A/B has a remaining capacity of 6.7Mm3 so there is ample capacity to receive the expected volume of dredge spoil from the Project.

Spoil Ground 2B

Spoil Ground 2B was developed for the capital dredging activities associated with Woodside's Pluto LNG Development (2007 – 2010). Spoil Ground 2B was established as the result of an extensive options investigation to provide a site distant from sensitive habitats. Accordingly, this site is located outside the mouth of Mermaid Sound and away from shallow reefs. The Pluto capital dredging program has been the only use of Spoil Ground 2B to date. The current capacity of Spoil Ground 2B is 38.5Mm3, calculated to an agreed ceiling of -23.5 m CD. As such there is significant remaining capacity to accommodate the entire volume of dredge spoil from the Project as well as future proponents.

BCH within and adjacent to Established Spoil Grounds

The benthic habitats at East Lewis Island Spoil Ground, Spoil Ground A/B and Spoil Ground 2B are likely to have been smothered during approved historic dredge disposal activities associated with previous dredging programs. As such, nearly all benthic communities within the spoil ground footprints are limited to resilient species which have managed to colonise the area (or on new habitat created from disposed blasted rock) since the last dredging program that utilised these spoil grounds.

Most of the sea floor within the bounds of the established spoil grounds is bare sediment. There are no significant corals within the established spoil grounds. Mixed communities and macroalgae occur in some locations within

all the established spoil grounds where there is soft sediment and where dredge spoil (blasted rock and rubble) has been previously placed and provides low relief low rugosity habitat. (see Attachment 1).

The coral communities that start approximately 100 m to the west of the East Lewis Island Spoil Ground that form fringing reef along the eastern shore of East Lewis Island are of high value and have significant coral cover. This coral habitat between the island and the spoil ground has a unique abundance of *Pavona decussata* which occurs as dome-shaped clumps up to approximately 3m in diameter and can cover up to 75% of some reef areas (Blakeway and Radford 2005). The current health and cover of this coral community indicates no irreversible impact from previous dredge spoil disposal at this site. A previous study looking at the impacts to the coral communities at this site from dredge generated turbidity plumes also demonstrated no impact (Stoddard et al. 2005).

The coral communities nearest to Spoil Ground A/B are those surrounding Conzinc Island, Angel Island and within Conzinc Bay. These communities have been shown to experience repeated elevated sedimentation as a result of sediment plumes emanating from disposal of spoil at Spoil Ground A/B (i.e. from much larger and protracted dredging campaigns). Historically, these elevations have not resulted in detectable coral mortality (MScience 2010b).

Very little BCH is present within Spoil Ground 2B. Video transects from the BCH validation Survey identified soft sediment/sand with isolated low density mixed communities. Monitoring of nearby coral habitats (e.g. Nelson Rocks, Hamersley Shoals) as part of the Pluto LNG Development dredging program found that dredging or spoil disposal operations at Spoil Ground 2B had caused no coral mortality (MScience 2010).

Assessment

The findings of the BCH Validation Survey (Attachment 1) support the PPA's consolidated BCH map of the Dampier Archipelago (Figure 3) and demonstrate that the mapped extent of BCH in the vicinity of the Project is suitable for calculating BCH cumulative loss for the Project. The results of the BCH Validation Survey show a very similar (and in some locations greater) extent of coral habitat around the Project than in PPA's BCH map (Figure 4). However, for consistency with PPA's historical BCH loss calculations in the Port, the PPA's mapped extent of coral habitat is used for this cumulative loss assessment.

The loss of existing BCH within these established spoil grounds, however, from disposal associated with the Project, is not within the scope of the Project's EIA or this BCH Cumulative Loss Assessment. This is due to these areas being previously approved for spoil disposal activities based on their low environmental value; and any BCH occurring within the spoil grounds is mostly BCH that has colonised rock or rubble habitat generated from previous spoil disposals. Additionally, the Dredge Plume Modelling Report (O2 Marine 2022c) for the Project does not predict any indirect permanent loss of BCH from spoil disposal. As such there is no irreversible impact to BCH to be considered outside of the established spoil ground boundaries for this BCH Cumulative Loss Assessment.

3. Local Assessment Units

EPA Technical Guidance for Protection of Benthic Communities and Habitat (EPA 2016b) outlines the requirement for significant marine proposals to clearly define spatially based Local Assessment Units (LAUs) within which cumulative losses for BCH can be calculated, assessed and presented. LAUs are established to allow proponents to quantify historical and proposed loss of BCH and subsequently cumulative loss. LAUs are location-specific and

should be configured to account for aspects of the local marine environment such as bathymetry and position of offshore reefs/islands, substrate type, water circulation patterns, exposure to waves and currents, and biological attributes such as habitat types. Wherever possible, other variables related to the functional ecology of the system should be considered when defining LAUs.

Between 2012–2014, PPA commissioned an assessment of the status of BCH within Port limits, established LAUs for the Port and undertook an assessment of historic loss of BCH for each LAU (MScience 2014). This was undertaken consistent with EPA technical guidance at the time. The objective of this was to provide a common framework for future assessments within the Port by establishing agreed LAUs, and to become the custodian of BCH data, including cumulative losses, for these LAUs. Fifteen LAUs have been developed within the Port limits. Each LAU is based on previously defined management regions (e.g. Pluto management zones) or on EPA Technical Guidance (EPA 2016b). These 15 established LAUs help streamline the assessment of BCH loss within the Port and Dampier Archipelago and future development proponents can use this framework to avoid repeating the work of others and to operate consistently within a set of guidelines agreed by the PPA and the EPA.

LAUs were designed based on contemporary local science taking into account aspects of local marine environments (i.e. bathymetry, aerial imagery, known habitats, and previous field experience). Where possible the proposed LAUs covered an area of approximately 50 km^2. The 15 new LAUs (shown in Figure 5) can be broken up into either outer or inner harbour/Mermaid Sound based on the local marine environment.

LAU1 encompasses the Project Footprint and is located in the inner harbour of the Port, extending from King Bay to the southwestern point of Conzinc Bay, including Withnell Bay (Figure 5). LAU1 encompasses a number of other large developments including the BLB, DCW, Pluto LNG wharf and NWSJV export facilities. LAU1 has been previously approved as a Management Zone through the Pluto project and approvals phase for the Dampier Port Authority's (DPA, now PPA) Dampier Marine Services Facility (DMSF), and more recently as an LAU for Woodside's Scarborough Project, allowing PPA to keep a consistent approach between projects. Furthermore, substantial surveying effort has been applied to LAU1 with accurate historic and current estimates of BCH, with known cumulative loss.

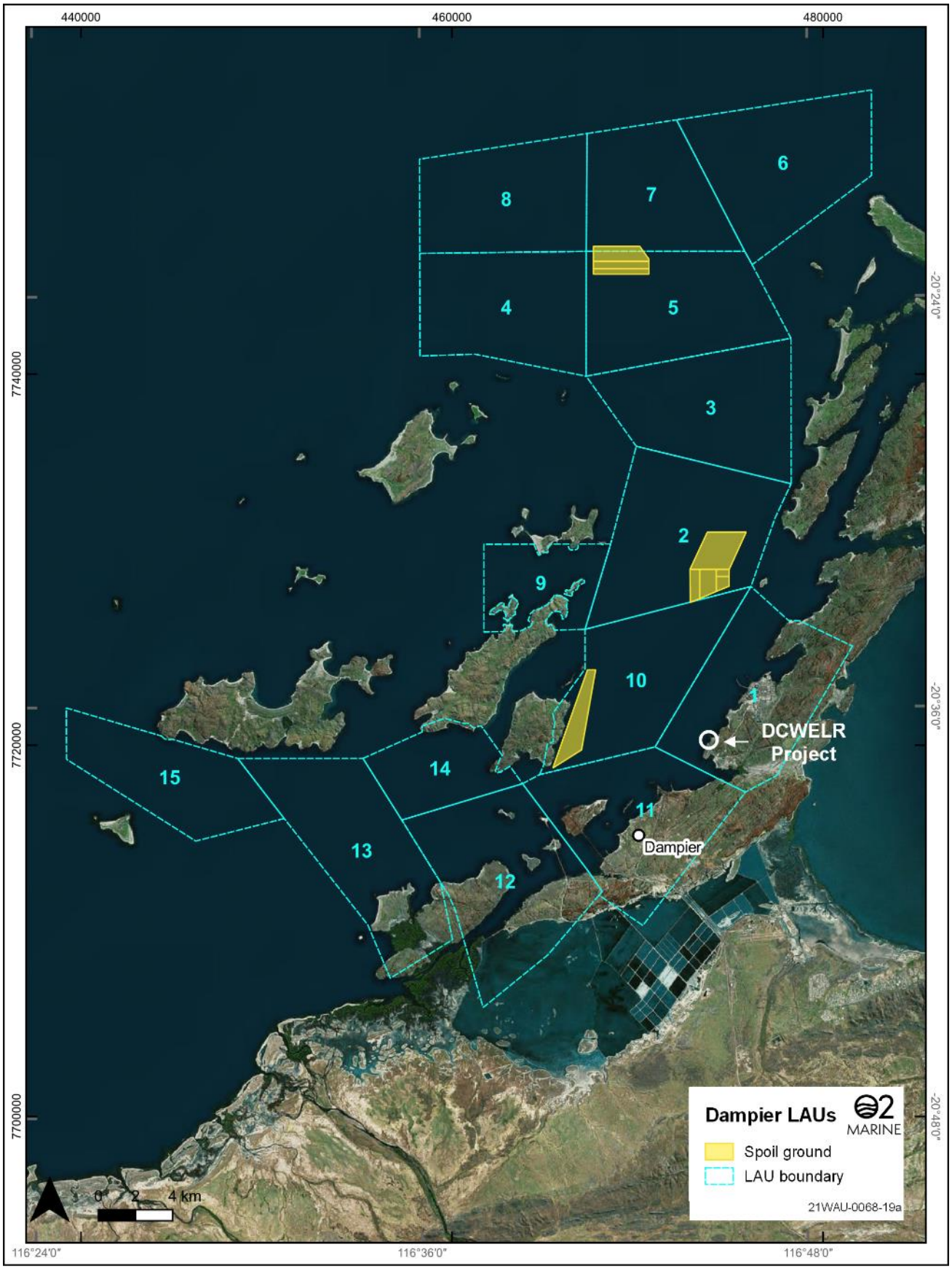

Figure 5 Port of Dampier Local Assessment Units and LAU1

3.1. Determination of BCH and Historical Loss within LAUs

LAU1 contains all the predicted irreversible impact to BCH from the Project (Figure 5) and is the focus of this BCH Cumulative Assessment. There have been a number of studies which have mapped estimates of BCH within the Dampier Archipelago and within LAU1 (e.g. Woodside (2007), Worley Parsons (2009), DEC - Bancroft et al. (2000), and MScience (2005a). The values from the Woodside (2007) Public Environmental Review, and the more recent Worley Parsons (2009c) report are the accepted values for the BCH loss in what is now LAU1. Surveys of BCH within Port limits have concentrated largely on coral habitats to date as they are the key BCH and sensitive receptor within the Dampier Archipelago.

Loss estimates of coral habitat within LAU1 have been compiled from historic data sources as set out in MScience (2005b) as at the conclusion of the Pluto LNG Project. The methodology examines only the irreversible impacts to BCH derived from construction around the King Bay Supply Base, Dampier Cargo Wharf and the Bulk Liquids Berth, the Karratha Gas Plant and the Pluto wharves and berths; together with associated sea walls and channels.

It was assumed within the assessment that the area of direct loss was entirely within the historic nearshore coral habitats (so includes constructions and berths): with the loss of habitat to channels being in deeper areas not occupied by coral. It has also been assumed (conservatively) that all coral habitat has been lost within disturbance footprints.

This assessment of historic losses in LAU1 has not considered EPA approved losses which did not occur due to Projects not being implemented or only partially implemented (e.g. DMSF); or very conservative predicted losses from indirect impacts (i.e. shading and smothering from dredge plumes) associated with historic capital dredging projects (e.g. Pluto). The magnitude of coral habitat loss in LAU1 has instead been calculated using previously reported values by MScience (2010), Woodside (2007), Worley Parsons (2009c).

Incidentally for LAUs 2-15 BCH loss (if any) was calculated where development footprints (e.g. nearshore development such as wharfs, and dredged areas) intersect with mapped coral habitat.

A working estimate of coral habitat loss assessed against the proposed LAUs has been developed and is presented in Table 3 including (where possible) the total area of current and historic coral habitat estimated within a proposed LAU and also the percentage cumulative loss of coral habitat for each LAU. Note the coral habitat spatial extent in this table is only from the Woodside (2007) and Worley Parsons (2009c) BCH surveys and does not include BCH mapped from other surveys such as DEC - Bancroft et al. (2000). The reasoning for this relates to data accuracy and is set out in MScience 2014.

Table 3 Working estimates of the current and historic areas of coral habitat within the Port LAUs (source: MScience 2014).

LAU	Current (ha)	Historic (ha)	% Loss
1	59.9	73.7	18.7
2	0.1	0.1	0
3	0	0	0
4	0	0	0
5	8.4	8.4	0

6	0	0	0
7	0	0	0
8	0	0	0
9	1.0	1.0	0
10	66.1	66.1	0
11	59.8	76.0	21.3
12	58.4	58.5	0.2
13	0	0	0
14	10.7	10.7	0
15	0	0	0

4. Predicted Impacts

The predicted irreversible losses and reversible impacts on BCH (coral habitat) are presented below. All predicted losses of BCH use the PPA's mapped extent of BCH for consistency with PPA's ongoing BCH cumulative loss assessment across the Port.

4.1. Zones of Impact

EPA Technical Guidance for EIA of Marine Dredging Proposals (EPA 2021) provides guidance for identifying three distinct zones of potential impact:

Zones of Impact

- Zone of High Impact (ZoHI): The area where serious damage to benthic communities is predicted or where impacts are considered irreversible. Serious damage is defined as damage that is irreversible or damage that is unlikely to be recovered for at least five years following the completion of dredging activities.
- Zone of Moderate Impact (ZoMI): The area within which predicted impacts on benthic organisms are sub-lethal, and/or the impacts are recoverable within a period of five years.
- Zone of Influence (ZoI): The area within which changes in environmental quality associated with dredge plumes are predicted and anticipated during the dredging operations, but where these changes would not result in a detectible impact on benthic biota. This area can be very large, but at any point in time the dredge plume is likely to be restricted to a relatively small portion of the ZoI. Note: the ZoI is not relevant to the BCH Cumulative Loss Assessment.

4.2. Impact Mitigation

The extension of the existing DCW, as proposed within the Project, will connect to the existing land-based operational areas currently used by PPA as lay-down and storage areas. The new multi-user wharf will align and extend directly south from the DCW, enabling larger vessels to access this terminal and support new trades and products being handled at the Port. Extending the existing DCW has minimised the amount of capital dredging

required as the Dredging Footprint includes highly modified seabed environments which have undergone previous capital dredging (Figure 6) and are subject to ongoing maintenance dredging in accordance with PPA's Commonwealth 5-year Sea Dumping Permit (SD2019/3962) and approved Long-Term Dredge Management Plan.

The PPA's previous DMSF (MS 868) was approved by the EPA under Ministerial Statement 868 but never fully implemented. The DMSF involved a dredging area of up to 47 ha and the dredging of approximately 2.2 million cubic metres (Mm3) of material. The EPA approved the permanent loss of up to 5 ha of coral for the DMSF. As no dredging has been undertaken for the DMSF this loss of coral habitat has so far been avoided.

Construction of the Project, however, does involve some unavoidable direct irreversible impact to coral habitat within the Project Footprint. PPA is investigating disposal of some of the broken-up rock from within the Project Footprint within the shallow waters (<10 m) of the western side of East Lewis Island Spoil Ground. Feasibility of this will depend on navigational depth requirements and safety. Targeted and careful placement of blasted rock and boulders will create potential coral habitat that is very similar to the existing rock habitat that is being physically removed and across a larger area of seabed. The shallow depth and available benthic light at this established spoil ground will assist new corals in colonising the new benthic structure. This beneficial reuse of the blasted rock material may result in a net gain of coral habitat; however, this is not included as part of the BCH Cumulative Loss Assessment.

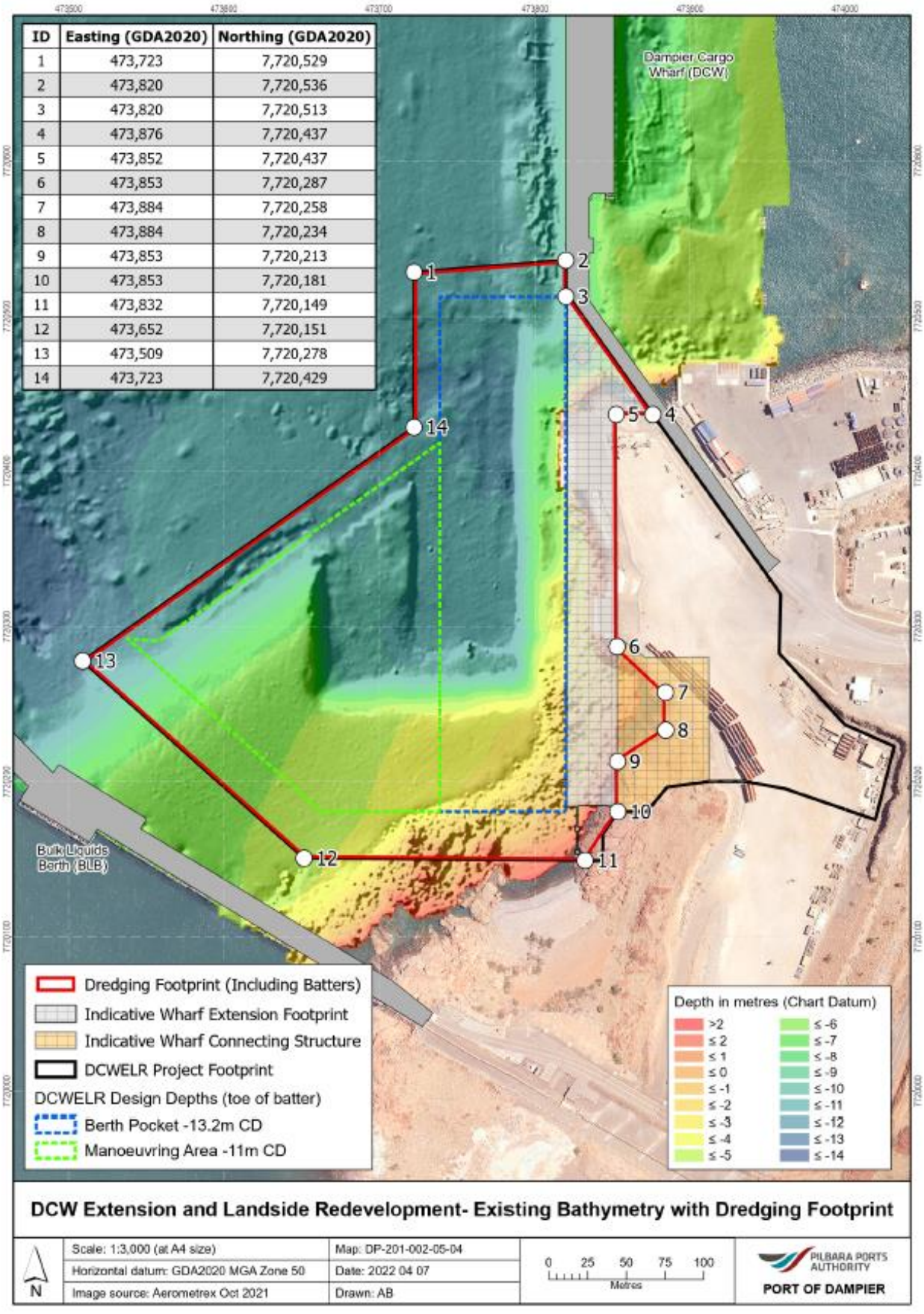

Figure 6 Existing bathymetry of DCW showing previous capital dredging within Dredging Footprint

4.3. Direct Irreversible Impact - Development Envelope

Direct impacts are certain to occur within and immediately adjacent to the proposed dredging, drilling and blasting footprint. Direct impacts typically involve irreversible loss.

Up to 380,000 m^3 of capital dredging will be undertaken to establish a new berth pocket and associated manoeuvring basin. This volume includes an estimated ~100,000 m^3 of underlying and surface granophyre rock at the south-east end of the dredging footprint. To undertake dredging of this material it must be broken up first using drilling and blasting techniques.

Dredging, drilling and blasting within the berth pocket and vessel manoeuvring area and within the proposed wharf extension structure will result in direct removal of subtidal coral habitat.

To be consistent with the PPA's conservative approach on assessing historical loss of BCH, it is assumed that all coral habitat within the Project Development Envelope will be permanently lost (or seriously damaged) such that the impact is irreversible. This is considered conservative as the Development Envelope is 50m beyond the Project Footprint. The extent of coral habitat within the Development Envelope is shown in Figure 9.

4.4. Indirect Impacts (Irreversible and Recoverable)

In addition to direct physical removal (within the ZoHI), EPA (2021) states that the critical indicators of dredging pressure on corals are light limitation caused by the shading effects of the sediment suspended through the water column and sediment deposition on coral surfaces as those sediments settle out. Indirect impacts to coral habitat can be caused due to increased Suspended Sediment Concentration (SSC), resulting in increased turbidity, reduction in available benthic light and localised increase in sedimentation.

In accordance with guidance provided in EPA (2021), a Dredge Plume Impact Assessment (O2Marine 2022c) was undertaken to develop predictions of the ZoHI, ZoMI and ZoI in the vicinity of the proposed dredging and spoil disposal.

The guideline values from EPA (2021) adopted for the Dredge Plume Impact Assessment relate to the impact of dredging on corals as that is the primary BCH type mapped through numerous studies in the vicinity of the dredge area (as described in Section 2.2). As such the ZoMI and ZoHI possible-effect and probable-effect guideline values for corals were adopted. For each zone of impact, possible and probable effects are given, outlining two confidence levels in the spatial extent of each zone, as stipulated in EPA (2021), which represent the realistic worst- and best-case extent, respectively, for each zone.

The Dredge Plume Modelling Assessment (O2 Marine 2022c) modelled both a backactor dredge and cutter suction dredge (CSD) dredge as it is not yet confirmed which type will be used (although use of a backactor is more likely). To ensure all potential impact from dredging is assessed the predicted extent of the zones of impact in this report represent the combined worst case of both the backactor and CSD model outputs. It is noted that the CSD typically generates the largest spatial extent of effect due to both the grinding action of the cutter head and the quantity of fines liberated through overflow as the hopper barge is filled.

Coral thresholds from EPA (2021) for Daily Light Integral (DLI) only and SSC and DLI in combination were initially adopted to model and determine possible and probable ZoMIs and ZoHIs. The EPA's DLI thresholds were developed for offshore corals that are more susceptible to reduced light availability than the more turbidity-tolerant species that typify inshore coral communities. During the dredge plume modelling it became apparent

that the DLI only thresholds for coral provided in EPA (2021) are too sensitive and generated unrealistic predictions of impact. This is due to natural selection pressures favouring the turbidity-tolerant species over the turbidity sensitive species in nearshore waters which have naturally elevated levels of turbidity. Furthermore, since the Port was first developed, these nearshore communities have been exposed to slight (but chronic) elevations above natural levels from vessel prop wash that is typically associated with ship passages through dredged channels. This issue has been highlighted by the EPA in its dredging guidance and encourages proponents to tailor criteria accordingly. A recent example of this was the application of a correction factor of 1.5 to recommended coral thresholds for predicting dredging impacts to nearshore turbidity-tolerant coral species for a recent capital dredging project in Mermaid Sound (MScience 2019).

Even by applying a correction factor of 1.5 to the DLI only threshold, the modelled possible and probably ZoMI boundaries (presented in O2 Marine 2022c) were considered to represent an unrealistic impact scenario that is not commensurate with the actual size of this dredging Project and documented effects associated with other campaigns of similar magnitude. EPA (2021) recommends that only 'realistic' predicted outcomes are presented for EIA of dredging proposals, therefore, the model outputs from the DLI only threshold were dismissed. The spatial scale and locations of the boundaries generated by the 'SSC and DLI in combination thresholds' (from Table 2A in EPA 2021), with a correction factor of 1.5 for nearshore turbidity-tolerant species, were considered far more realistic and were therefore adopted as the likely possible (worst case) and probable (best case) ZoMI boundaries for assessment.

With the approach outlined above and in the Dredge Plume Modelling Assessment (O2 Marine 2022c) these zones of impact represent the realistic best and worst case of predicted indirect dredging impacts to coral. The small predicted possible ZoHI from indirect impacts is partly due to the fringing coral on the rocky shore mostly being in shallow water (<6 m below CD) with sufficient benthic light available to avoid light reduction thresholds being triggered.

A sedimentation threshold was not applied as sedimentation effects on corals continue to be equivocal on the effects of sedimentation alone (Duckworth et al., 2017; Pineda et al., 2017a). Sedimentation impacts in this high energy location is very difficult to model (due to frequent resuspension forces) and will be driven by high SSC levels (which will also drive low light). The high SSC required to cause high sediment deposition rates will also cause significant light attenuation and reduced light availability at the seabed. Further, where thresholds have been evaluated for multiple stressors in combination, the SSC values and duration required to exceed the recommended sedimentation thresholds for coral in EPA (2021) are an order of magnitude higher than the SSC levels required to exceed light reduction thresholds for SSC and DLI. Thus, SSC and DLI thresholds proposed here (based on light reduction) would be breached well before SSC reached levels capable of sustaining sedimentation rates that are predicted to impact coral habitat.

The modelling results for the ZoMI and ZoHI for the proposed dredging and spoil disposal, including probable and possible impacts, are presented in Figure 7 and Figure 8. The modelling results presented here are for a likely summer dredging campaign.

The Dredge Plume Modelling Report (O2 Marine 2022c, Appendix D) for the Project does not predict any indirect recoverable impact (ZoMI) or permanent loss (ZoHI) of BCH from spoil disposal (Figure 8) using either the backactor or CSD.

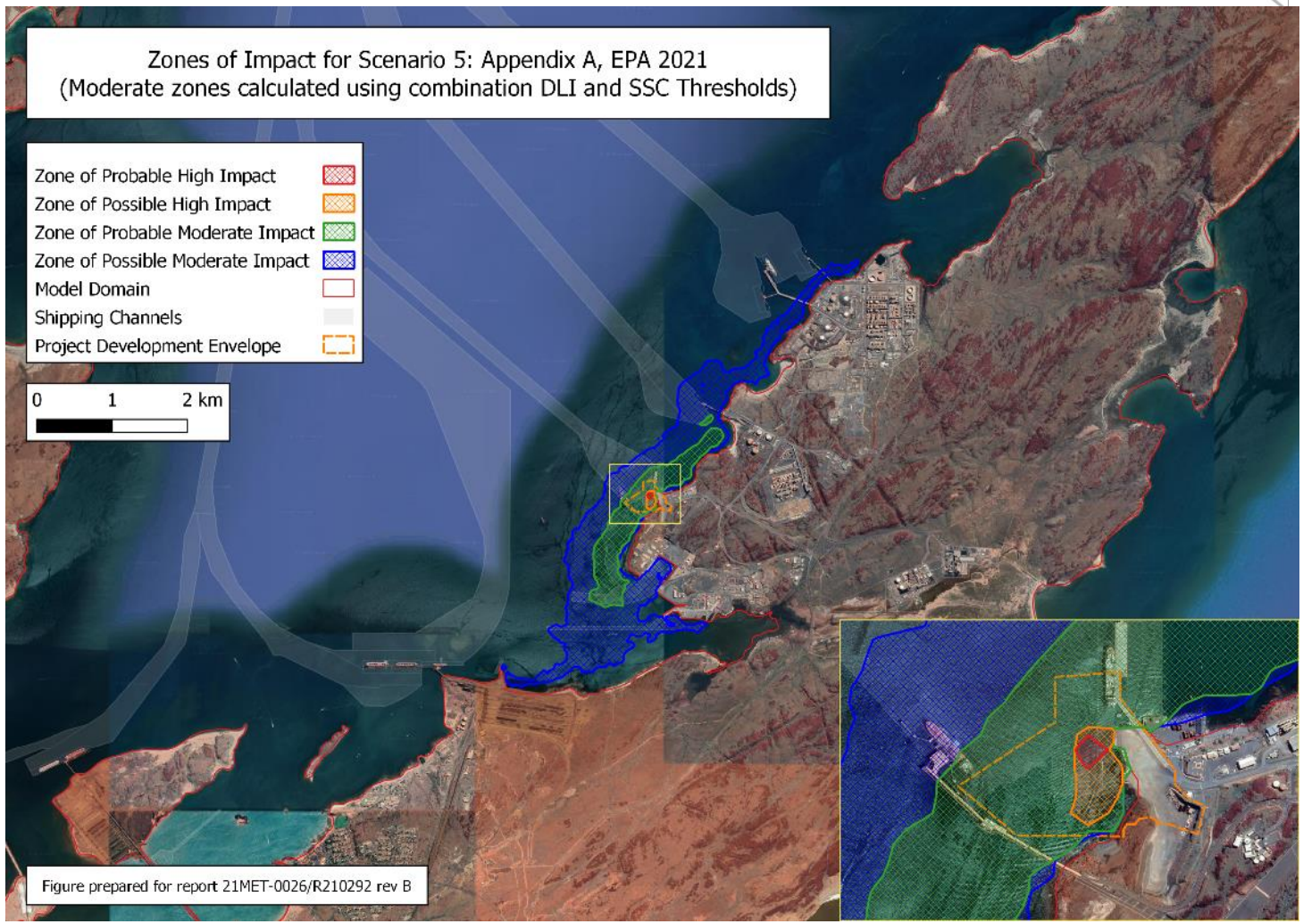

Figure 7 Dredging Zones of Impact showing ZoMI and ZoHI from dredging at Project DE (source: O2Marine 2022c).

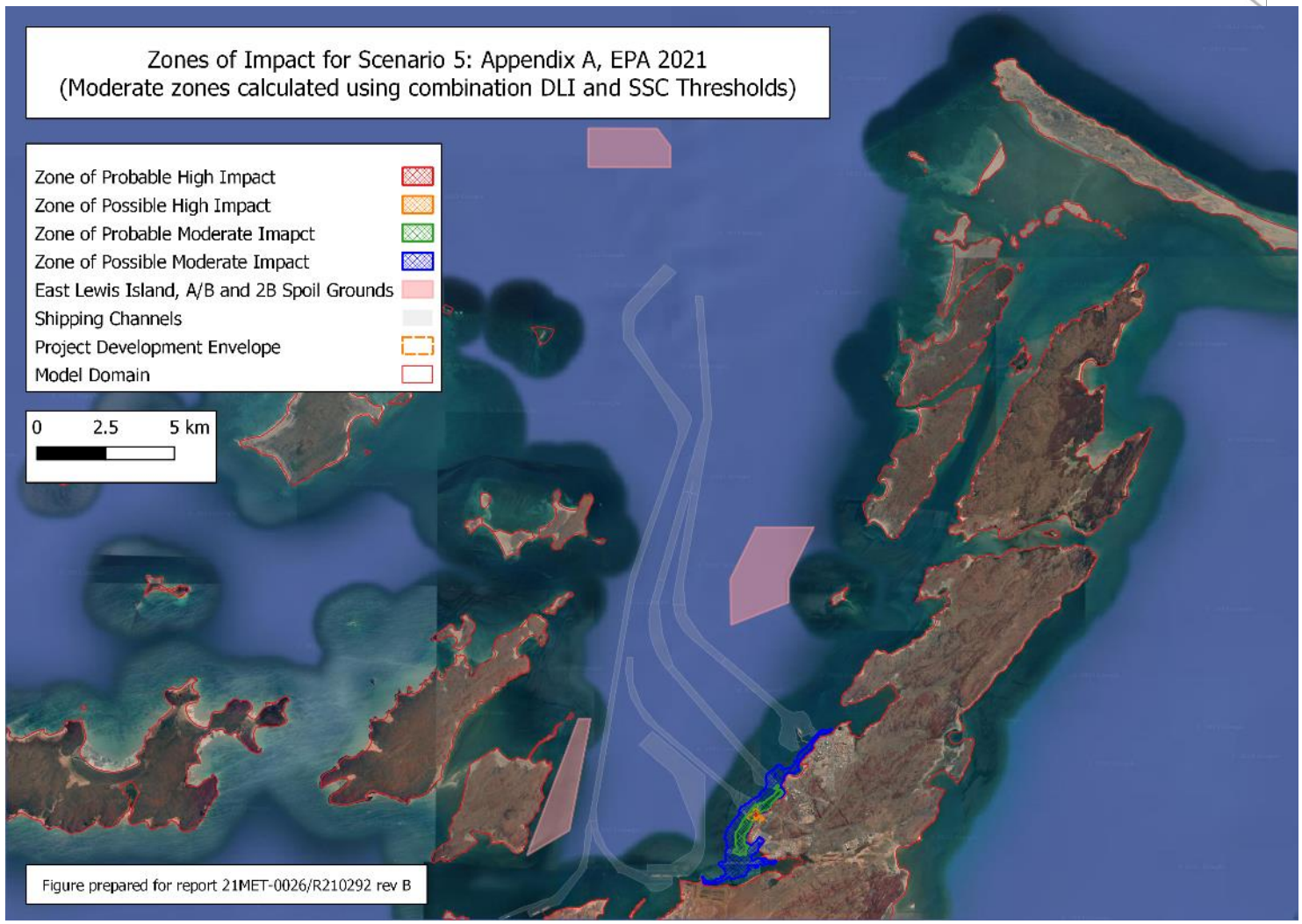

Figure 8 Dredging Zone of Impact showing no ZoMI or ZoHI from disposal at established spoil grounds.

4.4.1. Intersection of Zones of Impact and Mapped BCH

Following determination of the dredging zones of impact it was determined if they overlap with mapped coral habitat. Figure 7 shows that the possible effect or worst case ZoHI does not overlap with mapped coral habitat beyond the Development Envelope. Figure 8 shows that no ZoHI was observed within or outside any of the established spoil disposal grounds. Therefore no indirect permanent loss of BCH from dredging is expected outside of the Development Envelope from either a backactor or CSD dredge being used. It was therefore considered to take a conservative approach and use the boundary of the Development Envelope for the purposes of calculating irreversible impact to coral habitat. In other words all coral habitat within the Development Envelope is considered irreversibly impacted (as shown in Figure 9). This is consistent with the PPA's approach on assessing historical loss of coral BCH within direct disturbance footprints.

The DE overlaps with 0.8 ha of existing mapped coral habitat. It is therefore assumed that proposed dredging, drilling and blasting for the construction of the Project will result in direct irreversible impact to 0.8 ha of coral habitat.

No indirect recoverable impact (ZoMI) of BCH from spoil disposal (Figure 8) was predicted using either backactor or CSD. The possible ZoMI from dredging in Figure 7 was therefore used to estimate the extent of predicted indirect recoverable impacts to coral habitat as a result of dredging. The predicted recoverable impact to coral habitat (within the possible ZoMI) is shown in Figure 10.

A further 14.4 ha of bare substrate will also be directly impacted as a result of dredging. However, this area will still remain classified as bare substrate after the completion of dredging and so has not been considered further in the Cumulative Loss Assessment.

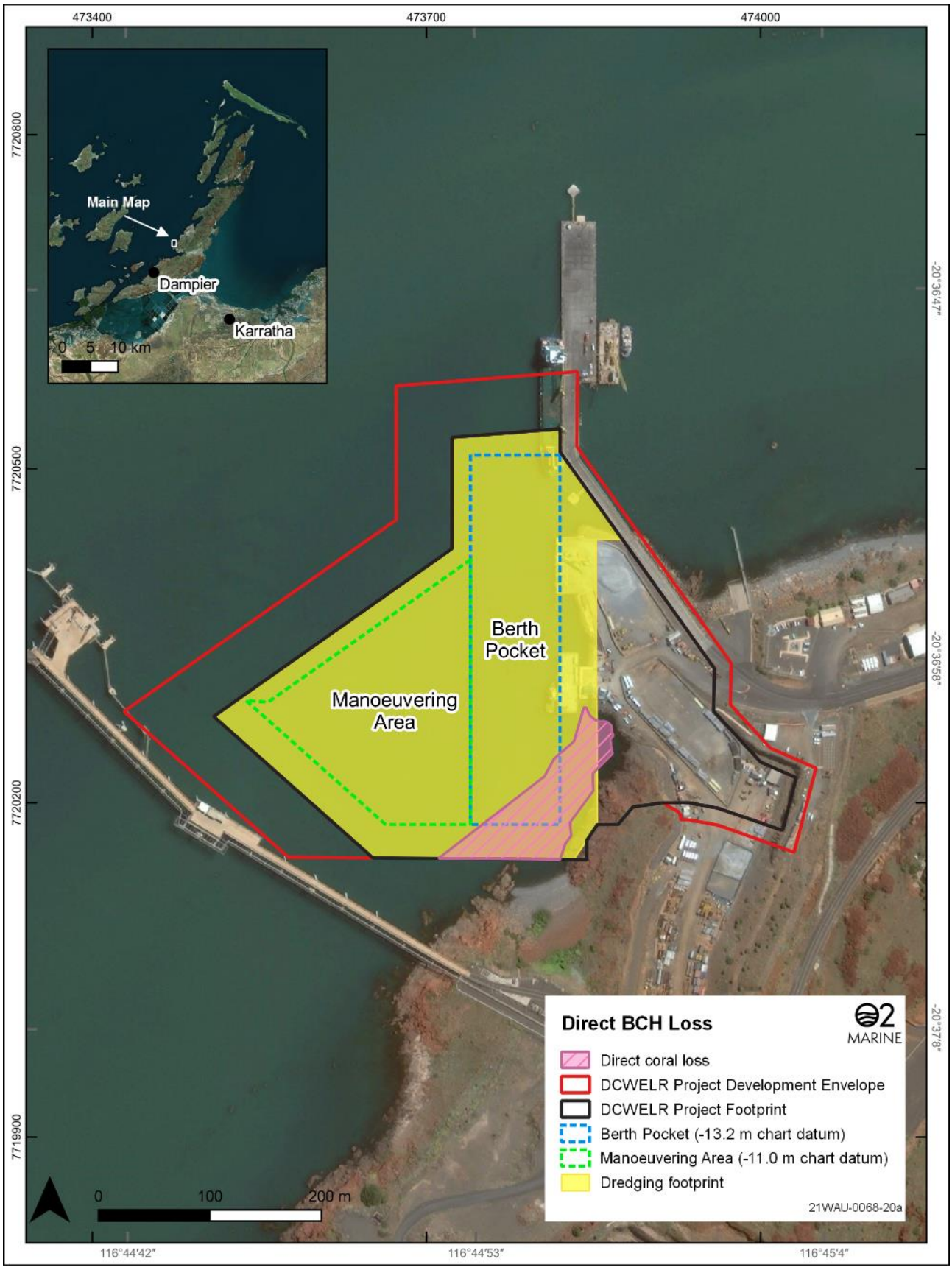

Figure 9 Development Envelope within which irreversible impact of coral habitat is assumed

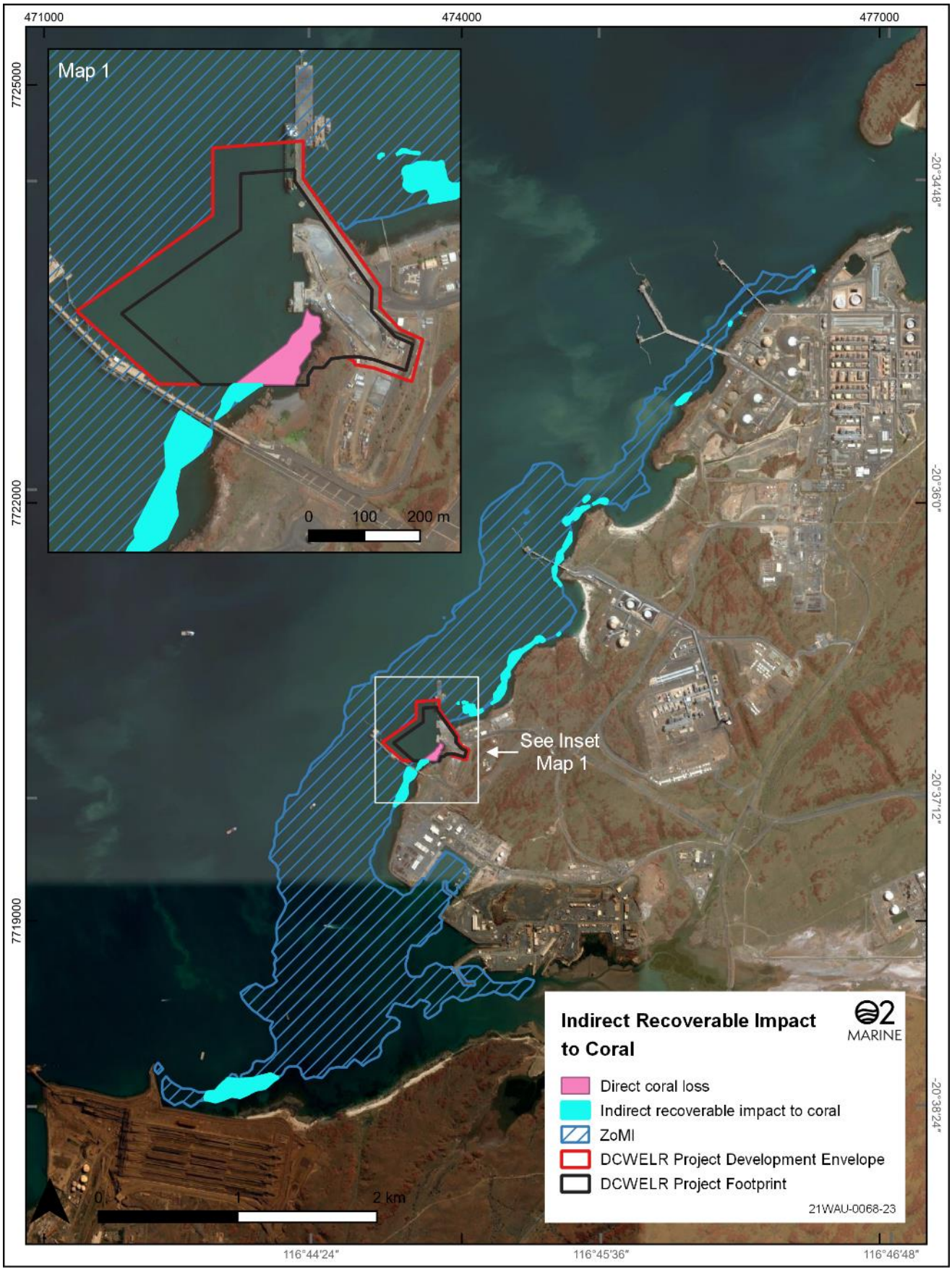

Figure 10 Predicted ZoMI and recoverable impact to coral habitat

4.5. Predicted direct and indirect impact to BCH

The area of existing mapped BCH overlapping with the ZoHI and ZoMI for the proposed dredging and spoil disposal is shown in Table 4.

Table 4 Coral habitat impacted by the proposed dredging and spoil disposal

Zone of Impact	Certainty	Coral (ha)
Moderate (Recoverable)	Possible	10.5
High (Irreversible)	Certain (everything within the Development Envelope)	0.8

All impact to coral habitat within the Development Envelope is considered with certainty to be irreversible.

The possible 'worst case' ZoMI (as described in Section 4.4) was used to estimate the extent of predicted indirect recoverable impacts to subtidal BCH as a result of dredging. The predicted recoverable impacts to BCH are also considered to be conservative in the event a backactor dredge is used rather than a CSD which was used in the modelled predictions as a worst case.

In summary:

- the area of estimated *irreversible* impact (i.e. ZoHI) to coral habitat is 0.8 ha.
- The area of estimated *recoverable* impact (i.e. ZoMI) to coral habitat is 10.5 ha.

5. Cumulative Loss Assessment

The current spatial extent of coral habitat within LAU1 has been determined by PPA (MScience 2014) and is presented in Table 5. As no irreversible impact is predicted in the other 14 Port LAUs they are not included any further in the results. Nor are recoverable impacts in LAU1 as these are not included in BCH cumulative loss calculations.

The current spatial extent is presented in hectares and is expressed as a percentage of historical conditions (Section 3.1). The area of coral habitat in LAU1 predicted to be irreversibly impacted has been calculated and total cumulative loss within LAU1 has then been calculated by adding the predicted irreversible impact to the historical loss and presented in hectares and as percentage of historical conditions within Table 5.

Table 5 Coral Habitat Cumulative Loss Assessment for LAU1.

LAU	Loss Assessment	Coral Habitat (ha)	% Loss
LAU1	Historic extent (Source: MScience 2014)	73.7	-
	Current extent (Source: MScience 2014)	59.9	-
	Historic loss	13.8	18.7

	Irreversible[1]	0.8	1.1
	Cumulative Loss	**14.6**	**19.8**

Note: if the PPA's DMSF is taken into account, which has been approved by the EPA but not fully implemented (no dredging or loss of coral), this would increase the historical loss of coral in LAU1 to 18.8 ha and the cumulative loss when adding 0.8 ha from this Project would increase to 19.6 ha or 26.6%. Although this is a greater cumulative loss value this is not considered to change the overall assessment of impact. EPA technical guidance does recommend including approved losses as well as indirect irreversible impacts, however, the PPA's approach only focusses on actual historic losses from direct irreversible impacts, which provides consistency and confidence when assessing cumulative losses from many historical dredging Projects within the Port.

6. Potential Consequences

Based on the calculations presented above, the historical loss of coral habitat within LAU1 is 18.7% and following implementation of the Project the cumulative loss is expected to increase by 1.1% to 19.8%.

EPA (2021) requires an evaluation and discussion on the potential consequences (i.e. impacts and risks) of the predicted cumulative loss of BCH on ecological integrity and biological diversity at local and regional scales.

By its very nature Port development will modify benthic habitats and cause some loss of BCH. Fringing coral reefs are present across the Port and the percentage cumulative loss of these communities as a result of historical Port development is very low, however, loss within LAU1 is higher. Once the local and short-term disturbance caused by development activities is over, coral communities can recover in disturbed areas and expand into suitable newly provided habitat such as rock causeways and breakwaters.

The fringing reefs within LAU1 are narrow and the amount of coral cover generally varies from under 10% to more than 20%. The coral is in reasonably healthy condition considering the proximity to significant anthropogenic disturbance over a long period of time and numerous episodic and extreme weather events associated with the passage of tropical cyclones. The coral habitat in the vicinity of the Project is of similar cover and health to most coral habitat throughout LAU1, although probably lower than that found on fringing reefs further from Port activities within Mermaid Sound, which is to be expected.

LAU1 is located in the inner harbour of the Port and encompasses a number of large developments including PPA's Bulk Liquids Berth, DCW, ALF and HLO, Woodside's Pluto LNG wharf and Karratha Gas Plant export facilities. The majority of the Project Footprint includes highly modified seabed environments which have undergone previous capital dredging and are subject to ongoing maintenance dredging in accordance with PPA's Commonwealth 5-year Sea Dumping Permit (SD2019/3962) and approved Long-Term Dredge Management Plan. The current extent of coral habitat within and adjacent to the Project, as mapped previously by PPA and recently validated for this assessment, demonstrates that the coral communities have fully recovered from any indirect impacts that may have occurred as a result of previous dredging undertaken in the area.

[1] where serious damage to benthic communities is predicted or where impacts are considered irreversible. Serious damage is defined as damage that is irreversible or damage that is unlikely to be recovered for at least five years following the completion of dredging activities.

In the absence of any evidence to the contrary, it would be reasonable to assume coral habitat adjacent to Port facilities is likely to be of poor quality, but this isn't the case in LAU1. The sustained cover and health of this coral habitat may be possibly due in part to the pressures and impacts from previous dredging and Port operations being 'offset' by the waters around Port facilities being a safety exclusion zone, so gaining some of the same protections as a marine conservation area. The environmental value of the coral habitat to be lost, therefore, is not underestimated.

The predicted extent of irreversible impact to coral habitat from this Project (0.8 ha or 1.1%) is considerably less to that previously considered acceptable by the EPA for the DMSF proposal (up to 5 ha or 6.7%). That proposal has not been fully implemented so no actual loss of coral habitat occurred.

To try and 'offset' the predicted loss of 0.8 ha of coral habitat associated with this proposal, PPA is investigating disposing of some of the broken-up granophyre rock (which is a component of the proposed dredging campaign) within the shallow waters (<-10m below CD) of the western side of East Lewis Island Spoil Ground. The feasibility of this will depend on required navigational depths and safety. Targeted and careful placement of the blasted rock and boulders would create potential coral habitat that is very similar to the existing rock habitat that is being physically removed but will occupy a larger area of seabed. The shallow depth of this established spoil ground will maximise the chances of new corals colonising the new benthic structure. Coral communities have successfully colonised rock structures placed previously within the Harbour, this is demonstrated along the East Intercourse Island causeway and the Dampier Salt causeway (MScience 2004). This strategic placement of rock material may result in a net gain of potential coral habitat; however, this is not included as part of the BCH Cumulative Loss Assessment for this proposal which only considers permanent loss of natural substrates.

7. Summary

If this Project is approved and implemented it will result in the loss of approximately 0.8 ha, or approximately 1% of the coral habitat existing in LAU1 prior to industrial development. Approximately 58.8 ha of healthy and resilient coral habitat will remain within LAU1 which equates to approximately 80% of the coral that existed prior to European habitation. PPA consider this a good outcome for what is a highly modified Port environment that has undergone many significant dredging projects and is exposed to chronic disturbance and turbidity from vessel propwash and frequent resuspension of fine sediment from severe weather events. Considered within this context, the predicted irreversible impact to coral habitat and cumulative loss from the Project is not considered to pose a significant risk to ecological integrity and biological diversity within the LAU or the broader Port environment.

8. Conclusion

Following construction the cumulative loss of coral habitat within LAU1 will be 19.8%. This Project will potentially only add 0.8 ha or 1.1% to that cumulative loss within an LAU that is located in the inner harbour of the Port. As such it is not considered to represent a risk to ecological integrity and biological diversity at either a local or regional scale. While every effort should be made to minimise the impacts of Port construction and operation on coral habitat, the loss of a small area of inshore turbid fringing coral habitat will not have a great effect of the coastal marine ecosystem as a whole. Based on this BCH Cumulative Loss Assessment and the predicted small

direct loss and no indirect loss of coral habitat it is considered that the Project will not result in significant impacts to BCH and the EPA's Objective can be met.

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Attachment 1. Benthic Communities and Habitat Validation Survey Report

SURVEY REPORT

Date	02 March 2022	Reference	21WAU-0068/ T210275
To	David Pozzari	Email	david.pozzari@pilbaraports.com.au
From	Gordon Motherwell	Email	gordon.motherwell@o2marine.com.au
Subject	Dampier Cargo Wharf Extension and Landside Redevelopment Project – Benthic Communities and Habitat Validation Survey Report		

1. Background

It was identified at the environmental risk assessment workshop for the Pilbara Ports Authority's (**PPA's**) Dampier Cargo Wharf Extension and Landside Redevelopment Project (**the Project**) that contemporary information on Benthic Communities and Habitat (**BCH**) was required for the environmental impact assessment (**EIA**) of the Project. The BCH which occurs within or adjacent to the Project Footprint was previously mapped (WorleyParsons, 2009) for the Dampier Marine Service Facility (**DMSF**).

2. Purpose

This report outlines the results of the BCH Validation Survey. This purpose of the survey is to provide contemporary information on the BCH within and adjacent to the Project Footprint and validate existing BCH data (Worley Parsons 2009) from the PPA's consolidated map of Significant BCH of the Damper Archipelago (MScience 2018, Figure 2). The results from this survey will inform the BCH Cumulative Loss Assessment for the Project.

The objectives of the BCH Validation Survey are to:

- Validate existing BCH mapping (Figure 2) within and adjacent to the Project Footprint and established spoil grounds (ELI/AB/2B).
- Accurately describe the BCH within and adjacent to the Project Footprint to support the assessment of BCH loss due to the Project.

3. Timing

The BCH Validation Survey was undertaken over three (3) survey days from the 31 January 2022 to the 2 February 2022. This included: two (2) days of detailed BCH validation survey work within and adjacent to the Project Footprint and another one (1) day to undertake a high-level survey within and adjacent to the three established spoil disposal grounds within the Port that are to be utilised for the Project.

4. Conditions

The meteorological conditions experienced during the survey period were challenging with very strong winds and seas, particularly in the first two days. Although the scope of the survey was completed some of the video footage is low quality due to strong wave and currents, poor water clarity and high turbidity. Conditions improved for the coral survey transects at the Project Footprint on the last day, so the data captured at that location is higher quality and good BCH validation was possible.

5. Location

The Project Location in the context of the Dampier Archipelago (and established spoil grounds) is shown in Figure 1. The existing mapped location of significant BCH of the Dampier Archipelago and adjacent to the Project is shown in Figure 2.

The BCH Validation Survey for the Project covered two areas:

a) detailed mapping within and adjacent to the Project Footprint where impacts are most likely to occur (Figure 3).

b) broadscale ground truthing to validate existing mapping within and adjacent to the established spoil grounds (Figure 4).

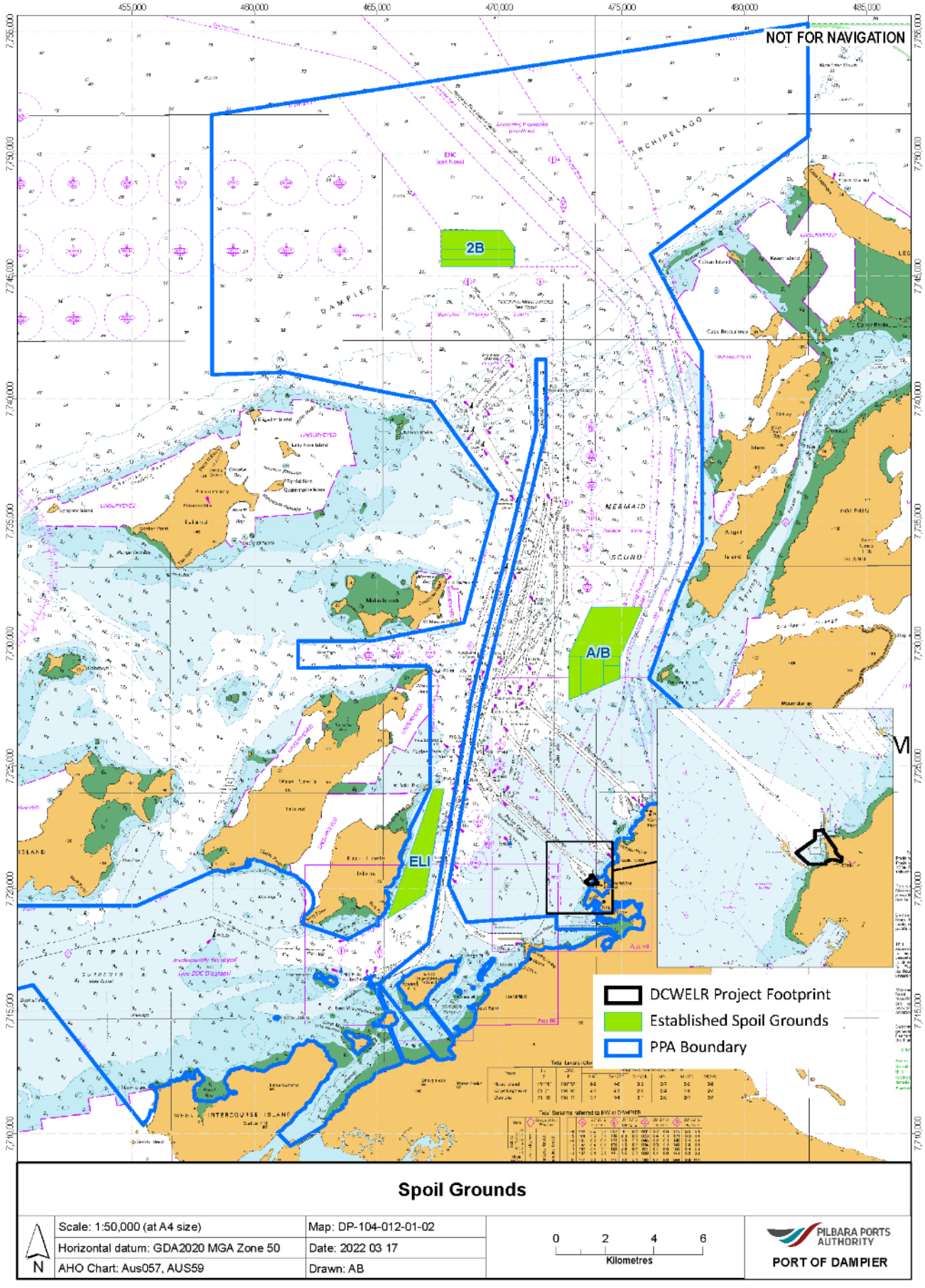

Figure 1 Project location and established spoil grounds

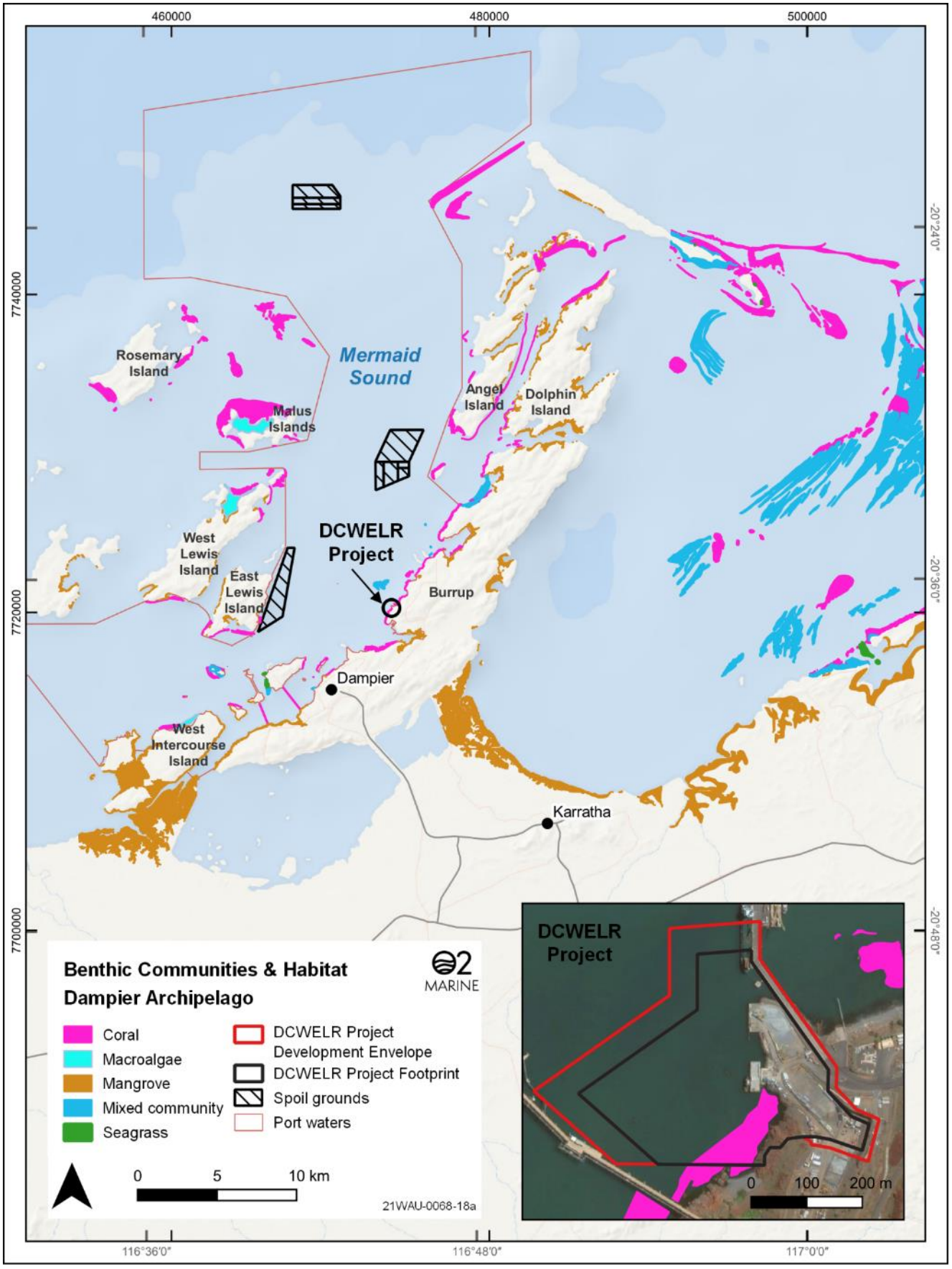

Figure 2 Significant BCH of the Dampier Archipelago and adjacent to Project (Source: MScience 2018)

Figure 3 BCH survey transects and drop camera locations within and adjacent to Project Footprint

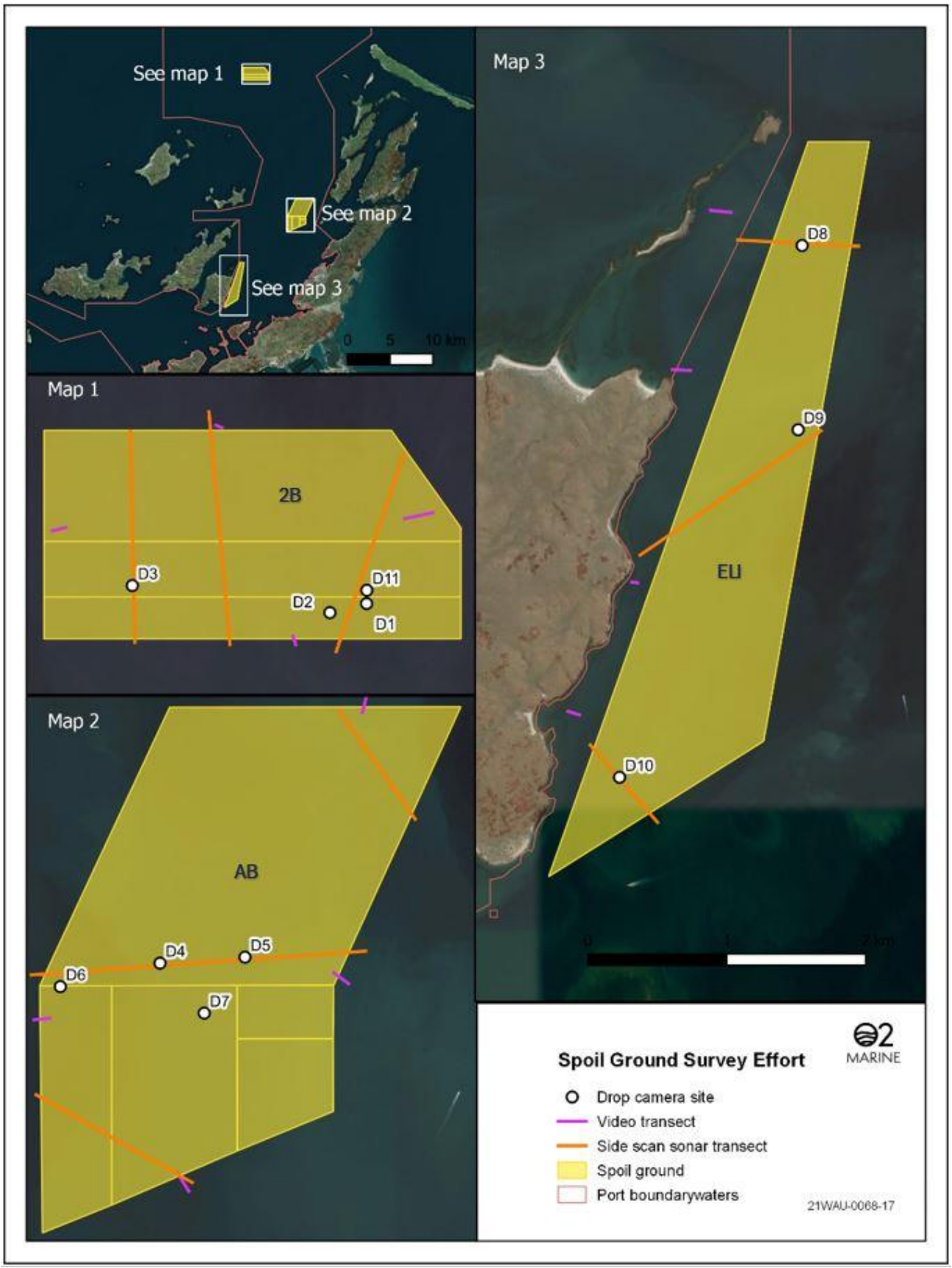

Figure 4 BCH survey transects and drop camera locations at Port of Dampier Established Spoil Grounds

6. Methods

To achieve the objectives of this scope the BCH Validation Survey required the use of drop camera/towed underwater camera and side scan sonar to capture actual BCH data as well as acoustic side scan sonar data to interrogate and ground truth. Sidescan Sonar transects, Tow Camera transects and Drop Camera locations are provided in Figure 3.

6.1. Survey Equipment

6.1.1. Vessel

O2 Marine undertook the survey on its 8.5m survey vessel '*Porter*' to undertake the scope of works (Figure 5). The proposed O2 Marine vessel is currently in survey, meeting all Australian Maritime Safety Authority and Department of Transport requirements. Porter is also fitted with AIS in accordance with PPA standards. Vessel registration and specifications can be found in the survey HSE plan.

Figure 5 O2 Marine's survey vessel 'Porter'.

6.1.2. Survey equipment

A 'TOWCAMhd' was utilised to capture BCH footage along transects from the rocky shoreline in and adjacent to the Project into the dredge/blasting footprint. Although the BCH Validation Survey Plan (27/01/2022) proposed using a 'QYSEA FIFISH V6' underwater ROV for this location, it was decided on the day that using the towed underwater camera would be easier, quicker and provide better data. The TOWCAMhd' is equipped with a top

side control unit to allow the operator to assess the seabed in real-time and has 128GB storage capacity, 1080pHD resolution video, a 70m tow cable and a SD Card which records at 1920 x 1080 Pixels for capturing optimal underwater footage. Tow camera transects were also undertaken using the 'TOWCAMhd' either side of the spoil grounds to survey potential BCH that may be impacted by turbidity plumes during dredge spoil disposal.

A StarFish 450F high-definition side scan sonar was used to survey the spoil grounds to ensure greater coverage. The swath width of the StarFish 450F varies between 40 m (at ~10 m depth) to 10 m (at ~2 m depth). The sonar was towed in a straight transect behind the vessel in a zigzag pattern across the spoil grounds (Figure 3) at a speed no greater than 4 knots. The backscatter data from the side scan sonar was used to identify key ecological features which were then targeted with a drop camera to verify benthic composition.

The 'TOWCAMhd' was utilised as the drop camera at chosen locations from the side scan sonar data.

The two different types of BCH survey equipment are shown in Figure 6.

a)  b) 

Figure 6 BCH survey equipment: a) TOWCAMhd, b) StarFish 450F Side Scan Sonar.

7. Survey results

Following completion of the survey, O2 Marine undertook data analysis including:

- Tow/drop camera video data analysis
- Side scan data analysis
- Compare existing BCH mapping with new BCH data.

The results for the Project Footprint and Established Spoil Grounds are discussed separately below.

7.1. Project Footprint

The results of the BCH survey indicate that the extent of the coral habitat is very similar and, in some locations, appears to have slightly increased in extent since it was last surveyed for the Dampier Marine Service Facility (Worley Parsons 2009). This demonstrates that the coral habitat was not irreversibly impacted from previous capital dredging undertaken in the area or if it was previously indirectly impacted it has recovered well.

From the grid pattern of drop cameras in the dredging footprint and tow camera transects of the nearshore it is clear that the BCH within and adjacent to the Project is mostly bare sediment with an intertidal and shallow subtidal rocky shore containing high to moderate profile reef colonised by coral communities (with some macroalgal and filter feeder communities). This coral/rocky habitat is categorised and mapped simply as 'coral' in the consolidated benthic habitat map of significant marine habitats of the Dampier Archipelago (Figure 2).

The coral habitat extends from approximately -1m to -6m Chart Datum (CD), seawards of the rocky shoreline areas. Coral cover is generally sparse to moderate, ranging from under 10% to more than 20% with limited areas of dense cover (>50%). This coral habitat occurs as a veneer of living coral growing on a substratum of bedrock outcrop and large boulders and is typically restricted to <100 m from shore before the habitat becomes bare sediment.

These reefs appear quite healthy with many large and long-lived coral colonies, although some signs of stress and damage was observed with sediment sitting on the surface of some coral colonies, a few partially bleached corals and some partially or completely dead corals. Coral genera in the area are predominantly faviids with *Turbinaria* species, with a mix of other genera making up the remaining cover. There was evidence of new coral recruitment at some locations, with small colonies between 2-10 cm across being relatively common on suitable dead coral substratum, and many fish species were observed on these reefs, both indicative of a healthy reef community.

The unconsolidated benthic substrate beyond this coral habitat typically comprises fine sediments typical of the south of Mermaid Sound.

Images of the fringing coral habitat within the Project Footprint from past (Worley Parsons 2009) and recent (O2 Marine 2022) surveys are shown in Figure 7 a and b) and Figure 8 (a – f).

a)  b) 

Figure 7 Coral habitat and bare sediment from DMSF Benthic Habitat Survey (Worley Parsons 2009).

Figure 8 Coral habitat and bare sediment from BCH Validation Survey transects within Project Footprint (O2Marine 2022)

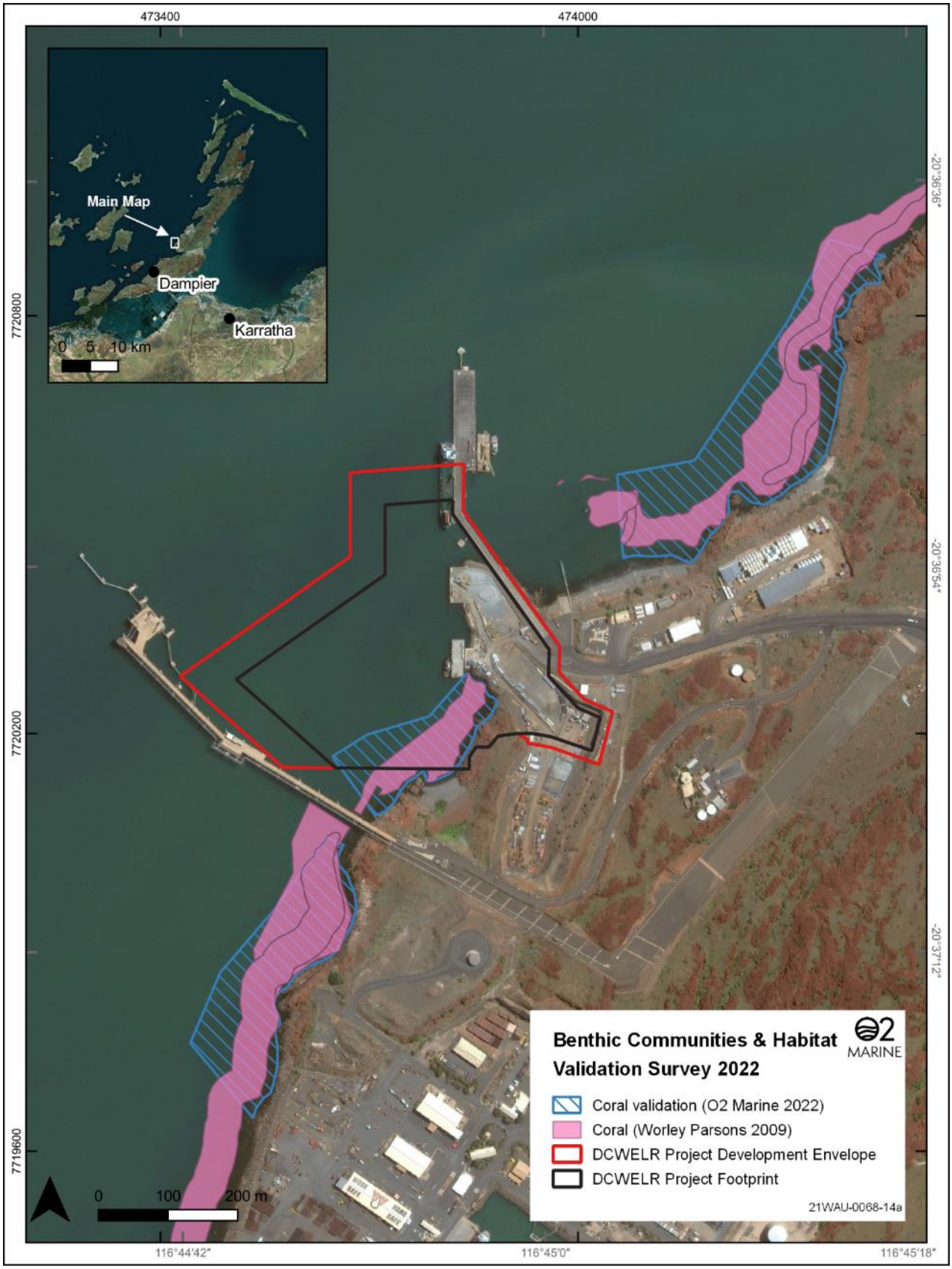

Figure 9 BCH Map comparing two surveys for the area within and adjacent to Project Footprint

7.2. Established Spoil Grounds

The benthic habitats at East Lewis Island Spoil Ground, Spoil Ground A/B and Spoil Ground 2B are likely to have been smothered during approved historic dredge disposal activities associated with previous dredging programs. As such, nearly all benthic communities identified during the sidescan sonar, drop camera and tow camera transects within and immediately adjacent to the spoil ground footprints are limited to resilient species which have managed to colonise the area (or on new habitat created from disposed blasted rock) since the last dredging program that utilised these spoil grounds.

Most of the sea floor within the bounds of the established spoil grounds is bare sediment (Figure 10). There are no significant corals within the established spoil grounds. Mixed communities and macroalgae occur in some locations within all the established spoil grounds where there is soft sediment or rubble habitat and where dredge spoil (blasted/dredged rock and rubble) has been previously placed and provides low relief low rugosity habitat.

a)

b)

c)

Figure 10 Typical bare seabed found across most of the three established spoil grounds: a) ELI b) A/B c) 2B

There is moderate cover of mixed communities found just outside the mid-western boundary of Spoil Ground A/B growing on extensive rock and rubble habitat. These communities are clearly resilient as they experience repeated elevated sedimentation as a result of sediment plumes emanating from disposal of spoil at Spoil Ground A/B. Sparse macroalgae and mixed communities are found within Spoil Ground A/B on soft sediment or on natural or disposed rock/rubble (Figure 11).

a) 

b) 

Figure 11 BCH footage from Spoil Ground A/B: a) macroalgae on rubble habitat within A/B b) sponge on rubble habitat just outside A/B

Very little BCH is present within Spoil Ground 2B. Sidescan sonar and drop camera footage identified soft sand with isolated low density mixed communities and invertebrates growing on previously disposed rock in the southwest of the spoil ground (Figure 12).

a) 

b) 

Figure 12 Previously disposed rock and rubble with mixed community and invertebrates in Spoil Ground 2B

Coral communities were observed that had colonised blasted/dredged rock previously disposed of in the southwest corner of Spoil Ground ELI (Figure 13). This finding was unique to Spoil Ground ELI and is probably due to its shallow depth and greater light available for coral growth and survival.

The coral communities approximately 100m to the west of Spoil Ground ELI that form fringing reef along the eastern shore of East Lewis Island are of high value and have significant coral cover. This coral habitat has a unique abundance of *Pavona decussata* which occurs as large dome-shaped clumps over large areas. The current health and cover of this coral community indicates no irreversible impact from previous dredge spoil disposal at this site. Images of the *Pavona* coral habitat adjacent to East Lewis Island Spoil Ground from past (Blakeway and Radford 2005) and recent (O2 Marine 2022) surveys are shown in Figure 14.

Figure 13 Coral communities growing on previously disposed rock/boulders in southwest corner of Spoil Ground ELI

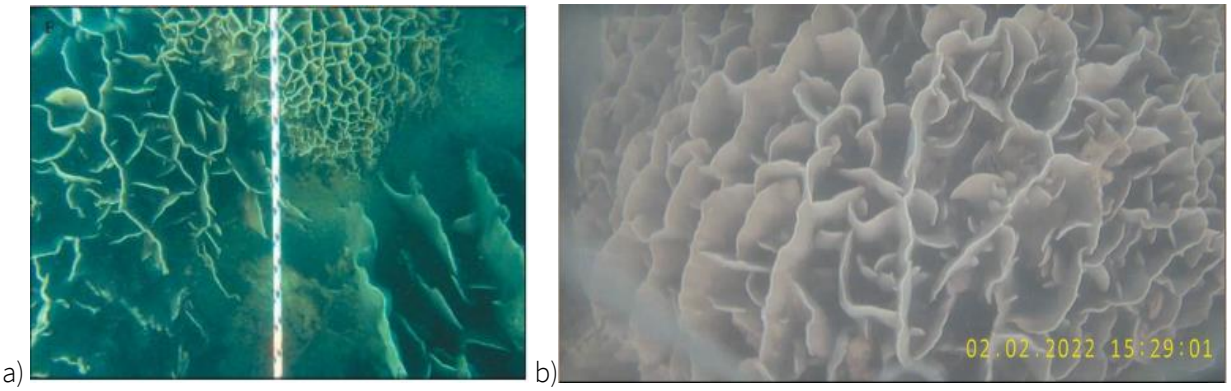

Figure 14 *Pavona* coral communities outside western boundary of Spoil Ground ELI a) Blakeway and Radford 2005 b) O2Marine 2022

8. Summary

The findings of the BCH Validation Survey validate the PPA's consolidated BCH map of the Dampier Archipelago and demonstrate that the PPA's mapped extent of BCH in the vicinity of the DCW is suitable for calculating BCH cumulative loss for the Project. The results of the BCH Validation Survey show a very similar (and in some locations greater) extent of coral habitat around the Project than in PPA's BCH map (Figure 9). However, for consistency with PPA's historical BCH loss calculations in the Port, the PPA's mapped extent of coral habitat will be used for the BCH Cumulative Loss Assessment.

The findings around the established spoil grounds may inform PPA's future placement of dredge spoil within the established spoil grounds (to avoid sensitive habitat adjacent to the spoil ground boundaries). The loss of existing BCH within these established spoil grounds, however, from disposal associated with the Project, is not within the scope of the Project's EIA or the BCH Cumulative Loss Assessment. This is due to these areas being previously approved for spoil disposal activities based on their low environmental value; and any BCH occurring within the spoil grounds is mostly BCH that has colonised rock or rubble habitat generated from previous spoil disposals.

The Dredge Plume Modelling Report (O2 Marine 2022) for the Project also does not predict any indirect permanent loss of BCH from spoil disposal. As such there is no irreversible impact to BCH to be considered outside of the established spoil ground boundaries for the BCH Cumulative Loss Assessment.

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