Dredging and Spoil Disposal Monitoring and Management Plan

Eramurra Solar Salt Project

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Version Register

Version	Status	Author	Reviewer	Change from Previous Version	Authorised for Release (signed and dated)
Rev A	Draft	B Campbell	C Lane		
Rev B	Draft	J. Abbott	C. Lane		
Rev 0	Final	C. Lane	J. Abbott		
Rev 1	Final	J. Abbott	C. Lane	Address Peer review comments	On file 20/6/2023
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Rev 3	Final	J. Abbott	G. Motherwell / C. Lane	Updates to reflected revised project design and plume modelling.	
Rev 4	Final	J. Abbott	G. Motherwell	Address regulator and client comments	

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Acronyms and Abbreviations

Acronym/Abbreviation	Description
AASS	Actual acid sulfate soils
ANZG	Australian and New Zealand Guidelines
BCH	Benthic Communities and Habitat
BCHMP	Benthic Communities and Habitat Monitoring Program
CALM	The Department of Conservation and Land Management
CD	Chart datum
CITIC	China International Trust Investment Corporation
CPE	Cape Preston East
CPEP	Cape Preston East Project
DAWE	Department of Agriculture, Water and the Environment
DBCA	Department of Biodiversity Conservation and Attractions
DCCEEW	The Department of Agriculture, Water and the Environment
DEC	Department of Environment Conservation
DSDMMP	Dredging and Spoil Disposal Monitoring and Management Plan
DEWHA	The Department of the Environment, Water, Heritage and the Arts
DLI	Daily Light Integral
DoE	Department of Environment
DoEE	Department of the Environment and Energy
DoT	Department of Transport
DVG	Default Value Guideline
DWER	Department of Water and Environment Regulation
EPA	Environmental Protection Authority
EPBC	Environment Protection and Biodiversity Conservation
EPO	Environmental Protection Outcomes
EPSG	European Petroleum Survey Group
ESD	Environmental Scoping Document
ESSP	Eramurra Solar Salt Project
GHD	Gutteridge Haskins and Davey

Acronym/Abbreviation	Description
GIS	Geographical Information System
GPS	Global Positioning System
ha	Hectares
LAT	Lowest Astronomical Tide
LAU	Local Assessment Unit
LoR	Limit of Reporting
LS	Leichhardt Salt Pty Ltd
M^3	Cubic metres
MARPOL	International Convention for the Prevention of Pollution from Ships
MBACI	Multiple before–after-control-impact
MCMP	Marine Construction Management Plan
MEOMMP	Marine Environmental Operational Monitoring and Management Plan
MEQ	Marine Environmental Quality
MEER	Maritime Environmental Emergency Response
MFO	Marine Fauna Observer
MNES	Matters of National Environmental Significance
MS	Ministerial Statement
MTs	Management Targets
Mtpa	Million tonnes per annum
MWQMP	Marine Water Quality Monitoring Program
NaCl	Sodium chloride
NAGD	National Assessment Guidelines for Dredging
PASS	Potential Acid Sulfate Soils
PAH	Polycyclic aromatic hydrocarbons
PER	Public Environmental Review
POLREP	Pollution Report Form
SSC	Suspended sediment concentration
TACC	Technical Advisory and Consultative Committee
TMF	Tiered Management Framework
TRH	Total Recoverable Hydrocarbons

Acronym/Abbreviation	Description
TSS	Total Suspended Solids
TSV	Transhipment vessels
UKC	Under keel clearance
WA	Western Australia
WGS	Wideband Global SATCOM
ZoHI	Zone of High Impact
ZoI	Zone of Influence
ZoMI	Zone of Moderate Impact

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1. Introduction

1.1. Project Overview

Leichhardt Salt Pty Ltd (LS) is seeking to develop the Eramurra Solar Salt Project (the Proposal), a solar salt project east of Cape Preston, approximately 55 km west$598south-west of Karratha in the Pilbara region of Western Australia (WA; Figure 1).The Proposal is an evaporative solar project that utilises seawater to produce raw salt as a feedstock for reprocessing to high purity salt. The Proposal aims for average annual production rates of 5.2 million tonnes per annum (Mtpa). To meet this production, the following infrastructure will be developed:

- Seawater intake, pump station and pipeline
- Concentration ponds totalling approximately 10,000 ha
- Crystallisers, totalling approximately 1,900 ha
- Drainage channels and bunds
- Process plant and product dewatering facilities
- Water supply (desalination plant)
- Bitterns disposal pipeline and outfall
- Pumps, pipelines, roads, and support buildings including offices and communications facilities
- Workshops and laydown areas
- Landfill, and
- Other associated infrastructure.

A general description of the of the Proposal is provided in Table 1, while the physical extent and Proposal content elements (e.g. development, action, activities or processes) are summarised in Table 2. The Proposal development envelopes are shown in Figure 2.

Table 1: Short Summary of the Proposal

Project Title	Eramurra Solar Salt Project
Proponent Name	Leichhardt Salt Pty Ltd
Short Description	Leichhardt Salt Pty Ltd (LS) is seeking to develop a solar salt project in the Cape Preston East area, approximately 55 km west-southwest of Karratha in WA (the Proposal). The Proposal will utilise seawater and evaporation to produce a concentrated salt product for export. The Proposal includes the development of a series of concentration ponds, crystallisers and processing plant. Supporting infrastructure includes bitterns outfall, drainage channels, product dewatering facilities, desalination plant, pumps, pipelines, power supply, access roads, administration buildings, workshops, laydown areas, landfill facility, communications facilities and other associated infrastructure. The Proposal also includes dredging at the Cape Preston East Port with disposal of dredge material at an offshore location and onshore within the Ponds and Infrastructure Development Envelope.

Table 2: Location and proposed extent of physical and operational elements

Element	Location	Proposed Extent
Physical Elements		
Pond and Infrastructure Development Envelope – Concentration ponds and crystallisers. Process plant, desalination plant, administration, water supply, intake, associated works (access roads, laydown, water supply and other services).	Figure 2	Disturbance of no more than 12,201 ha within the 20,157 ha Ponds and Infrastructure Development Envelope.
Marine Development Envelope – Seawater intake and pipeline, dredge channel, bitterns pipeline, outfall diffuser and mixing zone.	Figure 2	Disturbance of no more than 53 ha within the 703 ha Marine Development Envelope.
Dredge Spoil Disposal Development Envelope – Disposal location for dredge spoil.	Figure 2	Disturbance of no more than 100 ha within the 285 ha Dredge Spoil Disposal Development Envelope.
Operational Elements		
Bitterns discharge	Figure 2	Discharge of up to 5.9 Gigalitres per annum (GL pa) of bitterns within a dedicated offshore mixing zone within the Marine Development Envelope
Dredge Volume	Figure 2	Approximately 400,000 m^3

1.2. Purpose of this Plan

O2 Marine have been engaged by the proponent to undertake marine environmental investigations to help identify environmental risks of the ESSP, establish baseline conditions, help facilitate the environmental approvals process, and guide appropriate monitoring and management to minimise potential impacts to the marine environment during construction and operations.

The purpose of this Dredging Spoil and Disposal Monitoring and Management Plan (DSDMMP) is to support environmental approval for the proposal, through demonstration of best-practice environmental management to achieve acceptable Environmental Protection Outcomes (EPOs). Specifically, the plan will:

1. Address the Environmental Scoping Document requirement (Item 17) (Preston Consulting 2022) to ‘ Prepare a DSDMMP which includes monitoring and management actions to minimise impacts on Benthic Communities and Habitats (BCH) from dredging and spoil disposal activities.
2. Support a sea dumping permit application for disposal of dredge material in accordance with the Sea Dumping Act.
3. Provide the framework for environmental management of the proposed dredging activities, including defining the EPOs and Management Targets (MTs) associated with the dredging and dredge material disposal that are to be achieved for the proposed development.
4. Define detailed management and monitoring actions to ensure that the project EPOs are achieved.
5. Provide the framework to guide the preparation of a detailed operational management plan to be developed by the appointed contractor(s) or included within specific contract conditions accepted by the contractor(s), prior to the commencement of the dredging activities.

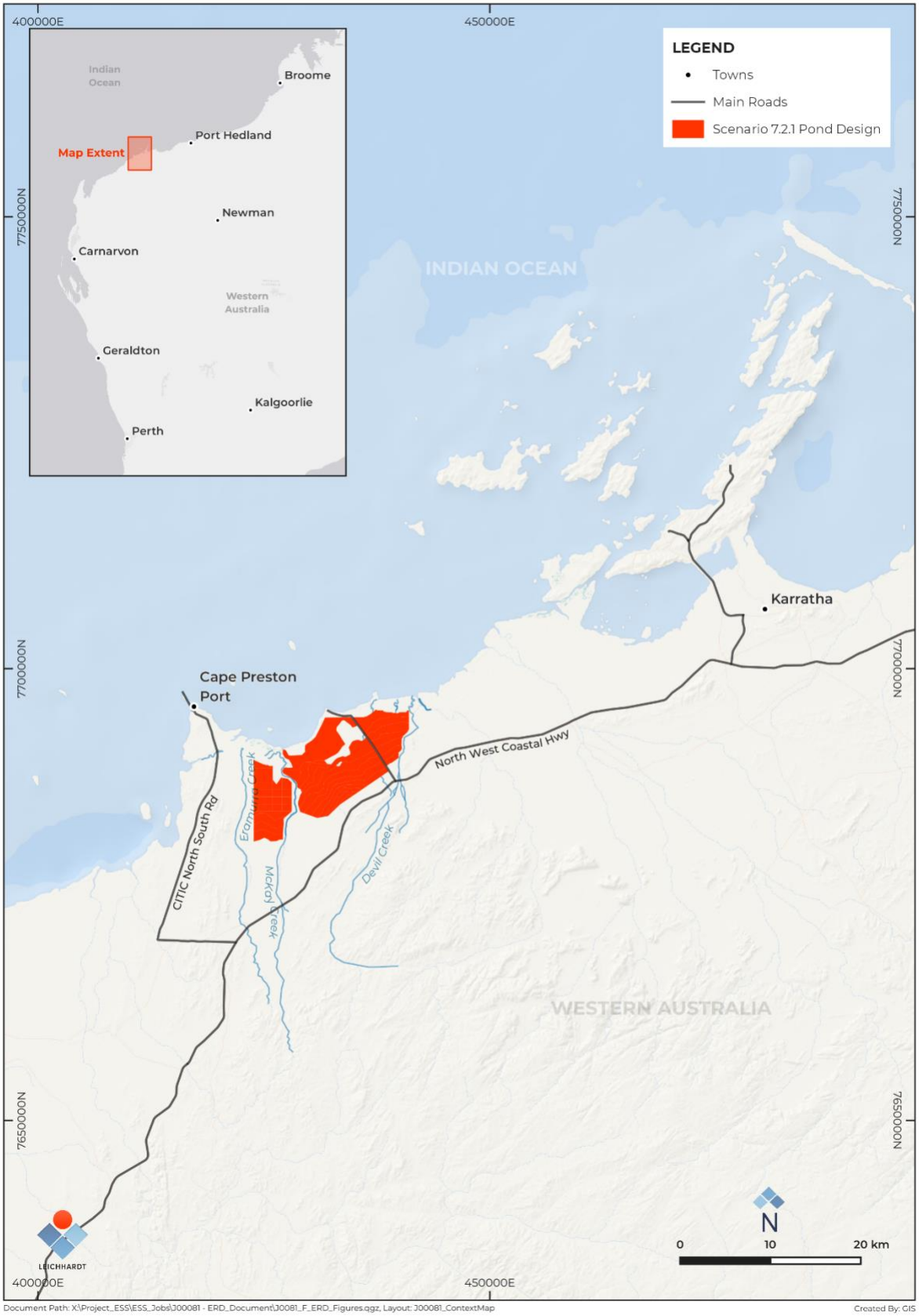

Figure 1: Regional location of the Proposal

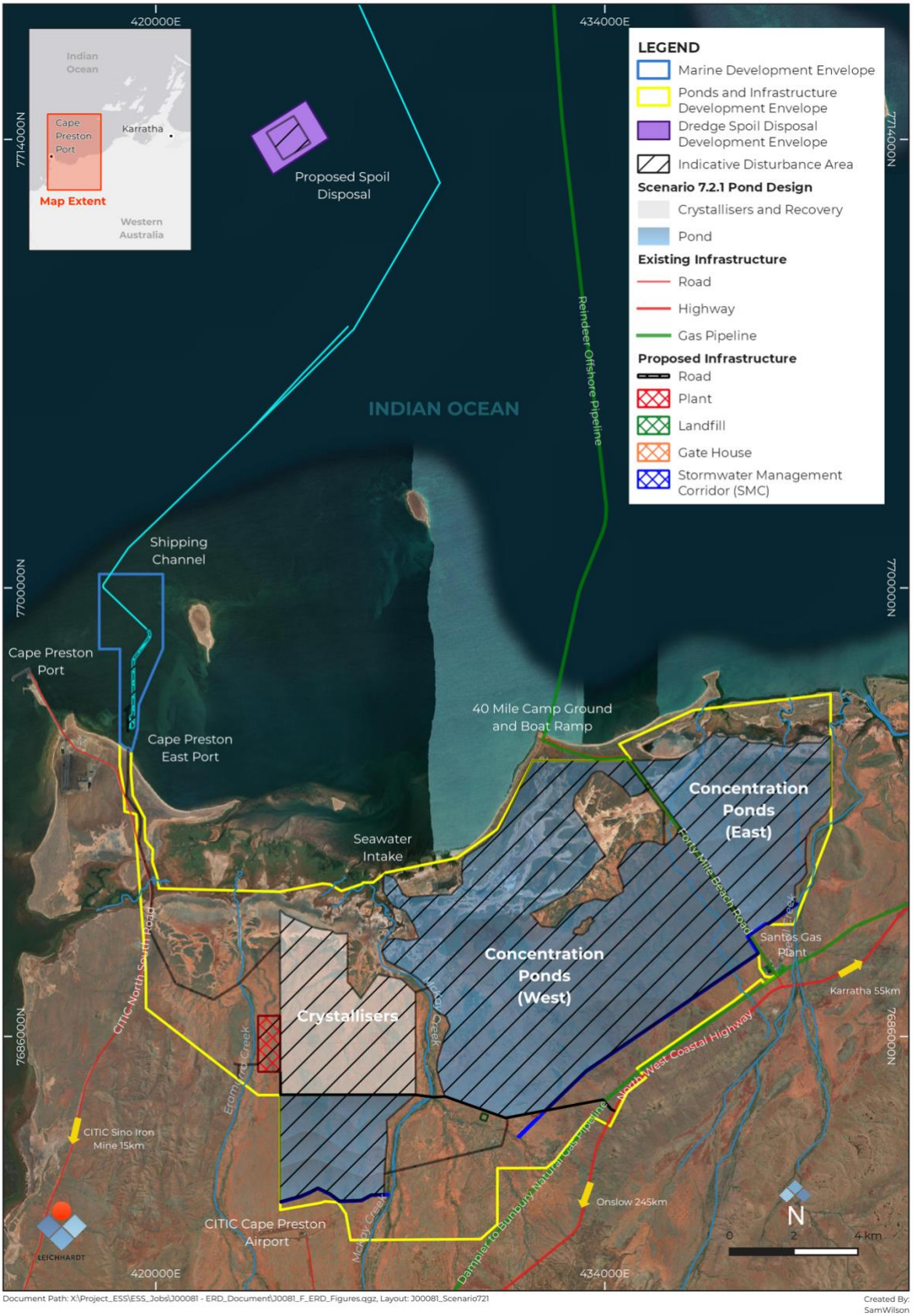

Figure 2: Proposed Development Envelopes and indicative layout

1.3. Objectives

The objective of the DSDMMP is to identify potential impacts and to assign appropriate management targets and management actions, where necessary, to ensure that state EPOs can be achieved. The specific EPOs defined in this DSDMMP are presented in Table 12 and are aligned with the environmental objectives presented within the Western Australian Environmental Protection Authority (EPA) State Guidance which are summarised below and explained in greater detail in Section 6:

- To protect BCH so that biological diversity and ecological integrity are maintained
- To maintain the quality of water, sediment and biota so that environmental values are protected
- To protect marine fauna so that biological diversity and ecological integrity are maintained.

1.4. Scope of the Plan

The scope of the DSDMMP applies to dredging and disposal related activities carried out during the marine construction phase of the Proposal, that have the potential to impact on the environmental quality of the marine environment of the Proposal. The DSDMMP applies to the following construction activities of the Proposal:

- Capital dredging activities associated with creation of a transhipment berthing pocket and a nominal 3km long shipping channel
- Offshore dredged material placement at the dredge spoil disposal area and Onshore disposal in the port stockyard area as indicated on Figure 7.

Impacts from the Proposal's construction (non-dredging) and/or operational activities will be covered by management and monitoring programs specific to these activities and are not addressed further within the scope of this DSDMMP.

The DSDMMP considers the EPA's *Instructions on how to prepare Environmental Protection Act 1986 Part IV Environmental Management Plans* (EPA 2021a) and details the specific process for continual revision and improvement of the Plan any time the Project progresses, or at any time key processes alter, and new risks are identified.

This DSDMMP is to be reviewed and updated accordingly where new data becomes available, inputs change (including methods, location and timing) or when approval conditions stipulate changes to monitoring, management and reporting procedures.

2. Approvals and Legislation

2.1. Approval Conditions

A list of approval conditions will be tabulated in this section when provided.

2.2. Approval Holder Details

Details of the holder of the approvals relevant to this Plan are provided in Table 3.

Table 3: Approval holder details

Company Name:	Leichhardt Salt Pty Ltd
Australian Business Number (ABN):	82613581614
Address:	Suite A7, Level 1/435 Roberts Road, Subiaco, WA 6008
Key Contact (Role):	Scott Nicholas (CEO)
Key Contact Details:	Scott.nicholas@leic.com.au

2.3. Legislation, Regulations and Guidelines

The potential environmental impacts of the Proposal were considered at Commonwealth, State and Local Authority level with each authority providing guidance on the level of assessment required. This DSDMMP forms a key documented process and is a tool for recognising and managing the various conditions and requirements of the environmental approvals and the various legislation as listed below.

2.3.1. Commonwealth

Commonwealth Environment Protection and Biodiversity Conservation Act 1999

The Department of Climate Change, Energy, and the Environment (DCCEEW) has determined that this Proposal is a controlled action and will be assessed under the *Environment Protection and Biodiversity Conservation Act 1999 (*EPBC Act). An Environmental Scoping Document (ESD) (Preston Consulting 2022) has been prepared to detail the studies required to support the environmental review of the proposed action. The ESD (Preston Consulting 2022) outlines key environmental factors that require assessment, those of which that are related to the proposed dredge program include BCH, Marine Environmental Quality (MEQ) and Marine Fauna.

Commonwealth Environmental Protection (Sea Dumping) Act 1981

A sea dumping permit is required under the Sea Dumping Act to authorise the dumping and loading for the purpose of dumping any wastes or other matter into Australian waters. A permit is required for this project due to the proposed offshore disposal of up to 400,000 m^3 of nearshore capital dredge material. A sea dumping permit requires the development and implementation of an approved Sampling and Analysis Plan (O2 Marine 2022a) in accordance with the National Assessment Guidelines for Dredging (NAGD 2009).

The NAGD contains provision for the granting of permits for dredging on the following basis:

- An assessment of the applicant's capacity to meet their obligations under the Sea Dumping Act and any permit granted
- Establishment of a Technical Advisory and Consultative Committee (TACC) for long-term management
- Development and the implementation of a satisfactory Environment Management Plan for the loading and disposal activities, which provides for sampling and analysis to support any future permit applications.

Other Commonwealth legislation, regulation, and guidelines

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

- *Protection of the Seas (Prevention of Pollution from Ships) Act 1983*
- Australian Ballast Water Management Requirements Version 8 2020
- *Biosecurity Act 2015*
- Biosecurity Regulations 2016
- National Water Quality Management Strategy (Australian Government 2018)
- *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZG 2018).

The following Threat Abatement Plans for marine species were also considered:

- Threat Abatement Plan for the impacts of marine debris on the vertebrate wildlife of Australia's coasts and oceans (DoEE 2018)

2.3.2. State

Environmental Protection Act 1986

This document has been prepared in consideration of the relevant guidelines for this Proposal, which apply to the management and assessment of dredging programs in Western Australia. These include, but are not limited to:

- Technical Guidance – Environmental Impacts Assessment of Marine Dredging Proposals (EPA 2021b)
- The National Assessment Guidelines for Dredging (NAGD), 2009 (NAGD 2009)
- Technical Guidance: Protecting the Quality of Western Australia's Marine Environment (EPA 2016)

Other State legislation, regulation, and guidelines

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

- *Biodiversity Conservation Act 2016*
- *Port Authorities Act 1999*
- Navigable Waters Regulations 1958
- Shipping and Pilotage (Port and Harbour) Regulations 1966
- *Western Australian Marine Act 1982*
- *Pollution of Waters by Oil and Noxious Substances Act 1986*
- *Marine and Harbours Act 1981*
- Environmental Protection Regulations 1987.

3. Roles and Responsibilities

The roles and responsibilities for the implementation of the DSDMMP are summarised in Table 4.

Table 4: Project Roles and Responsibilities

Position	Responsibility
Proponent (as principal) LS Dredging Manager	• Overall responsibility for implementation of this DSDMMP • Overall responsibility for complying with relevant legislation, standards, and guidelines • Ensures dredging activities are conducted in an environment safe for both site personnel and the public • Reports on environmental performance for the project to key stakeholders • Responsible for environmental compliance reporting • Responsible for reporting all environmental non-compliance incidents
LS Environmental Manager	• Complies with the requirements of this DSDMMP • Provides advice on dredging and dredged material environmental issues • Oversee implementation of environmental controls, monitoring programs, inspections, audits, and management actions in this DSDMMP • Completes compliance reporting requirements • Responsible for the implementation of the environmental monitoring program and inspections • Prepares environmental monitoring reports • Provides advice with respect to environmental issues as required
Dredging Contractor	• Undertakes dredging and excavation works • Prepares and implements an environmental management plan in accordance with the requirements of this DSDMMP • Implements the management actions of this DSDMMP • Ensures adequate training of all staff within their area of responsibility • Ensures all equipment is adequately maintained and correctly operated • Responsible for reporting all environmental incidents to LS within 24 hours in accordance with Pilbara Ports incident reporting procedures
All persons involved in the dredging	• Comply with the requirements of this DSDMMP • Comply with all legal requirements under the approval's documents and relevant Acts • Exercise a Duty of Care to the environment at all times • Report all environmental incidents

4. Existing Environment

4.1. General Environment

4.1.1. Climate and Oceanography

The Pilbara is characterised as an arid region, with pronounced wet (November to April) and dry (May to October) seasons and experiences an average annual rainfall of only 315 mm (which is dominated by wet season tropical storms). Maximum daily temperatures at nearby Eramurra reached a monthly average of 37.9°C in January, falling to 28.3°C in July (O2ME 2025). Winds range from easterly to south-easterly in the dry season to west and south-westerly in the wet season, when the area is also exposed to intense tropical storms and cyclones (with an average of 1 landfall cyclone every 2 years). Sea temperature varies from 18°C in the cooler months to a maximum of 31.5°C during the wet season, and inshore salinities may reach levels around 37 ppt (CALM 2005).

Wave energy in the area is typically relatively low, except during cyclones, with typical directions of west to south-west from May to July, and east to north-east between September to February (O2ME 2025). Various currents operate in the vicinity of the study area and are typically dominated by tides on the inner shelf. At the proposal site, tides are semidiurnal with a mean spring tidal range of approximately 3 m, and a maximum range of 4.5 m.

4.1.2. Geomorphology

The Pilbara comprises a very broad and shallow continental shelf, which ranges from around 100 km wide in the west to 300 km wide in the east (Heap and Harris 2008). According to James et al. (2004), shallower (continental shelf) deposits comprise mixed sediments, including both modern terrigenous (river derived) and carbonate (biogenic) materials, as well as the coarse preserved remains of ancient sediments (relict intraclasts).

Between North-West Cape and the Dampier Archipelago, numerous small bedrock islands lie in shallow water and introduce heterogeneity in the ambient hydrodynamic conditions (O2ME 2025) along the coastline, which in turn promotes heterogeneity in marine habitats. The Pilbara continental shelf is strongly influenced by the presence of limestone features that have been deposited during lower stages of sea-level and remain on the modern seabed as partially buried (reef veneer) or completely exposed rocky reef systems (LeBrec et al. 2022). These often-complex features vary greatly in morphology, state of weathering and bathymetric profile. Lebrec et al. (2022) identified that the seabed in the vicinity of the Regnard Islands to the 20 m isobath features a series of submerged ancient strandplains. The authors do not characterise the inner bay itself, though the satellite derived bathymetry product of Lebrec et al. (2022) indicates several distinct systems of ridges within the bay.

The oceanography of the region, including cyclone events, internal tides and ocean currents, play an important role in regulating sediment transport, deposition and erosion (James et al. 2004). Marine sediments are mobilised and deposited through the action of wave and tides, whereas terrigenous sediments are delivered to the coast episodically through flood plains and river deltas - the largest river within Regnard Bay being the Maitland River to the East of the proposed site.

4.1.3. Marine Water Quality

Nearshore waters typical of the Cape Preston region are characterised by variable turbidity and high sedimentation rates, with associated highly variable light regimes and seawater temperatures. Offshore waters exhibit fewer extremes in the water quality, but still display occasional high levels of sedimentation and turbidity, low light and variable seawater temperatures (Pearce et al, 2003).

Light, turbidity, seawater temperature and sedimentation rates are typically weather dependent and show a strong seasonal transition from the dry to the wet seasons. Large daily tidal ranges (>5 m), strong winds (gusts >50 km/h) and increased wave activity (such as associated with cyclonic activity) can impact background conditions resulting in increased turbidity (in the form of increase suspended sediment concentration (SSC) due to coastal runoff and wind/wave driven sediment resuspension. In summary, waters in the vicinity of the project area are subject to naturally elevated levels of turbidity and a reduced light climate heavily influenced by discrete weather events (Pearce et al. 2003).

O2 Marine (2022a) undertook 12 months of baseline marine water quality monitoring in the Eramurra Project area, which included:

- Continuous measurements of light, turbidity, temperature and salinity
- Monthly water sampling for laboratory analysis of heavy metals and hydrocarbons.

O2 Marine (2022a) identified the following from marine water quality baseline study conducted at the Eramurra Project study area:

- Salinity levels recorded a median value of 35.1 ppt and appeared to be indicative of well mixed oceanic waters
- Turbidity was found to be higher at the inshore monitoring locations than at the offshore location, which is consistent with other Pilbara water quality investigations (Jones et al. 2019; MScience 2009; Pearce 2003; O2 Marine 2022a)
- Derived Daily light Integral (DLI) was highest during wet season and lowest during the dry season and correlated with seasonal change in solar elevation angle, which is a primary factor influencing the amount of available benthic light in these areas. The lowest light levels in both areas corresponded closely with high turbidity levels, associated with the passing of several Tropical Cyclones and low-pressure systems over the sampling period
- Importantly, the EPA (2021b) default trigger values for SSC and DLI thresholds for possible and probable effects on coral and seagrass were found to be appropriate for use as criteria for monitoring dredging effects in the Eramurra Project area
- Laboratory analysis of marine water samples showed no evidence of heavy metal or hydrocarbon contamination. As such, the current allocation of maximum and high levels of ecological protection are appropriate for the marine waters of the Eramurra Project area.

4.1.4. Benthic Communities and Habitat

The dominant geological features in the area are erosional basaltic outcrops, sedimentary rock formations including limestone reef platforms and islands and expansive areas of mud flats formed by tidal processes. The marine area is bounded to the west by Cape Preston, a basalt outcrop fringed by a limestone shore platform, which extends to the east. This shelf runs seaward of the Eramurra creek floodplain and an extensive network of tidal creeks and mudflats. Fine sediments are delivered to coastal areas from inland mudflats during tidal action and rainfall events (Eliot et al. 2013). Scattered hard and soft coral communities have developed on limestone shelves, particularly around Gnoorea Point. In general, marine areas inshore of South-West Regnard Island and extending northeast to nearby Eaglehawk Island are very shallow. Offshore, depth contours run in WSW-ENE orientation and a notable depth increase from approximately -3 m LAT to approximately -13m LAT is recorded on bathymetry charts. The Maitland River drains into Regnard Bay and the intertidal areas along this stretch of coast support large stands of mangrove habitat (LeProvost 2008).

Previous Benthic Habitat studies have found that the Pilbara region supports a mix of sand, silt, algal mat, macroalgal, seagrass, sponge, ascidian, soft and hard coral cover (Lyne et al. 2006; Campey and Gilmour 2000; CALM 2000; Maunsell 2006; URS 2008; LeProvost 2008; Worley Parsons 2009; GHD 2013; and Olsen et al. 2019). Significant areas of high-density coral and other benthic invertebrate (i.e. sponge, ascidian, hydrozoan) cover was identified close to Cape Preston (LeProvost 2008; and GHD 2013).

O2 Marine undertook subtidal BCH studies in 2021, 2022, 2023 and 2024, with full details and habitat descriptions outlined in O2 Marine (2025a). The key habitat classifications across the subtidal Local Assessment Units (LAUs) (LAU5 – LAU13) are described below and detailed in Table 5 and Figure 3:

Unvegetated Soft Sediment

The majority (69.4%) of benthic habitat within the Proposal MDE was characterised by unvegetated soft sediment (Figure 3). This substrate is dominated with areas of little to no biota, particularly in zones beyond the 5 m (MSL) contour. Unvegetated soft sediment was prominent in deeper waters (LAUs 8, 9, 10, 11, 12, and 13), where it represents more than 50% of the mapped area in each unit.

Habitat with Seagrass Present

Vegetated sediments and habitats were widespread within the Proposal area, with seagrasses, predominantly in low densities, being the most common benthic primary producer type over the unconsolidated sediments. High-density seagrass areas, accounting for 51.6% of classified seagrass points, were restricted to shallow, sheltered zones above 2 m (MSL). The largest area of seagrass was found in LAU 6, comprising 1,446 ha (18%). Smaller patches of seagrass are visible in LAUs 3 (70 ha, 5%), 4 (66 ha, 7%), and 1 (110 ha, 8%), providing additional connectivity between vegetated habitats across the Proposal area.

Macroalgae Dominated Habitat

Macroalgae-dominated habitats appear to be associated with outcropping low-relief reef and were widely distributed across the Proposal area. Prominent distributions were found in LAUs 1 and 4, with the largest areas of macroalgae comprising 521 ha (38%) and 316 ha (32%), respectively. Smaller but notable patches were recorded in LAUs 2, 3, 5, 6, and 7, contributing to the overall habitat diversity.

Hard Coral Habitat

Hard coral habitats were primarily observed near limestone reef features and areas with higher topographic complexity, such as emergent shoals or isolated reef patches (Figure 3). These habitats were generally found in depths ranging from -5 m to -15 m, as shown in the bathymetry map. The highest densities of coral appear to be associated with reef structures around SW Regnard Island in LAU 6 (1,750 ha, 22%) and LAU 7 (1,573 ha, 20%), followed by significant areas in LAU 5 (301 ha, 11%). Smaller patches were also observed in LAUs 1, 2, 3, and 4.

Filter Feeder Dominated Habitat

Filter feeder habitats range from sparse to dense coverage, include bivalves, sponges, ascidians, bryozoans, and soft corals. These communities were distributed across various depths and are often associated with sediments and reef structures partially covered by sand veneers. Filter feeder-dominated habitats were most extensive in LAUs 7 (2,960 ha, 38%), LAU 8 (3,463 ha, 36%), and LAU 10 (3,742 ha, 49%), with substantial areas also present in LAU 6 (2,097 ha, 26%) and LAU 5 (299 ha, 11%).

Mixed Subtidal Habitat

These are generally a ‘no majority’ class, where no clear majority occurred for a particular data collection point. These areas are often transitional habitats, and generally included a combination of macroalgae (brown and other macroalgae), filter feeders (sponges, hydroids, and sea whips) and/or hard and soft corals.

Table 5: Benthic Community Habitat Types, including the areas mapped (in ha) within the project subtidal LAU's

BCH	LAU1	LAU2	LAU3	LAU4	LAU5	LAU6	LAU7	LAU8	LAU9	LAU10	LAU11	LAU12	LAU13
Unvegetated Soft Sediment	671 ha (49%)	960 ha (61%)	811 ha (59%)	492 ha (50%)	1,473 ha (55%)	2,215 ha (27%)	2,493 ha (32%)	6,161 ha (64%)	4,113 ha (77%)	3,869 ha (51%)	4,461 ha (73%)	22,495 ha (100%)	5,890 ha (100%)
Hard Coral Habitat	8 ha (0.6%)	18 ha (1%)	91 ha (7%)	65 ha (7%)	301 ha (11%)	1,750 ha (22%)	1,573 ha (20%)	-	-	-	-	-	-
Filter Feeder Dominated Habitat	15 ha (1%)	21 ha (1%)	10 ha (0.8%)	16 ha (2%)	299 ha (11%)	2,097 ha (26%)	2,960 ha (38%)	3,463 ha (36%)	1,240 ha (23%)	3,742 ha (49%)	1,622 ha (27%)	-	-
Macroalgae Dominated Habitat	521 ha (38%)	277 ha (18%)	348 ha (25%)	316 ha (32%)	363 ha (14%)	223 ha (3%)	18 ha (0.2%)					-	-
Habitat with Seagrass Present	110 ha (8%)	225 ha (14%)	70 ha (5%)	66 ha (7%)	125 ha (5%)	1,446 ha (18%)	399 ha (5%)	-	-	-	-	-	-
Mix Subtidal Habitat	38 ha (3%)	61 ha (4%)	41 ha (3%)	35 ha (4%)	101 ha (4%)	332 ha (4%)	315 ha (4%)		-	-	-	-	-
Total (ha)	1362.95	1564.09	1370.93	989.70	2661.90	8062.89	7758.21	9623.79	5353.28	7610.41	6083.35	22495.42	5890.25

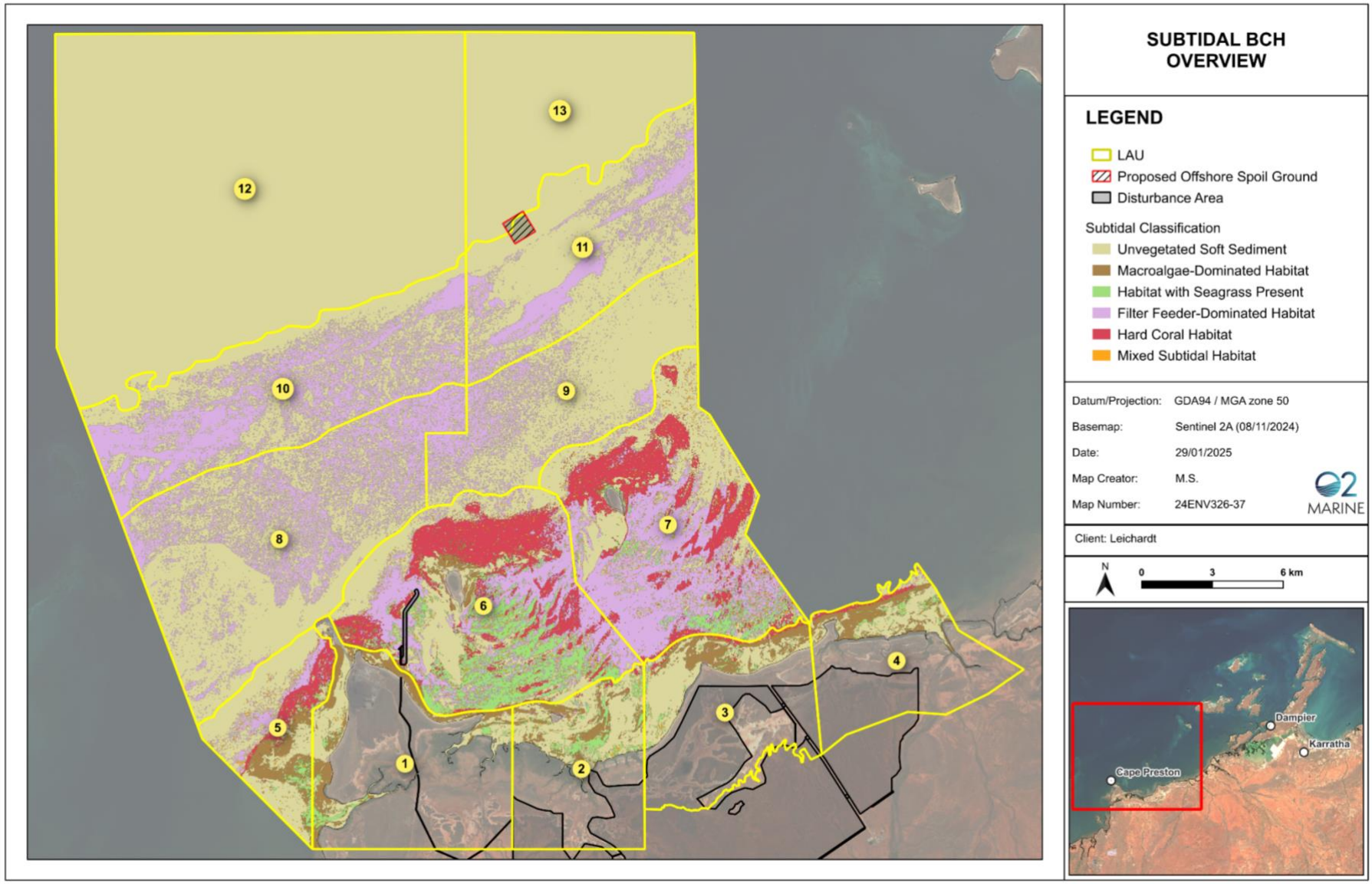

Figure 3: Subtidal BCH mapping

4.1.5. Marine Fauna

Key conservation significant marine fauna and socio-economically important fish species were identified in O2 Marine (2025b) for targeted EIA and management planning. These are:

Conservation significant species

- Humpback whale
- Dugong (Migratory)
- Australian humpback dolphin
- Indo-Pacific bottlenose dolphin
- Green turtle
- Hawksbill turtle
- Green sawfish
- Reef manta ray
- Flatback turtle

Socio-economically important fish species

- Blue spotted emperor
- Red emperor
- Spanish mackerel
- Western king prawn
- Brown tiger prawn

Identification of 'key' species as those with the highest conservation or socio-economic value, which could be impacted by the Proposal ensures that the correct level of attention is paid to those at greatest potential risk. The key conservation significant species were identified based on their status and likelihood of occurrence in the Proposal area. The key socio-economically fish species are those that are indicator species for the various aquatic resources that overlap with the Proposal area. Ecological windows (Table 6 and Table 7), which construction activities should aim to avoid, have been identified for the key species. Other management measures will also indirectly protect other, similar, species.

Table 6: Key Conservation Species' Ecological Windows (Dark Blue Represents Full Duration of Presence, Light Blue Represents Timing of Specific Behaviours, Diagonal shading represents peak timing

Species	J	F	M	A	M	J	J	A	S	O	N	D	Data Source
Dugong													DBCA (2021); DBCA (2024)
Australian humpback dolphin													Hanf et al. (2022); Raudino et al. (2023)
Indo-Pacific bottlenose dolphin													Hanf et al. (2022); Raudino et al. (2023)
Humpback whale													Irvine et al. (2018), Jenner et al. (2010)
- Northward migration													Jenner et al. (2010)
- Southward migration													Jenner et al. (2010)
-Southward peak calves													Irvine et al. (2018) ; Jenner et al. (2010)
Flatback turtle													DoEE (2017b)
- Foraging													DoEE (2017b); Peel et al. (2024)
- Nesting and inter-nesting													DoEE (2017a); Pendoley Environmental (2022; 2023a)
-Hatchling emerging													DoEE (2017a); Pendoley Environmental (2022; 2023a)
Green turtle													DoEE (2017b)
- Foraging													DoEE (2017b)
- Nesting and inter-nesting													DoEE (2017a); Pendoley Environmental (2022; 2023)
-Hatchling emerging													DoEE (2017a); Pendoley Environmental (2022; 2023)
Hawksbill turtle													DoEE (2017b)
- Foraging													DoEE (2017b)
*- Nesting and inter-nesting**													DoEE (2017a); Pendoley Environmental (2022; 2023a)
*-Hatchlings emerging (peak)**													DoEE (2017a); Pendoley Environmental (2022; 2023a)
Green sawfish													Morgan et al. (2015) ; Morgan et al. (2017); HBI (2023)
-Pupping													Lear et al. (2023)
Reef manta ray													Armstrong et al. (2020)

*Hawksbill turtle nesting and hatchlings emerging can occur throughout the year, these represent peak periods for each activity.

Table 7: Key Socio-Economically Fish Species' Ecological Windows (Yellow represents spawning; Green represents migration from nursery grounds)

Species	J	F	M	A	M	J	J	A	S	O	N	D	Data Source
Blue spotted emperor													Wakefield (unpub. Data); Ryan et al. (2019)
Red emperor													Ryan et al. (2019)
Spanish mackerel													Mackie et al. (2003)
Western king prawn													Noell et al. (2021)
Brown tiger prawn													Loneragan et al. (2013)

4.2. Sediment Characteristics

Chemical and physical assessment of marine sediments within the proposed dredge footprint and offshore spoil disposal ground are available from several separate geotechnical and sediment sampling campaigns. These assessments are discussed in detail in SKM (2013), O2 Marine (2023), and O2ME (2025), and summarised below:

1. A geotechnical investigation by Sinclair Knight Merz (now Jacobs) in 2013 included the assessment of 11 boreholes in the vicinity of the dredge channel (Figure 5). The study classified five geological layers, three material classes and included analysis of Particle Size Distribution (PSD) SKM (2013).
2. O2 Marine undertook a sediment assessment of 23 locations (Figure 4) along the proposed dredge footprint in 2020. Certified commercial divers utilised push cores to retrieve sediments for PSD, contamination and benthic infauna analysis. Vibracore sampling was implemented at six of the 23 locations, however, due to refusal, only samples down to -0.5 m were collected. Sediments were found to be dominated by medium (250-500um) and coarse (500-2000um) grained sand (Figure 6). All metals recorded concentrations below the default value guideline (DVG) (ANZG 2018), and, with the exception of arsenic, all metals were also below the background levels as stated in DEC (2006). Arsenic recorded comparable background level concentrations (and one instance above the background level of 18mg/kg (G7 – 20mg/kg)). All TRH, PAH and organotin were reported below their respective laboratory LoRs, and below their screening levels (ANZG 2018) and HILs (DEC 2010). All sediment samples were tested for actual acid sulfate soils (AASS) and potential acid sulfate soils (PASS). The results did not indicate the presence of any AASS. All samples recorded no reaction for PASS.
3. In March 2023, O2 Marine collected sediment samples within the proposed offshore spoil disposal ground. Offshore sediments were dominated by medium grained sand (250-500um), with all concentrations of contaminants either below the laboratory limit of reporting (LoR), or relevant guideline values. Dredge channel results were consistent with samples collected in 2020, indicating low levels of contamination. Indicative PSD results were consistent with previous findings (medium to coarse grained sand), however due to a laboratory reporting limitation, these results were not included in the assessment (O2 Marine 2023).

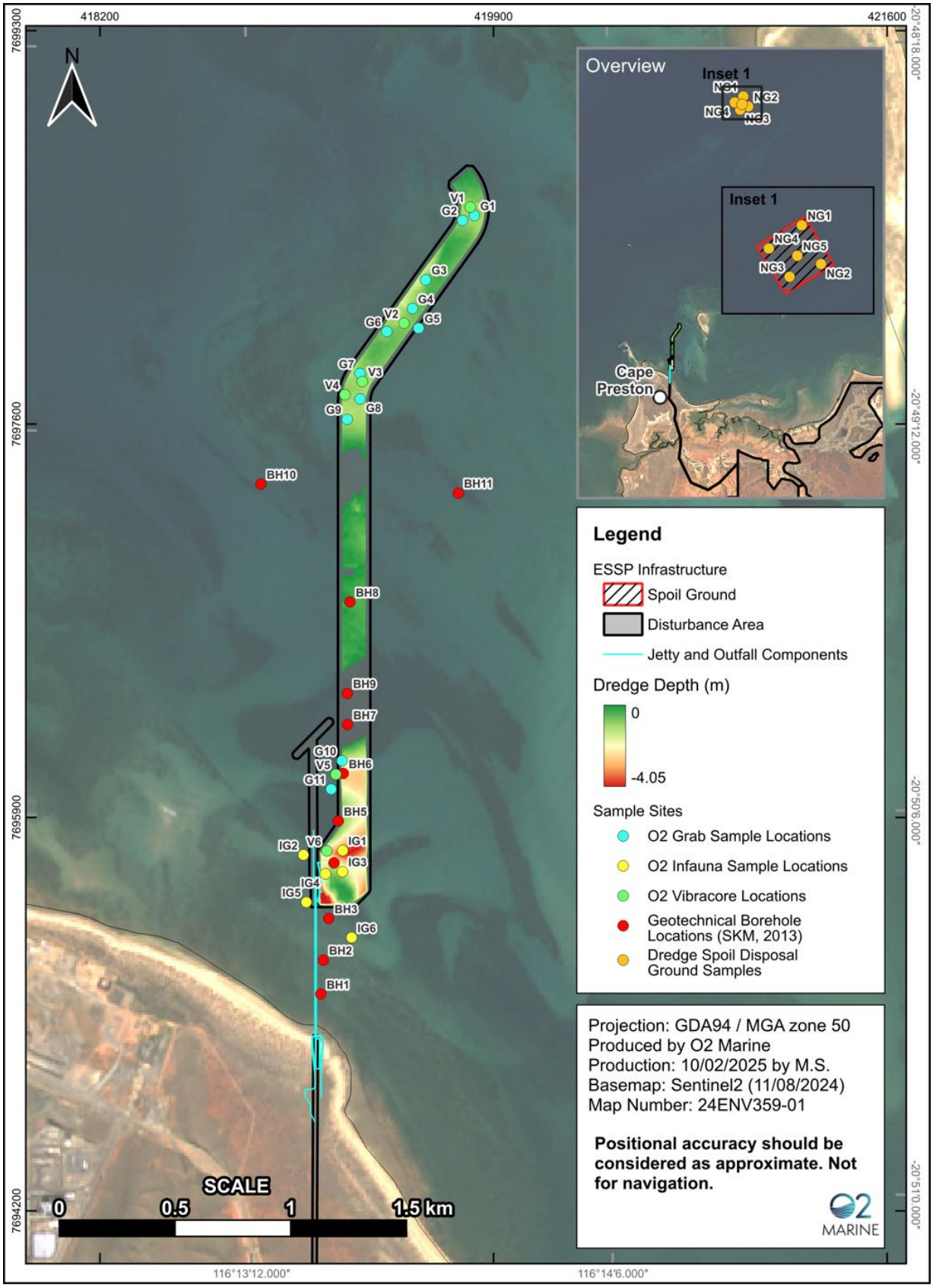

Figure 4: Location of geotechnical/sediment samples collected between 2013 and 2023.

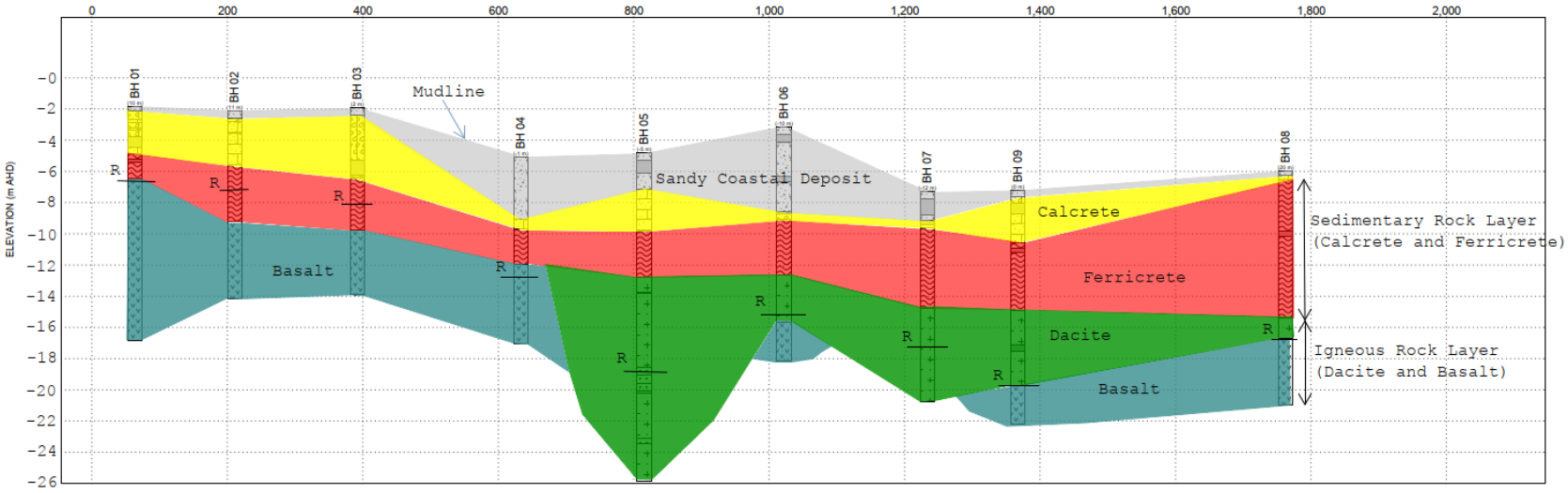

Figure 5: Borehole 1 to borehole 9 interpolation providing an approximate S to N cross section of geological (SKM 2013).

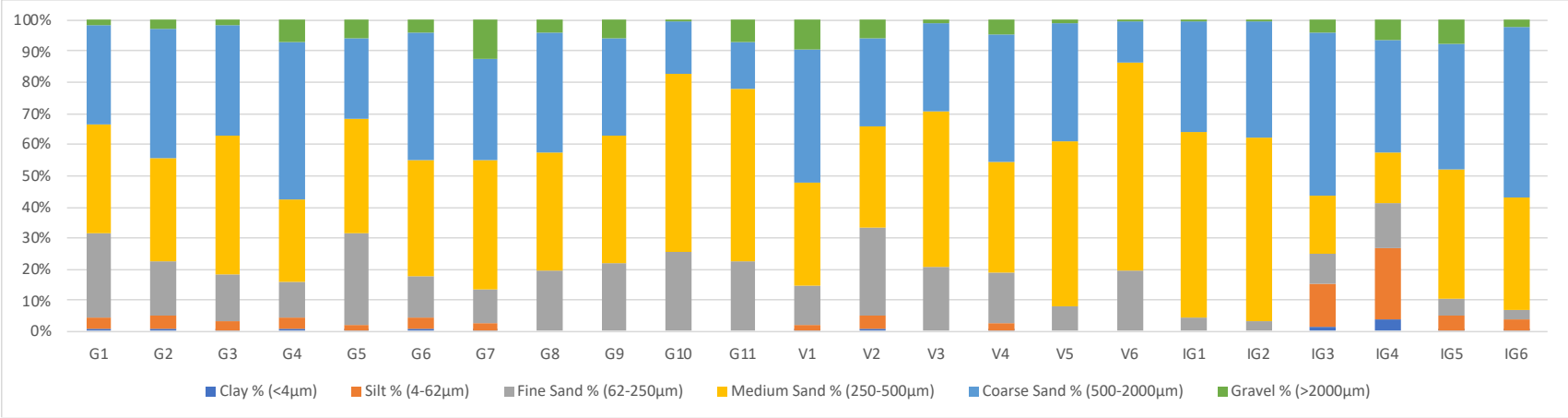

Figure 6: Particle Size Distribution analysis results

5. Dredging and Spoil Disposal Activities

5.1. History of dredging at Cape Preston East Port

The Port of Cape Preston East was approved under MS949, however the approved Port did not include dredging.

5.2. Proposed Dredging Summary

LS is proposing to dredge the berth pocket, southern channel and northern channel (Figure 7) to accommodate the self-propelled, self-unloading transhippers that will transfer salt from a trestle jetty to ocean going vessels located at anchorages 10-15km from the jetty. The ocean-going vessels that are proposed are Handy-size, Handymax and Panamax and will be used to export salt to overseas markets. LS has opted to dredge with a Cutter Suction Dredger (CSD). Two dredge volumes have been considered, a 'Base Case' and a 'High Volume Case', the latter allows for over-dredge and channel deepening or widening to accommodate for navigational safety recommendations (O2ME 2025). All modelled dredging impacts are conservatively based on the 'High Volume Case'. Monitoring and management for both offshore and onshore dredge spoil disposal have been considered and included within this plan, with disposal locations shown in Figure 7. A summary of the dredge and dredge spoil disposal program options are outlined in Table 8.

Table 8: Summary of the dredge and disposal program

Parameter	Base (Minimum)	Maximum	Notes
Dredge Volume	230,000m^3	398,000 m^3	Base Case and Maximum Case accounting for navigational safety and over-dredging.
Dredge equipment	CSD		Considerations made for cutter suction, trailer suction and backhoe dredging equipment. CSD selected as optimal equipment.
Dredge rate	140 – 183.75 m^3/hr		Hourly dredge rate of in situ material using a CSD, which varies throughout the campaign. Rates and schedule provided by LS
Dredge schedule	24 hours per day, 7 days a week		Dredging schedule is based on continuous operation with the dredger operating 24 hours per day. Dredging schedule allows for effective dredging operations for 21 hours per day to account for maintenance, inspections and stop-works (e.g. for marine fauna).
Duration of dredging	56 days	102 days	Anticipated duration of the dredge operation (based on LS provided schedule).
Disposal method	Two methods considered: • Disposal Option A • Disposal Option B		Based on the anticipated volumes that will be extracted from the southern-extent channel, berthing pocket, and northern channel, approximately 78% and 59% of the total dredge material will be disposed onshore for the Base Case and High-Volume Case, respectively.
Disposal location	Disposal Option A:		• Disposal locations shown in Figure 7.

Parameter	Base (Minimum) Maximum	Notes
	• Spoil Ground C [116.272E, 20.671S] Disposal Option B: • Spoil Ground C for northern-extent channel • Onshore for southern-extent channel and berthing pocket	• The offshore disposal site is located approximately 19 km from the berth pocket of the proposed dredging site at the following coordinates. • The proposed onshore disposal site is immediately south of the ESSP. Material will be decanted at this onshore disposal site, and tailwater discharged nearby. The exact location of the tailwater discharge is yet to be defined, but it will be in close proximity to [116.225E, 20.8465S], where it was modelled.
Disposal frequency	• Onshore portion = Constant • Offshore portion = 8 hours	Offshore portion estimated based on dredge rate, sediment bulking factor, loading times, transit times, and disposal times for a split hopper barge.

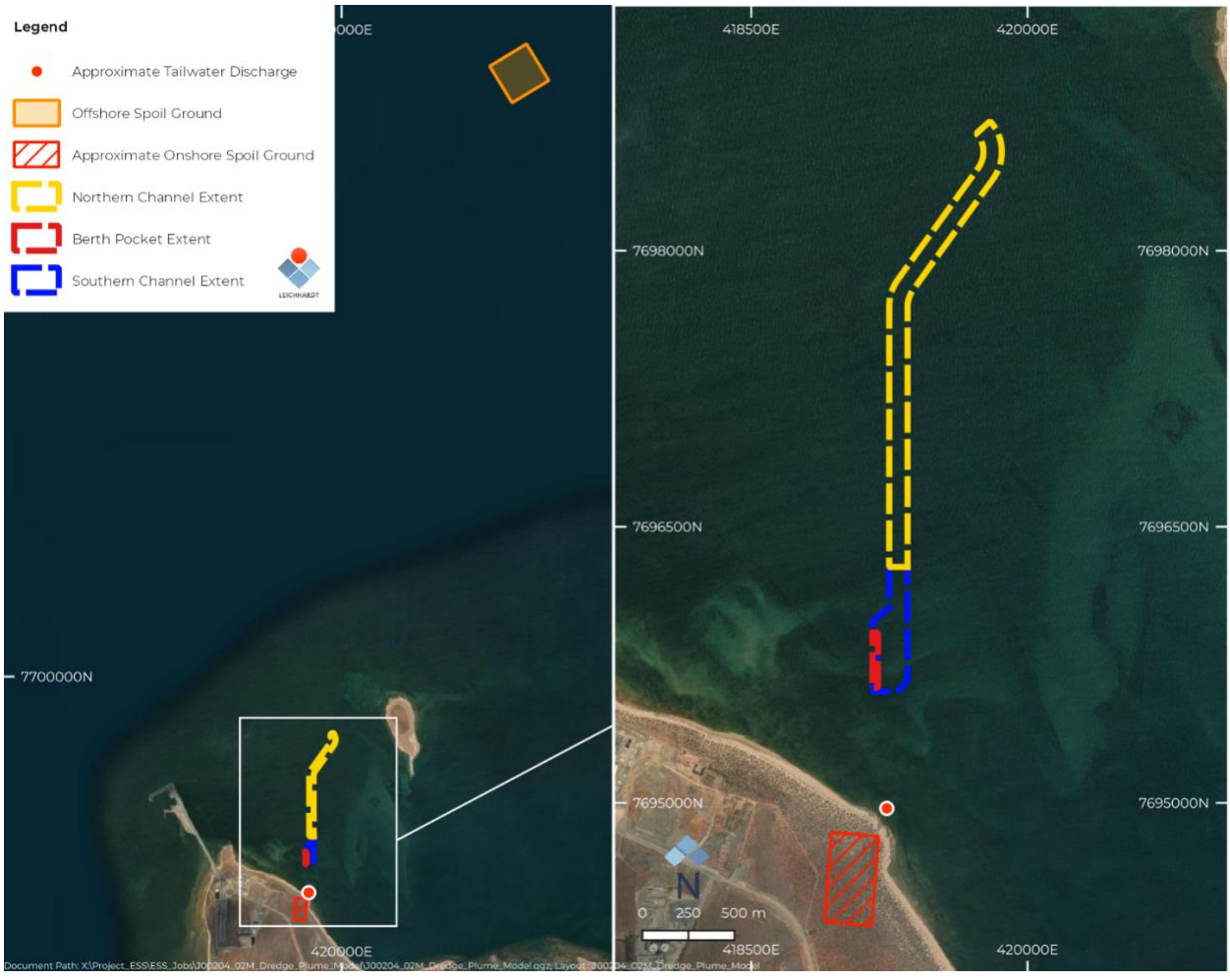

Figure 7: Proposed dredge areas, offshore spoil ground and onshore spoil disposal locations.

5.2.1. Dredging Volume and Material

The total volume required to be removed to meet the ESSP Scenario 7.2.1 refined navigational channel, turning basin, and berth pocket design is 230,000 m^3. This volume is referred to as 'Base Case'. Over-dredge and channel deepening or widening to accommodate for navigational safety recommendations may result in a larger dredge volume. As such a 'Base case' and a 'High volume case' were assessed as part of the dredge plume dispersion modelling study (O2ME 2025). However, all discussion around dredge methods, schedule and monitoring and management of potential environmental impacts, are based on the worst case scenario i.e. the 'High Volume Case'.

- Base Case: 230,000 m^3 of material is considered the minimum dredge volume required to achieve the design, and includes
  - Berth Pocket - A berth pocket will be dredged with a plan area of 37m x 160m to RL-4.8mCD, providing 1m under keel clearance (UKC) and 0.3m over-dredge allowance.
  - Southern Channel Extent – including a turning basin of 190m diameter will be dredged to RL-4.3mCD, providing 0.5m of UKC and 0.3m over-dredge allowance.
  - Northern Channel extent - The channel will be dredged to RL-4.3mCD, providing 0.5m of UKC and 0.3m over-dredge allowance.
- High Volume Case: Upper limit dredge volume of 398,000 m^3, which accounts for the Base Case and the following increments:
  - Channel widening at the channel bend location (58,000 m^3)
  - Channel deepening by 0.3 m (54,000 m^3)
  - Berth pocket widening (9,000 m^3)
  - Expansion of turning area (18,000 m^3)
  - Over dredging allowance of 0.3 m (29,000 m^3)

Using information from the above-mentioned sediment studies (Section 4.2), PSD for each of the dredge zones identified in Figure 7 was generated using a weighted average method, and is presented in Table 9. Further details on this calculation, and how it is incorporated in the dredge plume model is included in O2 Marine (2025).

Table 9: PSD of representative material for scenarios

Zone	% Clay (< 2µm)	% Silt (2 µm-62 µm)	% Fine Sand (lower) (62 µm-150 µm)	% Fine Sand (upper) (150 µm-250 µm)	% Coarse Sand (250 µm -2000 µm)	% Gravel (> 2000 µm)
Southern Channel Extent	0.16	4.37	1.35	11.01	77.03	6.08
Berth Pocket Deepening	2.87	24.12	5.04	6.35	50.20	11.42
Northern Channel Extent	0.06	2.65	3.08	15.49	73.65	5.09

5.2.2. Dredging Method and Sequence

Dredging will be implemented using a CSD. A summary of the dredge methods and sequence is outlined below:

1. General equipment and ancillaries will be mobilised over a period of approximately four weeks (after equipment has been inspected and approved for use).
2. A six week setup period where settlement and decant pond infrastructure is constructed along with setup of dredge spoil pipeline and pumps.
3. CSD arrives on site following the ten week equipment and site setup. CSD connected to the pipeline ready for commissioning.
4. Dredging commences for a period of eight weeks. This includes continuous dredging in the nearshore area and 24 hours day, seven days week, operation of the spoil disposal area and decant system. A summary of order of dredged zones and method includes:
    a. The order in which zones will be dredged is:
        i. Southern channel extent (onshore disposal)
        ii. Berth pocket deepening (onshore disposal)
        iii. Northern channel extent (offshore disposal)
    b. For each zone, dredging will begin at the SW corner. The dredger will advance northward by alternating one W to E pass, followed by an E to W pass, and so forth
    c. The CSD will dredge at a constant rate, thus it will progress more slowly in areas requiring more volume (where the seabed is farther from target dredge depth).
5. The split hopper barges are mobilised approximately week 12 ready for operation for approximately week 19. One week without production has been allowed to relocate the cutter suction dredge to the outer channel area. Dredging will continue for another seven weeks during which spoil will be disposed in the offshore area.
6. A final detailed bathymetric survey will confirm the channel complies with design depths before the dredge equipment is demobilised from site.
7. Treatment of the onshore disposed spoil will continue after the dredge equipment is demobilised, with periodic decanting of seawater from the pond, raking of spoil to promote drying and after analysis potentially blending with other borrow to ensure the area is suitable for construction of port infrastructure and stockyards.

5.2.3. Dredging Schedule

The selected dredge and disposal window (June to September) has been developed to contain all works (including onshore disposal decanting), outside of the cyclonic season and peak turtle nesting periods (1 December and 31 March). The dredge and disposal operation will run 24 hours a day, 7-days a week, with one weeks intermission (no production) to allow for dredge equipment relocation to the northern channel extent (approximately mid-way through the dredging schedule).Assuming a cutter suction dredge rate of 183.75m^3/hr the work will be finished within approximately 102 days.

5.2.4. Dredging Project Vessels

Mobilisation of dredge plant and associated equipment will be carried out in accordance with the requirements of Pilbara Ports through LS's contract with the dredging contractor undertaking the dredging program, the requirements of the Sea Dumping Permit and Pilbara Ports's standards, procedures and regulations including Pilbara Ports's Introduced Marine Species Risk Assessment Procedure. Vessels required for the works would include at a minimum:

- CSD
- Split hopper barge
- Crew transfer vessel

5.3. Dredge Material Management

5.3.1. Onshore Dredge Spoil Disposal

A floating slurry line will transfer dredge spoil to the shore and then on to the spoil deposit pond (Figure 7). Given the coarse nature of the dredge spoil, it is envisaged that the slurry will be 25% solids by mass. i.e. the spoil will be delivered to the pond as a slurry of 1 part solids and 3 parts water by mass. Decant water from the pond will pass through a silt curtain to a sump before being returned to the ocean. The spoil material will be suitable for use as construction fill material and will be used in development of port sites as required. The onshore dredge spoil disposal site will be utilised for material dredged from the berth pocket and southern channel extent.

5.3.2. Offshore Dredge Spoil Disposal

A split hopper barge will be used to deliver dredge spoil from the northern channel extent to the offshore dredge spoil disposal ground where it will be deposited. The preferred spoil ground is located 18.5 km offshore from the jetty head. The indicative boundary location of the proposed spoil ground is summarised in Table 10 and shown in Figure 2.

Table 10: Offshore Spoil Ground Coordinates

Boundary	Latitude	Longitude	Easting	Northing
North-West	-20.670704	116.260305	422954	7714119
North-East	-20.660815	116.27689	424677	7715221
South-East	-20.671564	116.283605	425382	7714034
South-West	-20.681676	116.266943	423651	7712908

5.4. Modelled Impacts of Dredge Plume

O2 Metocean undertook dredge and dredge disposal plume modelling for the refined Proposal design and updated model inputs in January 2025. Full details on the modelling rational, inputs and results are detailed in O2ME (2025). A high level summary of the modelling scope of works included:

1. Conduct a desktop review of the proposed dredge methodology, available geotechnical information and water quality reports.
2. Derive sediment flux inputs for three-dimensional (3D) far-field (transport distances greater than a few hundred metres) numerical assessment based on the above.
3. Conduct a 3D far-field numerical assessment of dredge and dredge spoil disposal plume dispersion under varied environmental conditions.
4. Estimate the effect of the dredge plume on benthic light.
5. Generate zones of impact and a zone of influence in accordance with the Environmental Protection Authority of WA (EPA) Technical Guidance for the Environmental Impact Assessment of Marine Dredging Proposals (EPA, 2021) for the purpose of environmental impact assessment for the environmental conditions modelled.

The resultant predicted impact zones[1] associated with the subtidal BCH for both Disposal Option A (offshore only) and Disposal Option B (offshore and onshore) include:

- Moderate and High impact criteria for Seagrass (ZoMI and ZoHI) was not exceeded.
- Moderate impact criteria for Corals (ZoMI) was exceeded for possible thresholds only.
- High impact criteria for Corals (ZoHI) was not exceeded.

Considering no moderate or high impact criteria exceed for seagrass as a result of the dredge plume, it has been assumed that macroalgae communities, which are generally more capable of withstanding and recovering from reduced light availability, will also likely experience negligible plume related impacts. In comparison to seagrass, macroalgae generally have higher growth rates, lower light requirements, and are ephemeral in nature, meaning they can quickly colonise disturbed environments (Littler and Littler, 1984).

The possible ZoMI for corals (combined for both disposal options) and the intersection with subtidal BCH is shown in Figure 8, and summarised in Table 11. Note that for BCH that do not have an associated assessment criteria (e.g. macroalgae), the zones of impact to coral have been assumed for area calculations.

Table 11: Area of mapped BCH that intersect with modelled zones of impact (hectares)

Habitat	Disposal Option A		Disposal Option B	
	Moderate Impact (ha)	High Impact (ha)	Moderate Impact (ha)	High Impact (ha)
Hard Coral	0.94	0.00	0.06	0.00
Seagrass	0.00	0.00	0.00	0.00
Macroalgae Dominated	0.00	0.00	0.00	0.00
Filter Feeder Dominated	5.42	0.00	0.06	0.00
Mixed Subtidal	0.11	0.00	0.00	0.00
Unvegetated Soft Sediment	0.00	0.00	0.00	0.00

[1] Note: predicted plume impacts do not include direct loss of BCH within the dredge footprint.

6. Environmental Factors and Objectives

6.1. Key Environmental Factors

The key environmental factors and objectives to be managed under this DSDMMP have been derived from the Statement of Environmental Principles, Factors and Objectives (EPA 2018), which outlines objectives aimed at protecting all environments (Themes) including: Sea, Land, Water, Air and People. The Project specific EPOs and MTs for each of the key marine environmental factors (BCH, marine environmental quality, and marine fauna) and are outlined in **Table** 12.

Table 12: Potential environmental impacts and associated project specific Environmental Protection Outcomes and Management Targets

Environmental Factor	EPA Objective	Potential Environmental Impact Pathway	Environmental Protection Outcome (EPO)	Management Target (MT)	Risk Management Strategy
Benthic Communities and Habitats	To protect BCH so that biological diversity and ecological integrity are maintained	Direct impacts of BCH due to removal within the dredging and disposal footprint	No irreversible loss, or serious damage to BCH outside of the Zone of High Impact (ZoHI) (**Figure 8**)	Dredging operations do not occur outside the defined dredging footprint (**Figure 7**)	Refer to **Table 13.**
				Disposal operations do not occur outside the defined spoil grounds	
		Indirect impacts of BCH due to reduction in available light caused by increase in suspended sediments released into the water column during dredging	No irreversible loss to BCH within the possible ZoMI (**Figure 8)**	Recoverable impact to BCH within the probable ZoMI (**Figure 8**)	
			No reduction in the BCH outside of the possible ZoMI (within the Zone of Influence (ZoI) (**Figure 8**)	No reduction in the BCH outside of the probable ZoMI (within the ZoI) **(Figure 8)**	
	To maintain the quality of water, sediment and biota so that	Disturbance of contaminants in sediments during dredging has the potential to deteriorate water		MEQ shall be maintained at a moderate level of ecological protection (**Figure 9**) during dredging	Refer to **Table 14**, **Table 17** and **Table 18.**

Environmental Factor	EPA Objective	Potential Environmental Impact Pathway	Environmental Protection Outcome (EPO)	Management Target (MT)	Risk Management Strategy
Marine Environmental Quality (MEQ)	environmental values are protected.	quality and contaminate marine organisms	No residual changes to MEQ as a result of dredging or disposal activities	and return to a High Level of Ecological Protection within 2 weeks following completion of dredging MT recognises the increased turbidity which will occur in the vicinity of the dredging activities.	
		Changes to the physico-chemical properties of the water column as a result of dredging			
		Hydrocarbon release into the marine environment from a vessel spill and or bunkering operations		No hydrocarbons spill to the marine environment.	
Marine Fauna	To protect marine fauna so that biological diversity and ecological integrity are maintained.	Injury or death of marine fauna as a result of dredge operations.	No reported adverse impacts on marine fauna attributable to dredging works	No incidences of marine fauna injury or death as a result of dredge operations	Refer to Table 15 and Table 16.
		Injury or death of marine fauna due to vessel movement (strike).		No incidences of marine fauna injury or death as a result of vessel strike	
		Disturbance to turtle nesting due to marine construction work (noise).		No disturbance to turtle nesting as a result of dredge operations	
		Turbidity impacts on marine fauna.		No incidences of marine fauna injury or death as a result of turbidity impacts	
		Introduced Marine Pests translocation from construction vessels.		No introduction and/or spread of invasive marine species	

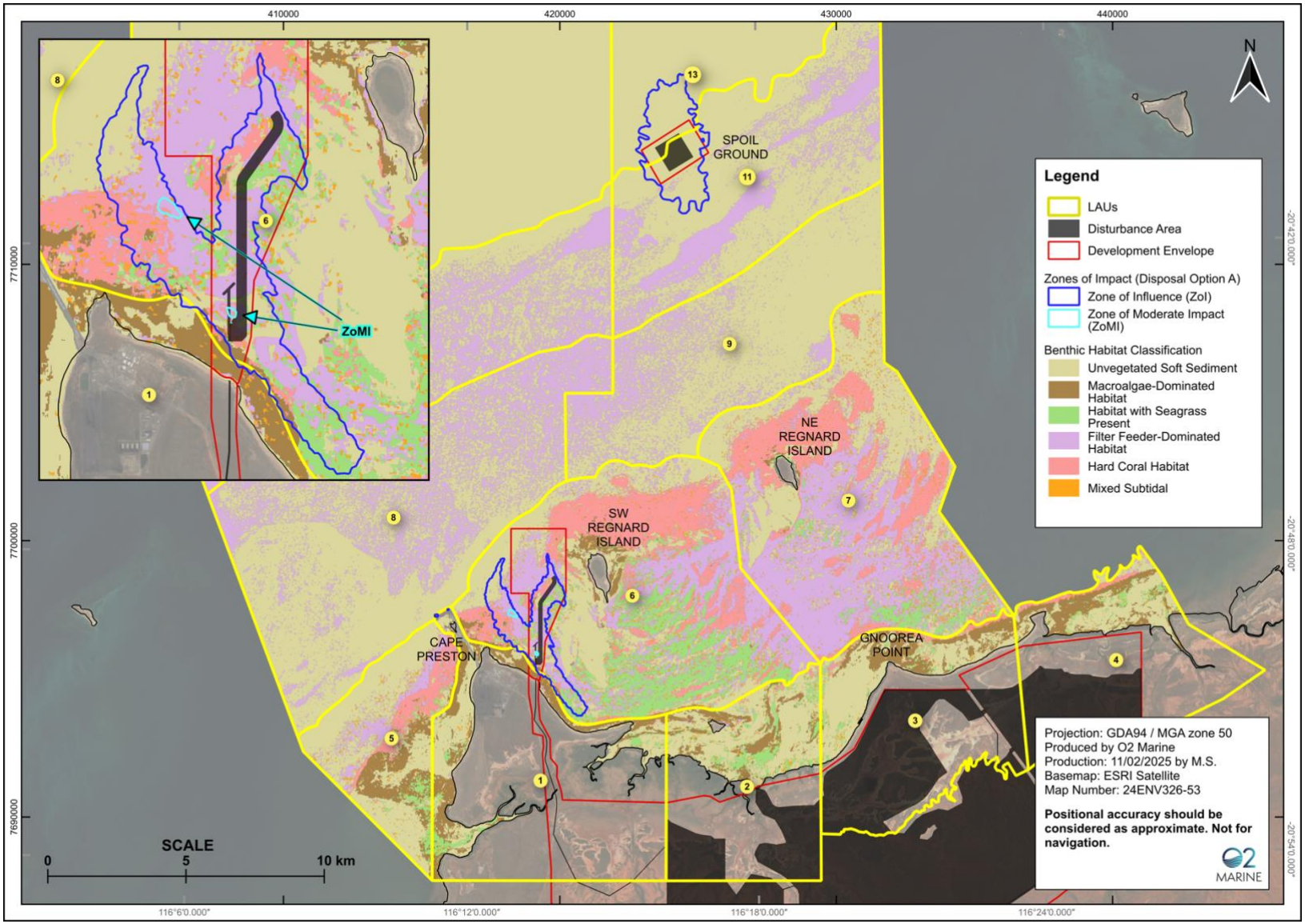

Figure 8: Intersection of zones of impact for corals and mapped BCH (SSC thresholds and DLI along thresholds combined).

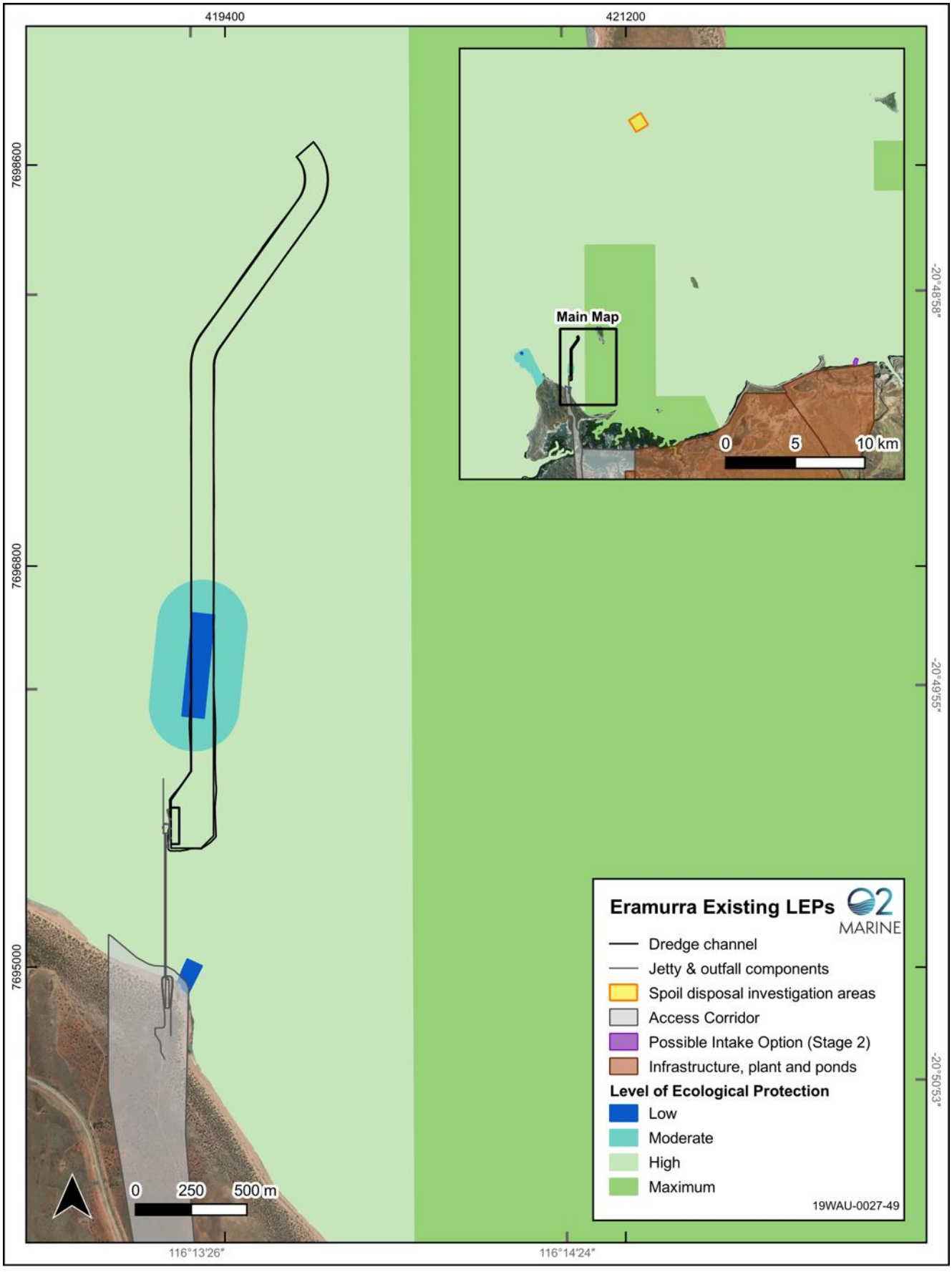

Figure 9: Existing (i.e. Prior to Development) designated Levels of Environmental Protection

7. Monitoring and Management

The potential environmental impacts identified above in Table 12, have been assigned monitoring and management actions to measure compliance against the EPOs and MT. Management measures for each environmental factor (EPA, 2018) are detailed below. Management actions have been separated into:

- Tier 1 (which specially address the three identified environmental factors, BCH, MEQ and marine fauna, including MNES)
- Tier 2 (which relate to the overall works and can be managed through standard operational procedures (including introduced marine pests, hydrocarbons, and waste))

7.1. Benthic Communities and Habitats

The (Tier 1) management actions to minimise potential impacts on the environmental factor 'Benthic Communities and Habitat' are described in Table 13.

Table 13: Management actions to minimise impacts on Benthic Community Habitats

Environmental Factor	**Benthic Communities and Habitats**					
Activity	Dredging and disposal operations					
Potential Impacts	• Direct loss of benthic communities and habitats due to dredging activities • Indirect impacts of benthic communities and habitats due to reduction in available light caused by increase in suspended sediments released into the water column during dredging					
Management Targets	Management Actions			Environmental Performance		
	Item	Actions	Responsibility	Reporting/Evidence	Timing	Contingency
Recoverable impact to BCH within the probable ZoMI (Figure 8) No reduction in the BCH outside of the	1.1	Implement the Marine Water Quality Monitoring Program (MWQMP) as defined in Appendix B-1.	Approval holder	• Telemetered monitoring data (light/turbidity) • Daily Satellite imagery (Plume extent) • MWQMP monthly and final reports.	• Commence at least one month prior to commencement of dredging • Continuous during dredging • Continue for one month after cessation dredging or	• Implement Tiered Management Framework (TMF) as defined in Appendix B.1

Environmental Factor	Benthic Communities and Habitats					
Activity	Dredging and disposal operations					
Potential Impacts	• Direct loss of benthic communities and habitats due to dredging activities • Indirect impacts of benthic communities and habitats due to reduction in available light caused by increase in suspended sediments released into the water column during dredging					
Management Targets	Management Actions			Environmental Performance		
	Item	Actions	Responsibility	Reporting/Evidence	Timing	Contingency
probable ZoMI (within the ZoI) (Figure 8)					until water quality has returned to pre-dredging baseline for at least 2 weeks.	
	1.2	Implement the Discharge Water Quality Monitoring Program (DWQMP) as defined in Appendix B.2	Approval holder	• Telemetered monitoring data (turbidity) • Daily Satellite imagery (Plume extent) if required • DWQMP monthly and final reports.	• Commence as soon as enough water exists in onshore disposal ponds • Continuous during dredging • Continue for one month after cessation dredging or until water levels within ponds become too shallow for water quality sensors.	• Implement Tiered Management Framework (TMF) as defined in Appendix B.2
	1.3	Implement the Benthic Communities and Habitat Monitoring Program (BCHMP) as defined in Appendix B-3	Approval Holder	• Pre-disturbance Survey Report • Post-dredging Survey Report • Monitoring Close-out Report	• Pre-dredging surveys at least one month prior to commencement of dredging • Post-dredging surveys within 12 months following completion of dredging	• Continue post-dredging surveys on an annual basis (Maximum of five years) as required to identify evidence of BCH recovery within the authorised ZoMI as per Appendix B-3

Environmental Factor	Benthic Communities and Habitats					
Activity	Dredging and disposal operations					
Potential Impacts	• Direct loss of benthic communities and habitats due to dredging activities • Indirect impacts of benthic communities and habitats due to reduction in available light caused by increase in suspended sediments released into the water column during dredging					
Management Targets	Management Actions			Environmental Performance		
	Item	Actions	Responsibility	Reporting/Evidence	Timing	Contingency
	1.4	Inspect and maintain all dredge and barge equipment to minimise leakage of dredge spoil	Contractor	• Pre-mobilisation equipment checklist • Equipment maintenance schedule/documentation	• Prior to commencement of dredging and daily during dredging	• Cease dredge operations and repair leakage
Dredging operations do not occur outside the defined dredging footprint	1.5	Employ high-resolution positioning system to control dredge operations	Contractor	• Validate positioning and vessel monitoring system • Dredge progress reports submitted throughout dredging works period	• Prior to and during dredge operations • Weekly throughout dredging	• Cessation of dredging and relocation of dredge • Service/replacement of positioning system
Offshore disposal operations do not occur outside the defined spoil grounds	1.6	Employ high-resolution positioning system to control hopper barge during placement at the dredge material placement area (Proposed spoil ground locations)	Contractor	• Active recording of vessel position • Dredge reports submitted throughout works period	• Prior to and during dredge operations • Weekly throughout dredging	• Cessation of dredging and relocation of dredge material dump position; and • Service of positioning system

7.2. Marine Environmental Quality

The (Tier 1) management actions proposed to minimise potential impacts on the environmental factor 'Marine Environmental Quality' are described in Table 14.

Table 14: Management actions to minimise impacts on Marine Environmental Quality

Environmental Factor	**Marine Environmental Quality**					
Activity	Dredging and disposal operations					
Potential Impacts	• Disturbance of contaminants in sediments during dredging has the potential to deteriorate water quality and contaminate marine organisms • Changes to the physico-chemical properties of the water column as a result of dredging • Hydrocarbon release into the marine environment from a vessel spill and or bunkering operations					
Management Targets	Management Actions			Environmental Performance		
	Item	Actions	Responsibility	Reporting/Evidence	Timing	Contingency
MEQ shall be maintained at appropriate levels of ecological protection (Table B1-2 and Table B2-1) during dredging.	2.1	Undertake a sediment contamination and geotechnical investigation prior to dredge operations.	Approval holder	• Sediment Quality Assessment Report • Sediment Geotechnical Assessment Report	• Prior to dredging	• NA – both investigations complete.
	2.2	Implement the Marine Water Quality Monitoring Program (MWQMP) as defined in Appendix B-1	Approval holder	• Telemetered monitoring data (light) • Daily Satellite imagery (Plume extent) • MWQMP monthly reports and final report.	• Commence at least one month prior to commencement of dredging • Continuous during dredging • Continue for one month after cessation dredging or until water quality has returned to	• Implement Tiered Management Framework (TMF) as defined in Appendix B.1

Environmental Factor	Marine Environmental Quality					
Activity	Dredging and disposal operations					
Potential Impacts	• Disturbance of contaminants in sediments during dredging has the potential to deteriorate water quality and contaminate marine organisms • Changes to the physico-chemical properties of the water column as a result of dredging • Hydrocarbon release into the marine environment from a vessel spill and or bunkering operations					
Management Targets	Management Actions			Environmental Performance		
	Item	Actions	Responsibility	Reporting/Evidence	Timing	Contingency
					pre-dredging baseline for at least 2 weeks.	
	2.3	Implement the Discharge Water Quality Monitoring Program (DWQMP) as defined in Appendix B-2	Approval holder	• Telemetered monitoring data (physico-chemical) • Routine water sampling (contaminants and acidification) • DWQMP monthly reports and final report.	• Commence at least one month prior to commencement (receiving environment), and when suitable water levels exist (OSG) • Continuous during dredging • Continue for one month after cessation dredging or until water quality has returned to pre-dredging	• Implement Tiered Management Framework (TMF) as defined in Appendix B.1
	2.4	Inspections of all dredge and barge equipment to check for leaks or damage	Contractor	• Vessel and Site Environment Safety and Health inspection checklist	Daily throughout dredging	• Cease works if significant spillage or damage observed • Activate spill response actions (control drainage, clean up) as required; and

Environmental Factor		Marine Environmental Quality				
Activity		Dredging and disposal operations				
Potential Impacts		• Disturbance of contaminants in sediments during dredging has the potential to deteriorate water quality and contaminate marine organisms • Changes to the physico-chemical properties of the water column as a result of dredging • Hydrocarbon release into the marine environment from a vessel spill and or bunkering operations				
Management Targets		Management Actions			Environmental Performance	
	Item	Actions	Responsibility	Reporting/Evidence	Timing	Contingency
						• Undertake incident investigation and implement recommendations
No hydrocarbons spill to the marine environment.	2.5	Implement Hydrocarbon Management and Waste Management Action in Table 17 and Table 18, respectively				

7.3. Marine Fauna

The (Tier 1) management actions proposed to minimise potential impacts on the environmental factor 'Marine Fauna' (including MNES) are described in Table 15.

Table 15: Management actions to minimise impacts on Marine Fauna

Environmental Factor	**Marine Fauna**					
Activity	Dredging and disposal operations General Vessel Operations					
Potential Impacts	• Injury or death of marine fauna as a result of dredge operations (loading and dumping) • Injury or death of marine fauna due to vessel movement (strike) • Direct impacts from underwater noise from dredging operations • Direct impacts from light pollution • Habitat disturbance and indirect impacts through reduction temporary localised increase in SSC.					
Management Targets	Management Actions			Environmental Performance		
	Item	Actions	Responsibility	Reporting/Evidence	Timing	Contingency
No reported incidences of marine fauna injury or death as a result of dredge operations	3.1	Implement marine fauna monitoring and management as outlined in **Appendix B.4** Dredging to occur outside of the turtle nesting season, dredging period June to September. The CSD to include a turtle exclusion device.	Contractor	Marine Fauna Observer (MFO) daily records Final summary report Refer to **Appendix B.4**	Daily Refer to **Appendix B.4**	Where marine fauna are observed within an Exclusion Zone then dredging will cease immediately.
No reported incidences of marine fauna injury or death as a result of vessel strike	3.2	Implement marine fauna monitoring and management as outlined in **Appendix B.4** The maximum vessel speed within all areas of the Proposal is 10 knots and all vessels are to adhere to standard set in the National Whale Watching Guidelines (DoEE 2017b) and the Biodiversity	Contractor	Refer to **Appendix B.4**	Daily Refer to **Appendix B.4**	Where marine fauna are observed within an Exclusion Zone then dredging will cease immediately.

Environmental Factor	Marine Fauna					
Activity	Dredging and disposal operations General Vessel Operations					
Potential Impacts	• Injury or death of marine fauna as a result of dredge operations (loading and dumping) • Injury or death of marine fauna due to vessel movement (strike) • Direct impacts from underwater noise from dredging operations • Direct impacts from light pollution • Habitat disturbance and indirect impacts through reduction temporary localised increase in SSC.					
Management Targets	Management Actions			Environmental Performance		
	Item	Actions	Responsibility	Reporting/Evidence	Timing	Contingency
		Conservation Regulations 2018. (see **Appendix B.4)**				
No direct impacts to marine fauna from light pollution from dredge and/or disposal operations	3.3	Marine construction and associated light pollution will be undertaken outside of key ecological windows of marine turtles, as far as practicable. Implement the Artificial Light Management Plan (Nocterra, 2025)	Contractor	As per measures outlined in Artificial Light Management Plan (Nocterra, 2025)	As per measures outlined in Artificial Light Management Plan (Nocterra, 2025)	As per measures outlined in Artificial Light Management Plan (Nocterra, 2025)
No direct impacts to marine fauna from underwater noise from dredge operations	3.4	Implement marine fauna monitoring and management as outlined in **Appendix B.4** Dredging activities will be undertaken outside of key ecological windows Ensure all vessel equipment and machinery is in good condition and subject to regular maintenance	Contractor	Refer to **Appendix B.4**	Refer to **Appendix B.4**	Where marine fauna are observed within an Exclusion Zone then dredging will cease immediately.

Environmental Factor	Marine Fauna					
Activity	Dredging and disposal operations General Vessel Operations					
Potential Impacts	• Injury or death of marine fauna as a result of dredge operations (loading and dumping) • Injury or death of marine fauna due to vessel movement (strike) • Direct impacts from underwater noise from dredging operations • Direct impacts from light pollution • Habitat disturbance and indirect impacts through reduction temporary localised increase in SSC.					
Management Targets	Management Actions			Environmental Performance		
	Item	Actions	Responsibility	Reporting/Evidence	Timing	Contingency
		When in transit, all Proposal vessels will be operated in accordance with EPBC Regulations 2000- Part 8 Division 8.1 Minimise the duration of run-time for vessel engines, thrusters and dredging plant by avoiding stand-by or running mode to the degree practical and consistent with safe operations				

7.4. Introduced Marine Pests

The (Tier 2) management actions proposed to minimise potential impacts associated with marine pests are described in Table 16.

Table 16: Management actions to minimise the risk of introduced Marine Pests

Activity	Vessel mobilisation to site					
Potential Impacts	• Translocation of introduced marine pests to the environment adjacent to the project area.					
Management Targets	Management Actions		Environmental Performance			
	Item	Actions	Responsibility	Reporting/Evidence	Timing	Contingency
Manage vessel activities to prevent the introduction of introduced marine pests into and within State waters.	4.1	All vessels that mobilise to the project site are required to adhere to the Department of Primary Industry and Regional Development (DPIRD) Vessel Biofouling Risk Assessment and Management Procedure – see Vessel Check Portal an online integrated biofouling risk assessment and management tool managed by DPIRD. Vessel-Check | Marine Biofouling Biosecurity Management Tool	Contractor	• Completed Vessel Biofouling Risk Assessment Procedure undertaken together with any supporting documentation, including antifoul certificates and inspection reports. • If pest is identified record location, date and time, size, colour, water depth, environment (e.g. beach, sand etc), and take a photo.	• Prior to dredge entering Western Australian Waters from overseas or interstate.	• Vessels are not to enter WA waters without approved Introduced Marine Pest documentation • Notify DPIRD of the introduction of IMPs within 12 hours (1800 815 507).
	4.2	All dredging vessels shall comply with Commonwealth Department of Agriculture and Water Resources – Australian Ballast Water Management Requirements and the National Biofouling Management Guidelines for commercial vessels.	Contractor	Vessel management procedures	Prior to dredge entering Australian Waters or moving from one Australian port to the Port.	Vessels are not to mobilise to the Port without approved documentation

7.5. Hydrocarbon Management

The (Tier 2) management actions proposed to minimise potential impacts associated with hydrocarbon spill described in Table 17.

Table 17: Management actions to minimise the risk of Hydrocarbon Pollution

Activity	General Vessel Operations					
Potential Impacts	• Impacts on the MEQ (both sediment and water) and marine fauna due contamination from hydrocarbon release into the environment. • presence of foreign materials Altering of the diversity, geographic distribution and viability of fauna at the species and population levels • Degradation of the structure, function, distribution, diversity and viability of benthic communities					
Management Targets	Management Actions			Environmental Performance		
	Item	Actions	Responsibility	Reporting/Evidence	Timing	Contingency
Manage vessel bunkering, chemical storage and spill response to ensure no adverse impacts to the marine environment.	5.1	Document vessel bunkering management, including appropriately licensed bunkering facilities	Contractor	Vessel management procedures	Prior to dredge entering Western Australian Waters from overseas or interstate.	Dredge operations not to commence prior to development and Proponent approval of vessel bunkering management procedure
	5.2	Undertake vessel maintenance and bunkering in accordance with dredging contractors approved vessel management systems	Contractor	Vessel management procedures	For the duration of dredging	Vessel bunkering management systems to be reviewed and refined (if required) in the event of an identified procedural breach or hydrocarbon spill
	5..3	Implement industry standard hydrocarbon management practices (chemical handling, storage, segregation and spill response)	Contractor	Vessel management procedures The approval holder and Pilbara Ports is to be notified immediately in the event of a hydrocarbon spill of any volume	Prior to commencement of dredging	Dredge operations not to commence prior to development and approval of vessel management procedures Investigate spill event and review management actions and responses

Activity	General Vesse	l Operations				
Potential Impacts	• Impacts on the MEQ (both sediment and water) and marine fauna due contamination from hydrocarbon release into the environment. • presence of foreign materials Altering of the diversity, geographic distribution and viability of fauna at the species and population levels • Degradation of the structure, function, distribution, diversity and viability of benthic communities					
Management Targets	Management Actions			Environmental Performance		
	Item	Actions	Responsibility	Reporting/Evidence	Timing	Contingency
	5.4	Undertake an environmental inspection of all dredging vessels	Contractor	Vessel management procedures	Prior to the commencement of dredging	Dredge operations not to commence prior to development and approval of vessel management procedures

7.6. Waste Management

The (Tier 2) management actions proposed to minimise potential impacts that waste management may have on the environment are listed in Table 18.

Table 18: Management actions to manage Waste

Activity	Incorrect or accidental disposal from a vessel					
Potential Impacts	• Impacts on the MEQ (both sediment and water) and marine fauna due presence of foreign materials					
Management Targets	Management Actions		Environmental Performance			
	Item	Actions	Responsibility	Reporting/Evidence	Timing	Contingency
Manage waste in compliance with requirements for Pilbara Ports and in accordance with MARPOL 73/78 Convention Annex IV (sewage) and Annex V (garbage).	6.1	Dredging contractor to establish a sewage and implement a garbage disposal plan in accordance with Pilbara Ports requirements and MARPOL 73/78	Contractor	Plan – one week prior to dredging Incident - Within 12 hours of a reportable incidence	Prior to commencement of dredging Duration of dredging operations	LS to approve Plan prior to commencement of dredging Plan and procedures to be revised to prevent recurrence of incident LS to audit performance during dredging if/as required
Manage the correct onshore disposal and reporting systems	6.2	Only a licenced Controlled Waste Carrier to be used for any controlled waste discharged ashore	Contractor	Controlled waste tracking forms to be completed as soon as possible	Duration of dredging operations	LS to audit performance during dredging if/as required
	6.3	All forms of waste need to be stored in appropriately labelled drums or tanks and be correctly disposed of and not discharged to the environment	Contractor	Approval certification and tracking forms to be completed as soon as possible Vessel waste management plan/procedures	Duration of dredging operations	Vessel management plan/procedures to be reviewed and endorsed by LS prior to dredging LS to audit performance during dredging if/as required

Activity	Incorrect or accidental disposal from a vessel					
Potential Impacts	• Impacts on the MEQ (both sediment and water) and marine fauna due presence of foreign materials					
Management Targets	Management Actions		Environmental Performance			
	Item	Actions	Responsibility	Reporting/Evidence	Timing	Contingency
	6.4	Reporting of any type of spillage within the marine environment directly to Pilbara Ports.	Contractor	As soon as possible, within 24 hours	During the duration of dredging operations	Revise associated management plans or procedures to ensure no incident recurrence Pilbara Ports to audit performance during dredging if/as required

8. Reporting

8.1. Compliance Reporting

A summary of the reporting requirements for the project are provided in Table 19.

Table 19: Compliance reporting requirements

Report	Content	Timeframe	Responsibility	Recipient
Environmental Incidents or Environmental Risks Report	Report any environmental incident or environmental risk Detail the incident or risk, the measures taken, the success of those measures in addressing the incident or risk and any additional proposed to be taken Document any incidents involving the dumping activities that result in injury or death to any marine species. The date, time and nature of each incident and the species involved, if known, must be recorded.	Within 12 hours	Contractor	Approval Holder Pilbara Ports / DoT – Reportable Oil Spill/POLREP DBCA – Reportable wildlife incident DPIRD – fish kills and IMPs identification
Non-compliance Summary Report	Identify which EPO has not been achieved Detail the monitoring results that identified the EPO was not being achieved Describe the investigation being undertaken into the cause of the EPO not being achieved Identify any corrective or contingency management actions proposed to be implemented or being implemented	Within 7 days of determining that an EPO has not been achieved	Proponent	DWER DCCEEW
Non-compliance Investigation Report	Identify which EPO has not been achieved Detail the findings of the investigations undertaken into the cause of the EPO not being achieved	Within 30 days of determining that any EPO has not been achieved	Approval Holder	DWER DCCEEW
Close-out Report	Report which evaluates the performance of monitoring and management in achieving the EPOs.	Within 12 months following completion of dredging	Approval Holder	DWER DCCEEW
Any additional reporting commitments under approval conditions must be included within this Table.				

8.2. Additional Reporting

A summary of the additional reports that are expected to inform compliance reporting commitments (Table 19) are listed in Table 20.

Table 20: Additional reporting requirements required to demonstrate compliance

Topic	Content	Timeframe	Responsibility	Recipient
BCH Reporting	• Pre-dredging BCH Survey Report • Reactive BCH Survey Report • Post-dredging BCH Survey Report	• Pre-dredging survey report issued prior to commencement of dredging • Post level 3 water quality exceedance, issued three weeks post reactive survey completion • Post-dredging surveys issued within 6 months following completion of dredging	Approval Holder	DWER DCCEEW
Water Quality Reporting	• Online Data Summary (MWQMP and DWQMP) • Monthly Monitoring Summary Reports (MWQMP and DWQMP) • Final Summary Report (MWQMP and DWQMP)	• Monitoring data to be online throughout dredging • Monitoring summary report to be issued with Close-out report	Approval Holder	DWER DCCEEW
Site and vessel inspection checklists / logs	• Vessel Environment, Safety and Health inspection – (e.g. equipment inspection, navigation equipment systems, speed, MFO personnel, bunkering log). • Dredge operation log – (e.g. operations times, types of operations, Global Positioning System (GPS) location, dredge volumes). • Marine fauna observation Logs – (e.g. dredge operation time, name of observer, fauna species, distance/direction from vessel, management response)	• Daily during dredging	Contractor	Approval Holder
Pollution Incidents	All marine pollution incidents shall be reported to Approval Holder as an environmental incident. Approval Holder will coordinate the state reporting requirement to the DoT Maritime Environmental Emergency Response (MEER) duty officer (24 hours) on (08) 9480 9924 and followed by an online Pollution Report Form (POLREP), which is available at:	• All marine incidents (including pollution) to be reported to the Approval Holder immediately and to DOT within 24 hours.	Contractor Approval Holder	Approval Holder DoT / Pilbara Ports

Topic	Content	Timeframe	Responsibility	Recipient
	http://www.transport.wa.gov.au/mediaFiles/marine/MAC-F-PollutionReport.pdf.			
Complaints	Approval Holder to be notified of any complaints received in relation to the dredging activities. Notification should detail the nature of the complaint and how it was resolved.	• Within 72 hours of any complaint received	Contractor	Approval Holder

9. Ongoing Stakeholder Consultation

Pilbara Ports facilitates a Technical Advisory Consultative Committee (TACC) as required under existing Commonwealth Sea Dumping permits held by Pilbara Ports. The TACC meets at least twice per annum to discuss all matters relating to dredging in the Port. The TACC was formed in September 2006 with the purpose to:

- Keep stakeholders informed on dredging activities
- Provide continuity of direction and effort for environmental protection matters related to dredging and ocean disposal of dredged material
- Provide a forum for communication and resolution of any issues that may arise that stakeholders would like to be addressed
- Assist in establishment of long-term permitting arrangements, including review over development and implementation of:
  - Sampling and Analysis Plans
  - Dredge Management Plans, and
  - Other research and monitoring programmes
- Review on-going management of dredging and ocean disposal activities in accordance with guidelines and permits; and
- Make recommendations as appropriate.

The main objective of the TACC is to ensure a transparent process with respect to dredging and ocean disposal of dredged material.

The TACC is representative of industry, community and government at all levels, including the following organisations:

- Pilbara Ports (Environment and Heritage Manager (Dampier) and Dredging and Survey Manager, or their representatives);
- GHD Pty Ltd representing Pilbara Ports in a technical capacity;
- Government organisations:
  - Department of Climate Change, Energy, the Environment and Water (DCCEEW);
  - Department of Water and Environmental Regulation (DWER);
  - Western Australia Department of Primary Industries and Regional Development (DPIRD) Fisheries Service, previously Department of Fisheries;
  - Western Australia Department of Biodiversity Conservation and Attractions (DBCA) Parks and Wildlife Service, previously Department of Parks and Wildlife; and
  - DoT;
- City of Karratha
- Pilbara Native Title Service;
- Port User Groups: CITIC Pacific Mining Management
- Community Groups

Consultation with the TACC should be implemented to discuss the Proposal and Pilbara Ports consideration of placing dredge material within one the proposed offshore spoil grounds. This consultation would include a review of a risk assessment matrix created for the Proposal and the placement of material at sea under a Commonwealth Sea Dumping Permit. The TACC will continue to meet twice annually, or more frequently as required, and will be updated on the progress of this Proposal.

10. Availability of the DSDMMP

This DSDMMP will be made available on the EPA and LS websites and will further be made available to the public or stakeholders upon request.

11. Audit and Review

LS will undertake audits of the dredge contractor and their operations as required throughout the project, to assess compliance against this DSDMMP. The performance of the dredging operations against these requirements will be reported as per Section 8.1.

This DSDMMP is a living document and will be reviewed in accordance with Table 21. Any significant changes must be documented in Appendix A. LS are committed to continual improvement and will conduct regular review of the content and implementation of this DSDMMP.

Table 21: DSDMMP Review Schedule

Timing	Rationale
To address stakeholder comments received during public review period	Comments are anticipated to be received during the public review period. Addressing these comments may require further revisions of this Plan.
Upon Receipt of approval conditions	Ministerial approval conditions obtained will necessitate a comprehensive review of this DSDMMP to ensure all relevant commitments are covered within this Plan to ensure compliance.
Prior to commencement of action	To ensure that the contractor and approval holder implement all commitments accordingly and that no operational details are non-compliant
Any time operational activities significantly alter	Operational changes to the project may result in an altered risk profile. Therefore, the DSDMMP will require a review to ensure that it remains fit-for-purpose for altered operational conditions. Any significant change in environmental risk will require the DSDMMP to be resubmitted to DWER for endorsement
Following any significant incidents or non-compliance events	To ensure that the management actions and controls in place are adequate to ensure no re-occurrence of incidents or non-compliances

During review of the DSDMMP, consideration will be given, but not limited to:

- Overall effectiveness of the Plan
- Changes in schedule
- Changes to monitoring trigger values, where determined to be ineffective or inappropriate
- Any changes in methodology or equipment used.

12. References

ANZG (2018) Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Governments and Australian state and territory governments, Canberra ACT, Australia. Available at www.waterquality.gov.au/anz-guidelines

Armstrong AJ, AO Armstrong, MB Bennett, F McGregor, KG Abrantes, A Barnett, AJ Richardson, KA Townsend and CL Dudgeon (2020) The geographic distribution of reef and oceanic manta rays (*Mobula alfredi* and *Mobula birostris*) in Australian coastal waters. *Journal of Fish Biology*, 96(3):835–840. doi: 10.1111/jfb.14256

Australian Government (2018). Australian Government 2018, Charter: National Water Quality Management Strategy, Department of Agriculture and Water Resources, Canberra, March. CC BY 3.0.

Beyers, D.W. (1998) Causal inference in environmental impact studies. Journal of the North American. Benthological Society 17: 367–373.

CALM (2000) Regional Perspective Dampier Archipelago / Cape Preston. Department of Conservation and Land Management, Perth, Western Australia

CALM (2005) Indictive Management Plan for the proposed Dampier Archipelago and Cape Preston Marine Management Area. Marine Conservation Branch: Department of Conservation and Land Management, Perth, Western Australia.

Campey ML and Gilmour JP (2000) Baseline survey of benthic marine communities of Cape Preston and Preston Island. Report prepared for Halpern Glick Maunsell Pty Ltd.

Department of Biodiversity, Conservation and Attractions (DBCA) (2021) *Dolphin and dugong sightings recorded during dolphin aerial surveys undertaken in 2015, 2016 and 2017 within the vicinity of the Dampier Archipelago, Western Australia*. Unpublished data shared by the Marine Science Branch for O2 Marine for the purpose of environmental assessment..

Department of Biodiversity, Conservation and Attractions (DBCA) (2024) DBCA Threatened Species Database. Prepared by the Species and Communities Program for O2 Marine for the purpose of environmental assessment.

DEC (2006). Background quality of the marine sediments of the Pilbara coast. Department of Environment and Conservation, Marine Technical Report Series, No. MTR 1.

DEC (2010). Assessment levels for Soil, Sediment and Water. Contaminated Sites Management Series. Version 4, Revision1. Western Australia.

Department of the Environment and Energy (DoEE) (2015) Threat abatement plan for predation by feral cats. Canberra, ACT: Commonwealth of Australia. Available from: http://www.environment.gov.au/biodiversity/threatened/publications/tap/threat-abatement-plan-feral-cats.

Department of the Environment and Energy (DoEE) (2017a) Threat abatement plan for predation, habitat degradation, competition and disease transmission by feral pigs (Sus scrofa). Canberra, ACT:

Commonwealth of Australia. Available from: http://www.environment.gov.au/biodiversity/threatened/publications/tap/feral-pig-2017.

Department of the Environment and Energy (DoEE) (2017b) Recovery Plan for Marine Turtles in Australia. Australian Government, Canberra. Available from: http://www.environment.gov.au/marine/publications/recovery-plan-marine-turtles-australia-2017.

Department of the Environment and Energy (DoEE) (2017c) *National Strategy for Reducing Vessel Strike on Cetaceans and other Marine Megafauna.* Commonwealth of Australia 2017. Available from: National Strategy for Reducing Vessel Strike on Cetaceans and other Marine Mega-fauna.

Department of the Environment and Energy (DoEE) (2017d) *Australian National Guidelines for Whale and Dolphin Watching.* Canberra, ACT: Commonwealth of Australia. Available from: Australian National Guidelines for Whale and Dolphin Watching 2017

Department of the Environment and Energy (DoEE) (2018) Threat Abatement Plan for the impacts of marine debris on the vertebrate wildlife of Australia's coasts and oceans. Canberra, ACT: Commonwealth of Australia. Available from: http://www.environment.gov.au/biodiversity/threatened/publications/tap/marine-debris-2018.

Downes, B.J., Barmuta, L.A., Fairweather, P.G., Faith, D.P., Keough, M.J., Lake, P.S., Mapstone, B.D. and Quinn, G.P. (2002). Monitoring Ecological Impacts: Concepts and practice in flowing waters. Cambridge University Press, Cambridge, UK.

Eliot I, Gozzard B, Eliot M, Stul T and McCormack G (2013) Geology, Geomorphology and Vulnerability of the Pilbara Coast, In the Shires of Ashburton, East Pilbara and Roebourne, and the Town of Port Hedland, Western Australia. Damara WA Pty Ltd and Geological Survey of Western Australia, Innaloo, Western Australia.

Environmental Protection Authority (EPA) (2016). Technical Guidance: Protecting the Quality of Western Australia's Marine Environment. Environmental Protection Authority of Western Australia, Perth, Western Australia.

Environmental Protection Authority (EPA) (2018). Statement of Environmental Principles, Factors and Objectives. Environmental Protection Authority of Western Australia, Perth, Western Australia.

Environmental Protection Authority (EPA (2021a). Instructions on how to prepare Environmental Protection Act 1986 Part IV Environmental Management Plans. EPA, Western Australia.

Environmental Protection Authority (EPA) (2021b). Technical Guidance Environmental impact assessment of marine dredging proposals. Environmental Protection Authority of Western Australia, Perth, Western Australia.

GHD (2013) Cape Preston East Project: Marine Benthic Community Assessment. Report prepared for Iron Ore Holdings Ltd by GHD, Jan 2013.

Hanf D, J Smith, AJ Hodgson, H Kobryn and LB Bejder (2022) Dolphin distribution and habitat suitability in coastal north Western Australia: Applications of a broadscale, opportunistic dataset. *Frontiers in Marine Science.* 8(733841):1-18. doi: 10.3389/fmars.2021.733841

HBI (Harry Butler Institute Murdoch University) (2023) *Eramurra Sawfish Survey October 2023,* Prepared by Morgan D, M Allen, T Fazeldean and K Lear. Prepared for Leichhardt Salt Pty Ltd – Eramurra Solar Salt Project

Heap AD and PT Harris (2008) Geomorphology of the Australian margin and adjacent seafloor, Australian *Journal of Earth Sciences*, 55(4), 555-585.

Irvine LG, M Thums, CE Hanson, CR McMahon and MA Hindell (2018) Evidence for a widely expanded humpback whale calving range along the Western Australian coast. *Marine Mammal Science*. 34(2):294-310. doi: 10.1111/mms.12456

James NP, Y Bone, TK Kyser, GR Dix and LB Collins (2004) The importance of changing oceanography in controlling late Quaternary carbonate sedimentation on a high-energy, tropical, oceanic ramp: north-western Australia, S*edimentology*, 51(6):1179-1205.

Jenner KCS, MN Jenner, N Gales and MC Double (2010) Satellite tracking of south-bound female humpback whales in the Kimberley region of Western Australia. Final Report for the Australian Marine Mammal Centre.

Jones R, R Fisher, C Stark and P Ridd (2019) Temporal Patterns in Seawater Quality from Dredging in Tropical Environments. *PLoS ONE* 10(10): e0137112. doi:10.1371/journal.pone.0137112

Jones R, M-C Pineda, HM Luter, R Fisher, D Francis, W Klonowski and M Slivkoff (2021). Underwater Light Characteristics of Turbid Coral Reefs of the Inner Central Great Barrier Reef. *Front. Mar. Sci*. 8:727206. doi: 10.3389/fmars.2021.727206

Kutser T, L Metsamaa, E Vahtmae and R Aps (2007) Operative monitoring of the extent of dredging plumes in coastal ecosystems using MODIS satellite imagery. Journal of Coastal Research, SI 50 (Proceedings of the 9th International Coastal Symposium), 180 – 184. Gold Coast, Australia, ISSN 0749.0208.

Keough MJ and BD Mapstone (1995) Protocols for designing marine ecological monitoring programs associated with BEKM operations. CSIRO, Canberra, Australian Capital Territory. (National Pulp Mills Research Program Technical Report No. 11)

Lear KO, T Fazeldean, RL Bateman, J Ingelbrecht and DL Morgan L (2023) Growth and morphology of Critically Endangered green sawfish *Pristis zijsron* in globally important nursery habitats. *Marine biology*, 170(6):70. doi: 10.1007/s00227-023-04220-5

LeBrec U, R Riera, V Paumard, MJ O'Leary and SC Lang (2022) Morphology and distribution of submerged palaeoshorelines: Insights from the North West Shelf of Australia. *Earth-Science Reviews*. 224:1-31. doi: 10.1016/j.earscirev.2021.103864

LeProvost (2008) Sino Iron Project – Marine Management Plan. Prepared for CITIC Pacific Mining Management Pty Ltd by LeProvost Environmental Pty Ltd.

Littler, M. M., & Littler, D. S. (1984). Relationships between macroalgal functional form groups and substrata stability in a subtropical rocky-intertidal system. Journal of Experimental Marine Biology and Ecology, 74(1), 13-34.

Loneragan NR, M Kangas, MDE Haywood, RA Kenyon, N Caputi and E Sporer (2013) Impact of cyclones and aquatic macrophytes on recruitment and landings of tiger prawns *Penaeus esculentus* in Exmouth

Gulf, Western Australia. *Estuarine, Coastal and Shelf Science*. 127:46–58. Doi 10.1016/j.ecss.2013.03.024.

Lyne V, M Fuller, P Last, A Butler, M Martin and R Scott (2006) Ecosystem characterisation of Australia's North West Shelf. Series: Technical report CSIRO. Marine and Atmospheric Research. North West Shelf Joint Environmental Management Study; no. 12.

Mackie M, DJ Gaughan and RC Buckworth (2003) Stock assessment of Narrow-barred Spanish mackerel (*Scomberomorus commerson*) in Western Australia, final report. Fisheries Research and Development Corporation project 1999/151, Western Australian Department of Fisheries, Perth.

Maunsell (2006) Marine and Coastal Environmental Report. Prepared for Mineralogy Pty Ltd.

Morgan DL, B Ebner, M Allen, A Gleiss, S Beatty and J Whitty (2017) Habitat use and site fidelity of neonate and juvenile green sawfish *Pristis zijsron* in a nursery area in Western Australia. *Endangered Species Research,* 34:235–249. doi: 10.3354/esr00847

Morgan DL, M Allen, B Ebner, J Whitty and S Beatty (2015) Discovery of a pupping site and nursery for critically endangered green sawfish *Pristis zijsron, Journal of Fish Biology.* 86(5):1658–1663. doi: 10.1111/jfb.12668

MScience (2009) Wheatstone LNG Development: Baseline Water Quality Assessment Report. Report to URS Australia Pty Ltd, November 2009.

NAGD (2009). National Assessment Guidelines for Dredging. Department of the Environment, Water, Heritage and the Arts, Commonwealth of Australia

Noell C, C Beckmann, L McLeay, M Kangas and A Roelofs (2021) Status of Australian Fish Stocks Report, Western king prawn 2020. Fisheries Research and Development Corporation.

O2 Marine (2022a) Eramurra Project – Marine Environmental Quality Baseline Report. Report Prepared for Leichhardt Salty Pty Ltd. Report Number R200160.

O2 Marine (2023) Eramurra Solar Salt Project – Sediment Analysis Report. Report to Leichhardt prepared for Leichhardt Salt Pty Ltd. Report Number: R210087.

O2 Marine (2025a) Eramurra Solar Salt Project - Subtidal Benthic Communities and Habitat Report. Report prepared for Leichhardt Industries Pty Ltd by O2 Marine, Report Number R210228.

O2 Marine (2025b) Eramurra Solar Salt Project – Conservation Significant Marine Fauna Desktop Study. Report prepared for Leichhardt for Leichhardt Salt Pty Ltd. Report Number: R210296

O2ME (2025). Dredge Plume Modelling. Eramurra Solar Salt Project. Report prepared for Leichhardt Salt Pty Ltd. Report Number: R210324.

Olsen YS, L Mattio, AZ Perez, RC Babcock, D Thompson, MDE Haywood, J Keesing and GA Kendrick (2019) Drivers of species richness and abundance of marine macrophytes on shallow tropical reefs of north-western Australia. Journal of Biogeography, 46(1), 170-184. https://doi.org/10.1111/jbi.13470

Pearce AF, S Buchan, T Chiffings, N D'Adamo, CB Fandry, PRCS Fearns, DJ Mills, RC Phillips and CA Simpson review of the oceanography of the Dampier Archipelago, Western Australia. In: Wells FE, Walker DI, Jones DS (2003) The Marine flora and fauna of Dampier, Western Australia: proceedings of the

Eleventh International Marine Biological Workshop; 24 July-11 Aug. 2000; Dampier, Western Australia. Perth, W.A.: Western Australian Museum; 2003. 13-50.

Peel, L. R., Whiting, S. D., Pendoley, K., Whittock, P. A., Ferreira, L. C., Thums, M., ... & Fossette, S. (2024). I still call Australia home: Satellite telemetry informs the protection of flatback turtles in Western Australian waters. *Ecosphere*, *15*(5), e4847.

Pendoley Environmental (2023a) *Eramurra Solar Salt Project: Marine Turtle Monitoring 2022/2023.* Prepared for Leichhardt Salt Pty Ltd.

Pendoley Environmental (2023b). Eramurra Solar Salt Project, Marine Turtle Monitoring 2022/23. Prepared by Pendoley Environmental Pty Ltd for Leichhardt Salt Ltd. Report Number ESSP-EN-14-TRPT-0019.

Pendoley Environmental (2024) *Eramurra Solar Salt Project: Marine Turtle Monitoring 2023/2024.* Prepared for Leichhardt Salt Pty Ltd.

Preston Consulting (2022) Eramurra Solar Salt Project – Environmental Scoping Document. Prepared for Leichhardt Salt Pty Ltd, Rev C

Quinn GP and MJ Keough (2002) Experimental Design and Data Analysis for Biologists, Cambridge University Press, Cambridge, UK.

Raudino HC, PJ Bouchet, C Douglas, R Douglas and K Waples. (2023) Aerial abundance estimates for two sympatric dolphin species at a regional scale using distance sampling and density surface modelling. *Frontiers in Ecology and Evolution,* 10(1086686):1-13. doi: 10.3389/fevo.2022.1086686

Ryan KL, NG Hall, EK Lai, CB Smallwood, A Tate, SM Taylor and BS Wise (2019) State-wide survey of boat based recreational fishing in Western Australia 2017/18, Fisheries Research Report 297. Department of Primary Industries and Regional Development, Western Australia.

SKM (2013). Iron Ore Holdings – Buckland Project. Marine Geotechnical Investigation. Interpretive Report. Report Number: WV04717. Rev 0. Prepared by Sinclair Knights Merz, for Iron Ore Holdings.

URS (2008). Marine Water and Sediment Quality Study. 42906729-1892: R1359. Prepared for INPEX Browse Ltd, Perth.

Worley Parsons (2009) Comparison of the Dampier Port Fringing Reef Benthic Community with nearby reef areas. Unpublished Report to Dampier Port Authority.

Appendix A. Plan Amendments

Appendix A.1. Document Change Register

Organisation	Date	Comment	Response

Appendix B. Monitoring Programs

Appendix B.1. Marine Water Quality Monitoring Program

B.1.1. Rationale

The MWQMP should be implemented prior to, during and post dredging of the channel and berth pocket areas to ensure that the EPOs and MTs for MEQ and subtidal BCH in this area are achieved. The monitoring approach is based on:

- Real-time telemetered monitoring of light and turbidity conditions at the seabed at sensitive receptor locations within the ZoMI, at the boundary of the ZoI/ZoMI, and at relevant reference sites.
- Daily assessment of dredge plume extent based on the satellite imagery acquisition and analysis of total suspended solids (TSS) concentration at the surface and derived benthic light availability at the seabed.
- A Discharge Water Quality Monitoring program (DWQMP), detailed in Appendix B2.

No telemetered monitoring is proposed at the spoil ground due to the lack of sensitive receptors around this area. However, daily visual plume monitoring at the spoil ground is proposed via the analysis of suitable daily satellite imagery, with a resolution of at least 325m x 325m per pixel. It should be noted that whilst daily imagery is provided, atmospheric conditions (cloud cover, fog etc) mean that daily plume analysis may not always be available.

B.1.2. Monitoring Locations and Duration (Water Quality)

Light Intensity and Turbidity

Continuous DLI and NTU measurements will be recorded at three coral impact sites, one macro algae impact site, one seagrass impact site, and two reference sites (Figure B1-1; Table B1-1). The impact monitoring stations will be used to monitor EPO's and MT's associated with no negative change from baseline conditions and have been positioned over identified receptors within the ZoMI (Figure B1-1). A tiered management framework has been developed to ensure the EPOs and MTs for the protection of BCH are achieved during dredging (Figure B1-2). No DLI monitoring is proposed at the spoil ground as described below.

It is recommended that baseline marine water quality data be collected (for a total of up to one month) prior to the commencement of marine dredging activities. This data can then be used to validate historic baseline data and inform the management criteria.

Spoil Ground Plume Extent

Daily[2] visual plume monitoring at the spoil ground one week prior to, during and one week following completion of dredging is proposed via the analysis of daily satellite imagery.

[2] Images will be collected at least daily where satellite platforms and environmental conditions allow, noting these images do not penetrate cloud cover

Table B1-1: Indicative water quality monitoring locations and management targets outcomes

Site Name	Zone	Early Warning - Level 1	Management Target - Level 2	Environmental Protection Outcome - Level 3
CWQ1	ZoI	Early warning	No negative change - reduced time	No negative change to coral BCH
MWQ1	ZoI	Early warning	No negative change - reduced time	No negative change to coral BCH
SWQ1	ZoI	Early warning	No negative change - reduced time	No negative change to seagrass BCH
ZOMi1	ZoMI	Early warning	Possible recoverable impact to coral BCH	Probable recoverable impact to coral BCH
ZOMi2	ZoMI	Early warning	Possible recoverable impact to coral BCH	Probable recoverable impact to coral BCH
CWQRef	Reference	N/A	N/A	N/A
SWQRef	Reference	N/A	N/A	N/A

B.1.3. Environmental Protection Outcomes, Management Targets and Trigger Levels

The EPOs, MTs and trigger levels for protection of coral and seagrass BCH during dredging are presented in Table B1-2.

EPOs and MTs threshold values have been adopted from the EPA's *Technical Guidance for Technical guidance - Environmental Impact Assessment of Marine Dredging Proposals* (EPA 2021b)

Table B1-2: Impact management targets for protection of benthic communities and habitat

Impact Monitoring						Comparison to Reference		
Zone of Influence – Coral *(Applicable to sites CWQ1)*								
Level 1 - Early Warning								
Averaging Period	**Threshold Type**	**NTU**		**DLI**		Type	NTU	DLI
5 days	*x day running mean of impact should not be…*	>6.4	AND	<2.6	AND	*x day running median of impact should not be…*	<80th percentile of relevant reference site	>20th percentile of relevant reference site
10 days		>5.1		<3.2				
24 days		>4.0		<3.8				
Level 2 - Management Target - No Negative Effects (Conservative Thresholds)								
Averaging Period	Threshold Type	NTU		DLI		Type	NTU	DLI
7 days	*x day running mean of impact should not be…*	>8.2	AND	<1.8	AND	*x day running median of impact should not be…*	<80th percentile of relevant reference site	>20th percentile of relevant reference site
7 days		>7.3		<2.2				
10 days		>6.5		2.5				
14 days		>5.2		<3.1				
28 days		>4.5		<3.8				
Level 3 - Environmental Protection Outcome - No Negative Effects								
Averaging Period	**Threshold Type**	**NTU**		**DLI**		**Type**	**NTU**	**DLI**
3 days	*x day running mean of impact should not be…*	>10.7	AND	<1.2	AND	*x day running median of impact should not be…*	<95th percentile of relevant reference site	>5th percentile of
7 days		>8.1		<1.9				
10 days		>7.2		<2.3				
14 days		>6.4		<2.6				
28 days		>5.1		<3.2				

Zone of Moderate Impact – Coral *(Applicable to sites ZOMi1 and ZOMi2)*								
Level 1 - Early Warning								
Averaging Period	**Threshold Type**	**NTU**		**DLI**	**AND**	**Type**	**NTU**	**DLI**
5 days	*x day running mean of impact should not be…*	>8.2	AND	<1.8		*x day running median of impact should not be…*	<80th percentile of relevant reference site	>20th percentile of relevant reference site
10 days		>6.5		<2.5				
24 days		>5.2		<3.1				
Level 2 - Management Target – Possible Effects								
Averaging Period	**Threshold Type**	**NTU**		**DLI**		**Type**	**NTU**	**DLI**
3 days	*x day running mean of impact should not be…*	>10.8	AND	<1.1	AND	*x day running median of impact should not be…*	<80th percentile of relevant reference site	>20th percentile of relevant reference site
7 days		>8.2		<1.8				
10 days		>7.3		<2.2				
14 days		>6.5		<2.5				
28 days		>5.2		<3.1				
Level 3 - Environmental Protection Outcome - Probable Effects								
Averaging Period	**Threshold Type**	**NTU**		**DLI**		**Type**	**NTU**	**DLI**
3 days	*x day running mean of impact should not be…*	>19.9	AND	<0.3	AND	*x day running median of impact should not be…*	<95th percentile of relevant reference site	>5th percentile of relevant reference site
7 days		>13.6		<0.6				
10 days		>11.6		<0.9				
14 days		>10.0		<1.1				
28 days		>7.3		<1.8				

Zone of Influence – Seagrass *(Applicable to sites SWQ1 and MWQ1)*					
Level 1 - Early Warning					
Averaging Period	**Threshold Type**	**DLI**		**Type**	**DLI**
10 days	*x day running mean of impact should not be…*	<0.9	AND	*x day running median of impact should not be…*	>20th percentile of relevant reference site
Level 2 - Management Target - No Negative Effects (Reduced Time)					
Averaging Period	Threshold Type	DLI		Type	DLI
14 days	*x day running mean of impact should not be…*	<0.9	AND	*x day running median of impact should not be…*	>20th percentile of relevant reference site
Level 3 - Environmental Protection Outcome - No Negative Effects					
Averaging Period	**Threshold Type**	**DLI**		**Type**	**DLI**
21 days	*x day running mean of impact should not be…*	<0.9	AND	*x day running median of impact should not be…*	>5th percentile of relevant reference site

B.1.4. Parameters and Procedures

Light Intensity

Light quantity (as measured by the DLI) and quality[3] will be recorded every 30 minutes at each of the monitoring locations. At all locations, DLI data will be collected using in-situ water quality loggers located approximately 0.5 m above the seabed on a steel frame and connected to a surface telemetry buoy. Data will be downloaded daily using the telemetry system. This data will be assessed daily in accordance with the tiered management framework (Table B1-2 and Figure B1-2). Measuring light quality refers to the measurement of different spectrums of the downwelling irradiance. This can be important for discerning the source of potential light reductions (Jones et al, 2021)

Turbidity

Turbidity (NTU) will be recorded every 30 minutes at each of the monitoring locations. At all locations, NTU data will be collected using in-situ water quality loggers located approximately 0.5 m above the seabed on a steel frame and connected to a surface telemetry buoy. Data will be downloaded daily using the telemetry system. This data will be assessed daily in accordance with the tiered management framework (Table B1-2 and Figure B1-2).

Spoil Ground Plume Extent

OCIL and or VIIRS satellite imagery will be examined in accordance with published techniques (such as those described by Kutser et al. 2007). The data will be downloaded as available, and the images interrogated to assess the dispersion of sediment plumes around the disposal area. Total Suspended Solids (TSS) algorithms may be applied to allow interrogation of absolute TSS level (both natural and anthropogenic influences). This data will be used to provide context to the project attributability of any elevated turbidity levels observed beyond the spoil ground.

[3] Although light quality information is not required for assessment against EPOs and MTs, light quality measured during dredging provides valuable information for the WAMSI Dredging Science Node to improve the science and understanding of potential impacts to seagrass BCH as a result of decreased light quality during dredging.

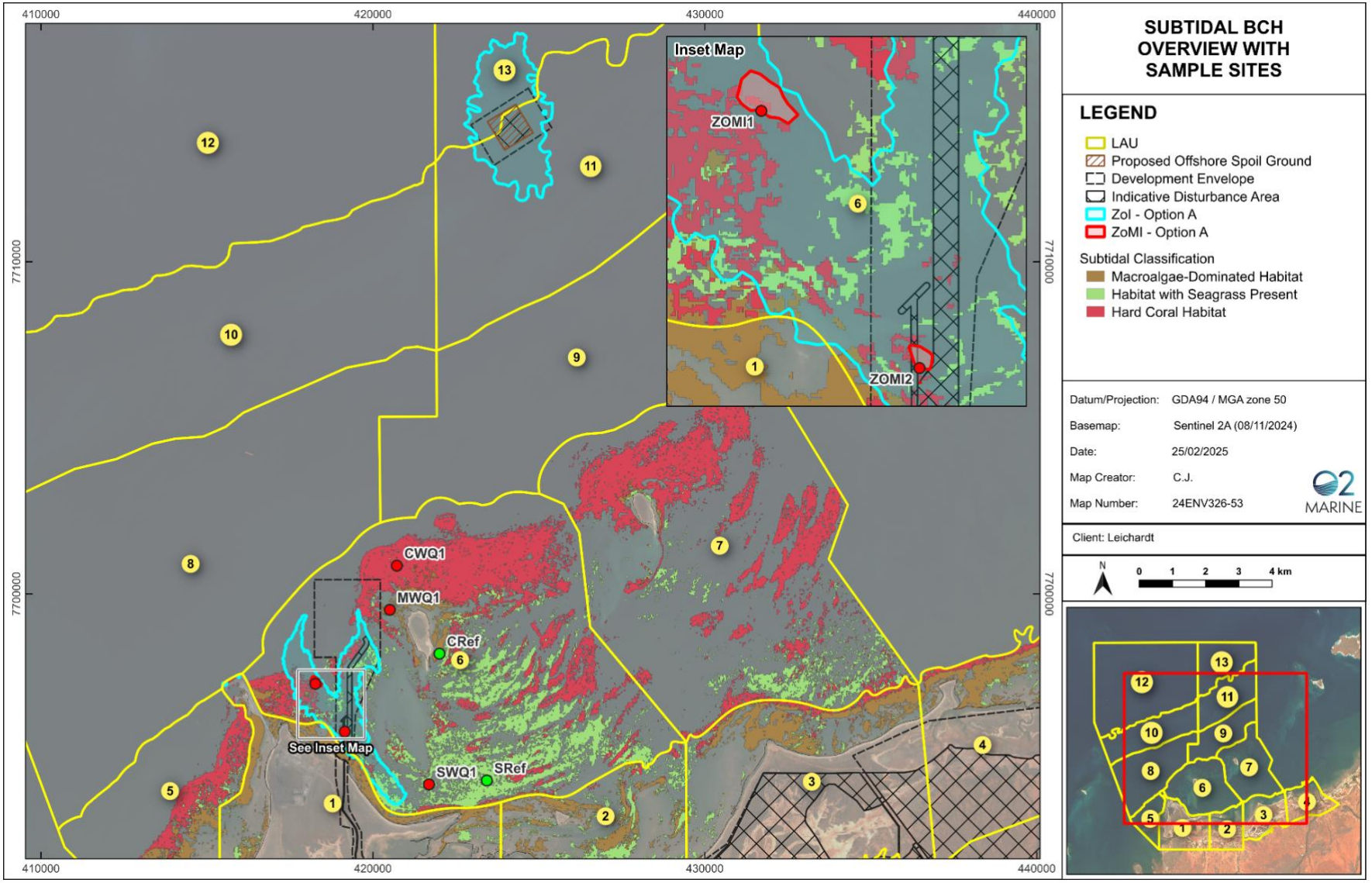

Figure B1-1: Indicative water quality monitoring locations

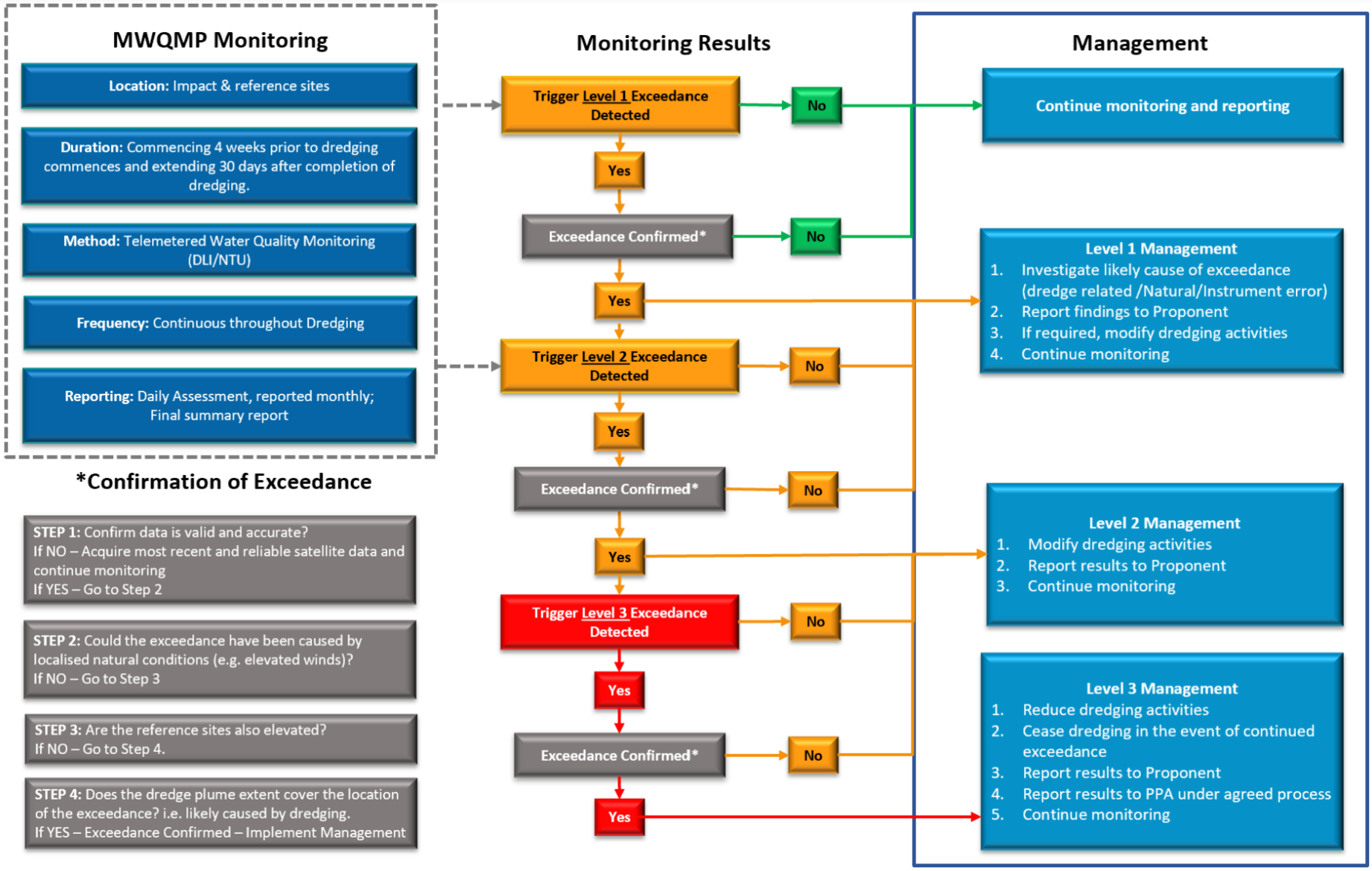

Figure B1-2: Tiered management framework for MWQMP

B.1.5. Data analysis

Any potential impact of dredging on water quality decline will be assessed and will include a consideration of the following factors:

- Correct instrument calibration, function, operation and maintenance;
- Potential influence of shipping movements through the channel;
- Locations of and status of dredging activities in relation to the site(s) at the time of the exceedance;
- Metocean conditions at the time of the exceedance;
- Assessment against background conditions (reference site); and
- Spatial extent of water quality decline at the time of exceedance based on review of plume extent (i.e. multispectral imagery).

Monthly reports and a final report shall be prepared to document the marine water quality monitoring program.

B.1.6. Corrective actions

The DLI data will be reviewed daily and used to update the 7-day, 14-day and 28-day running means which will then be assessed against the established Trigger Levels (Table B1-2). If the Trigger Levels are exceeded (or indicate a progressive increase towards the Trigger Levels) then modifications to the dredging program are to be considered, and may include, but not necessarily be limited to:

- Temporary pause to dredging activities (e.g. if exceedance appears to be due to non-dredging vessel movements, tide and/or weather conditions);
- Relocate the dredge (e.g. to an area of coarser sediment); and/or
- Reduce the cutter head speed (if cutter-suction dredge is used), dredge cut depth, rate of swing-speed and/or increase the dredge pump flow.

Modifications to the dredge program are to continue until the Trigger Levels are no longer exceeded. If Trigger Level 3 is exceeded for two consecutive days ('continued exceedance') dredging will cease, and Level 3 Management Actions shall be instigated. In this instance dredging will only recommence after Trigger Level 1 is no longer exceeded. In addition, detailed investigations on the likely causes of the exceedance and the recommended changes to dredge program is required within 7 days of this Trigger Level 3 exceedance.

Analysis of dredge plume extent will be undertaken through Geographical Information System (GIS) interpolation of the dredge plume as a function of TSS spatially at the spoil ground and nearest sensitive receptor survey areas. Where there are no observable elevations greater than the defined trigger level from the dredge plume then predicted impacts are considered met. If the plume has resulted in an increase in TSS above the trigger values, then sampling will be conducted daily until the plume is no at a concentration high enough to cause impacts from dredging and dredge related activities. Where the trigger level is exceeded, dredging related activities will be reviewed, with management such as reducing dumping frequency or even suspending operations to be considered until an observable plume is no longer evident (as directed by daily plume assessment).

Appendix B.2. Discharge Water Quality Monitoring Program

B.2.1 Monitoring Rationale

The DWQMP should be implemented prior to, during and post tail water discharge from the onshore spoil ground (OSG) to ensure that the EPOs and MTs for protection of marine environmental quality and BCH in in the receiving environment are achieved and potential acidification in the OSG is managed. The monitoring approach is based on:

- Real-time telemetered monitoring of water quality (Turbidity, pH, Salinity, Temperature and Dissolved Oxygen) at:
  - One location within the OSG, prior to discharge (BRS);
  - One location within the receiving environment, approximately 70m from the discharge location (i.e. ARS); and
  - One reference location within the receiving environment, away from the influence of dredging and dewatering activities (i.e. DREF).
- Weekly sample collection for analysis of Total Titratable Acidity (TTA) within the OSG prior to discharge.

EPOs, MTs and associated trigger levels were developed assuming the potential for a temporary, localised reduction in marine environmental quality in the immediate vicinity of the tail water discharge. Trigger levels were also developed for management of potential acidification in the OSG.

B.2.2 Environmental Protection Outcomes, Management Targets and Trigger Levels

The EPOs, MTs and trigger levels to be applied for protection of marine environmental quality, intertidal BCH and management of acidification during tail water discharge from the OSG are presented in Table B2-1.

B.2.3 Tiered Management Framework

A DWQMP TMF has been developed based on monitoring and reporting against the three trigger levels presented in Table B2-1 to ensure EPOs and MTs for protection of marine environmental quality and intertidal BCH are achieved during tail water discharge operations from the OSG to the receiving environment. A TMF is provided and presented for physico-chemical and contaminant monitoring and management (Table B2-1), and acidification monitoring and management (Table B2-2).

Table B2-1: Environmental Protection Outcomes, Management Targets and Trigger Levels for protection of marine environmental quality and subtidal BCH from potential discharge water quality impacts

Monitoring Location: OSG Discharge (BRS)		**Monitoring Location: Receiving Environment (ARS)**	
Tail water discharge location within the OSG, prior to discharge		70m from tail water release point (within receiving environment)	
Early warning: > Moderate Level of Ecological Protection	Trigger Level 1 Physico-chemical Targets Turbidity: Median <90th percentile of reference Temperature: Median >10th percentile and <90th percentile of reference Salinity: Median >10th percentile and <90th percentile of reference pH: Median >10th percentile and <90th percentile of reference Dissolved Oxygen = >60% Saturation Contaminant targets Dissolved metals: 99% SPL TBT: 99% SPL Acidification targets pH = >6.5 TTA = <40 mg/L	Management Target: > High Level of Ecological Protection	Trigger Level 2 Physico-chemical Targets Turbidity: Median <70th percentile of reference Temperature: Median >30th percentile and <70th percentile of reference Salinity: Median >30th percentile and <70th percentile of reference pH: Median >30th percentile and <70th percentile of reference Dissolved Oxygen = >70% Saturation Contaminant targets Dissolved metals: 95% SPL TBT: 95% SPL Acidification targets pH: >6.8 TTA - As Required – Refer to Figure B2-2:
Management Target: Moderate Level of Ecological Protection	Trigger Level 2 Physico-chemical Targets Turbidity: Median <95th percentile of reference Temperature: Median >5th percentile and <95th percentile of reference Salinity: Median >5th percentile and <95th percentile of reference pH: Median >5th percentile and <95th percentile of reference Dissolved Oxygen = >60% Saturation Contaminant targets Dissolved metals: 99% SPL TBT: 99% SPL Acidification targets pH = >6 TTA = <40 mg/L	Environmental Protection Outcome: High Level of Ecological Protection	Trigger Level 3 Physico-chemical Targets Turbidity: Median <80th percentile of reference Temperature: Median >20th percentile and <80th percentile of reference Salinity: Median >20th percentile and <80th percentile of reference pH: Median >20th percentile and <80th percentile of reference Dissolved Oxygen = >80% Saturation Contaminant targets Dissolved metals: 95% SPL TBT: 95% SPL Acidification targets pH: >6.5 TTA - As Required – Refer to Figure B2-2:

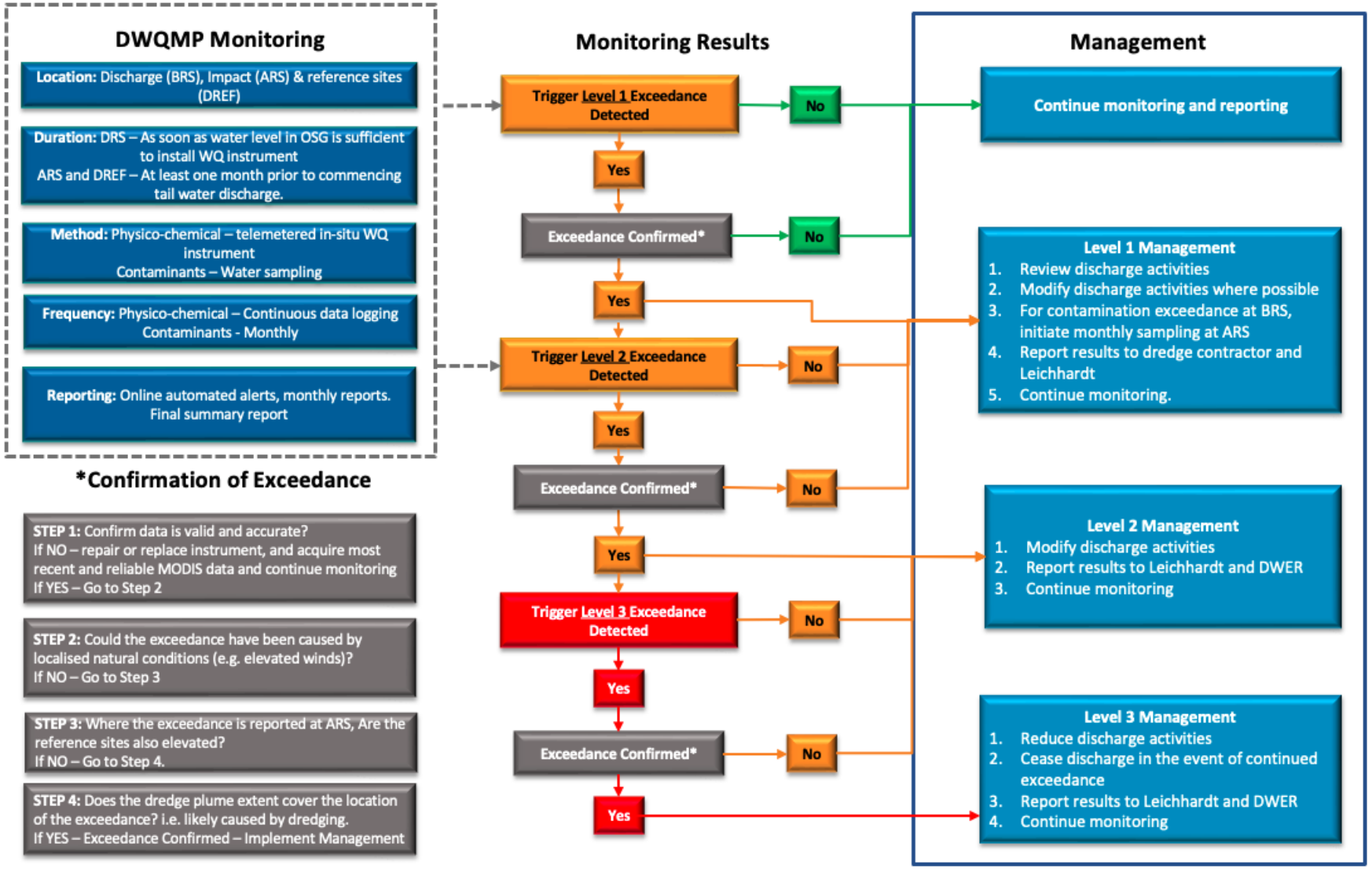

Figure B2-1: Tiered Management Framework – Physico chemical and contaminant monitoring

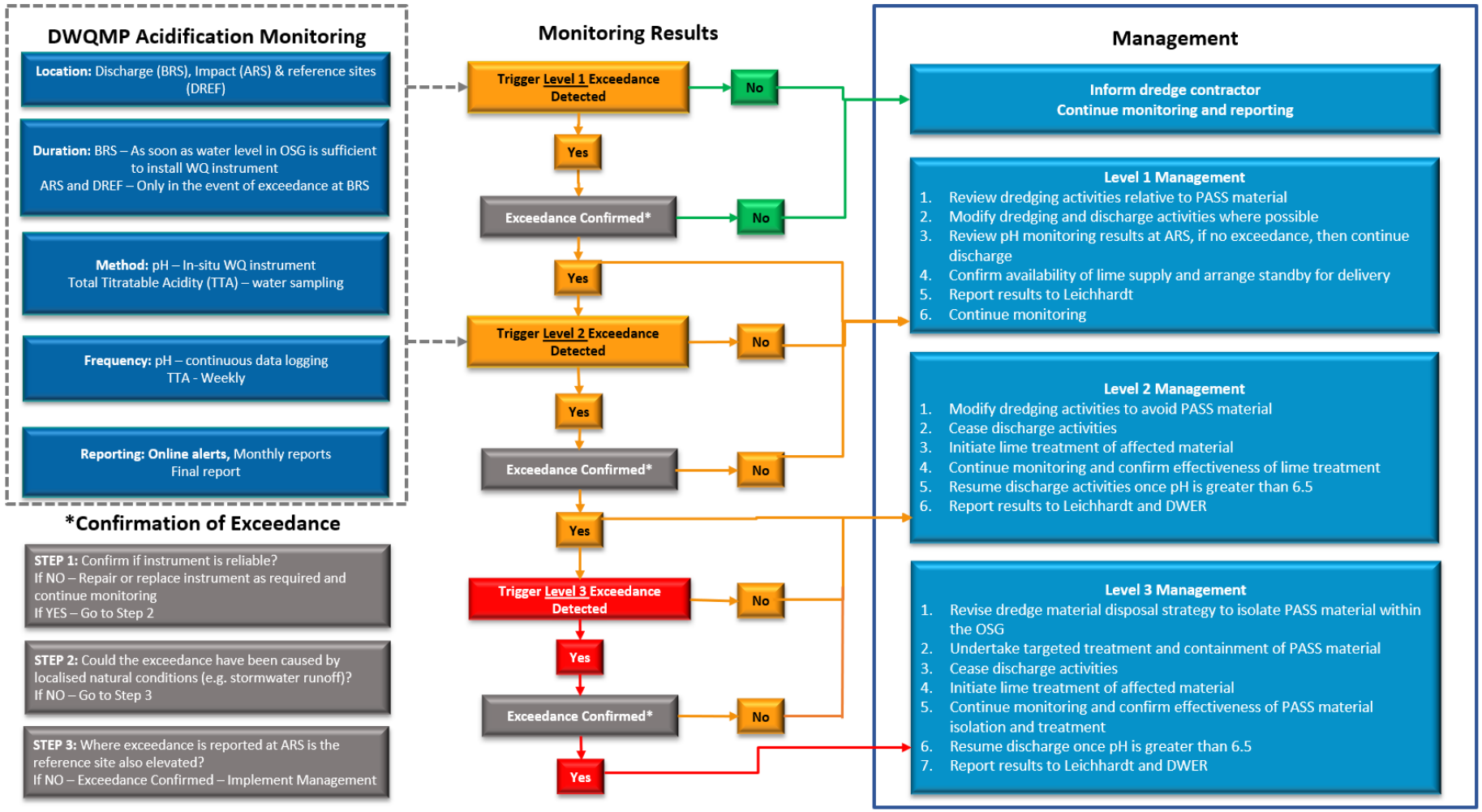

Figure B2-2: Tiered Management Framework – Acidification

B.2.4 Monitoring Locations & Frequency

The three indicative DWQMP monitoring locations described in Table B2-2 and presented in B2-3 are proposed to be monitored for physico-chemical parameters in real-time during tail water discharge operations. Monitoring locations presented in Figure B2-3 are indicative only and will be subject to safe navigation and final discharge location from the OSG.

Table B2-2: Indicative DWQMP Monitoring Locations

Site Name	Location	EPO	MT	Latitude (GDA 2020)	Longitude (GDA 2020)
BRS - Before Release Site	Impact – within OSG	N/A	Moderate Level of Ecological Protection	-20.845024	116.2231949
ARS - After Release Site	Impact – 70m from outfall	High Level of Ecological Protection	> High Level of Ecological Protection	-20.84309794	116.2239773
DREF - Discharge Reference Site	Reference	N/A	High Level of Ecological Protection	-20.84659835	116.2658537

Discharge water quality monitoring at the receiving environment locations (ARS & DREF) will commence one month prior to tail water discharge from the OSG and continue until at least one month following completion of tail water discharge from the OSG.

Acidification and contamination water sampling for laboratory analysis (TTA and dissolved metals) in the OSG will commence as soon as sufficient water level is achieved to facilitate sampling and continue until tail water discharge from the OSG is completed. Acidification (TTA) sampling will be undertaken weekly, while contamination sampling (dissolved metals) will be undertaken monthly. The monitoring location, parameter and frequency for the DWQMP are summarised in Table B2-3.

Table B2-3: DWQMP monitoring parameters and frequency

Site Name	Location	Physico-chemical monitoring	Acidification (pH and TTA)	Contamination
Before Release Site (BRS) – within Onshore Spoil Ground	Impact	Continuous data logging (telemetered)	pH - Continuous data. logging (telemetered) TTA Sample - Weekly water samples	Dissolved metal Sample - monthly
After Release Site (ARS)	Impact	Continuous data logging (telemetered)	pH - Continuous data. logging (telemetered) TTA Sample – weekly only if exceedance recorded at BRS	Dissolved metal Sample - monthly
Discharge Reference Site (DREF)	Reference	Continuous data logging (telemetered)	pH - Continuous data. logging (telemetered) TTA Sample – weekly only if exceedance recorded at BRS	Dissolved metal Sample - monthly

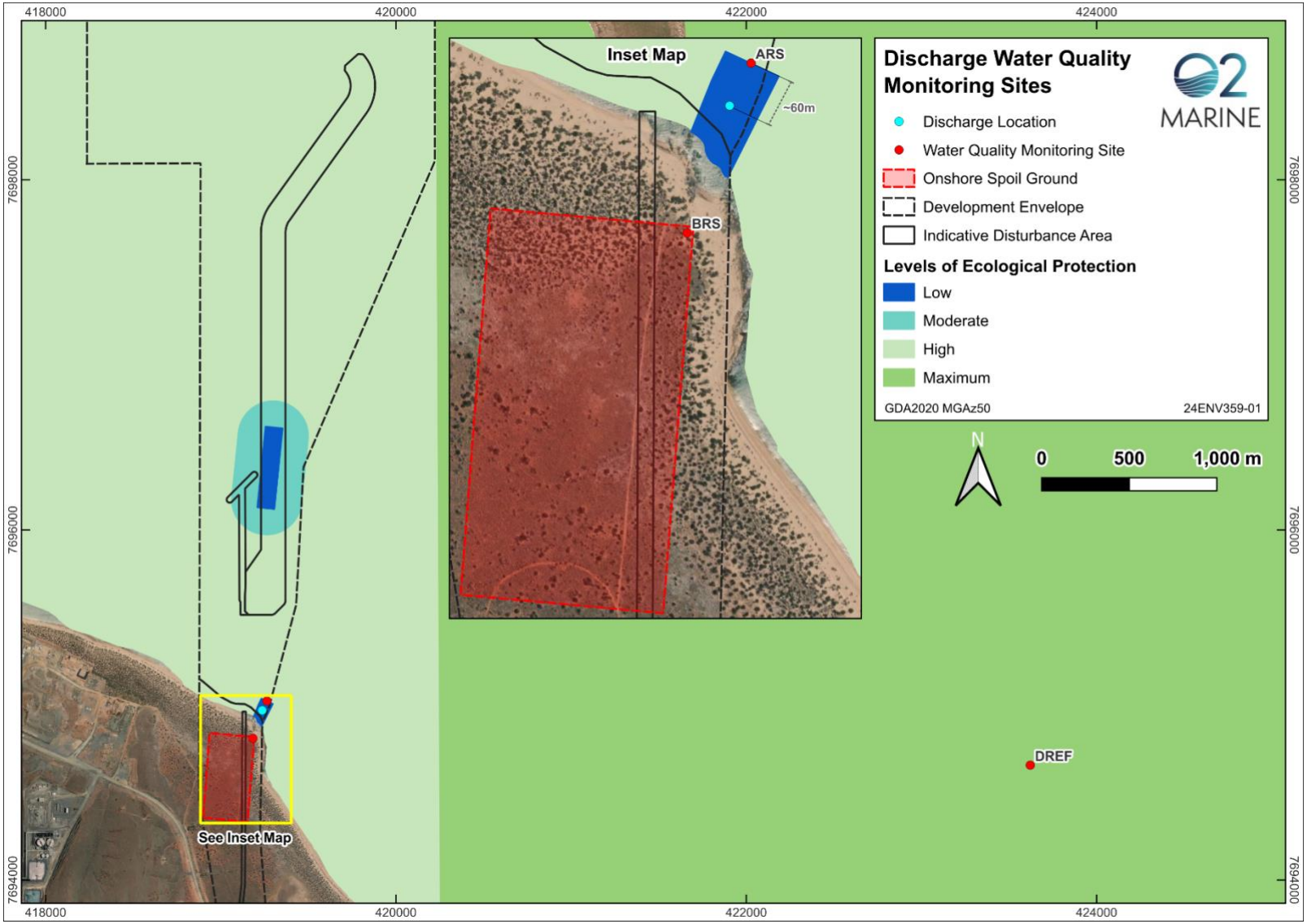

Figure B2-3: Indicative DWQMP Monitoring locations

B.2.5 Parameters and Procedures

Physico-chemical parameters

Turbidity, temperature, salinity, pH and dissolved oxygen will be measured every 30 minutes at each of the monitoring locations presented in Table B2-2. At all locations, water quality data will be collected using in situ water quality loggers with telemetry capability. Within the receiving environment, the water quality sensors will be located approximately 0.5 m above the seabed on a steel frame at each specified monitoring location. At the tail water discharge location, the water quality sensors will be installed at an appropriate depth (to avoid drying out) immediately prior to (i.e. within 50m) discharge via the weir box.

Data will be downloaded daily using the telemetry system deployed with the logger. Loggers will be calibrated during regular maintenance surveys and in accordance with manufacturer specifications to ensure accurate datasets are acquired.

Dissolved Metals

Surface water samples will be collected monthly at the tail water discharge monitoring location for laboratory analysis of dissolved metals (As, Cd, Cr, Cu, Pb, Hg, Ni, Se, Zn).

Acidification

As part of the physico-chemical monitoring described above, pH will be measured every 30 minutes in the OSG prior to discharge (i.e. BRS). Water quality data will be recorded using in situ water quality loggers with telemetry capability. The water quality station will be installed immediately prior to (i.e. within 50m) discharge via the weir box.

Data will be downloaded daily using the telemetry system deployed with the logger. Loggers will be calibrated monthly to ensure accurate datasets are acquired.

Surface water samples will be collected on a weekly basis at the tail water discharge monitoring location for laboratory analysis of Total Titratable Acidity (TTA). Only in the event of a TTA exceedance (40 mg/L, see Table B2-1), will acidification sampling be undertaken at ARS and DREF.

B.2.6 Data analysis

Physico-chemical water quality parameters will be measured continuously throughout monitoring period and will be used to provide early warning of potential water quality deterioration at each of the monitoring sites. The likelihood of a link between tail water discharge and water quality decline in the receiving environment will be assessed in terms of the following factors:

- Correct instrument function and operation;
- Status of discharging and dredging activities at the time of, and leading up to the exceedance;
- Water quality conditions at the tail water discharge point;
- Hydrodynamic conditions within the receiving environment, for example wind and tide at the time of the exceedance; and
- Effects of an extreme weather event in the region.

Monthly reports and a final report shall be prepared to document the marine water quality monitoring program.

Appendix B.3. Benthic Communities and Habitat Monitoring Program

B.3.1. Objectives

The Benthic Communities and Habitat Monitoring Program (BCHMP) together with the MWQMP will aim to provide an evaluation of the EPOs for BCH which are:

1. Recoverable Impacts to BCH within the Zone of Moderate Impact (ZoMI); and
2. No Negative Change to the Baseline State of BCH within the Zone of Influence (ZoI).

B.3.2. Monitoring Rationale

As identified in Section 4.1.4, coral and seagrass communities are the most vulnerable (of those BCH present in the impact area) to the effects of increased SSC and the associated decline in benthic light availability. Therefore, coral and seagrass health have been selected as the lead indicator for monitoring of benthic community health within the ZoMI and ZoI.

A standard Before After Control Impact (BACI) design is proposed for the coral monitoring sites, however, to achieve a statistical power of 0.8, the BCHMP will focus on monitoring of individual (tagged) coral colonies before, during and after dredging activities at the designated impact and control sites. Presence and absence surveys will also be conducted for filter feeder and seagrass habitats, with results mapped. The BCHMP is designed to identify and measure changes in condition of individual colonies that are attributable to dredging activities, and which are greater than the changes occurring naturally at control sites. Additional benthic cover information will also be collected to inform multiple lines of evidence assessment.

For the seagrass sites, due to the ephemeral nature of the seagrass and lack of any predicted impacts, if seagrass is present during the post-dredging survey in areas where it was present prior to dredging, then the seagrass in this area will be presumed to be unimpacted.

B.3.3. Effect Size

The EPOs and associated proposed effect size for assessment of dredging-related impacts to hard coral, filter feeder, macro algae and seagrass BCH are:

1. No irreversible loss of, or serious damage to, BCH outside of the ZoHI;
2. Protection of at least 70% of baseline BCH (within tagged colonies) at coral monitoring sites within the ZoMI; or
3. No detectable reduction of net live coral cover (within tagged colonies) attributable to the Proposal activities within the ZoI.
4. No detectable reduction seagrass attributable to the Proposal activities in areas where seagrass was present previously.

B.3.4. Locations

The selected indicative monitoring sites were chosen to complement and verify data from historic surveys, and to assess the status of benthic communities in areas that are predicted to be impacted by the Proposal. The indicative monitoring sites are presented in Figure B3-1, and detailed in Table B3-1.

For coral colonies, indicative monitoring locations have been selected in areas of at least moderate coral cover and include:

- Eight (8) reference locations (CRef1 – CRef 8) to assess no change from baseline
- Two (2) location locations within the ZoMI (C-ZoMI-1, C-ZoMI-2) to assess recoverable impacts; and
- Three (3) locations within the ZoI (C1 – C3) to assist in validating potential impact.

For seagrass communities, indicative monitoring locations include:

- Six (6) reference locations (SRef1 – SRef 6) to assess no change from baseline; and
- Three (3) location locations within the ZoI (C-ZoMI-1, C-ZoMI-2) to assist in validating potential impact.

No Zone of High Impact (ZoHI) was identified during the assessment, indicating that potential impacts are expected to be within acceptable limits and not exceed established thresholds.

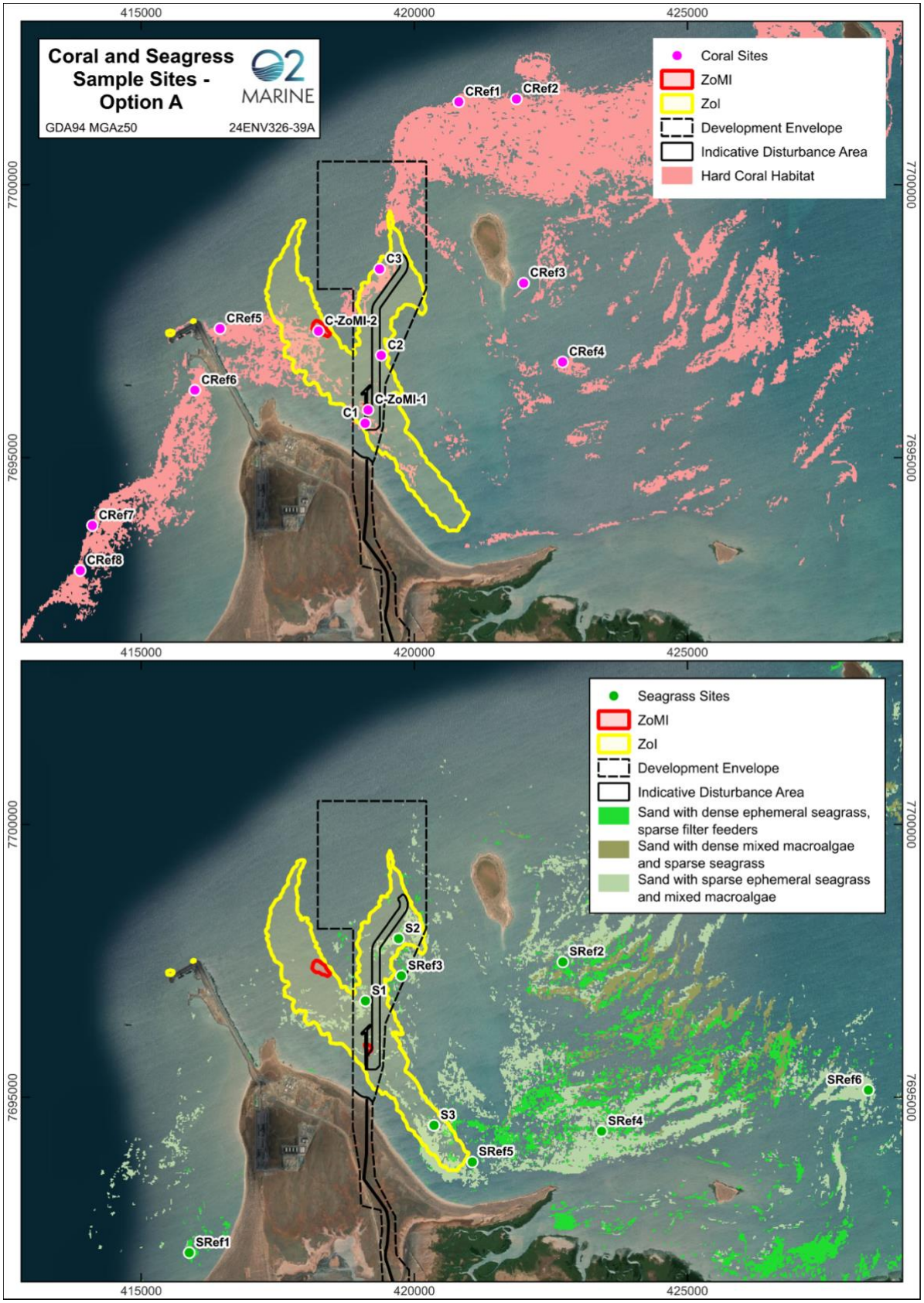

Figure B3-1: Indicative BCH Monitoring Locations

Table B3-1: Indicative BCH Monitoring Locations

Site Name	Location	Survey	Latitude	Longitude
Coral colonies				
CRef1	Reference	Coral & WQ	-20.78444452	116.2391985
CRef2	Reference	Coral	-20.78402288	116.2493372
CRef3	Reference	Coral	-20.8145057	116.2504438
CRef4	Reference	Coral & WQ	-20.82759333	116.2572351
CRef5	Reference	Coral & WQ	-20.82180811	116.1969956
CRef6	Reference	Coral	-20.83196667	116.1925
CRef7	Reference	Coral & WQ	-20.85428121	116.1743602
CRef8	Reference	Coral	-20.86172466	116.1721857
C1	Zone of Impact	Coral & WQ	-20.8375807	116.2224407
C2	Zone of Impact	Coral & WQ	-20.82635582	116.2253212
C3	Zone of Impact	Coral	-20.8120601	116.2251058
C-ZoMI-1	Zone of Moderate Impact	Coral	-20.8353823	116.2229727
C-ZoMI-2	Zone of Moderate Impact	Coral	-20.8222862	116.2142947
Seagrass communities				
SRef1	Reference	Seagrass	-20.86885203	116.1913275
SRef2	Reference	Seagrass	-20.82102247	116.257317
SRef3	Reference	Seagrass	-20.82319122	116.2288918
SRef4	Reference	Seagrass	-20.84907167	116.2639823
SRef5	Reference	Seagrass & WQ	-20.85406702	116.2412176
SRef6	Reference	Seagrass & WQ	-20.84244975	116.3109719
S1	Zone of Impact	Seagrass	-20.82731185	116.222541
S2	Zone of Impact	Seagrass	-20.81702835	116.228431
S3	Zone of Impact	Seagrass	-20.84795837	116.2345125

B.3.5. Frequency

Baseline Surveys

Given the existing baseline surveys in the area, one pre-dredge baseline survey is required to be undertaken prior to dredging. The baseline survey should be undertaken at least one month prior to commencement of dredging.

Reactive Monitoring

In the event that a Trigger Level 3 exceedance is recorded for water quality (see Tale B1-2 and Figure B1-2), reactive BCH monitoring will be implemented within one month of the recorded exceedance at all sites presented in Figure B3-1 and Table B3-1, and in accordance with Section B.3.6, to assess BCH status.

Post-Dredging Survey

One post-dredging survey should be undertaken within 12 months following completion of dredging to evaluate status of EPOs within the ZOMI and the ZOI. Where dredging impacts are detected in areas outside of the ZOMI, then post-dredging BCH surveys will continue, on at least an annual basis, for up to 5 years, or until BCH that is impacted as a result of dredging is considered to have recovered to a pre-dredging (baseline) condition as demonstrated through monitoring.

B.3.6. Survey Methods

Seagrass Communities

The seagrass monitoring sites (Figure B2-1) will be used to validate the predicted impacts to seagrass habitats , involving the implementation of a standard BACI design. The survey design is to include three (3) 50 m transects radiating in different bearings at each monitoring location, capturing still photographic images of a 20 x 20 cm quadrat at each metre along the transects. Images are to be collected within <1 m above the substrate. Total percent cover (all species combined) and percent cover of individual species will be determined using visual estimates by experience marine scientists, to inform assessment against baseline and reference data for benthic cover).

Individual Coral Colonies

At each site, up to 80 colonies will be selected, across five permanent transects (i.e., 16 colonies per transect). Colonies will be selected on the basis of an initial appraisal of condition (i.e., no obvious signs of mortality, bleaching or excessive mucous production) and targeted between the size range conducive to photography: 11-75 cm. Where larger colonies (<75 cm) are present, these colonies will be divided into smaller (0.5 m) sections along the transect for separate evaluation. Where possible, colonies will be selected from a broad range of species, representative of different family groups and morphologies at each site, including sensitive genera (e.g., *Acropora*) and less sensitive genera (e.g. *Turbinaria*).

Colonies will be selected from within 1 m either side of the permanent transects. Using the permanent transect as a reference point, the locations of colonies will be recorded using bearings and offset distances from the tape to enable re-location during subsequent surveys. Where there are limited colonies recorded, additional colonies may be added by searching the area between 1-2 m either side of the transect.

Sub-lethal indicators will be recorded for each colony *in-situ* using the classification details provided in Table B3-1. Digital photographs will be collected at distances which allow the colony to maximise the field of view on the image. A set of Coral Reference Photographs taken during the first baseline survey showing the original image of each of the corals with the location bearings and distances from the transect will be used to compare against each colony to ensure that the correct corals are assessed on each sampling occasion. Colonies will be photographed from the same orientation/perspective (from start of transect) and distance. Where an area of colony is covered in sediment, it will not be cleared away from the colonies before photographs are taken. Where macroalgae obscure a colony, the macroalgae will be moved to allow a clear photograph to be taken, unless the macroalgae are growing on or within the colony and its removal would damage either the coral or the macroalgae.

Table B3-1: *In-situ* classification details of sub-lethal indicators to be recorded for each colony during each survey.

Indicator	1	2	3	4	5
Partial Mortality	<10%	10-30%	30-60%	60-80%	>80%
Sediment deposition					
Coral colour	paling	focal bleaching	non-focal bleaching	partial bleaching	total bleaching
Mucous Production	Presence/absence				
Disease	Presence/absence and Type (i.e., White syndrome, black band, brown band, other)				
Predation/Type	Presence/absence and Type (i.e., Fish scars, Polychaetes, Tremetodes, other)				

Line Intercept Transect

A tape measure will be run over each 20 m permanent transect, then a suitably qualified coral specialist will identify and record benthic cover type and form located directly beneath the tape measure for each transect. Data will be used to calculate percentage benthic cover type across the monitoring location.

B.3.7. Data Analysis

Seagrass Data

For the seagrass sites, due to the ephemeral nature of the seagrass and lack of any predicted impacts, if seagrass is present during the post-dredging survey in areas where it was present prior to dredging, then the seagrass in this area will be presumed to be unimpacted.

Prescence/absence of seagrass is to be evaluated on a per site basis, with comparison made against baseline and in consideration of reference site information. Absence of seagrass at a site is defined as >90% of quadrats having <2% cover of seagrass.

Coral Image Analysis

Each individual image will be analysed using coral point count with excel extensions (CPCe) to determine the extent of live coral cover for each coral colony. Sixty (60) points will be assessed per image and coral condition (i.e., live/dead) will be recorded for each point.

The sub lethal indicators recorded in the field will be evaluated to determine the metrics shown in Table B3-2. The mean of the scores from the assessment of partial mortality, coral colour and sediment deposition will be compared to the baseline record. A shift of three points on the six-point classification (including zero) will constitute an adverse change in sub-lethal coral indicators. The incidence of colonies exhibiting evidence of coral mortality, bleaching, mucous production, predation and disease will be calculated by summing the number of colonies with evidence of these effects divided by the total number of colonies. This will be expressed as a percentage reduction in coral condition from the baseline level.

Table B3-2: Post-processing data for the following indicators.

Indicator	Analysis Description
Partial Mortality	Total mean partial mortality[1] scores from CPCe
Colony mortality	Proportion of colonies in Category 5
Coral colour	Total mean coral colour scores[1]
Colony bleaching	Proportion of colonies in Category 4 and 5
Sediment deposition	Total mean sediment cover[1] scores
Sedimentation	Proportion of colonies in Category 5
Mucous production	Proportion of colonies with evidence of the presence of mucous
Disease	Proportion of colonies with evidence of the presence of coral disease
Acanthaster	Incidence of *Acanthaster* species along transects
Drupella	Proportion of colonies with evidence of the presence of *Drupella*
Predation	Proportion of colonies with evidence of predation

[1] All colonies included in the assessment (i.e., colonies scoring zero are included in calculating the mean)

Line Intercept Transect

The percentage of benthic species cover that directly intercept the tape measure length of each 20 m transect using the line-intercept method will be calculated into a proportion of each benthic group (i.e., 20 m equals 100%). The benthic groups used will be calculated manually in excel to determine the relative abundance, mean, standard deviation, standard error and the Shannon-Weaver diversity Index of each benthic cover type at each site. Line intercept data will not be used for EPO assessment.

Statistical Analysis

The process for analysis of lethal and sub-lethal data and comparison against the EPOs is shown in Table B3 3. The first step of the analysis is a statistical paired-samples t-test of gross negative change in live coral cover at the impact location. This uses a null hypothesis of no difference between the impact location at time 'x' during dredging compared to baseline to test the one-tailed alternative hypothesis that the negative change at the impact location is significantly greater than the negative change at reference locations.

This is followed by a similar test, but of net negative change at the impact location (i.e., factoring in change in cover that occurred concurrently at reference locations). Specifically, the (one-tailed) hypothesis being tested is that difference in the negative change is greater at the impact location than at the reference locations. The appropriate statistical test is a two-(independent)-sample t-test between the average of the impact locations and the average of reference locations. This uses a null hypothesis of no difference between the impact location at time 'x' during dredging compared to baseline to test the one-tailed alternative hypothesis that the negative change recorded between baseline and time 'x' at impact locations is greater than the negative change recorded at impact locations.

The t-tests of changes within sites proposed here are equivalent to the main interaction test (before–after × control–impact) in a standard Multiple Before–After, Control–Impact (MBACI) design (Keough and Mapstone 1995; Downes et al. 2002; Quinn and Keough 2002). The only difference is that there will only ever be one measurement in the "after" (during dredging) period that is being assessed, so there is additional temporal imbalance compared to a usual MBACI design. The statistical analysis is also based on an asymmetrical design, characterised by a before versus after contrast at multiple control sites but only a single impact site. The impact sites for the tests may be grouped together to form an additional balanced statistical test where three sites represent each of the impact zones and provide greater confidence that EPOs have been achieved for the Project. Results will be compared against the results from the control reference sites to confirm impact.

A conventional Type I error rate of 0.05 will be applied across the tests. Type II error rates of statistical power will be determined during the baseline study.

Table B3-3: The process for evaluation of EPOs

Name	Description	Objective
Average Baseline	Calculate average measurements for each colony across each site over multiple sampling times before dredging	To determine natural levels of change before dredging
Gross Change	Subtract the Average Baseline from the recent dredging survey for each colony/transect and average across each site	To calculate the average change from baseline to recent dredge survey at each impact and control site
Test of Gross Change	Paired-sample t-tests performed between baseline and recent dredge survey averages where negative change was recorded at impact site.	A statistically significant negative change might provide evidence supportive of a dredging-related impact.
Test of Net Change	Two-(independent)-sample t-test performed to compare negative changes between impact and control sites where negative change was recorded at impact site.	A statistically significant negative change might provide evidence supportive of a dredging-related impact.
Multiple Lines of Evidence	Detailed interrogation of all data collected using supportive univariate and multivariate analyses where Test of Net Change is exceeded	To rigorously assess whether the detected change at an affected reef was due to dredging or simply the result of natural change

Multiple Lines of Evidence

In the event that management criteria are exceeded, a series of investigations and statistical analyses will be initiated in a structured decision-making framework to rigorously assess whether the detected change at an affected reef was due to dredging or simply the result of natural change.

The first step will be an assessment of the magnitude of change (effect size and its confidence interval) in coral cover for the individual colonies between the impact and reference locations, from before dredging to the current survey period (that is, whether the difference in coral cover between the affected reef and the control reefs had increased or remained consistent since dredging). The purpose of this method is to compare the effect size during baseline with the effect size after dredging. A confidence interval approach provides important information for decision-making not gained from a test of a null hypothesis and focuses on the

magnitude of change, with some measure of uncertainty. A larger mean effect size (+- confidence interval) following dredging may provide evidence supportive of the dredge impact hypothesis.

A comparison of trends in mean coral cover through time will then be compared among the impact and reference locations. Evidence supportive of the dredge impact hypothesis would be a decline in cover at the impact location following dredging, but no corresponding decline at the reference location.

An inference assessment will then be undertaken, which includes the collation and synthesis of all available circumstantial evidence supporting or refuting the conclusion that either dredging or a natural agent of disturbance resulted in an observed decline in coral cover at the impacted location.

Multiple lines of evidence, based on causal indicators, are used to assess the impact hypothesis and may apply a variety of univariate or multivariate analysis. With lines of evidence there is a need to seek evidence not only to support the impact prediction, but evidence to rule out plausible alternative predictions, such as that the observed difference was due to natural processes (Beyers 1998; Downes et al. 2002). Potential natural or other anthropogenic causes of impact within the Project area may include thermal bleaching from warm water temperatures, natural mortality, pollution, predation, cyclonic events, salinity change and anthropogenic causes for elevated turbidity (e.g. ship propeller disturbance, maintenance dredging). Potential natural and anthropogenic causes not related to the dredging activities will be monitored and noted during routine surveys as part of the MWQMP.

A number of factors are relevant to the likelihood and level of severity of an impact occurring, including existing stress levels, age, size and health status of colonies, associated biota and adaptations to localised conditions. Differences in the physical characteristics between reference and impact locations and how this could affect the scale of effect observed between the corals should also be considered. The data will be compiled to provide a weight of evidence as to whether or not dredging activities were reasonably considered to cause or contribute to the impact.

It is predicted that impacts from the proposal on subtidal BCH will include:

Irreversible loss

- 3.1 ha (7.1%) of filter feeders (high cover)
- 17.9 ha (1%) of coral reef (low-moderate cover)
- 3.6 ha (0.5%) of macroalgae, including:
  - 2.5 ha (0.04%) of macroalgae (low-moderate cover)
  - 1.1 ha (0.1%) of seagrass / macroalgae

Recoverable impacts

- 2.5 ha (0.05%) of macroalgae
- 81 ha (4.5%) of coral reef.

To verify this, post dredge surveys will continue on an annual basis (Maximum of five years) as required to identify evidence of BCH recovery within the authorised ZoMI. Where BCH has not shown evidence of recovery within the authorised ZoMI after 3 years, options will be considered for translocation, artificial reef, seagrass transplantation and/or restoration. In the event the water quality triggers are exceeded at the outer boundary of the authorised ZoMI, the pre- and post-dredging BCH surveys will consider a variety of health measures of

BCH in the areas outside the authorised ZoMI and ZoHI, which can be used to provide evidence that this EPO has or has not been met.

B.3.8. Reporting

Baseline Report

The Baseline Report will be prepared following the final quarterly baseline survey be completed prior to commence of dredging. The results of the baseline surveys will be summarised and assessed with the intention to characterise natural background changes in the condition of coral communities in the areas likely to be affected by capital dredging and in the reference locations.

The report is proposed to also include a summary of the weather and marine water quality conditions (i.e., benthic light availability), which will be recorded during the pre-dredge period. This information will be used to develop understanding of how the condition of coral communities in the areas likely to be affected by capital dredging and control locations are influenced by natural processes.

Reactive BCH Survey Report

A Reactive BCH Survey Report will summarise the status of BCH in comparison to baseline conditions, and provide recommendations to ensure appropriate management is implemented to ensure recoverable impacts of BCH. The reactive report will include:

1. A summary of data collected during the survey;
2. Comparison of seagrass community composition and cover with baseline and against reference locations;
3. Comparison of coral community condition with baseline and against reference locations;
4. Multiple lines of evidence assessment (including the outcomes from the Marine Environmental Quality Monitoring and Management Plan);
5. Evaluation of whether coral EPOs been achieved or not;
6. Evaluation of the effectiveness of the BCHMP and MWQMP; and
7. Recommendations for additional investigations / management / monitoring if required.

Post-Dredging Report

The post-dredging report will be prepared following completion of each annual post-dredging survey. The post-dredging report will include all items (1-7) included above for the Reactive BCH Survey Report.

Appendix B.4. Marine Fauna Observations

B.4.1. Protocols and Procedures

The monitoring protocols and procedures have been informed by the Sea Dumping Permit application requirements to determine the appropriate Observation and Exclusion zones. The zones are presented in Table B4-1.

Risk of interaction, underwater noise or collision with vessels to marine fauna from dredging and disposal activities resulting in injury or fatality will be managed through the use of Observation and Exclusion Zones.

Table B4-1: Dredging marine fauna management zones, Exclusion Zones required under corresponding Sea Dumping Permit application requirements.

Marine Fauna Group	Observation Zone (metres)	Exclusion Zone Disposal (metres)	Exclusion Zone Dredging (metres)
Whales	500	300	300
Dolphins	500	300	300
Dugongs	500	300	300
Turtles	500	300	300

To mitigate potential impacts of the proposed works on significant marine fauna the Contractor must implement the following management and monitoring protocols during dredging and disposal works.

Dedicated MFO

Dedicated marine fauna observer (MFO) is a person with qualifications in ecology, zoology or environmental sciences and demonstrated experience with the identification and management of dolphins or whales, including behaviour, as well as distance estimation. They will be suitably trained and qualified, adhering to the requirement of the Wildlife Conservation (Closed Season Marine Mammals) Notice 1998. MFOs must demonstrate a knowledge of marine wildlife species in the North-west marine bioregion, including Threatened and Migratory Species listed under the EPBC Act and BC Act and priority listing, including morphological and behavioural characteristics. The dedicated MFOs will have demonstrated knowledge and experience in marine fauna species observation, distance estimation and reporting. They will not have other duties while engaging in visual observations. Evidence of personnel and training certificates will be kept on record, which may be used in future audits. Information will include:

- Name and contact details
- Proof of relevant university qualification/s (biology, ecology, zoology or environmental sciences degree)
- Details of MFO training (including provider and course dates)
- Previous experience as an MFO (on operations such as piling, dredging or seismic surveys)
- Other observing experience (research and data collection of marine fauna) .

It is vital to ensure the protection of marine fauna for the duration of the project. The frequency and location of the observer are paramount to ensure the safety of the marine fauna, with the continuity of the project depending on their response to potential interactions with marine fauna.

The dedicated MFO and dredging Contractor must implement the following procedures for dredging and disposal.

Dredging

Pre-start

Prior to the commencement of dredging (and following a break of more than 30-minutes) the dedicated MFO will undertake continuous observations of the Managements Zones for 30-minutes. If target marine fauna is observed within the Exclusion Zone, dredging operations shall be delayed until target marine fauns have been observed exiting the Exclusion Zone or have not been seen for 30-minutes. If target marine fauna is not observed within either the Exclusion Zone within 30-minutes, dredging can commence with soft-start procedures.

Soft-start

30-minute soft-start (i.e. slower speed and building up) procedure apply to dredging operations at all times and during this period the MFO will maintain continuous observations on the Management Zones. For a cutter suction dredge (CSD) soft-start involves activating the cutter in a slow and controlled manner, increasing in energy/speed over a 30-minute period, to passively disturb and deter resident marine fauna. Full energy/speed dredging may only commence after the 30-minute soft-start period.

The dedicated MFO will continually monitor the management zones during soft-start procedure and the following procedures will be implemented:

- If target marine fauna is observed in the Observation Zone, soft-start procedures will continue and the MFOs will continue to monitor.
- If target marine fauna is observed in the Exclusion Zone shut-down procedures apply, soft-start procedures will cease until the observed target marine fauna is sighted leaving the Exclusion Zone or has not been seen for 30-minutes.

Further, the 30-minute soft-start procedure will be implemented following a shut-down or a break >30 minutes.

Dredging

The dedicated MFO must monitor the Observation Zone radius of 500 m around the dredging activities continuously during these works to identify if there are any cetaceans, dugongs, and marine turtles. If marine fauna are sighted within the Exclusion Zone then shut-down procedures will be implemented. If fauna is observed within the Observation Zones (but outside the Exclusion Zones) during dredging activities (including Soft-Start procedures), then following action shall be taken:

- If target marine fauna is sighted and is in distress then dredging activities shall be suspended within two minutes of the sighting, or as soon as safely possible.

- If target marine fauna is not showing signs of distress and remains within the Observation Zones (but outside the Exclusion Zones), dredging activities will continue and the MFO will continue to monitor the target marine fauna.

Shut-down

If target marine fauna is observed within the Exclusion zone during dredging (including soft-start procedures), then the following actions shall be taken:

- Dredging must be suspended within 2 minutes of sighting or as soon as safely possible.
- Dredging activities that have been suspended must not recommence until the sighted marine fauna have moved beyond their respective Exclusion zone or not sighted for at least 30 minutes
- Once able to resume, dredging will recommence following Soft-start procedures.

Low visibility

During periods of low visibility or at night-time (where a distance out to 500 m cannot be clearly viewed), dredging activities may be undertaken, provided that during the preceding 24-hour period:

- There have not been 3 or more marine fauna shutdowns
- A 2-hour period of good visibility has been maintained prior to onset of low visibility, and no marine fauna were sighted
- If marine fauna is detected in the exclusion zone during poor visibility, operations must cease until visibility improves to enable full visual monitoring of the management zones.

Offshore disposal

Transit to disposal ground

- A suitably trained MFO on duty during barge transit to spoil ground location
- Barges must maintain vessel approach distances and speeds outlined in Section B.4.4.
- Monitor and log the occurrence of sick, injured and dead marine fauna within the development envelope or during disposal.

Disposal pre-start

Prior to the commencement of disposal, the dedicated MFO will undertake continuous observations and must ensure no marine fauna are present within the disposal Exclusion Zone (300 m) for 30-minutes. If target marine fauna is observed at disposal site, then dumping activities must not commence until no marine fauna has been sighted for 30 minutes, or vessel has moved to another area within disposal site which is >300 m from marine fauna.

Disposal

Disposal activities are expected to be quick, given the use of split hopper barges or similar. The direct act of opening the barge and allowing the disposal material to be released is also not possible to be suspended, and therefore the pre-start procedures are extremely important, however closing the barge and preparing to move may be suspended if it is safe to do so. During disposal activities the dedicated MFO must maintain continuous observation of the Management Zones (Table B4-1). If target marine fauna is observed within the Exclusion Zone during disposal, then the following actions shall be taken:

- Barge activities following disposal must be suspended within 2 minutes of sighting or as soon as safely possible.
- Barge activities that have been suspended must not recommence until the sighted marine fauna have moved beyond their respective Exclusion zone or not sighted for at least 30 minutes. Following this, disposal is able to recommence.

Low visibility

During periods of low visibility or at night-time (where a distance out to 500 m cannot be clearly viewed), dredging activities may be undertaken, provided that during the preceding 24-hour period:

- There have not been 3 or more marine fauna shutdowns
- A 2-hour period of good visibility has been maintained prior to onset of low visibility, and no marine fauna were sighted
- If marine fauna is detected in the Exclusion Zone during poor visibility, operations must cease until visibility improves to enable full visual monitoring of the Management Zones.

B.4.2. Frequency

Marine fauna observations shall be undertaken for the duration of dredging and offshore disposal activities.

B.4.3. Location

Appropriate monitoring locations shall be selected by the trained MFO and Contractor prior to the commencement of a dredging and disposal activities that is suitable elevated and ensure an unobstructed view of the Management Zones describe above (Table B4-1). This point may need to shift pending the location of dredging on any given day (i.e. site construction activities).

B.4.4. Records and Reporting

Field log

Trained MFOs will use pre-designed datasheets to record observer effort, fauna observations and mitigation measures. They will be based on those developed by the Australian Government to record marine fauna sightings made during seismic surveys. Datasheets will include:

- Location, date and start time of survey
- Name, qualifications and experience of MFOs involved in the survey
- Location, times and reasons when observations were hampered by poor sighting conditions
- Location and time of pre-start and soft-start procedures
- Location and time of start-up delays, power downs, or stop work procedures as a result of marine fauna sightings
- Location, time and distance of any fauna sightings including species where possible.

Monitor and log the occurrence of present, sick, injured and dead turtles and other marine fauna within the development envelope. Injured, sick and dead marine fauna are to be reported as outlined below.

Reportable incidents

All contractor employees shall immediately report all environmental incidents as a non-conformance (i.e. performance indicators are not met or management actions are not followed (See Section 8; Table 19) to the site supervisor who will investigate the incident with both the LS Project Manager (PM) and Contractor Project Manager.

Reportable incidences are injury to wildlife as a result of the Proposal activities or general observations of injured wildlife not related to Proposal activities to be reported to Contractor PM. The PM is to notify LS, who will notify the Department of Biodiversity Conservation and Attractions (DBCA) within 24 hours. A summary of reporting requirements for marine fauna is presented in Table B4-2.

It is a requirement that all incidents follow LS's Incident Management Procedure. The employee is to report the incident immediately to the site supervisor. In every case the site supervisor is to document the incident using LS's Incident Management System.

Table B4-2: Reporting requirements and contact details for injured marine fauna and marine fauna incidences

Wildlife	Content	Timeframe	Responsibility	Recipient
Sick or injured wildlife	• Location including GPS coordinate • Within or outside of work area • Time of observation • State/condition of individual/s • Affected species • Image (if possible).	Within 24 hours as being notified (as soon as possible)	Dredging contractor Approval holder	WILDCARE Helpline (24 hr) (08) 9474 9055
Fish deaths/fish kills	• Location including GPS coordinate of fish kill • Estimated number of dead fish • Species affected • Photograph.	Within 24 hours as being notified (as soon as possible)	Dredging contractor Approval holder	Fish Watch (24 hr hotline) 1800 815 507
Possible IMP	• Location (GPS coordinate, or nearest landmark) and water depth • Date and time of detection • Size and colour of IMP • Environment (i.e. beach, sand, rock pool, in weed, water, attached to structure) • Photo	Within 24 hours as being notified (as soon as possible)	Dredging contractor Approval holder	FishWatch on 1800 815 507 Email: aquatic.biosecurity@dprid.wa.gov.au Local DPIRD office

Completion report

A log detailing marine fauna sightings and activities will be maintained on all vessels including the dredge and barges. On completion of the program, a full report and the full observation logs will be submitted which will allow for compliance auditing. The full report will include summary of all the sightings logs, including MFOs on duty, number of delays, shut-downs or stop work from marine fauna sightings, summary of management implemented (e.g. pre-start, soft-start, low-visibility conditions), number of sightings in each zone and any no-conformance.

B.4.4. Vessel approach distances

A suitably trained MFO must maintain a watch for cetaceans (i.e. whales and dolphins), dugongs, and marine turtles during transit of the dredge, barge and other support vessels. The distances in Table B4-3 have considered the National Strategy for Reducing Vessel Strike on Cetaceans and other Marine Megafauna (DoEE 2017c), the Australian National Guidelines of Whale and Dolphin Watching (DoEE 2017d), and separation distances within the WA Biodiversity Conservation Regulations 2018. A suitably trained MFO is generally a crew member trained in marine fauna species observations and mitigation measures, consistent with this DSDMP. Trained MFOs will be on duty on proposal vessel during dredging and disposal and may have other vessel duties but not during observation periods. There will be always at least one Trained MFO on duty during dredging and disposal.

All vessel crews engaged for the marine construction and dredging for the Proposal will attend a minimum of one marine fauna induction to become familiar with the range of conservation significant marine fauna that could be present in the proposal area and the risks the dredging may present to this fauna. All commitments made by LS to manage dredging activity with conservation significant marine fauna will be included in the induction. The content of the induction will be updated as required to ensure it remains current and reflects the marine fauna being observed in the Proposal area and any vessel interactions with marine fauna that has occurred. This marine fauna induction can be combined with other crew inductions that may be required.

The speed limit within the Project DE is 10 knots and if vessel is within the species caution zone then they must reduce to no more than 6 knots. Caution zones cannot be entered into by a vessel if the animal is injured, stranded, entangled, or distressed or if a single calf or pod of calves are present. No more than three vessels are permitted to be in a caution zone at the same time. Should a travelling dolphin enter the no approach zone, including with an attempt to 'bow ride', the vessel shall either maintain its course and speed, or maintain its course and gradually slow down. No more than three vessels are to be within a caution zone at the same time. A log detailing marine fauna sightings and activities will be maintained on all vessels (including support vessels).

Table B4-3: Marine fauna approach distances and speed restrictions

Marine fauna group	Vessel speed	Caution zone	No approach zone	Distress/disturbance
Adult whales (Figure B4- 1)	No faster than 6 knots within 300 m	300 m	100 m to the side of the whale 300 m in front or to rear of the whale	Withdraw from caution zone at speed less than 6 knots
Whale calf* present	No faster than 6 knots within 300 m	-	300 m	Withdraw from No approach zone at speed less than 6 knots
Adult dolphins (Figure B4-2)	No faster than 6 knots within 150 m, except for animal's bow-riding	150 m	50 m to the side of the dolphin 150 m in front or to rear of the dolphin except for animal's bow-riding	Withdraw from caution zone at speed less than 6 knots
Dolphin calf* present	No faster than 6 knots within 150 m, except for animal's bow-riding	-	150 m	Withdraw from No approach zone at speed less than 6 knots
Dugong	No faster than 6 knots within 100 m	300 m	100 m	Withdraw from caution zone at speed less than 6 knots
Turtle	No faster than 6 knots within 100 m	300 m	150 m	Withdraw from caution zone at speed less than 6 knots
**A calf is defined as half the length of the mother/nearest adult*				

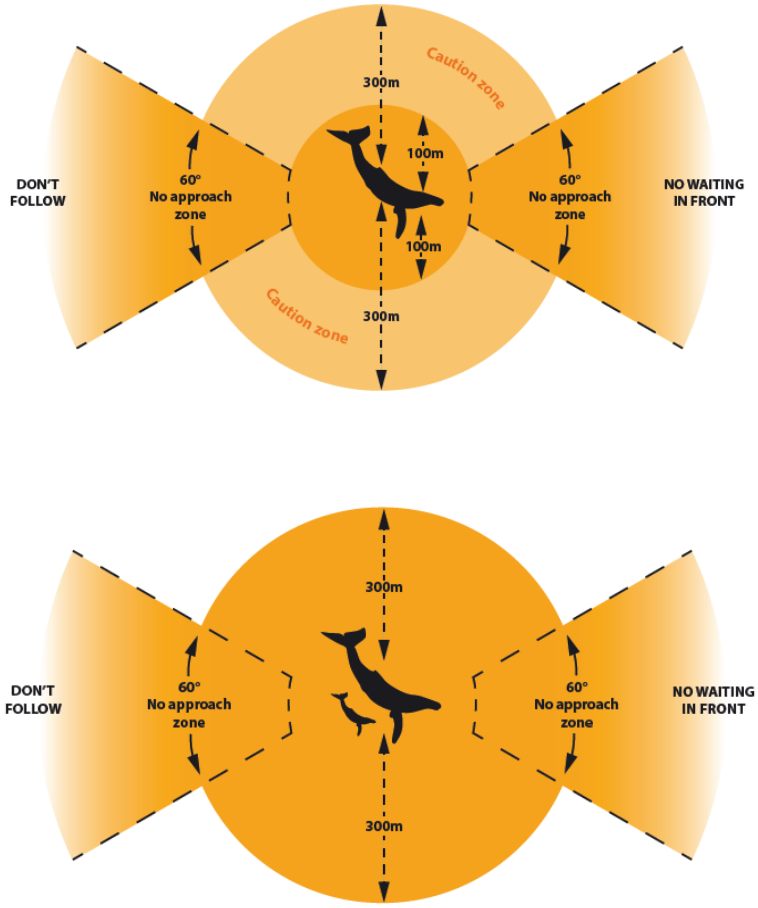

Figure B4-1: Vessel approach distances for adult whales (top) and whales with calves (bottom) (Commonwealth of Australia 2017d)

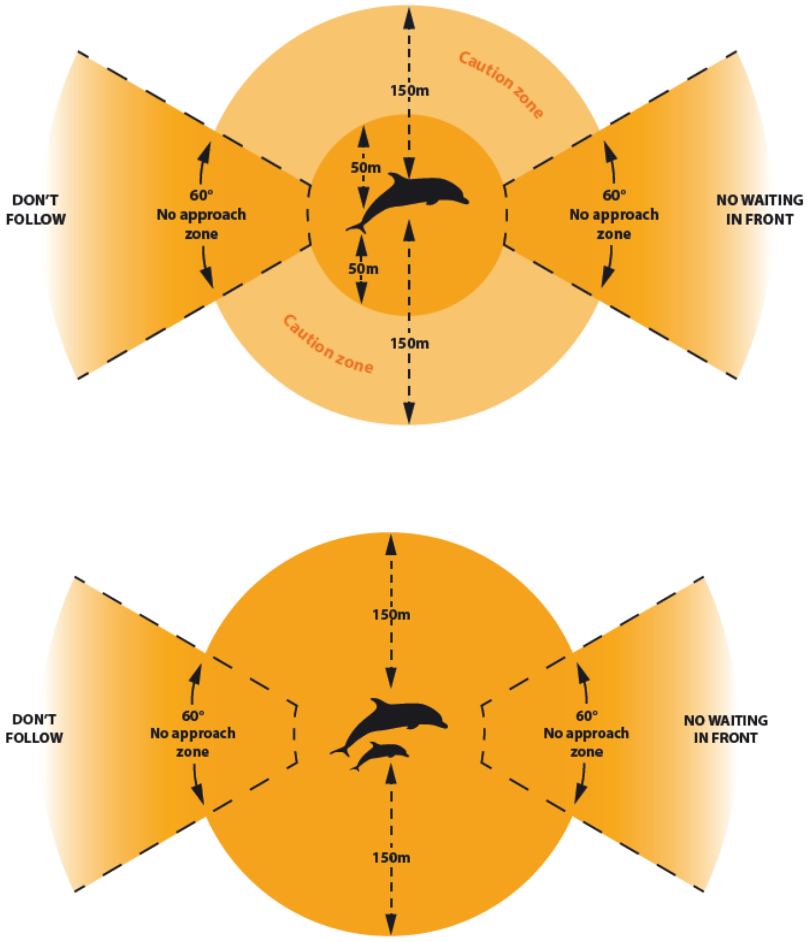

Figure B4-2: Vessel approach distances for adult dolphins (top) and dolphins with calves (bottom) (DoEE 2017d)